REAL CORP 2021

Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI,
Clemens BEYER, Judith RYSER, Gernot STÖGLEHNER (Eds.)

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of the 26th International Conference on Urban Planning, Regional Development and Information Society

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CITIES 20.50

CREATING HABITATS FOR THE 3RD MILLENNIUM SMART – SUSTAINABLE – CLIMATE NEUTRAL

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REAL CORP 2021: CITIES 20.50
Creating Habitats for the 3rd Millennium
Smart – Sustainable – Climate Neutral

Proceedings of

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PREFACE

Manfred SCHRENK,

Conference Director,
President CORP – Competence Center of Urban and Regional Planning

WELCOME to REAL CORP 2021, the
26th International Conference on Urban & Regional Development and Spatial Planning in the Information Society!

Urbanisation of the world is progressing rapidly and seems to be an unstoppable process. According to current forecasts, more than 6 billion people will live in cities in 2050. Compared to 1950, this is almost a tenfold increase in 100 years, resulting from global population growth and the continuing influx of people into urban areas. As a rule, population growth also means additional land requirements. Urban growth often takes place across administrative borders, cities grow into their surrounding areas, (cross-border) urban and metropolitan regions emerge and also influence the development of rural areas, where in turn numerous initiatives for independent sustainable development emerge.

This dynamic development is accompanied by enormous challenges for the organisation and maintenance of urban processes, particularly in the areas of technical and social infrastructure, affordable housing, mobility, recreation, security of supply, etc. Sustainability, resilience and smartness are essential characteristics of cities and regions and are often compared by means of benchmarks. The key question is how quality of life can be maintained and improved in the face of dynamic development of living space.

Even though the world is currently under the spell of the COVID-19 pandemic, it is clear that climate and environmental issues will be decisive for urban development in the coming decades. Climate adaptation strategies will play a central role, because especially in cities, high density, increasing land sealing, lack of greenery and inadequate ventilation increasingly lead to the formation of urban heat islands and the problem of urban warming.

How can urban and spatial planning and all related disciplines contribute to maintaining urban flows, functioning infrastructure and preserving and improving the quality of life? How can urban and rural living spaces actively cross-fertilise each other's development?

The REAL CORP 2021 call for papers was very broad and invited for contributions from all areas of expertise dealing with cities, regions and spatial development to gain a holistic and multi-faceted view on challenges and future scenarios in the urban realm. Next to science-based contributions we also asked for practise-based reports on short term actions and/or long-term strategies on urban and regional development.

This year's conference also featured some special topics in close co-operation with the respective partners mentioned:

- New Social Housing – Urban Climate Adaptation Strategies and Affordability of Life: How can that work? (partner: IBA Vienna)
- EU Mission: Climate Neutral and Smart Cities (partners: BMK, AustriaTech)
- Integrated Spatial and Energy Planning (partner: IRUB/BOKU)
- Cross-Border Spatial Development (partner: RWTH Aachen)
- Emergencies, Disasters, Epidemics – and the Big One: Pandemics (coordination: Judith Ryser)
- Sustainable Urbanisation Global Initiative: Food-Water-Energy Nexus (partners: BOKU, AIT, HFT – Stuttgart University of Applied Sciences)

And last but not least, REAL CORP 2021 was also host of the first ISCOCARP International Regional Event. Alongside to the annual world congress, ISOCARP is starting to experiment smaller-scale symposia which focus on issues of local importance, and which can be repeated on several occasions throughout the year in different regional and macro-regional contexts.

This year we brought together some 250 participants from more than 30 countries worldwide. The main goal of the REAL CORP conference series isto bring together leading experts in the field of spatial planning, geoinformation and related disciplines to exchange their knowledge, share their ideas, discuss current developments and get together for face to face networking leading to the development of new thoughts, partnerships and projects.

In times of a pandemic, this can be quite difficult, as travel warnings and other restrictions make the organisation of such an event very difficult and many decisions are based on uncertain forecasts. REAL CORP 2021 will take place as a hybrid conference: On the one hand, we have tried to welcome as many visitors as possible in Vienna in spite of all the restrictions, but on the other hand, it was also very important to us to make all the contents of the conference accessible to those participants who, for whatever reason, were not able to come to Vienna.

The success of the REAL CORP conferences is – clearly without doubt – the result of the efforts of participants, reviewers, and the conference organising team consisting of CORP association and the Institute of Spatial Planning, Environmental Planning and Land Rearrangement (IRUB) at the University f Natural Resources and Life Sciences. We would like to acknowledge the Reviewer Team and Programme Committee members for their valueable voluntary help with the review process.

Our thanks go to all participants and authors of the submitted papers as well. The proceedings of this year's conference contain around 130 scientific papers; more than 100 of them were selected after a double-blind, double-stage (for both abstracts and full papers) peer-review process for publication and presentation at the 26th International Conference on Urban Planning and Regional Development in the Information Society, REAL CORP 2021. The non-reviewed papers were accepted by the programme committee after a double-blind abstract review. The conference is held from 7 to 10 September 2021 in Vienna, Austria, as well as in virtual space.

Welcome to Vienna! Have a great conference!

Manfred SCHRENK, Clemens BEYER & the REAL CORP Team

Leonore GEWESSLER

Austrian Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology

Dear honoured experts and planners!

I appreciate this profound pool of knowledge and expertise gathered in the course of this conference, which is more than welcome and urgently required to tackle our multi-dimensional challenges in sustainability and climate-neutrality whilst ensuring a high quality of life.

You as planning professionals and as planning community will have a key-role in the transformation of our society. High complexity and quick pace of change call for a new understanding of planning beyond traditional skills, tasks and singular disciplines. We need planners as visionaries, enablers for innovation, as intermediaries between different sectors and responsibilities, as coordinators and integrators, as advisors, but also as critical observers and sparing partners to challenge policy and administration.

I am sure that this conference can significantly contribute to the broadening of the knowledge and solution base, foster the exchange of experiences and will allow for joining forces and concerted actions in future planning in Austria and beyond.

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Gernot STÖGLEHNER

Conference Host, Professor of Spatial Planning
Head of the Institute of Spatial Planning, Environmental Planning and Land Rearrangement
at BOKU Vienna

Dear Participants of REAL CORP 2021,

a warm welcome at BOKU University, either virtually or in real! We are in a time of disrutpions. The climate crises enters our daily lives. Storms, heavy rain, floodings, drought, heat, forest and bush fires, the news are full of such events, making the necessity of climate protection clear to everyone, but also mitigation must be planned.

At the same time we still are in the middle of a pandemia, and coping strategies open a window in a digital future. Digitalisation only starts with the broadband infrastructure, and will impose major changes to the ways we work and we organize our daily lives. In a study at my Institute we combined major studies about change in working procedures with the local labour markets on a municipality base. We found out, that up to 70% (!) of all work that now provides income to the people will be substituted by computers and machines.

Urban areas are a bit less hit by this transformation than rural areas, but on national average about 56% of all activities that provide income now might be substituted. This change is massive and can hopefully be utilized to create more jobs that consume less resources. And this transformation will change the way how we utilize space, whit major impacts on urban and regional planning. This transformation also offers opportunities to turn towards new planning solutions: CREATING HABITATS FOR THE 3RD MILLENNIUM SMART – SUSTAINABLE – CLIMATE NEUTRAL. Therefore, I wish the conference participants many interesting new insights, fruitful discussions, and I hope you have a good time in Vienna with new chances to meet people at CORP!

Welcome to Vienna!
Prof. Gernot Stöglehner and the whole IRUB/BOKU team

Hubert HASENAUER

Rector of BOKU Vienna, Professor of Forest Ecosystem Management

Dear Participants of REAL CORP 2021,

a warm welcome at the 26th REAL CORP, one of the major conferences in Europe on urban planning and regional development of our society. The University of Natural Resources and Life Sciences (BOKU) with about 2,900 faculty and staff members and 11,000 students, is strongly committed to sustainable development according to the UN sustainable development goals. In our research, teaching and third mission, we integrate sustainable development by managing natural resources and biodiversity as well as the environmental planning for cities and regions including their infrastructure.

With about 1,100 SCI publications annually and around 1,000 ongoing research projects, our research is well perceived within the scientific community and fundamental for our 7 bachelor, 27 master and 9 doctoral programsme. BOKU’s 15 departments cover all aspects of sustainable transition including the planning and design of living spaces; the production and utilization of (renewable) raw materials; technological, environmental, social and economic aspects up to impact assessment; the protection of biodiversity, soil, water, climate and landscape as well as resource recovery with respect to circular economy.

The conference topic “Creating habitats for the 3rd millennium – smart – sustainable – climate neutral” covers key BOKU competences in research, teaching and societal engagement. It fits perfect to one of the current key policy fields “Fit for 55” proposed by the European Union. I thank the organisers as well as the sponsors for making this meeting possible and wish all of you an inspiring conference with exciting days in Vienna.

With kind regards,
Univ.Prof. Dr. DDr.h.c. Hubert Hasenauer

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Table of contents – Inhaltsverzeichnis:

ISBN 978-3-9504945-0-1. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, G. STÖGLEHNER

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A Prospective Approach for Cities in Transformation: Vision of the Leipzig Charter in the Light of the Covid-19 Experience

Judith Ryser, Teresa Franchini

(Arch. Judith Ryser, CityScope Europe, London, UK, judith@urbanthinker.com)
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1 ABSTRACT

Covid-19 acted as a trigger of an extreme situation that affected all aspects of life worldwide. Its effects on cities have been and are devastating. Covid-19 also revealed the lack of resolution of previous persistent urban problems and the reluctance of many governments to face up to short-term, politically unpopular solutions. Conversely, the pandemic has led to the emergence of trends whose effects could give rise to new sustainable urban dynamics in the medium and long term.

The paper explores how positive and negative changes of the built environment and its uses altered by the pandemic could be harnessed as lessons for sustainable post-Covid-19 urban development. It concentrates on identifying the main challenges of the Leipzig Charter's objectives - the "just, green and productive" city, pillars of sustainable urban development - to cope with the effects of worldwide calamities. The global and all-pervasive nature of the pandemic offers planners an opportunity to reflect on prospective scenarios that address truly resilient urban development.

Keywords: planning for the new normal, EU Leipzig charter, Covid-19 pandemic, scenarios, cities for the common good

2 PANDEMICS AND CITIES

2.1 Conceptual framework

The official recognition of sustainability as an objective at the Rio de Janeiro Summit in 1992 and of concern for climate change at the Tokyo Summit in 1997 were the milestones that directed universal action towards a collective objective, which was challenged in 2019 by the effects of Covid-19.

The uncertainty that characterises contemporary urban societies stems primarily from the combined effects of an unsustainable development model, a looming climate emergency and a pandemic that has revealed unresolved imbalances in cities. These three phenomena are interdependent and do not unfold in a vacuum. They are framed by the relentless exploitation of the planet, the political, administrative governance systems of nations, the current state of cities and their dynamics and also, critically, by human behaviour and underlying socio-cultural values that intertwine intrinsically in shaping unpredictability. The adaptation of contemporary societies to the effects of the pandemic depend to a large extent on collective as well as individual human behaviour which are shaping the direction of travel within an exceptionally turbulent context, giving rise to crucial conceptual questions.

Which directions of travel?

To-date and despite difficulties, the tri-partite economic, environmental and social nature of sustainability - although a rather elusive concept, possibly deliberately so - has been used for half a century to guide development policies around the world at global and local levels with varying results. The evolution of climate change and the urgency to act are well documented by scientific knowledge, observation and modelling. Now, the unexpected emergence of the pandemic deepens uncertainty about the planet and its inhabitants. All three phenomena are characterised by their universal nature. The urgency to act globally on the effects of the pandemic is testing the resilience of cities the effects of the health crisis on economic and political structures have taken priority at least for the time being over environmental and climate change initiatives, while redressing social inequalities inherited from the industrial era is again lagging behind.

Why is it so difficult to move in sustainable directions?

Corporate, collective and individual interests stand in the way of overcoming the obstacles that limit sustainable development, combating climate change and overcoming the effects of Covid-19. Governance has become more inclusive in many parts of the world, but the current global neo-liberal economic model remains dominant despite moves towards alternatives, such as the circular economy, the sharing or regenerative economy, collaborative consumption, co-working and consumer-production. At the local level,

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Transition Towns, Citta-Slow and the 15-minutes-city have pioneered some of these principles but such initiatives are few and remain fragmented.

Can a pandemic process be a turning point towards new breakthroughs?

Living in society means being in contact with viruses, parasites and bacteria. This cohabitation has produced recurrent epidemic and pandemic events whose effects have marked the fate of many cultures and civilisations throughout history.

It is said that the Athenian Plague (431-426 B.C.) put an end to the Athenian hegemony in the Peloponnese. The Antonine plague (165-180) affected the Western Roman Empire providing conditions for its decline but also the expansion of Christianity. The Plague of Justinian (541-750) affected the Byzantine Empire encouraging the decline of Antiquity and the spread of Islam. The Black Death (1347-1353) marked the end of the Middle Ages, the advent of the Renaissance and the economic power of Europe. The recurrent global epidemics of cholera (between 1817 and 1973) led to the birth of international medical cooperation. The Spanish Influenza (1918-1919/ 1920) contributed to the end of World War I, the discoveries of modern medicine and the advancement of public health. The Health Organisation was created in 1923, replaced by the World Health Organisation in 1948. The 20th and 21st centuries recorded the greatest number of global events: Asian Influenza (1957- 1958), Hong Kong Flu (1968), AIDS/HIV (1981-) SARS (2002-2003), Zika (2007-), Influenza A (2009-2010), Ebola (2014-2016) and now COVID- 19 (2020-). The search for vaccines led to accelerated activities of scientists and pharmaceutical companies and fostered greater international cooperation. This short historic overview shows the emergence of transforming socio-cultural and political changes once such tragic episodes were overcome. What will be the effects of COVID-19 on today's societies in the medium and long term? What new opportunities will they mean for cities?

2.2 An opportunity for urban planners?

The effects of the pandemic on cities offer a new approach for urban planners in the 21st century. The relationship between the physical environment, human behaviour and the governance of European cities challenges the principles proposed by the New Leipzig Charter (European Commission, 2020).

The paper focuses on physical-material changes necessary to make cities resilient. It refers to the recommendations of the New Leipzig Charter following a simple methodology:

- to discuss the aspects of the ‘just’, ‘green’ and ‘productive’ city proposed in the New Leipzig Charter using these issues as an analytical filter to detect the positive and negative aspects that emerged during the pandemic as a basis of future urban scenarios;
- to conjecture scenarios for the medium term - prospective visions for 2030
- as a means to promote the “power of transformation of cities for the common good”, the key concept of the New Leipzig Charter.

3 THE COMMON GOOD AND THE NEW NORMAL IN EUROPEAN CITIES

3.1 The scope of the New Leipzig Charter

The New Leipzig Charter - the Power of Transformation of Cities for the Common Good - approved in November 2020 by the ministers responsible for urban affairs of the EU promotes integrated and sustainable urban development in European cities, calling on the transformative powers of cities for the common good. The Charter responds to the demands of global agreements endorsed in 2007 by the first Leipzig Charter. Among them are the 2030 UN Programme for Sustainable Development (2015) and its New Urban Agenda (2017); the Paris Agreement under the UN Framework Convention on Climate Change (2016); the EU Urban Agenda (2016), the EU New Green Deal of the European Commission (2019), the EU Circular Economy Action Plan (2020) and the EU Territorial Agenda 2030 (2020).

The role of the New Leipzig Charter is particularly prominent in the Territorial Agenda 2030. The occurrence of the Covid-19 pandemic during the process of drafting the Territorial Agenda changed the outlook for Europe's future development, which recognises the importance of territorial cohesion in the recovery process, essential to increase the resilience of municipalities, regions and countries. The role of cities in this process is relevant and the New Leipzig Charter is the instrument that provides them with guidance on urban resilience in the face of global challenges, including pandemics. The principles of good governance and quality urban design are fundamental to ensuring attractive, inclusive, durable and adaptable places.

The New Leipzig Charter provides a roadmap for action to achieve fair, green and productive cities, with a site-based, multi-level and participatory approach. It aims to promote resilient and robust cities and urban systems to respond to disruptive events and chronic stresses, supported by nimble governance for the common good, underpinned by predictive and preventive policies, plans and projects including diverse scenarios to anticipate challenges of all kinds. This requires resources, finance, leadership and governance at all levels of government including key actors, both governmental and non-governmental.

3.2 What is expected of cities according to the Leipzig Charter?

According to the Leipzig Charter, the transformative power of cities is achieved by integrating the social, ecological and economic aspects of sustainable development which translates into 'just', 'green' and 'productive' cities: three cities in one.

The just city

The stated aim of the 'just city' is to provide equal opportunities and environmental justice regardless of gender, socio-economic status, age and origin, equal access to education, social services, health care and culture, energy supply and adequate, accessible, safe and affordable housing.

The green city

The "green city" is expected to contribute considerably to combating global warming by promoting polycentric, compact and dense multipurpose settlement structures with an adequate access to green and recreational spaces and efficient, carbon-neutral, safe and multi-modal transport and mobility systems.

The productive city

The "productive city" fosters the knowledge-based society and supports a diversified, digital, innovative and competitive economy, with a skilled, service-oriented and low-carbon workforce. It provides an innovative environment with attractive locations with social, technical and logistical infrastructures.

3.3 What is expected of the "new normal" in the post Covid-19 era?

The current "new normal" will remain in place at least until science reverses the spread of the virus or manages to eradicate it. The responses to the new normal in cities have been two-fold. Governance tended to concentrate on changing human behaviour ("hands, face, space": wash hands, keep social distance, stay at home) while physical adjustments took place at city level, in neighbourhoods and in homes, both spontaneously and planned. Most of them were temporary in response to Covid-19 government regulations, often in terms of emergency measures based on the latest scientific knowledge, aimed at curbing the spread of the pandemic, mainly to alleviate pressure on the health service, however with severe adverse impacts on the economy. What was hoped to be a short, sharp, shock has developed into a far longer term issue and is predicted to stay on in mutating form, akin to other virus diseases.

What aspects of the old normal will be permanent? What aspects of the Covid-19 situation will remain? What will the world be like after Covid-19? How will urban societies evolve? The proposed scenarios will address these questions.

3.4 How do "new normal" changes affect the sustainability principles?

The "New Urban Agenda" adopted at UN Habitat III in Quito in 2016 specifies the goals of sustainable development, inclusive urban economies and environmental protection for signatory governments to transpose into policies. Despite widespread consensus to reach such goals, there is hesitancy in implementing these measures. How can these goals be achieved if the general public lacks confidence in the responsiveness of their governments in charge of driving these changes forward and in the businesses which should spearhead a circular-plus economy leading to a more sustainable way of life of today's societies? The Covid-19 crisis has exposed the fragility of the dominant economic model and the lack of resilience both at global and local levels. It also shows that cities are ill prepared for future pandemics, potential energy crises, technological blackout and the biodiversity erosion.

4 IMPACTS OF COVID-19 ON THE THREE LEIPZIG CHARTER PILLARS

4.1 New effects or reinforcement of existing trends?

Covid-19 has added new trends to the "three types of cities in one" proposed in the New Leipzig Charter but, most importantly, brought to the fore existing inequalities and contradictions. The dominant economic model in Europe may provide some explanations: enhanced social divergence; government hesitancy towards social welfare; unequal access to healthcare and education; gender and ethnic inequity; and lack of genuine channels of participation for people to express their demands and achieve satisfaction. New effects are still in the making during the unpredictable evolution of the pandemic.

4.2 Just cities

Socio-cultural inequalities were a serious issue for cities before the pandemic but Covid-19 has made them more apparent and demands for a fairer society have become more vocal. Covid-19 has exacerbated political instability and accelerated uncertainty, reaching unprecedented levels of turbulence, growing populist nationalism and heightened fragility of liberal democracies.

In European neo-liberal market economies many parts of society are experiencing inadequate social wellbeing and welfare. Existing social-spatial polarisation, continuous shortage of affordable housing, weakness of the public health system, lack of adequate channels of participation to express their demand, and precarious employment or joblessness have increased more among the most deprived in society. So has domestic violence in vulnerable households. Women are carrying the brunt of the pandemic effects; burdened with even more unpaid work, child care and home education, they are also most at risk of job loss.

The young are likely to flout pandemic restrictions due to frustration and have the highest incidence of mental illness, while anti-social ideas of individual freedom are flourishing. Mental illness is also detected in older people, linked to loneliness, a structural problem in mature societies. Even in highly cosmopolitan cities, discrimination against minorities prevails, expressed in unequal service provision, poorer health conditions and lower life expectancy.

Regarding the justice system, the pandemic demonstrated the ineffectiveness of existing legislation to deal with high-risk situations, demonstrated by the need to adopt ad-hoc laws and the resistance to passing them in the parliamentary system.

4.3 Green cities

Covid-19 shifted awareness and concern for the environment and climate change towards maintaining public health. The shutdown of all activities and government instructions not to use public transport and travel by private car reduced air pollution to low levels during the early stage of the pandemic. Regrettably, this situation changed drastically during the de-escalation, reaching previous pollution levels across Europe. The need to maintain social distance has highlighted the difficulty for cities to accommodate travel by public transport and more walking and cycling were restricted by lack of safe space on streets and pavements.

The inherent inertia of the current often densely built up areas with sealed surfaces hampers the transformation of cities into a balanced green-blue-grey environment. The housing stock in cities is generally energy inefficient, with retrofitting measures scarce and poorly financed or subsidised. The lack of policies that resolve the dilemma of benefiting the owner-investor or the tenant is an issue that hampers energy adequacy of buildings. Public realm for social activities has proven scarce during the pandemic. High urban densities without adequate green space pose an insurmountable challenge, as transforming urban land for buildings into open space without real estate profitability contradicts the current economic system.

4.4 Productive cities

Hyper-globalisation underway before the pandemic may be countered by the need of countries to resort to local production of essential goods and services, or at least to reduce extreme dependency on global trade. After exceptional worldwide economic decline brought about by measures against Covid-19, economic recovery may take decades and progress only resume in a generation's time. Meanwhile, national debts may rise due to increasing interest rates and inflation, leading to austerity policies and cuts in public spending, even as welfare (especially health and infrastructure) may have to be strengthened to cope with future pandemics, notwithstanding the need to attenuate growing social-spatial inequalities to prevent social unrest.

Covid-19 has also brought to the fore latent changes in the world of work which may persist in post-Covid-19 organisation of business and working arrangements. Covid-19 accelerated the existing trend towards digitalisation: teleworking, robotics, artificial intelligence, automated services, telematics. This was already affecting the labour market and is likely to create new structural unemployment or underemployment in the longer term. The existing digital, spatial and social divide, the danger of excessive surveillance and risks to privacy protection have become more acute under the pandemic. The shift to homeworking is disadvantaging specific groups, and especially women who have to combine work with domestic activities and lower wages, as well as families with children affected by lack of computer equipment and technical skills, cost of broadband and inadequate space to work and study.

5 EMERGING CONTRADICTIONS

5.1 Covid-19 contradictions

Due to the urgency to act, the pandemic brought to the fore critical contradictions about the relation between competing interests. First among them is the contradiction about the relation between the economy and public health and how their mutual recoveries are seen either as oppositional or interdependent. While corporate interests and neo-liberal politics are contrasting economic recovery with overcoming the coronavirus and attributing priority to the economy over public health, science puts the right to material wellbeing on a par with the right to health. Scientists and environmental lobbyists consider humans as an inherent part of the global ecological system, in need of coping with existing realities, shaped by human behaviour and framed by continuous trade-offs. In their view the pandemic and the economy require integrated and hopefully synergetic solutions.

The pandemic has highlighted the complexity of human behaviour which, far from assuming a unitary response based on equality and solidarity, relies on emotions that contribute to the disruption of consensus. In the name of freedom, large segments of the population put individual rights before collective norms enacted to safeguard the common good by imposing spatial and functional lockdowns. Denial and anti-social behaviour, espoused by various groups including political parties, is reaching disturbing levels of intolerance.

The pandemic temporarily limited the fight against adverse climate change as it was unavoidable to take measures to address the health crisis, such as the production of plastics and non-reusable materials to avoid contagion. The new generation of waste associated with pandemic needs increased domestic energy demand, and the gradual return to global mobility of goods and people are challenging the GHG reduction targets.

Moreover, political responses to balance the demands made by economic and social sectors urging a return to the "old normal" have led to diverse types of measures, some of which difficult to reconcile with formal rule of law. The Covid-19 crisis has served as an excuse for many governments, at any level, to strengthen their power, potentially curtailing citizens' rights, the actions of domestic political oppositions and even intraregional or international cooperation. Most importantly, citizens do not trust governments.

5.2 "Three cities in one" contradictions

Similar contradictions can be identified between the three types of cities proposed in the Leipzig Charter, analysed in isolation instead of "in one". For example, economic growth philosophy (underlying the productive city) contradicts ecological capacity-bound resource consumption (defining the green city), while unfettered competition (driving the productive city) contradicts the collective common and mutual support of those most in need (motivating the just city). For the time being, the Covid-19 crisis has displaced the three pillars of sustainability expressed as productive, green and just cities. However, it provides the opportunity to reshape them to assist interdependent public health and economic recovery and, beyond that, to act upon the intrinsic links to climate urgency and adopt a broad understanding of social-spatial justice needed to underpin a genuinely sustainable city.

Not only are the "three types of cities in one" always treated separately without considering the overall structure of which the three pillars are an integral part, but the Leipzig Charter's vision does not take account of the political-administrative system and its pivotal role in achieving the common good of the sustainable city. Similarly, the Covid-19 effects on the three productive, green and just cities are analysed separately, without making the necessary connections between them which would uncover the contradictions inherent in

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this tri-sectoral understanding of the 'sustainable city'. Some of their implied objectives may well be incompatible and the dichotomy between economic and public health recovery, a key debate of the political arena, is shining some light on this.

5.3 The missing fourth pillar: politics

The COVID-19 crisis illustrates the intersection between politics, economics, public health, environmental and social considerations. Although experts had warned of this potential pandemic, no government was adequately prepared to address this health threat. Investing time, money and political capital to tackle an abstract possibility is not part of the political agenda, as the focus on the next election reduces interest in funding policies with benefits beyond their term of office.

Responses to the crisis have varied across countries, depending on the interplay of relationships between different local interest groups, whether they are producers (industries, banks, corporations, trade unions) or consumers. Whatever the weight of these groups, the battle between interests of different nature is waged in the political arena which, in turn, decides the votes in elections in the short term and the survival of political parties in the long term. The policies adopted by governments to deal with the effects of COVID-19 have been strongly influenced by domestic pressures from the electorate, as well as by the action of international institutions (World Health Organisation, EU, OECD) in charge of coordinating a cooperative global response to the crisis.

5.4 A new model of thinking

A new model of thinking becomes necessary. It has to incorporate the political dimension of urban development as overarching all sectoral objectives and with the democratic mandate to establish a sustainable balance between all divisive interests. Such a model should incorporate the many innovative approaches to a more sustainable future promoted by enlightened business, ecological lobbies and social movements, as well as the political goals of achieving zero GHG emissions by 2050, a regenerative economy and social-spatial inclusion.

Once the pandemic is under control albeit not necessarily eliminated the other urgencies and how they have to be dealt with by urban development and change will need to be brought into mainstream policy and action again. The scenarios are imagining alternatives which may be able to respond to the new challenges brought about by the pandemic, the need for economic recovery and also for a more equitable society. At best society could resort to synergetic actions to achieve a better post-Covid 'new normal'; at worst adversarial human behaviour could undermine balanced economic, environmental and social recovery from Covid-19.

6 TOWARDS A DESIRABLE TRANSITION: TENTATIVE AND PROSPECTIVE MEASURES FOR POST-COVID CITIES

6.1 Opportunity for more people-led city powers?

Unprepared for Covid-19 cities responded with haphazard measures and governments imposed arbitrary restrictions on citizens, while people had to adjust to their externally determined situations with ad hoc reactions. Many of these spontaneous and often creative actions may well show the way to more permanent adjustments, although others may vanish as soon as the situation resorts to some normality.

While globalisation is trying to claim back its supremacy, nations are re-affirming greater sovereignty and mega-regions are demanding more devolution. Cities are also insisting on more autonomy and seize this unique opportunity of the pandemic to experiment with alternative productive, green and just models, aiming at smaller ecological footprints and more equitable deployment of human resources.

6.2 Towards a diversified economy in an innovative business environment

Despite global efforts towards sustainable development, the economy is bound to take priority in recovery and in shaping the post Covid future. For that reason, it may be necessary for a "new productive city" and its people to push for fundamental changes by resorting to alternative economic models, more conducive to generating sustainable development in an innovative business environment. Many such experiments have been tried already. There exists an extensive literature on alternative economic initiatives, too extensive to quote individually but succinctly referred to in the bibliography.

Such an alternative economic transition advocates an economy with a purpose, shifting from the unlimited growth ideology to an economy in which organisations identify their purpose and the impacts they want to generate in society aligned on the Agenda 2030 global goals. Alternative proposals have been designed for different levels and sectors: e.g. an economy for the common good; the "B Corps movement", fair trade, 'banking with values' or 'impact investments'; combined producer, consumer and user associations.

New alternative, more people-centred metrics have been developed to measure the success of the global economy and the performance of companies. Examples are OECD Better Life Index, UN Human Development Index, the New Economics Foundation Happy Planet Index or the Bhutan's Gross National Happiness Index for national economies, or the common good balance sheet or triple bottom line for business. In Europe, these measures intend to promote the JEDI concept - Justice, Equity, Diversity and Inclusion principles - and pledges to reach net zero carbon emissions by 2050.

These changes are supported by the Circular Economy principle, based on the concept of a "regenerative economy" that respects nature in order to mitigate the negative effects of climate change and the destruction of ecosystems. It is about achieving a resilient economy capable of achieving self-sufficiency at the local level with locally generated productive resources to face pandemic, energy or food crises. The new economy is also based on changes in consumer attitudes. "Consume less and better" has become a key concept, whereby. consumers can become producers or participate in collaborative consumption. Likewise, the Circular Economy blurs the boundaries between production and consumption into co-production, giving rise to collaborative consumption or "prosumption" networks, compounded by change of behaviour to reduce consumption and ecological footprint altogether and reinventing the worth of work. Advances in technology enable this cultural and lifestyle change. These economic considerations and many more are included in the targets of the European Green Deal to transform the EU´s economy into a sustainable future.

6.3 New planning and design principles to achieve a greener urban realm

The transition to the "new productive city" impacts also on the other two Leipzig pillars – the "green city" and the "just city" - which aim at zero pollution; preservation and restoration of ecosystems and biodiversity; fair, healthy and environmentally sound food production and consumption systems; sustainable and smart mobility, and 'leave no-one behind'. The financing of these objectives will support specific EU targets: maintaining the 2030 and 2050 climate goals; use of clean, affordable and secure energy; boosting the circular economy in industry; and encouraging construction and renovation using energy and resources in an efficient way.

The principles of sustainability and the climate change urgency had already prepared the ground for change to a more sustainable future and greener cities before the pandemic. Cities have already implemented many 'green' measures, physical, fiscal and behavioural. e.g. building insulation and retrofitting; congestion charging to curb motor traffic air pollution and congestion; shift from car use to public transport, cycling and walking and to electric vehicles and machines; waste recycling and reduction; reuse and repair of materials and products instead of discarding them; greening cities with trees, green walls and roofs; de-sealing surfaces; urban agriculture and more open space; and overall planning for greater resilience of buildings, neighbourhoods and cities. These measures to revert excess adverse climate change into ecological equilibrium and self-recovery will now have to be combined with measures to make cities more pandemic-resilient in the future as pandemic resilience is guided by the same ecological and sustainability principles.

Post-pandemic recovery is providing an opportunity to rethink sustainability criteria for cities comprehensively. This means taking into account the interdependence between productive, green and just city – the need to incorporate human health wellness, economic welfare and social wellbeing. Most important though is to obtain government support to realise change toward city sustainability. This also requires a step beyond a circular 'going-round' economy towards a sustainable 'spiralling-up economy based on primary resource sufficiency. Supported by political will these are achievable goals. An example is how the response to Covid-19 agreed in 2019 at EU and city level has strengthened the European New Green Deal.

6.4 From abstract promises to equal rights

The pandemic shed a new light on social relations, equal opportunities and environmental, spatial and social justice and main points to latent social change towards a just city. Public discourse moved identity politics

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from social class to women, demographics, ethnic minorities, and gender. All these different identifications are influencing the notion of the just city. Pandemic lockdowns created new socio-economic divides and inequalities, affected by and affecting collective as well as individual human behaviour, albeit without a clear notion of how lasting these changes may be. An example is the enormous decline of mobility and its unequal effects. Staying at home meant less social contact, less travel for work or leisure by car, train or plane, but also a shift to virtual reality. The existing digital divide is affecting personal as well as professional communication and it remains an open question whether the necessary infrastructure to provide more equal access to digital communication, seen by many as a basic need akin to energy and water, will be forthcoming during or after Covid-19.

Overcoming the pandemic successfully means to compound constructive behavioural change towards it while coping simultaneously with climate change urgency and resource sufficiency. Most importantly, strong political will is required to curb the persistent dominance of the economy over ecology, sustainability and social-spatial justice. It also requires power of persuasion to gain cooperation from collectivities as well as individuals to change their habits. Conversely, communities and individuals can make an invaluable contribution to post-pandemic sustainable development. This would require resorting to genuine public participation, shifting from its lip-service position in planning to public engagement with real teeth, powers and responsibilities, including a share of material rewards resulting from improvements currently reserved to the development industry and the public sector alone. Citizens' voluntary actions should no longer be considered as free labour and information, but be rewarded according to its true economic as well as social and environmental value. This would mean enshrining effective powers, rightful roles and material awards for citizens into the development process of an integrated productive, green and just city.

7 PROSPECTIVE SCENARIOS FOR POST-COVID CITIES

7.1 Scenarios and their context

For 'Futuribles' (Hugues de Jouvenel) "the future is the domain of freedom, power and will", thus the usefulness of building 'prospective scenarios', of structuring reflections on the future in a situation of uncertainty. 'Foresight' explores possible scenarios to define desirable and doable futures. Scenarios can be beneficial during crises like the present pandemic and aim to provide long term assistance in terms of anticipation and action to the elaboration of public policies. For the OECD 'Foresight' can support government policy-making with better anticipation, policy innovation and future-proofing (OECD, n.d.).

Scenarios have to start from the here and now, no matter how much they take account of the past. This also applies to the post-Covid future, linked to a rapidly evolving and hard to grasp present, and it is important to detect, understand and highlight its latent trends. At the time of writing consensus on the 'is-state' includes the possibility of Covid-19 to persist for a long time in its current or mutated form which means that lifestyles need to adjust to this 'new normal'. This includes long term policies of prevention and preparation for future pandemics beyond the scope of this paper. Another latent trend is that governments worldwide aim to realise economic recovery and to resolve practical issues emerging from over a year of cohabitation with Covid-19 accordingly. Technological innovations such as artificial intelligence and robotics will essentially influence businesses and economic institutions rather than social responsibility, while national interests as well as ideological standpoints will continue to motivate the political apparatus.

7.2 UN scenarios for post-Covid cities

In "Cities and Pandemics: Towards a More Just, Green and Healthy Future" (UN, 2021) the United Nations propose four issues for analysis and action: "rethink the form and function of the city"; "address systemic poverty and inequality in cities"; "rebuild a 'new normal' urban economy"; and "clarify urban legislation and governance arrangements".

According to the UN, different uses of buildings and outdoor spaces during the pandemic already point toward changes in urban morphologies, and provide an indication of how they could be made more resilient to recurrent pandemics. To this end, inclusive spatial planning should incorporate specific interventions designed to address inequalities in cities and mitigate their impact on poor and vulnerable groups. Most important for these changes is a more integrated and cooperative multi-level governance. With regard to the urban economy, tackling the crisis involves seeking innovative financing mechanisms for services and infrastructure while ensuring social protection programmes to encourage sustainable production and consumption patterns. It includes support for renewable energy transition, green building methods, land use regulation and investment in digital technologies to improve logistics and supply chains, as well as support for smaller enterprises, informal workers and risky sectors.

Such measures, together with inclusive local development would also contribute to enhancing social relationships, combating poverty and inequality in cities and improving living conditions for all. At a broader and necessarily longer term scale mismatch between populations, inequalities in the built fabric and occupancy rates which accelerated virus transmission would need to lead to restructuring city forms and functions. In conjunction it postulates nimble and flexible urban governance, as well as leadership acting transparently, building trust and fostering community engagement at all levels to obtain public support in crisis situations, get short term measures accepted and produce sustainable long term solutions.

7.3 Scenarios for a new understanding of sustainable cities

The scenarios presented here are visualised in terms of their overarching goals: ‘business as usual, ‘genuinely-sustainable’, ‘build-back-better’, ‘pragmatic-realistic’. They rest on the dialectic between people’s right to the city and the tasks of political-administrative governance to balance economic, environmental and social development equitably. However, any post-Covid future remains constrained by the staying power of both human behaviour and political interests. This pragmatic selection of four scenarios is based on people’s preoccupations about their future during the pandemic on the one hand and the political roadmaps on the other hand, both set against an ideal-state akin to that depicted by the UN.

Nevertheless, the scenarios focus on a ‘new normal’ framed by past habits, responses provoked by Covid-19 disruptions, political interventions at all levels, together with events outside anyone’s control. Combined with creative initiatives in everyday life all these aspects are contributing to shaping the changes towards a post-Covid reality. After initial optimism and activism, the mood has been hardening with Covid fatigue and the ‘new normal’ could well be less palatable than the old one, expressed in the ‘business as usual’ scenario. Although a return to the ‘old normal’ is not considered desirable it is acknowledged as a very realistic option and therefore the “materialistic scenario” follows current trends and projects them into the short and medium term.

Conversely, the other scenarios are imagining a range of possible sustainable futures based on promising changes which took place during the pandemic and starting points detected for local action and related governance reform and they also propose examples of practical planning and urban design solutions. The sustainable scenario projects the desired future for a better world; the optimistic scenario proposes the lines to follow under new rules of the game; and the expert foresight proposes feasible proposals.

7.4 Back to the pre-Covid scenario: a return to the ‘normal’ past?

This urban scenario overcomes the limitations of the "new normal" and returns to the "normal" trends of the previous context. Even if it adopts certain changes in economic, social and environmental attitudes, its effects will remain limited as long as the deep structures of society remain intact. Despite serious warnings about climate change, systematic destruction of the environment, increasing social polarisation and political imbalances, there will be no substantial changes that will help the model to adapt and develop.

Its economic context is a very flexible capitalist system which will recover rapidly, organising new models of production, especially those related to the collection, management and commercialisation of data (surveillance capitalism). Global corporations, the concentration of power and decision-making and the accumulation of large fortunes will become more widespread. Even if companies are adopting criteria of social responsibility and respect for the environment ("green capitalism", "green and digital transformation"), the economy would take time to decarbonise, create jobs and reduce poverty. Demand for goods and services and for energy and materials will continue to rise. The loss of trade union power, the disappearance of regulatory agencies and the removal of control over international movements of capital, fuelled by digital technology, will increase the polarisation between rich and poor and deepen inequality, precariousness, unemployment and urban poverty.

In urban societies people's daily behaviour will return to previous lifestyles, albeit embracing the changes brought about by digitisation during the pandemic of work, shopping, education and leisure. Teleworking will lead to sedentary lifestyles and isolation, with physical and mental consequences for some segments of

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the population, accentuating the symptom of burnout generated by the freely assumed obligation to maximise personal productivity. Collective awareness will disappear in favour of "Covid-NIMBYism": let others take precautions. The economic downturn will impose harsh conditions: precariousness of employment, increase in temporary work (the gig economy), need to adapt to professional transitions and polarisation of income related to types of activities.

Regarding city form and function the rise of telework, tele-education, tele-health and techno-finance are likely to stimulate migration from metropolitan regions to medium-sized cities, towns and suburbs which could increase their economy, cultural life and diversity if people take root. The search for safe urban spaces will promote segregation between traditional neighbourhoods and self-sufficient neighbourhoods with locally generated energy and self-sustaining agriculture, small-scale industries, proximity care services, coworking spaces and telework-friendly housing. Housing will become an even more essential commodity, increasing its value in the housing market. The lack of social housing in favour of public rental policies will deepen social inequality.

In terms of governance the role of the political-administrative apparatus will have to focus on balancing emerging social, economic and environmental tensions. The positioning of the sectoral groups affected and the entrenchment of the prevailing ideological parameters on the political left and right will generate circumstances that are difficult to control: loss of confidence in governments and political parties, deterioration of democracies, strengthening of extremist movements, consolidation of populism and independence movements and the reduction of the welfare state will generate massive protests.

7.5 Genuinely Sustainable Scenario: a universal paradigm?

Such an ‘ideal-state’ future is improbable but could be an inspiration for a desirable and possibly necessary future. It combines the three e’s of sustainability: economy, environment and equity, together with taming and preventing pandemics. It aims at universal human material wellbeing, ecological survival of the planet and inclusive social-spatial justice. What underpins this blue-sky-thinking is that these dimensions are totally interdependent for a sustainable future. Efforts to reduce green-house-gas emissions had been displaced by fighting Covid-19 but climate change urgency remained in the forefront of collective consciousness, especially of younger generations. Conversely, the pandemic has exacerbated social divides and spatial segregation, most of all in deprived areas, often with disadvantaged populations and ethnic minorities, in greatest need of redressing. It means that economic recovery has to be accompanied by more integrated and cooperative governance, redistribution of resources, access to services for all and empowered citizenry. This applies to all levels from neighbourhoods to the global sphere, thus requires action and consensus among political opponents and across continents.

Unfortunately, even at the EU level on which this paper is focusing, agreement on how to operationalise the New Green Deal remains under debate, although there seems to be convergence on the climate change targets. However that leaves divergent views on economic recovery, with those opting for austerity and self-reliance, while others are seeking more inclusive solutions with fairer tax burden sharing and solidarity across generations and territories regarding employment and welfare support. Only thus can social and spatial polarisation be redressed comprehensively, based on regenerative economy and a sustainable ecological footprint: in this scenario the foundation of ‘build back better’.

Such an "ideal" future also promoted by the Leipzig Charter is improbable but inspiring as it proposes to coordinate interdependent responses that are difficult to connect: sustainable economic recovery; redressing of growing social and spatial polarisation, including the digital divide; action on the environment, especially climate change; and anticipation and prevention of pandemics and other catastrophic events. Nevertheless, over the last three decades many initiatives have been taken at city level to achieve a greener economy and a more equitable future achieved by more integrated and cooperative urban governance. Under the constraints of the pandemic, designers focused on compact, mixed-use neighbourhoods which make it possible to satisfy basic needs within walking distance, with a road network that supports active mobility and more accessible and equitable green spaces as a move towards the morphologically sustainable city. The pandemic led to more neighbourhood living and non-motorised travel, although reduced use of public transport remains unrealistic for cities dependent on mass transit. In some cities participatory platforms for decision-making based on the views of residents, entrepreneurs and community organisations were promoted and were effective in meeting the needs of residents during mandatory lockdowns.

To what extent political decision makers will seek post pandemic synergy between alleviating and/or preventing future pandemics, coping with climate change urgency, redressing the growing social and spatial inequalities in cities and dealing with the need for governance reform remains unknown, although such an integrated approach may be the only viable strategy for the long term survival of the planet and humankind.

7.6 "Build-Back-Better" Scenario: towards a new social contract?

Aiming at a return to the 'old normal' seems unrealistic and undesirable. However, a 'new normal' - a post-Covid or with-Covid future may either be better, albeit most likely only in parts, or worse, with increasing polarisation within and between cities and countries as well as globally; only paying lip service to targets for climate change with little or no action, everyone waiting for others to take the lead in accepting environmental constraints and reducing consumption; and leading to a neo-liberal economy with even fewer regulations and welfare provision.

Politically "Build-back-better" is understood as a 'new normal' after the pandemic whose economic recovery has to include a plan to repay unprecedented national debts, reinstate jobs and restore economic sectors particularly damaged by past lockdowns. So far, there is little sign of fresh, let alone structural or innovative government rethinking towards a more equitable future. Speed of economic recovery considered essential for a better livelihood is of the essence, to which all other needs - better lives, health and social care are subordinated. During Covid, spontaneous, shared and sometimes altruistic initiatives have given way to sectarian claims competing for dwindling public resources and financial support, thus short-termism towards "build-back-better" may lead to harsher, skewed hardship and conflicts. In some countries, government emergency laws claiming to pursue unity gave rise to exceptional powers and centralisation which, if not reversed, may well provoke claims for more devolution of decision-making and resources, and thus to fragmented and uneven economic and social recovery.

The pandemic has highlighted the mismatch between population size, high densities, overcrowding, virus transmission and mortality rates globally, although cities are better equipped to absorb the effects of calamities. Spatial inequalities manifest themselves in physical segregation as well as uneven distribution and access to basic services and infrastructure, affecting deprived urban areas most, but also low density remote suburbs. Change of use of spaces in cities due to the pandemic and lockdowns is pointing towards more permanent urban transformations. For example, the design of urban spaces will be relevant in accommodating more and safe outdoor activities, improving hygiene measures, converting buildings to absorb home-working and designing buildings for more flexible use. It will be necessary to rethink planning regulations and building codes to manage safe, affordable, reliable and efficient public services, including reducing the digital divide in disadvantaged communities. It will require neighbourhood improvement strategies and the promotion of new lifestyles, new treatments of public space and the incorporation of mixed uses with co-working spaces to energise neighbourhoods. Quality of recovery should be led by pro-active local governments with public participation in inclusive planning and decision-making about the transformation of people's neighbourhoods into viable local economies satisfying both residents and businesses and a green and healthy environment. Transparency and trust building will be of the essence to obtain public support and facilitate compliance. Overall, as a desirable future "build back better" needs to redress spatial-social segregation and re-direct neo-liberal economics to ensure greater welfare.

7.7 Pragmatic-Realistic Scenario, towards a post-Covid form of capitalism?

For this scenario it is particularly important to have a clear understanding of the "is-state". The main transformations emerging from over a year under the influence of Covid-19 appear in change of working habits, shopping, education and mobility. Already homes and offices are being restructured to accommodate pandemic conditions. More homeworking is already leading to more diversified office activities and affecting mobility with lower use of public transport, more active movement, fewer trips made overall replaced by digital communication, as well as less travel and especially long distance journeys for leisure, business, and even possibly tourism. Clearly public transport is indispensable for the functioning of cities, and while cycling, walking and other personalised small scale mobilities like scooters and curbing especially single occupancy car journeys are positive contributions to curbing GHG emissions, the whole road network will have to be reimagined for a more sustainable modal balance which may also be affected by longer term need for social distancing. The issue of density of use as well as of buildings will need revisiting and allowances made for more open and green spaces, public and private in cities, including spaces for growing food and local recreation. The accelerated shift to online shopping is affecting retail premises. All these changes are having adverse impacts on hospitality, culture and leisure, most acutely in centres of large cities which usually concentrate a broad range of urban functions. The current empty premises due to fewer commuters and tourists, at least in the short term, have left behind blind ground floors and less footfall and require innovative solutions for the recovery of city centres.

These and many other urban design considerations are serious challenges for planners, designers and the property industry, but they present opportunities for creative newcomers with creative ideas about post-Covid urban life. Small scale, alternative, experimental, doable and already realised regeneration projects, recycling and in-fill buildings can add up and make a valuable contribution to urban sustainability. However, they are neither comprehensive nor 'universal' and cannot replace the current strategic political objectives of the current neo-liberal economic capitalistic system.

The 'pragmatic-realistic' scenario which is geared towards cities concentrates on initiatives likely to become the focus of post-pandemic reality.

8 CONCLUSION

This paper imagines four scenarios for cities in the near future based on the social, economic, environmental and political processes generated during the pandemic. The content of these scenarios rests on a two-prong basis: proposals for actions at European (Leipzig Charter) and international (UN New Urban Agenda) levels providing the methodological framework; and the urban situation facing the health crisis, revealing the lack of resilience of cities to cope with unexpected calamities.

The paper outlines four different visions of the path that cities could take in the near future:

- one that continues past trends
- one that projects a desired future for a better world
- one that proposes to change the rules of the game
- one that seeks feasible proposals within the current state of affairs.

It is recognised that the results of all four paths will always be partial. They may not even be encouraging, considering the weight of the legacy of existing cities and, in particular, their material constraints and political-administrative structures. As the pandemic left the basic material structure of cities intact there is no urgency of reconstruction, except for social coexistence.

The future will also be shaped by ongoing social, economic and environmental processes taking place in cities. In part they depend on a network of global relations framed by international treaties like the UN sustainability goals and the Leipzig Charter objectives aimed to steer their implementation, albeit with uneven and unpredictable results in practice. Conversely, Covid-19 has also unleashed fragmentation of the globalising world and retrenchment on local concerns which may make cities looking more inward. Added to these contradictory trends is uncertainty of both collective and individual human behaviour and how they will influence the realisation of change.

Nevertheless, several issues have been emerging during the pandemic which are likely to persist or be desirable to retain after recovery:

- value of science in its mission to save humanity
- increase in the symptom of burnout, driven by the need to increase performance by a model of exploitation without legitimacy
- need to change lifestyles which proved their limitations during confinement.

Covid-19 is not the first and will not be the last pandemic, but it is hoped that its consequences will serve as a lever for change to improve living conditions in cities.

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Age-friendly Urban Living Environment and Quality of Public Space

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1 ABSTRACT

Due to the corona crisis and its consequences for the target group 65+, the term autonomy and self-determination in old age was assigned a further great meaning and is becoming extremely important. 43 percent of corona deaths in Austria are residents of retirement and nursing homes.[1]Mental illnesses as a result, caused by isolation, such as restrictions on going out and visiting by others and the fear of dying alone. All of these are factors that drastically reduce the demand for the traditional nursing home as a residence for the 65+ target group. And still, we are right in the middle of the age shift due to demographic change, which increase the need for adaptation of the living environment. The over 65-year-old population in Europe is forecast to increase by an average of up to 55% by 2050.[2]

Housing in connection with the urban environment is an essential factor to remain autonomous.Housing must not be considered in isolation, but in context. Here, not only one's own home plays an important role, but also public space and open space. This paper will use the research survey of 307 people of the 65+ target group living in Graz to investigate what conditions need to be met in order to create an age-friendly district where people 65+ can live autonomously. Questions were asked in the areas of digitalisation, social life, infrastructure and mobility, in relation to habit and relevance. 86% would not think of changing their residence, the idea of leaving one's own home to become dependent is not widely accepted. Here, the public space in the immediate vicinity of the housing situation is a decisive factor because it is a place of social interaction. A place where collective life is created. Loneliness in old age is often accompanied by the lack of accessibility to public spaces. How should public space be designed for the daily walk? What distances are manageable for daily errands? Living in connection with the external context, such as a barrier-free accessible green space, is important for over 95 percent of the target group. The daily route must be barrier-free and easily manageable. Infrastructure, mobility and public space play a major role here. Homes and their associated open spaces must have alternative concepts to strengthen connections and promote community. Using the survey results as a foundation for a senior-friendly city, this paper looks at factors for a better quality of life. In view of demographic change, urban development must go hand in hand with the requirements of public space. Based on the survey a principle recommendation for the transformation of public space are suggested. It means high-quality designed public spaces in combination with easily accessible, barrier-free mobility and infrastructure.

Keywords: urban living environment, public space, age-friendly, mobility, autonomy

2 DEMOGRAPHIC CHANGE

Demographic change describes the adjustment of the age structure in relation to the changed living conditions of a population. It is a result of social upheavals caused by a change in the composition of the age structure in society.[3] In our affluent society, people not only live longer, but also age more slowly. This higher life expectancy is the result of growing prosperity, hygiene and health care, advances in medicine and accident prevention.[4]According to the study "Europas demografische Zukunft", prepared by the Berlin Institute for Population and Development in 2017, European demographic trends are projected to increase the number of people over 65 in Europe by an average of 55% in 2050.[5]Not only a change in the age structure of society, but for example the composition of the population structure in a spatial context is referred to as demographic change. Demographic change also brings with it an increasing number of people in need of care, among other things due to a high number of single households. In Austria, the number of household members per household fell on average from 3.11 persons to 2.22 persons between 1951 and 2018.This reduction in household sizes brought with it an increase in one-person households. According to

[1] APA (18.05.2021)
[2]Berlin-Institut für Bevölkerung und Entwicklung 2017, 29.
[3] Dinges u.a. 2015, 12.
[4]Hergott2012, 8-11.
[5] Berlin-Institut für Bevölkerung und Entwicklung 2017, 29.

Statistics Austria, the share of single households was already 37.2% of the total number of private households in Austria in 2018.[6] Thus, the number of people living in cities will also increase. Demographic change is accompanied by an increase in the ageing population and thus attributes great importance to the housing situation and the associated local area in terms of independence in old age in the form of age-appropriate cities and neighbourhoods.[7]

3 INTEGRAL LIVING

Housing in conjunction with the urban environment is an essential factor in being able to live independently in old age. It must not be considered in isolation, but in context. Not only one's own home plays an important role, but also public space and open space. The socio-spatial context can act as a barrier or as a conducive support and compensate for possible missing competences as well as health restrictions.[8] A good example is the consideration of a "mini master plan" for each building, each flat, where housing is considered as a building block in the context of the city. In Brussels, this approach is already used as an operational tool to support the construction of social housing, in order to think about the necessary infrastructure with surroundings in the planning.[9]The flat must remain interesting as a living space even in old age, be it through the exciting view offered in combination with the visual relationships, the public space, meeting zones or community facilities. Fields of action for independent living in old age can be divided into three spatial scale levels: *Dwelling - centre of daily life *Open space - meeting place *Social infrastructure - support in the neighbourhood.

In the form of the onion model, where different layers of private to public space are formed around one's own dwelling, the urban connection between one's own dwelling and the context can be illustrated. As the radius of action of older people decreases more and more, the layers that can be experienced towards the public space become smaller and smaller.[10]The path from the door of the flat to the public space is a place for spontaneous encounters. The entrance as a meeting space has a special quality of place and is of great importance especially for people with limited mobility.Intermediate spaces as semi-private spaces with a high frequency of encounters are transitions, such as threshold areas, ground floor zones, arcades and staircases.Public space as an extension of living space and as a recreational and communication space is becoming increasingly important.[11]An interconnected, small-scale development network serves as a foundation for short distances in the local area and the neighbourhood and forms the basis for encounters in public space. It is about connecting with the surroundings in order to pursue integrative, cross-district planning approaches to support in the ageing process.[12]

4 HOUSING AND AUTONOMY

Due to the Coronaviruscrisis and its consequences for the 65+ target group, the concept of autonomy and self-determination in old age has taken on even greater significance. One's own home as a person's private living space is associated with personal memories. The older a person is, the more time he or she spends on average in his or her own home, which therefore stands for safety, self-determination and security.[13] If independence in everyday life is no longer possible, this is often accompanied by a loss of self-determination to act in accordance with one's own wishes and interests.[14] Dependence, but also loss of independence and adaptation are negative associations that are associated with nursing homes.[15] The wish to spend the last phase of life at home, in familiar surroundings, rather than in a nursing home, was furtherstrengthened by the developments of the pandemic.Since the beginning of the coronavirus pandemic until 18.01.2021, 43 percent (2.855 people) of all COVID-19 deaths in Austria (6.568 people) have been residents of nursing homes.[16] Here, mobility is also seen as a prerequisite for quality of life and an important factor for a self-determined

[6] Statistik Austria 2018.
[7] Kreuzer 2006, 67.
[8] Kreuzer/Scholz. 2011, 14.
[9] perspectivebrussels (28.05.2021)
[10] Kreuzer/Reicher/Scholz2008, 123.
[11] Feuerstein u.a. 2015, 45.
[12] Kreuzer/Reicher/Scholz2008, 127.
[13] Böhm/Wilkes 2018, 32.
[14] Kreuzer/Scholz 2011, 3.
[15] Seifert 2016, 6.
[16] APA (18.05.2021)

life.[17]As a result of the pandemic, isolation by others as well as isolation and lockdown in nursing homes were perceived as negative restrictions for the residents and strengthened the trend towards alternative forms of living.

Fig. 1 COVID-19 deaths in Austria (18.01.2021)

5 DYNAMIC PLANNING

Dynamic development for dynamic family growth.What is needed are individual flats that can be combined and connected to grow, and be connected with other residents. Multiple use thus ensures a diverse, lively mix, for flats that have become too large, vacancies or even communal areas. A small flat that can grow into a family flat and then shrink again when there is less demand because the costs are high or loneliness threatens are in demand.[18]Dynamic planning also means planning for accessibility. Accessibility is essential for 10% and important for 30%, but it is an advantage for every user.[19] Dynamic planning can also have a supporting and helping effect for the ageing population through the dynamic use and occupation of the areas in the neighbourhood. Thus, various additional services such as delivery services, common rooms, household support services,caretaker and shopping services as well as senior citizens' offices can be available.

6 LIVING IN OLD AGE

If the retirement from working life is taken as the entry into the old age phase, as well as the increased life expectancy and biological age, the result is the old age phase with a period of up to more than 30 years. If the varying circumstances and lifestyles are added to this, it becomes apparent that old age is made up of the most diverse processes with great variety and the differences are clear.[20] In old age, everyday life largely means everyday living in one's own home and local area. A survey in Zurich even showed that the target group65+ had been living in the same home for an average of 30 years at the time of the survey. Of the participants surveyed, 68% stated a very high degree of attachment to their own home. However, if a change of flat was imminent, 77% of the respondents would prefer a flat in the same neighbourhood.[21] Due to an increasing "singularisation" of the older population and the loneliness associated with it, there is additional interest in alternative forms of living, such as the concept of "living for help", where living space is shared between students and people who need help in the house. Other alternative forms of housing would be assisted living, living in a multi-generational house or an assisted living group, and co-housing. Recognisable motives are the avoidance of loneliness and the possibility of mutual support.[22]

7 TARGET GROUP SURVEY 65+

The survey of 307 people of the target group 65+ living in Graz was conducted over a period of four months, from August to November 2020, and shows which conditions must be fulfilled in order to create an age-friendly district in which people 65+ can live self-determined lives. Questions were asked in the areas of digitalisation, social life, infrastructure and mobility, in terms of habit and relevance. A total of 62% were women and 38% men. 25.7% were between 65 - 69 years old, 18.2% between 70 - 74 years old. 26.4% of the respondents were 75 - 79 years old, 16% between 80 - 84 years old. 8.8% were in the 85 - 89 age group. 4.6% were in the 90 - 94 age group and 0.3% were over 95 years old at the time of the survey. The evaluations showed that 95% were satisfied to very satisfied with their form of housing. For 46% of the respondents, the living situation is not accessible, but almost 86% are not willing to change their living situation. This shows great potential for urban development.

[17] Dinges u.a. 2015, 7.
[18] Haumann 2020, 522.
[19]Querraum 2015, 8.
[20]Kreuzer/Scholz 2011, 14.
[21]Seifert 2016 Umzugspräferenzen, 4.
[22]LaFond u.a. 2012, 160.

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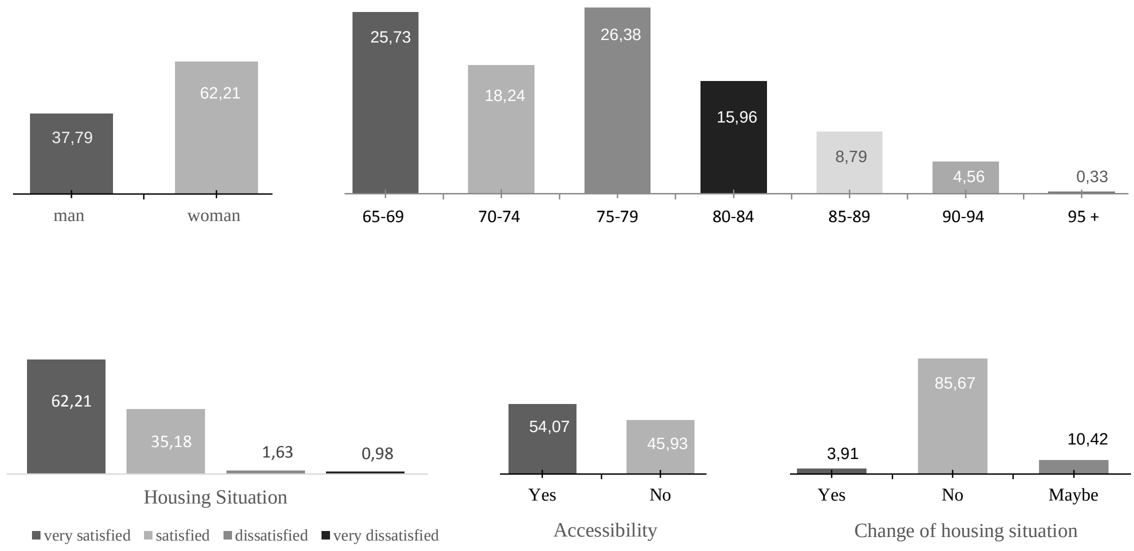

Fig. 2 Core data of the respondents

8 LIVING IN THE DISTRICT

Being able to lead a self-determined life even in old age is one of the essential attributes of successful preventive health care for older people. According to the survey of the 65+ target group in Graz, the ageing population also wants to be able to stay at home as long as possible. What is important here is the supply structure in combination with the concerns of the ageing population. Urban planning can help here. With declining mobility and health, the radius of action is concentrated on the local area and the district as a level of action.[23] What does the city need as a living space? The public space in the immediate vicinity of the living situation is a decisive factor, because it is a place of social interaction. A place where collective life is created. Loneliness in old age is often supported by the lack of accessibility to public space. Accessibility is considered an important factor, as 87% find accessibility to public space important. Open space plays a central role in the design of age-friendly and liveable urban districts and serves as a place for movement and encounters as well as a connection between different places. Accessibility, well-connected open spaces are especially important for older people due to their ever decreasing radius of action.[24]Short distances are essential, the survey makes this clear. A districts is defined as an individually considered area that can be reached on foot in everyday life. In the survey, a distance of 1500m was considered a realistic walking distance by only 40%. However, a distance of 500m is manageable on foot for 84% of the respondents. This results in a clear recommendation for a 500m radius in the neighbourhood. The routes for daily needs should therefore be designed with a maximum distance of 500 metres, as thisdistance can be reached in up to 15 minutes, even at a walking speed of 0.7 m/s.[25] Short distances to medical care, short distances to shopping and short distances to green spaces are very important to important for 94%.The daily commute must be accessibleand easy to manage. Infrastructure, mobility and public space play a major role here.

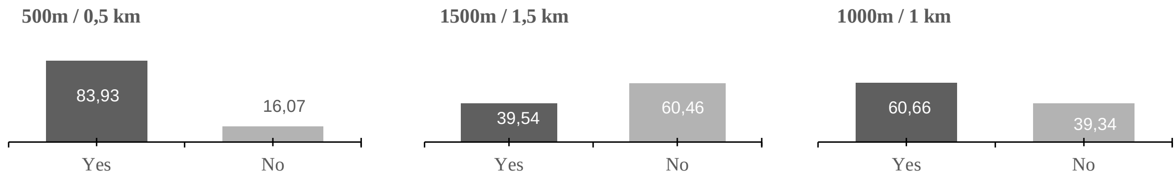

Fig. 3: manageable walk distance of the respondents

[23] Wolter 2010, 208 – 210.
[24]Kreuzer/Reicher/Scholz 2008, 124.
[25]Kreuzer/Scholz 2011, 36.

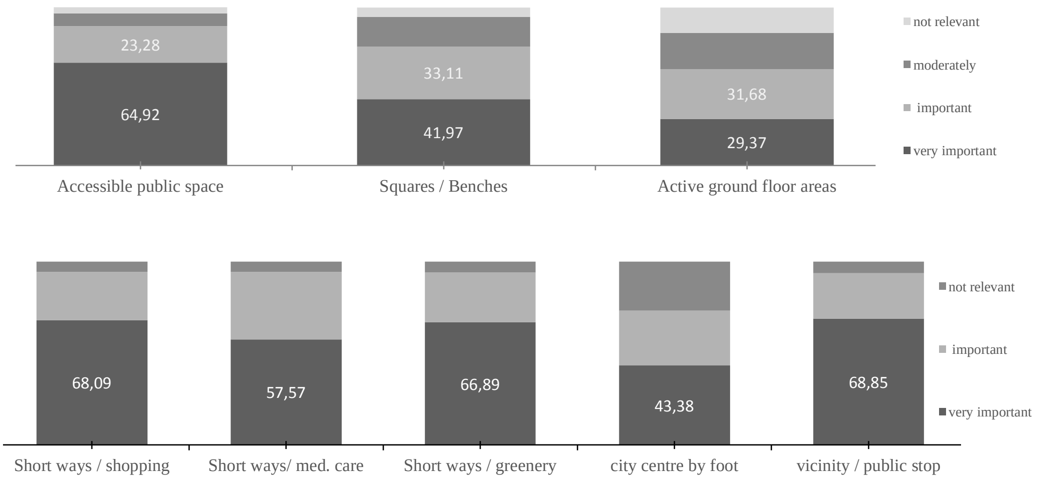

Fig. 4: distance preferences of the respondents

The survey also revealed wishes in the area of public space and mobility. Wishes in the area of pavements (9%) concern a sufficiently wide pavement separated from bicycle traffic and a barrier-free design, as well as sufficient lighting. Pedestrian crossings (16%) was also reported as a stressful situation because the green phase does not last long enough. There is also a desire for sufficient seating in public spaces (13%), as well as accessible waste collection points and letterboxes.In the area of public transport (48%), accessibleaccess to bus stops, avoidance of jerky braking behaviour, lower travel speeds, assistance with ticket purchase, as well as longer waiting times when getting on and off the bus were noted. The wish was also expressed for a separate bus for senior citizens, which would explicitly take into account the needs of the older population.

Pedestrian crossings 16%
more time to cross
Public transport 48 %
Improve public transport / shorter intervals
Less jerky braking and driving away too quickly
Illuminate bus stops
accessible stops/bus stations
secure seating for senior citizens
more time to get in and out

public space 13,04%
more public green spaces
More benches
Accessible waste collection points
More post boxes and public toilets
Pavement 9 %
Accessible pavements
Separate cycle paths and pavements
No additional boards on the pavement

Table 1: wishes regarding urban development

9 COMMUNITY

In the future, greater importance will be attributed to personal non-family associations such as neighbourhoods. The survey showed that 46% are very satisfied and 26% are satisfied with their neighbourhood relations. More networking would be desired by 44% of the respondents.

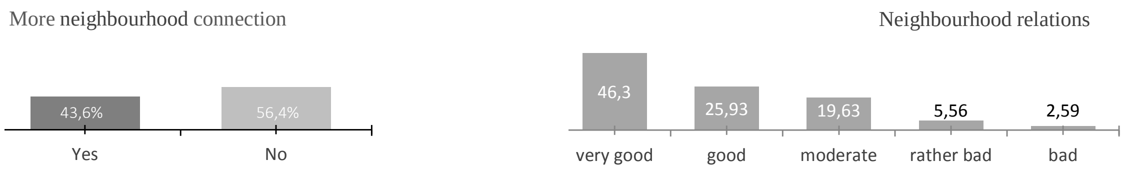

Fig. 5: Neighbourhood

Assistance and mutual support as well as the desire for community are wishes of the 65+ target group that can be supported by the choice of housing form and the resulting social network, because assistance and participation in the community has a great impact on a self-determined life in old age and already begins with minimal everyday help or manual work. Interpersonal contacts and conversations as well as emotional

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support of social networks make an important contribution to the subjective quality of life.[26] A better cohesion is also created through joint activities such as cooking together or working in the community garden. Good togetherness requires a harmonious coexistence, not only a taking but also a giving. Reciprocal relationships and interactions, such as sharing, which takes on new relevance, are seen as an important element of house communities. Networking, swapping and sharing knowledge, food, services and everyday objects can also save costs in daily life. Neighbourhood help is seen as an essential element for independent living in old age.[27]

10 PRODUCTIVITY AS A BOND BETWEEN LIVING SPACE AND ENVIRONMENT

It is not only about living, but about fulfilling a task. In this sense, the idea of extended family in the form of neighbourhood help and personal productivity is also important.Studies show that voluntary engagement in old age is associated with higher life satisfaction and mental and physical health. This positive effect of activity on one's own well-being is explained with the help of activity theory. This states that the satisfaction of older people is significantly promoted by active participation in life and the maintenance of their social network. More community can also mean more infrastructure. In addition to the possibility of spatially undefined voluntary activities, active neighbourhood assistance also offers the possibility of exercising these activities in the spatial context of one's own environment. Neighbourhoodhelpincludes: minor assistance, personal conversations, looking after the flat and house,social get-togethers and childcare.In social associations, however, the older population does not only act as recipients of help, but also makes valuable contributions themselves. For example, cooking or childcare can be taken over by the older population, while the younger generation pursues their working lives. Almost 40% of the respondents look after children from time to time and attend anassociation meeting at least once a week. The 65+ target group is involved in voluntary work in various areas. This involvement increases with retirement and decreases again with advancing age.[28]The older population wants to be needed. For example, at the Viennese "Café Vollpension", seniors can supplement their income by baking cakes. This offer is so well received that there are not enough places for all applicants. Participation, even in old age, is important. The participation rate of respondents in Graz in association life is 49% and there is also a high level of professional and voluntary activity in retirement at 30%. Around 30% of the respondents attend courses on average every month. Community and public spaces are also perceived as very positive. In the evaluation of the personal favourite place, one's own home gained the highest value with 37.4%. Social areas such as common rooms with 4.8% and family and friends with 3.4% also make up a significant part of the personal favourite place.

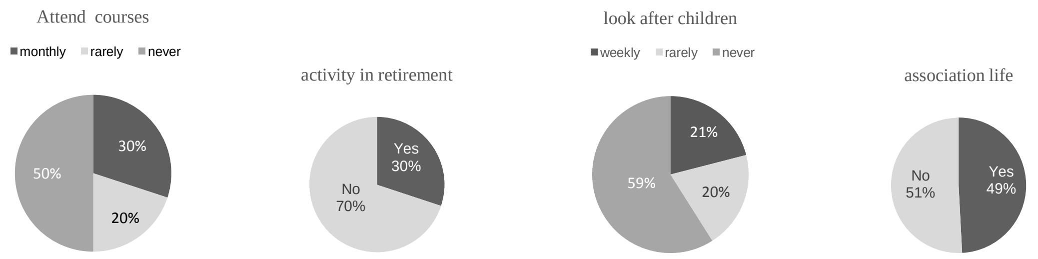

Fig.6 Activity of the respondents

personal favourite place	%
at home/ in the flat	37,43
garden / inner courtyard	15,92
Balcony & Terrace	13,41
nature / park	13,13
with family or friends	3,35
activity room / common room	4,75

Most mentioned activities in retirement	%
association life / social activity	19,00
Self-employment	16,53
Consulting and Coaching	12,40
construction site work	9,92
office work	9,09
organisation	8,26

Table 2: favourite place and activity in retirement

[26] Kreuzer 2006, 47 – 67.
[27]Korab 2020, 242.
[28] Seifert 2016 Freiwilliges, 151 -156.

11 CONCLUSION

The municipality plays a central role in the integrative planning process of an age-friendly city and cannot be considered separately. Social infrastructure in the neighbourhood is important, because networking in the community has a significant influence on housing satisfaction and is an important quality feature. Community spaces are important, because housing cannot be considered autonomously. In the future, the social aspect should be considered even more strongly in the planning and design of neighbourhoods. Housing must be thought of in the context of social and community services to promote quality of life, satisfaction and independence of older people.Demographic change will anchor the promotion of productivity and the associated participation in social life of older people as an essential task in our society.[29]In this way, living as independently as possible in old age is to be promoted and made possible by a lively neighbourhood in the trusted residential environment through mutual support.

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[29] Kreuzer 2006, 47.

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reviewed paper

alBOX: White Label Parcel Lockers as Sustainable Solution for Last Mile Delivery

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1 ABSTRACT

Online commerce is an expanding and therefore challenging market. Due to its complexity, innovative solutions are required to guarantee a resource-saving supply quality with flexible goods and services in urban and rural areas. The challenges lie in developing an economically, ecologically and socially sustainable receiving and shipping system that offers the possibility of directly involving the local economy and strengthening locations overall. In particular, overcoming the last-mile in parcel delivery by courier express parcel services (CEP services) is associated with numerous problems.

Based on these logistical-organisational problems and challenges, vendor-independent ("white-label") parcel lockers were developed within the alBOX research project framework. Therefore, a pilot operation of white-label parcel systems in two target areas with different settlement structures (rural community of Kaumberg in Lower Austria and Vienna's 5th district Margareten) was implemented for twelve months. The implementation of the white-label parcel lockers system was accompanied by conducting a mixed methods research which uses quantitative data (e.g. average package sizes, frequency of orders, usage times etc.) as well as qualitative data (e.g. user experience, operability etc.) to test, analyse and evaluate this innovative service.

In this paper, the project's results are linked to delivery and distribution logistics' challenges to explain white-label parcel lockers' contribution to ensure a nationwide, innovative and demand-oriented (local) supply structure for spatially scalable and flexible flows of goods, information and services. For this purpose, supply-related, social, economic, and ecologically and environmentally relevant objectives were considered. The focus is on the results that describe the delivery situation from the recipients' perspective and their usage behaviour. It is discussed to what extent the parcel lockers as the first delivery address influence the delivery situation in the target areas of the pilot operation.

Keywords: white label, parcel lockers, last mile, CEP, distribution logistics

2 CURRENT SITUATION

Parcel lockers with permanent access are currently offered mostly by those CEP service providers with a corresponding market share in the respective segment. This development can lead to monopolies, especially in rural regions, with all the associated disadvantages. The parcel lockers of the two strongest providers, Post AG and Amazon, are managed exclusively as a closed system. So they are not accessible to other retailers and CEP delivery companies. In terms of cream-skimming, competition will primarily arise where there is particularly high demand. This will possibly (see LTE or 5G network) lead to spatial disparities. Local trade and the use of parcel lockers for municipal purposes (secure deposit of objects/documents between private individuals or public institutions) will be excluded from this service. It is comparatively more difficult to supply the local population with goods and services in rural and sparsely populated regions. The range of products in local stationary retail is mostly reduced to the essentials. Partly online retailing compensate for disparities in the supply quality of communities with retail and specialised shops between urban and rural areas (Gumz et al. 2020). Furthermore, an increase in online trade puts pressure on regional traders in peripheral areas. Platforms for the joint marketing of products or the bundled provision of products and services can sustainably strengthen retail and direct marketing in rural areas (Mensing 2016).

In order to capture the current developments in the delivery industry, especially concerning parcel lockers in Vienna and Lower Austria, a spatial analysis by Gregory Consultings (2019) and a survey by Logistic 2030 are combined in Figure 1. Thus, the development of the number of parcel locker locations per provider in Vienna and Lower Austria is summarised for the period March 2019 to October 2020. Furthermore, the figure shows the proportions of open and closed systems in the respective periods. From March to October 2019, the delivery service DHL closed all of its 28 parcel stations.

By October 2019, Variocube, a new provider, comes along. A1 triples, and Renz almost doubles its number of locations. In 2020, on the other hand, only Interspar will reduce its number of locations, while Myflexbox and Amazon will become new providers. Outstanding is that, despite the new start of Amazon, it takes immediate third place among the providers with the most locations in Vienna and Lower Austria. Renz, A1 and Variocube doubled their number of locations in this period. Post AG can also show an increase of 32%.

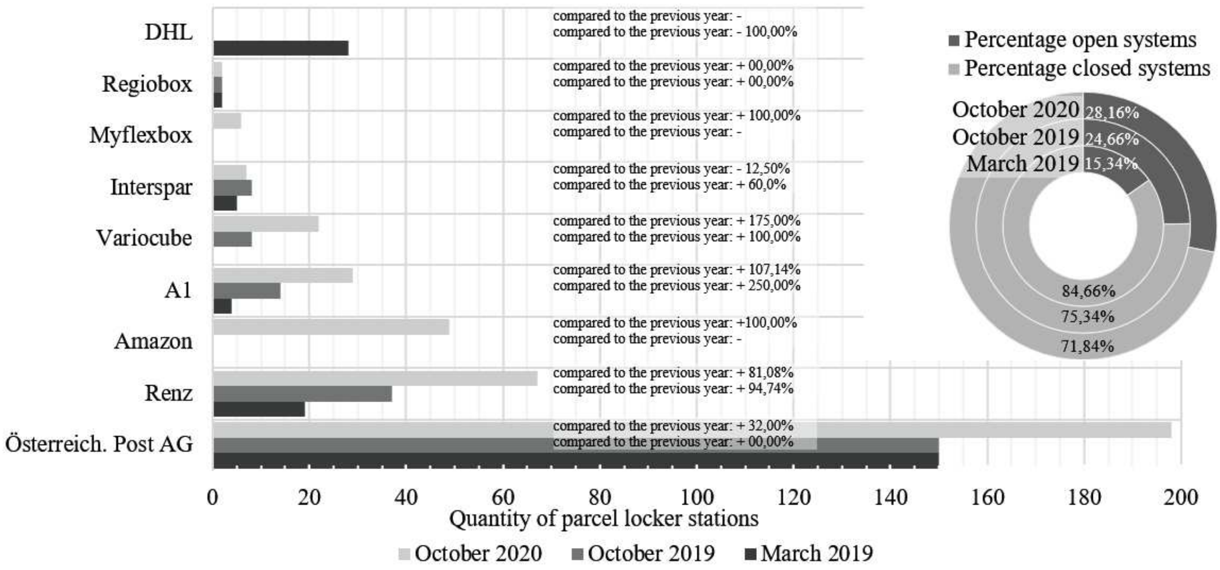

Fig. 1: Development of the number of parcel locker stations in Vienna and Lower Austria in the period of March 2019 until October 2020, Source: own calculation, Data: (Wirtschaftskammer Wien 2020 and Gregori Consulting 2019)

Overcoming the last mile in the delivery logistics of CEP companies is associated with numerous economic and ecological challenges. The traffic induced by parcel delivery increases, especially when the first delivery attempt at the recipients fails. If additional journeys have to be made by CEP providers and recipients to pick-up the parcel from a parcel shop in the vicinity, more time-, travel- and CO2-costs are generated.

To this end, Prandtstetter et al. (2021) calculate simulations using models conducted as part of the alBOX research project. Depending on the parameters "rate of successful first deliveries", "rate of recipients using parcel lockers", "rate of collecting parcels exclusively" and the selected region in combination with the corresponding modal split, distances travelled, and CO2 emissions of delivery traffic are determined for each scenario. A comparison of the results shows that parcel lockers can significantly help to reduce CO2 and achieve distance savings if their location can be easily integrated into the delivery process.

2.1 Comparison of existing forms of parcel lockers

Various systems exist for the delivery of parcels when recipients are absent. Those pick-up points for parcels are structurally bound to a location and have a particular spatial catchment area. They handle the delivery process of parcels without direct contact between the delivering company and the recipient. In a summary of national and international reception and dispatch systems, a distinction can be made between time-bound pick-up points and time-independent locker systems.

Time-bound pick-up points differentiate between directly at the residence or work located ones and those that are public and staffed. Pick-up points for parcels can be provided by partner shops of the CEP services or operated by the particular CEP services. The principle of the CEP partner shop is linked to existing infrastructures and is based on the time-efficient drop-off and pick-up of parcels. The integration of this process into the recipient's daily consumption routine is essential.

Building-integrated, time-independent parcel locker systems at the place of residence are a new dimension of shipment consolidation. The delivery of parcels is completely decoupled from the presence of the recipient and staff. Recipients and CEP services can access and process parcel shipments 24 hours a day. Public parcel locker systems can be provided by one CEP service or be operated by several CEP services.

2.2 Development of the mail order business in Austria

According to a European survey on ICT use, the proportion of people using online shopping increased enormously between 2003 and 2019 (Figure 2). Between 2003 and 2015, the target group of 25 to 34 year-olds made the most use of online shopping. However, from 2015 onwards, 16 to 24 year-olds are equally represented, as are people in the 35 to 44 age group. The year 2016 is remarkable because a decline in online shopping is noticeable in all age groups, except for the 25 to 34 year-olds and 65 to 74 year-olds (Statistik Austria 2019).

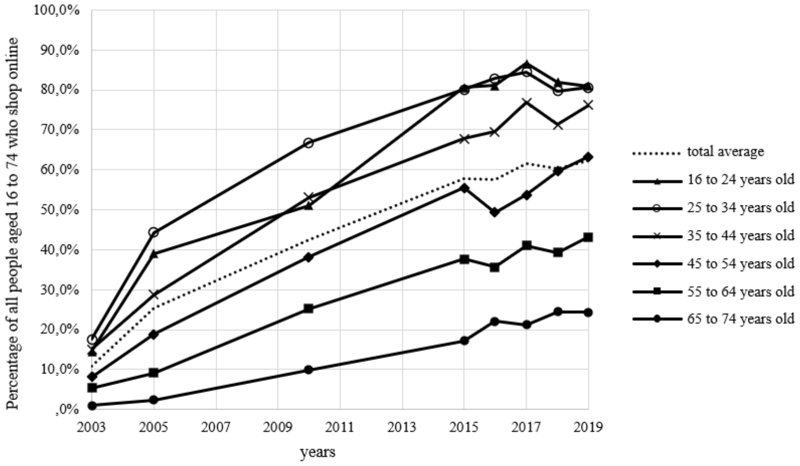

Fig. 2: Development of the proportion of people who shop online per age group; Data: (Statistik Austria 2019), own computation

The proportion of companies in Austria that are exclusively active in online retailing, and thus belong to the ÖNACE category Mail-order and Internet Retailing G4791, is continuously increasing. Figure 3 shows this increase and the percentage change in the number of companies compared to the previous year. After a substantial increase in companies in this sector of +36.33% between 2008 and 2009, the growth rates of percentage change per year are in the range of around 6-11% (Statistik Austria 2017).

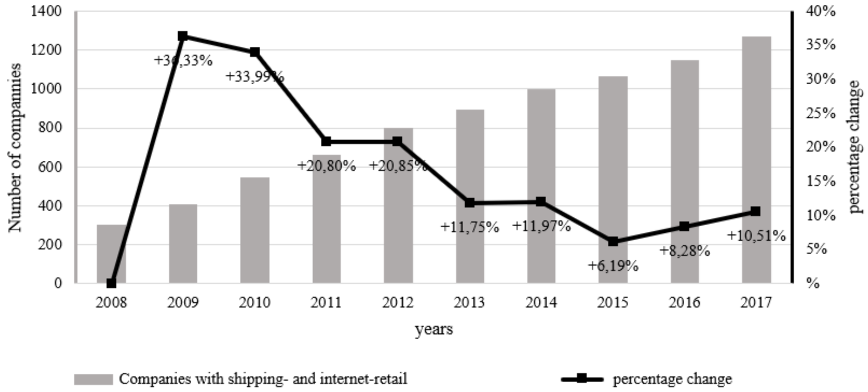

Fig. 3: Development of the number of companies belonging to the ÖNACE category G4791 - mail-order and internet retail trade; Data: (Statistik Austria 2017), own computation

3 WHITE-LABEL PARCEL LOCKERS

In the course of the alBOX research project, vendor-independent ("white-label") parcel lockers were developed as receiving and shipping systems for parcels and objects. Subsequently, the white-label parcel lockers were implemented as pilot operation in the two different target areas (rural community of Kaumberg in Lower Austria and Vienna's 5th district Margareten). In addition, the project investigates which further innovative services of white-label parcel lockers can lead to more overall municipal added values. In order

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for different groups of stakeholders to use the white-label parcel lockers, the interests of the recipients, operators, companies, municipal decision-makers, and logistics service providers are taken into account during the whole development process. For example, companies in the catchment area can offer their products and services via the white-label parcel lockers outside of their business hours with the help of the deposit function. The high degree of flexibility and independence between shipper and recipient in a delivery procedure via the white-label parcel lockers enables more efficient route bundling. Moreover, the white-label parcel lockers counteract the disparities in the delivery speed and efficiency of goods that occur in rural areas compared to urban centres.

The white-label parcel lockers currently have dimensions between 460 x 130 x 650 cm and 460 x 730 x 650 cm. They are weatherproof and designed to be tamper-proof. In Kaumberg the white-label parcel lockers are located outdoors, whereas at the location in 5th district of Vienna they are installed in the stairwell of a residential building. Further, in contrast to Kaumberg, only a closed user group can use the white-label parcel lockers at the location in Vienna. The white-label parcel lockers run autonomously and can be operated by the recipients and CEP services themselves. So no additional staff is needed to handle the delivery process.

In the context of the pilot operation, only the identified core services are offered. That includes the vendor-independent receipt of parcels and the deposit of items between private individuals or companies. For this purpose, each customer receives a personal parcel locker number after registering online. In the course of an order process, the address of the parcel locker location and the personal parcel locker number is entered. After successful (parcel) delivery, customers receive a five-digit pick-up code per e-mail. This code is entered directly on the touchscreen monitor of the parcel locker installation to open the parcel locker. After the parcel has been removed, the compartment is closed again and is ready for the following delivery process. A transfer order is created via the customer's account on the provider's website to deposit items for other people. With this code, the compartment can be locked and opened again within a specific time.

3.1 Pilot operation rural community of Kaumberg, Lower Austria

Kaumberg, one of 12 municipalities located in the Triestingtal valley in Lower Austria, has a cadastral area of 4,303.7 ha, with a share of forest land of 63.52%. The municipality is served by the Hainfeld Road B 18, which runs from the Vienna Basin via Günselsdorf and Leobersdorf (connection to A2) to Traisen (Mostviertel) and connects the Triesting Valley with its municipalities Berndorf, Pottenstein, Weissenbach an der Triesting, Altenmarkt an der Triesting, Kaumberg, Hainfeld, Rohrbach an der Gölsen, Rainfeld and St. Veit an der Gölsen. By public transport, Kaumberg can be reached by train in combination with the Postbus or the taxi business Trixi. When looking at the population development, an increase of approx. 73% to 1,011 inhabitants in 2017 can be recorded since 1991. Of these, 623 inhabitants are in the 15-60 age group (Amt der NÖ Landesregierung 2019). The white-label parcel lockers are installed in the market square area at the address Markt 13, 2572 Kaumberg.

3.2 Pilot operation Vienna's 5th district Margareten

Margareten is the fifth district of Vienna and is located southwest within the Vienna Gürtel. It is densely built-up and very well connected to the high-level transport network by public transport, e.g. underground line 4. The district boundaries cover an area of 201.1 ha, of which 129.3 ha are subject to building land use. 8.8 ha are used as parklands, and 63 ha are used for transport. The population increased to 55,405 inhabitants between 2009 and 2019, which means an increase of 5.9% within the last ten years. Of these, approximately 27,000 residents of the municipality of Margareten have a migration background in 2019. The social infrastructure within the district is cosmopolitan and has a wide range of medical care as well as educational institutions (Stadt Wien 2020). The white-label parcel lockers were installed at the address Grohgasse 5-7, 1050 Wien Margareten. The location is about 350m walking distance from the underground station Pilgramgasse (U4).

4 METHODOLOGY

The objective is the comprehensive, integrative and experimental piloting of vendor-independent locker systems that can be sustainably integrated into the cityscape. For this purpose, various methods will be used to interview different stakeholders about the delivery situation on the last mile and the role of the white-label parcel lockers presented in the project. It will be determined how and which ecological, economic and social effects white-label parcel lockers can achieve on a long-term level. The observation period of the entire pilot operation is 12 months from 01.07.2019 to 30.06.2020.

4.1 Evaluation of the quantitative user data to detect the actual use of the white-label parcel lockers

For the examination of the actual usage, the main focus is on evaluating the quantitative usage data that is continuously collected by the software. Further, the customers provided personal data during registration for the creation of a customer account.

The datasheet was reviewed to identify outliers, test or spam accounts to exclude them from the evaluation. Data records were declared as outliers if parcels were deposited for less than ten minutes or longer than two weeks. The affected records are congruent with the expected assumptions and knowledge about periods in which testing was conducted, or system malfunctions occurred.

Overall, 31% of the registered clients used the white-label lockers in the catchment area of Vienna Margareten and 69% in the catchment area of Kaumberg Lower Austria. The persons participating in the pilot project were predominantly male with a share of 62% and part of the age groups covering the ranges 21 to 40 years. Of all registered clients from the catchment area of the white-label parcel lockers at the pilot location Kaumberg, 93% of the persons directly reside in the cadastral municipality of Kaumberg. In contrast, at the pilot location in Vienna Margareten, the parcel boxes are only accessible to delivery staff, residents of Grohgasse 5-7, 1050 Vienna, and to employees of the nearby Storebox Holding GmbH.

4.2 Qualitative survey of the usage behaviour and experiences of the participating users

Within the framework of the qualitative surveys, information on user experiences and user behaviour could be generated. For this purpose, a workshop was conducted among so-called heavy users (above-average number of parcel deliveries) on 29.10.2019 in Kaumberg. Only male users participated, who were between 26 and 40 years old. The majority stated that they have an irregular or flexible daily schedule. For this reason, the white-label parcel lockers are willingly accepted, as they are independent of the opening hours of the postal partners. However, during the workshop, experience reports were also shared that the service has already been tried out by older generations together with the workshop participants.

From May to June 2020, a six-week online survey was conducted among registered participants. A total of 34 people out of 65 contacted persons participated, resulting in a response rate of 52.3%. Of these, 2/3 stated that they use the white-label parcel lockers at the pilot location in Kaumberg Lower Austria, and 1/3 use the white-label parcel lockers in Vienna Margareten. A similar proportion is also found among the actual, registered users. In July 2020, 69% of the users resided in the catchment area of Kaumberg, and 31% of the users resided in the catchment area of Vienna Margareten. Of these, 50% were between 24 and 34 years old. The gender ratio among the participants is balanced at 50%. Furthermore, 90% of the participants are employed and just over half state that they have a regular daily routine on weekdays. The household size of the participating clients is predominantly composed of 2 people over the age of 18.

In the course of the implementation of the white-label parcel lockers, a service hotline was set up. The hotline can be called to communicate support messages, wishes and suggestions. After a large number of open questions had already been answered during the workshop, only a few messages were received via the alBOX service hotline.

4.3 Qualitative interviews with other stakeholder groups

To assess the relevance and potential of white-label parcel lockers, several interviews with other stakeholders were conducted. For example, experts from the fields of municipal development and logistics, e-commerce, entrepreneurs in the catchment areas of the white-label parcel lockers and drivers of the CEP providers who already used parcel lockers, administrative functionaries of Lower Austrian municipalities from different spatial typologies (Statistik Austria 2016) were interviewed. The interviews were executed by telephone and in person.

5 RESULTS

The implementation of the white-label parcel lockers is about testing a new technology, initially in the area of parcel delivery. The service was tested primarily by people in the age groups 24 to 44, of whom 62% of the registered participants are male. However, the gender ratio is balanced in the course of the survey of usability and user experiences. Even though only a small percentage of registered customers are over 64 years old, reports from the workshops show that people from the 64+ generation use the white-label parcel lockers. In the further development of the white-label parcel lockers and additional services, the idea of an inclusive service design should definitely be pushed in order to create added value for as many stakeholder groups as possible so that no social groups are excluded.

The workshop's results in Kaumberg in October 2019 differ slightly from the online survey in May/June 2020. However, it should be noted that the online survey surveyed a significantly larger group of people and not only heavy users from Kaumberg as in the workshop in October 2019. As a result, the trends in the data are comparable but significantly more differentiated. Furthermore, the workshop in October 2019 in Kaumberg did not record the detours or time spent collecting parcels from the WLP, in contrast to the much more comprehensive online survey from May/June 2020. With the possibility of receiving products via the white-label parcel lockers, customers' usage behaviour, time, and distance efforts changed.

5.1 General situation of distribution logistics in the target areas of the pilot operations

In October 2019, 75% of the surveyed heavy users stated that the parcels would be deposited in a parcel shop in the case of an unsuccessful delivery attempt. However, in the survey in May/June 2020, 29% of the participants from the catchment area of Kaumberg stated that this option is not desired or not satisfactory. In the workshop in October 2019 in Kaumberg, all participants said that without the option of having parcels delivered via the white-label parcel lockers, problems frequently arise on a scale of 1 to 4 (always - frequently - rarely - never) due to absence during delivery by the CEP service.

In the case of an unsuccessful first delivery attempt, various options for depositing parcels are possible. When asked about the frequency of delivery problems, only 3% of the survey participants stated that problems never occur. In contrast, 53% described regular delivery problems (6% almost always and 47% frequently) when the recipient is absent. In the case of an unsuccessful first delivery attempt, the parcel is usually collected in the immediate vicinity of the delivery address by about one-third of the participants, but 67% have to make a trip to a pick-up shop or a post office. In the online survey from May/June 2020, it was asked which locations are not desirable to deposit parcels from the recipients' point of view.

It should be noted that all respondents selected at least one inappropriate deposit location (Figure 4). In order to categorise the reasons why the stated deposit locations are undesirable, the qualitative statements were summarised in the course of a qualitative content analysis and thus divided into the respective superordinate categories (Mayring 2015). The superordinate categories are composed of the previously queried deposit locations and were then supplemented with subcategories, which were defined inductively based on the qualitative statements (Döring et al. 2016).

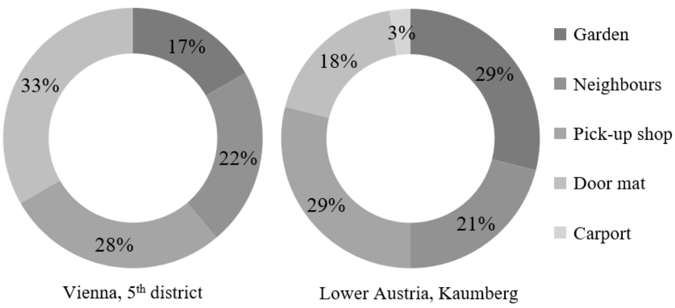

Fig. 4: Locations that are inappropriate for a parcel deposit from the participants' point of view (online survey May/June 2020)

Figure 5 should therefore be read so that the size of the rectangles in the graph represents the shares of the categories in the total number of justifications. It should be noted that each participant gave at least one reason. This shows which reasons occurred most frequently in relation to the others in connection with the superordinate category.

For example, a total of 33.3% of the statements referred to the fact that leaving the parcel in a parcel pick-up shop is undesirable. In this context, the necessary detours are a point of criticism for more than half of the participants, and for around 29% the limited opening hours are a reason why deliveries via a parcel pick-up shop are not desired. In the two categories "garden" and "door mat" the place of deposit was declared inappropriate in both cases due to the risk of theft. Furthermore, it was pointed out several times that dogs could carry away or destroy the parcels. Leaving parcels with the neighbours is inappropriate for the customers because they do not know them, or the possible pick-up time is very uncertain. Some described that the additional effort for the neighbours and for themselves is too great to accept the parcels.

Overall, the survey of the current distribution situation shows that it must be classified as problematic. The situation of the current range of options for depositing parcels is not satisfactory and can not be seen as a solution, but rather the lesser of two evils.

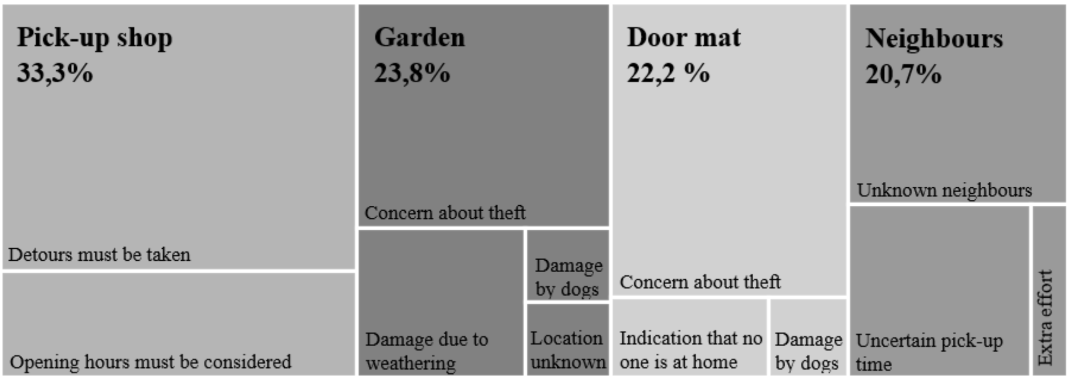

Fig. 5: Reasons for the undesirable deposit locations (online survey May/June 2020)

5.2 Analysis of delivery times at the target areas

The analysis of delivery and pick-up times is based on the quantitative usage data, which is permanently and automatically recorded by the white-label parcel locker system. Figure 6 clearly shows that the delivery of parcels by the CEP service takes place in very different periods than the collection of parcels from the white-label parcel lockers by the recipients. In Kaumberg, most deliveries are made between 08:00 and 10:00 in the morning and in Vienna between 11:00 and 13:00. The collection of the parcels by the customers, on the other hand, takes place in the afternoon or predominantly in the period between 17:00 and 20:00. Especially at the pilot location in Kaumberg, the parcels are also regularly collected until 22:00. A further evaluation shows that the distribution of delivery and collection regarding the days of the week is almost equally distributed at both pilot locations on weekdays and Saturdays. Only on Sundays and public holidays are there hardly any deliveries or collections.

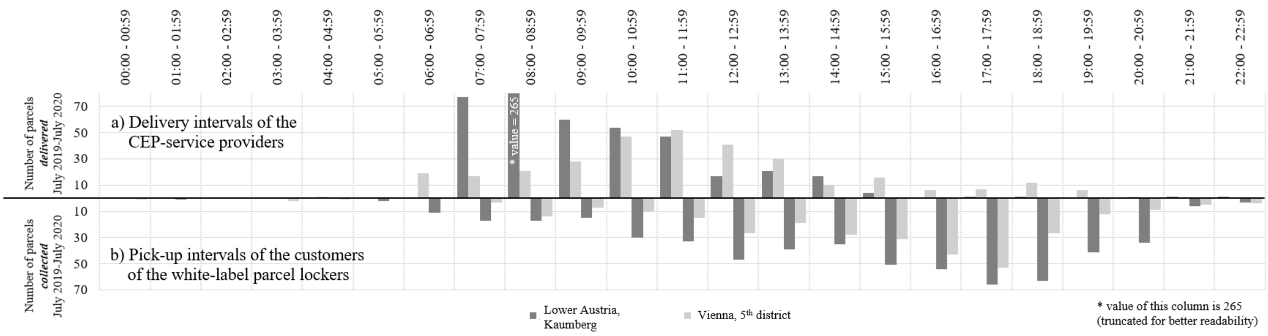

Fig. 6: Comparison of delivery (a) and pick-up (b) intervals at the pilot locations in the period July 2019 to July 2020

5.3 Analysis of the required detours to handle the delivery process at the target areas

The delivery situation without white-label parcel lockers leads to detours up to 15km, especially at the pilot location in Kaumberg. There the detours are covered by almost three-quarters of the people by car to pick up the parcel from a parcel shop. Furthermore, the pick-up is strongly restricted by the given opening hours, which causes a significant delay in receiving the parcel. In the catchment area of the pilot location in Vienna Margareten, the detours in kilometres are less decisive, but rather the additional time required for the recipients when a parcel has to be collected from a parcel shop.

Especially the results of the online survey from May/June 2020 shows that the distance to the nearest parcel shop from the respondents' homes is an important distinguishing feature of the catchment areas. In the area of Vienna Margareten, 55% of the respondents stated that the nearest parcel shop was within 500m of their place of residence and that they did not have to make a detour of more than 5km. Whereas in Kaumberg, the nearest parcel shop is 1 to 5 km away from the recipients' homes for 57%, and 14% have to travel more than 10 km to reach the parcel shop.

When considering the detours that are required to pick up a parcel from the parcel shop, this amounts to an average of 7 minutes in Kaumberg. On the other hand, in Vienna, the average detours take 17 minutes and over 90% of the people walk and none of the survey participants goes by car.

With the option of delivering a parcel via white-label parcel lockers, the diversions in minutes to pick up a parcel is reduced at both pilot locations. In Kaumberg, the average detour is reduced to about three minutes and in Vienna to less than one minute, as the parcel wall is located in the respondents' homes.

Furthermore, the information on the forms of mobility predominantly chosen for collection in the Vienna catchment area changes to a lower proportion of walking and the omission of public transport. As a result, the car is increasingly used. This may be because no extra detours have to be made, but the white-label parcel locker is on the way to work, for example, and no other walk is required. For the catchment area of Kaumberg, it is true that at the loss of mobility by car, parcels are picked up on foot about 10% more often. At the same time, the total time spent is reduced significantly.

5.4 Parcel volume during pilot operation

In contrast to the number of registered persons, only about 56% used the white-label parcel lockers as a delivery option. At the location in Vienna, 17 active users can be recorded, who had an average of 18 parcels per person delivered via the WLP from July 2019 to July 2020. This means an average value of 4.7 parcels delivered per month for the most active user and an overall average of 1.4 parcels per month per active user at the WLP location in Vienna Margareten.

At the pilot location in Kaumberg, Lower Austria, a total of 25 people used the parcel wall as a delivery option at least once in the period from July 2019 to July 2020. With 22.8 parcels per active customer, a higher average value was achieved than at the pilot location in Vienna. The maximum value of 88 parcels delivered for this registered person means that an average of 6.7 parcels per month were delivered via the white-label parcel lockers from July 2019-July 2020. Overall, an average of 1.7 parcels per month per registered person is achieved at the Kaumberg Lower Austria site in the period July 2019 to July 2020 inclusive. It must be emphasised that the median for both pilot locations is 15 parcels per active customer within the period of one year, if the outliers with over 60 parcels per year are eliminated.

The chronological analysis of the delivered parcels per month from July 2019 to July 2020 shows the highest delivery rates in October, November and December 2019 (Figure 7). At this point, it should be noted that since November 2019, the number of registered customers has remained almost constant at approximately 70 people. A further increase in the number of parcels delivered via the white-label parcel lockers occurred at both pilot sites in March and April 2020. This period was particularly affected by the Covid-19 pandemic and the associated restrictions on local trade due to the Austrian federal government's lockdown measures. The strong increase in delivery amounts in September 2019 at the Vienna location is due to the equal increase in newly registered customers in this month.

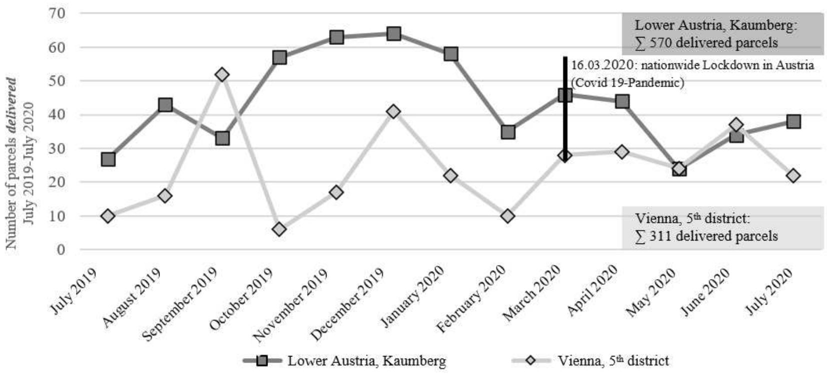

Fig. 7: Number of delivered parcels per month via the white-label parcel lockers in the perios July 2019-July 2020

5.5 Usage and ordering behaviour of participants in the target areas

In order to evaluate the usage and ordering behaviour, various situations were assessed by the customers on a scale from "strongly disagree" to "strongly agree". Almost 80% of the participants from the Kaumberg catchment area stated, both at the workshop in October 2019 and in the online survey in May/June 2020, that the white-label parcel lockers have no negative influence on the local suppliers and small shops/service providers in the municipality. All participants can reduce the time and distance spent compared to the delivery situation without white-label parcel lockers. For the Vienna location, the result is similar, but significantly more people (almost 40%) stated that substituting local shopping due to the white-label parcel-lockers is not out of the question. The possibility of making deliveries via the white-label parcel lockers prompts most of the participants to order more items online. The range of product groups ordered online is also expanding to include product categories that tend to be more expensive, such as computers and car accessories as well as electronic items. The Sankey diagram in Figure 8 shows how delivery frequencies per category have changed, indicating that in most cases the change per person tends towards a more frequent delivery number per unit of time.

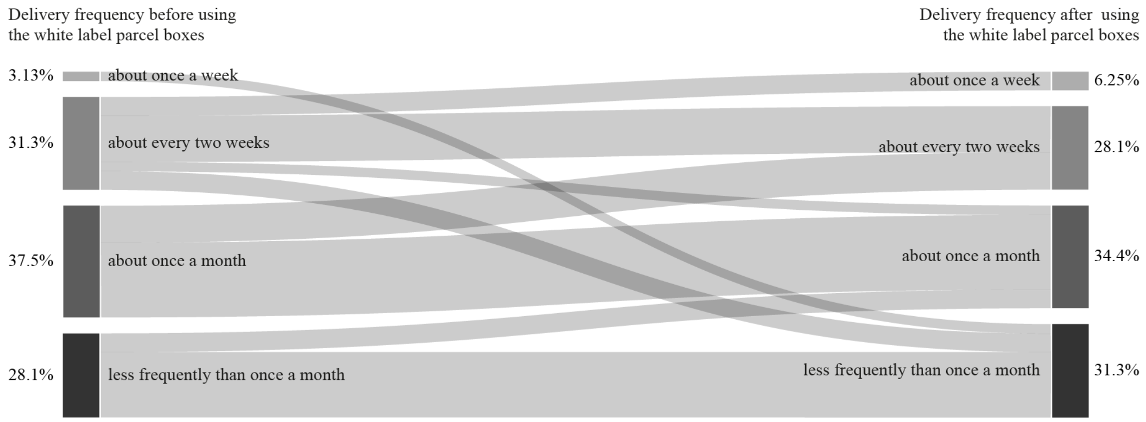

Fig. 8: Frequency of deliveries by CEP services before and after the possibility to receive orders via the white-label parcel lockers (online survey May/June 2020)

5.6 SWOT-Analysis of the white-label parcel lockers

In order to assess the strengths, weaknesses, opportunities and threats of the WLP, interviews with people from different stakeholder groups were conducted in addition to the surveys and workshops related to the pilot operation. The resulting findings are summarised in a SWOT analysis (Figure 9). SWOT refers to the fields of action Strengths - Weaknesses- Opportunities - Threats. (Krogerus et al. 2017).

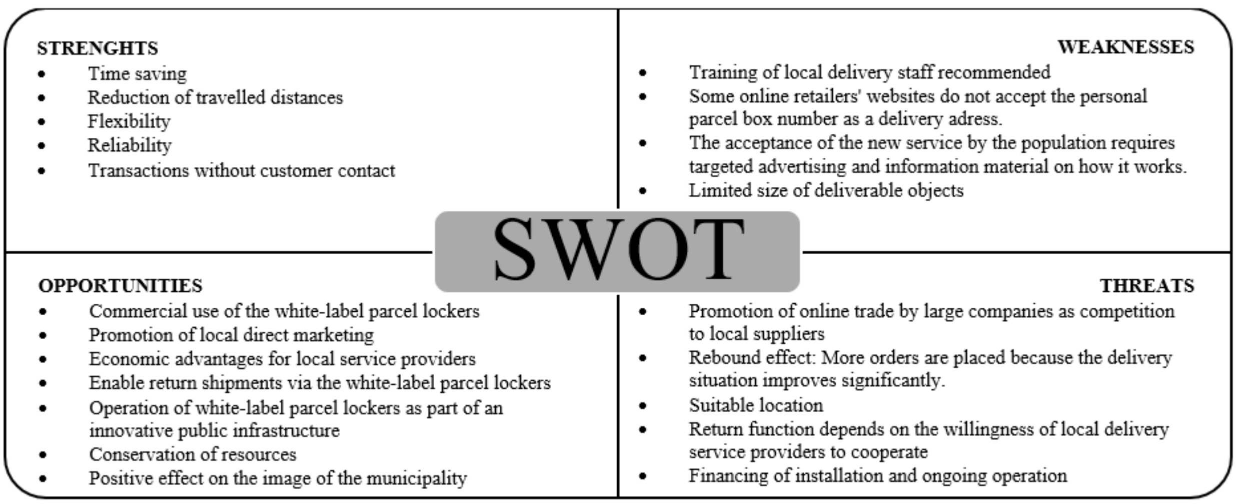

Fig. 9: SWOT analysis of the white-label parcel lockers

For example, more than half of the CEP drivers surveyed, see the use of parcel lockers as a very positive alternative to traditional door/mailbox delivery. Mainly due to the possibility leaving parcels at any time and thus process them faster. Especially for entrepreneurs, the handling of transactions without customer contact and at any time represents a very high added value. By using the WLP as a delivery option, hardly any negative effects can be identified by the customers surveyed.

The interviews with functionaries of the municipal administration and experts of the economy and regional development refer to the economic situation, business landscape, and spatial structure of the municipality. Further, the effects on residents, the environment, traffic and local businesses are discussed. Based on the interviews it is critically pointed out that white-label parcel lockers have to be used carefully so that they do not represent additional competition to the local retail trade. Regarding to the achievable economic added value in the supply chain, it is noted that this requires intensive cooperation with the companies in the catchment areas. In addition, the price/performance ratio must be acceptable to the entrepreneurs. If these factors are met, an increase in the competitiveness of local businesses compared to online business is possible. Finding a suitable location involves a risk and should consider the local scene and cityscape. An opportunity for long-term independent operation is seen primarily in operating the white-label parcel lockers as part of the municipalities' public infrastructure. However, this would require financial support from the municipalities, especially in the course of installation.

Further it is essential for the implementation that the system is easily manageable and easy to use for all groups of people. Customer service must be permanently available to prevent frustration in case of problems. The development of a service for the last mile between the white-label parcel lockers and the residence for people with limited mobility would be desirable. Standards and regulations are necessary for a uniformly functioning system. Finally, the success of the system depends on the commitment of the municipal administration and the active cooperation with local stakeholders.

6 CONCLUSIONS

The pilot operation in the target areas of Kaumberg Lower Austria and Vienna Margareten lasted twelve months from July 2019 to July 2020. In this period the core services delivery of parcels, deposit of parcels C2C and deposit of parcels B2C could be tested free of charge by participants from the catchment areas. A total of 74 people registered during the pilot operation, of which 17 persons were identified as active users at the Vienna Margareten location and 25 at the Kaumberg Lower Austria location. The total number of successfully delivered parcels during this period was 881. Several surveys show that the greatest advantage of white-label parcel lockers is seen in the independence of parcel delivery. Therefore, the delivery reliability and efficiency can be significantly increased. At the same time, a reduction in energy consumption, savings in time and travel costs as well as a reduction in traffic-induced CO2 emissions can be achieved at both pilot locations by shortening the transport routes.

7 FUTURE WORK

The sustainable success of white-label parcel lockers depends on a variety of factors. Identifying these factors and linking them to existing data could enable optimal location decisions using machine learning or AI (artificial intelligence). It is already clear from alBox that location plays a key role in the economic and environmental savings potential. An analysis of alternative forms of financing (keyword PPP) could show a way to enable innovative logistics infrastructure, especially in rural areas. Possible commercial potentials need to be surveyed in order to investigate the economic viability of different locations.

8 ACKNOWLEDGEMENTS

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reviewed paper

Applying 3D Printing as a New Building Technology: Potentials and Challenges in the Egyptian Context

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1 ABSTRACT

In the context of the Fourth Industrial Revolution, the world of architecture and construction is being changed by new technologies with opportunities and limitations. Large-scale 3D printing (3DP) technology has recently been introduced as a new building technology to improve productivity and quality. Recently, worldwide stakeholders started experimenting with the technology substitute of traditional. This is due to achieve potentials benefits, such as increased accuracy, customisation, and design flexibility. Additionally, it reduces wasted material, costs, manpower, and printing time. However, these initial investigations are very fragmented at the time of the study. There are different views on where technology can be directed and a large gap between ideas and their applications. 3D printers will be used primarily to print buildings for low-income housing and emergency housing in developing countries such as Egypt, while most of the buildings that have been built were executed in developed countries. Therefore, it is necessary to understand the international applications and challenges of 3D printing. This paper was set out to give insight into applying 3D printing as a new building technology on an international scale and assessing the applicability potentials and challenges in the Egyptian context; through 1. gathering and analysis of documents and references of opportunities and limitations of 3D printing factors(design, environmental, social, and economical); 2. qualitative data analysis.The descriptive study of international examples outlines the factors used to assess the international examples with anassessment matrix and analysethem within the Egyptian context. It shows that projects divide internationally into projects which invest in optimising the performance and others which are optimising the production according to different characterisations. There are greatpotentials of using 3D printing in Egypt, but it needs to be adapted to numerous challenges in achievingits maximum potential.

Keywords: 3D Printing, Building technology, Architecture, construction, Egyptian context.

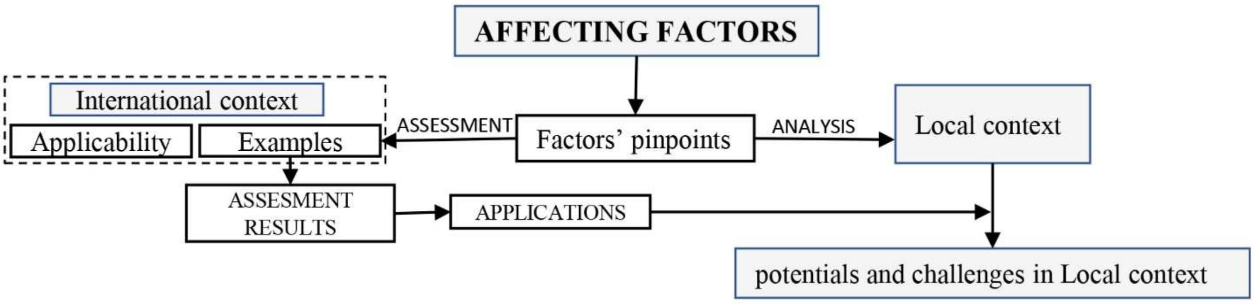

Fig 1The research flowchart

2 INTRODUCTION

The world is confronted with many challenges that have the potential to impact the well-being of societies severely. Climate change, rapid urbanisation, and the digital revolution are among the most pressing of these challenges(Renz et al., 2016). The creation of sustainable, cheap, durable, customisable, recyclable, and even environmentally reparable houses is a critical focus of recent research.The new wave of marketneedsduring the current crisis requiresasustainable economic approach to saving energy which will reduce the cost of housing and improve the quality of continuous production(Wu & Wang, 2016). Regarding the many social issues that must be considered. Fear of job loss is the main problem (De Schutter et al., 2018).

The construction sector plays a key role in any country's economy. According to a report published by the World Economic Forum, the construction industry currently accountsfor 6.2% of Egypt's GDP,and a 1 % increase in productivity around the world could save a lot in construction costs (Forum, 2018). "The promise of large-scale 3D printing (3DP) is that it can collapse these limitations, which is a fundamental shift in the relationship between architecture, construction, and manufacturing"(Hager, Golonka, & Putanowicz, 2016).

In Egypt, the traditional and most common way of building is witha load-bearing structure and a skeleton framework which requires transport of heavy materials (bricks, cement, sand, and aggregate) to the construction site where on-site wall construction is done with mixed concrete components and manual bricklaying. This approach results in the use of a large number of workers, a lengthy procedure, a high percentage of errors, waste of materials, unnecessary expense, and CO2 emissions resulting from long-distance transportation.

3 AFFECTING FACTORS IN APPLYING 3D PRINTING

3DP technology offers many opportunities for architecture and the construction sector, but also has limitations which determine its actual implementation in many aspects, concerning design, environmental, social and economic factors (Ma, Wang, & Ju, 2018; SKÖLD & VIDARSSON, 2015; Yeh & Chen, 2018).

	Opportunities	Limitations
Design-Related Factors	Production of specialised moulds (Camacho et al., 2018).	Conventional design approaches are not suitable for printing.
	3D printing technology will push design to change(SKÖLD & VIDARSSON, 2015).	The size of the built object is limited by a gantry or cable-suspended approaches
	It can also help build "smart structures" which include various properties(Camacho et al., 2018).	The building elements, doors windows, pipe systems, wires, and horizontal components were prefabricated and considered to reduce the absolute free flexibility in mass customisation.
	Complex geometries without a tool and less waste material(Camacho et al., 2018).	
	Improving the quality and reliability of elements by eliminating human errors.	Buildings today are limited to producing concrete-based load-bearing components.
Environmental-Related Factors	Some benefits of this technology can helpin adapt and mitigate climate change (Ding, 2008).	Limitation in material flexibility means that only specific material can move through a machine and can still be used in the desired manner without damaging or deforming the specific machine (Perkins & Skitmore, 2015).
	3D printing uses a significantly smaller amount of building materials than conventional buildings.	
	Reducing formwork, and waste material, (Camacho et al., 2018).	
	Decreasing the use of raw materials and removal and recycling from sites(De Schutter et al., 2018).	
	Using reused or recycled or rapidly renewable materials (De Laubier, Wunder, Witthöft, & Rothballer, 2018).	
	Decreases the emission rate of CO2 (De Schutter et al., 2018).	
	3D printing works on electricity and saving large quantities of fuel (Perkins & Skitmore, 2015).	
Social-Related Factors	Reduce the demand for professional craft while opening up new possibilities for the workforce with various skills (Camacho et al., 2018).	One great fear of a rise in the concept of automation is that workers will lose their jobs (De Schutter et al., 2018).
	Reducing exposure to harsh environments, reducing accident rates (Camacho et al., 2018).	Deal with many organisational and managerial obstacles (Yeh & Chen, 2018).
	Add more specialised suppliers (changing in the supply chain) (SKÖLD & VIDARSSON, 2015).	Directly influence already existing customers and suppliers (SKÖLD & VIDARSSON, 2015).
	For customers, 3DP. Allows end-users to adapt their house design to their own needs.	The adoption of 3DP. Was hampered by bureaucratic factors (De Laubier et al., 2018).
	For a new generation, completely new jobs that do not currently exist when they enter employment in the future.	The construction sector is one of the most conservative fields which is slowly changing and adapting with a new technology
Economics-Related Factors	Over the years, the cost of 3DP has decreased considerably (Perkins & Skitmore, 2015).	Economic unattractiveness of expensive automated equipment.
	3DP is cost-effective when it comes to a custom product with a complex form (De Schutter et al., 2018).	The unsuitability of the available automated fabrication technologies for large-scale products.
	3SP can manufacture complex geometries without additional cost (De Schutter et al., 2018).	Requires significant start-up costs and specially trained operators (Perkins & Skitmore, 2015).
	3DP decreases service staff costs (transport, accommodation, taxes, etc.)(Camacho et al., 2018)	The costs of machines arebased on print speed as well as material (Yeh & Chen, 2018).
	There is no waste or waste requiring removal and recycling from building sites (Camacho et al., 2018).	High initial costs for equipment and ongoing maintenance costs (Perkins & Skitmore, 2015).
	Reducing formwork labour costs, temporary moulding, and material costs from 35-60% of the total cost (Camacho et al., 2018).	The building elements, doors, pipe systems, and horizontal components which were prefabricated to fit custom products will increase the cost.
	The system as a whole will be capable of reducing construction costs by close to 30 % (Perkins & Skitmore, 2015).	The software packages would increase the cost (Perkins & Skitmore, 2015).
	Adding additional value (e.g., flexibility and scalability, mass customisation, thermal insulation, materials reduction, and time reduction) at no additional cost. (Camacho et al., 2018; Lim et al., 2012; Perkins & Skitmore, 2015).	In addition, automated systems operating on dirty worksites outdoors would need frequent cleaning and maintenance downtime (Perkins & Skitmore, 2015).

Table 1 Opportunities and limitations of affecting factors.(sources are cited for each point)

4 METHODS

Firstly, analysis and overview of documents for international applicability to determine the spread worldwide; secondly,descriptive study of international examples.

Fig 2 The world map showing international 3DP examples: countries which developed and export technology countries which import technology, develop and adopt it, countries which import technology (Compiled by the authors, sources are cited for each example)

TECLA habitat, Italy	YHNOVA H., France	Winsun projects, China	Residential H., Russia
On-site –2019 WASP	On-site - 2017 Batiprint3d	Off-site - 2014 Winsuns 3DP.	On-Site -2016 3DP.: Apis Cor
Clay (mould) + bio-materials	Polyurethane (mould) + concrete	Concrete with glass fibre	Concrete material
The circular housing model, created using entirely local reusable, recyclable materials moving towards eco-housing, designed to be resilient to any climate and energy-efficient (Chiusoli, 2019).	It improved the energy performance of construction, and with its zero waste, raw materials, and decreased transport, the project's ecological footprint was lowered (Furet, Poullain, & Garnier, 2019).	The highest 3DP building was prefabricated elements and assembled on a site. 10 houses in Shanghai, Winsun reduces the overall construction time by 50% to 70%, labour by 50% to 80%, and materials by 30% to 60% (Hager et al., 2016).	Ease of transporting systems, Only two people are required for operation and material supply, less time just 24 hours minimise human errors, It consumes only 8 kW of power, and The cost of the building is $10,000 (Craveiroa et al., 2019).

1. AMIE, USA	2. DFAB H., Switzerland	3. Grotesque – Switzerland	4. Fluid Morphology, Germany
Off-site -2015 Ornl'sBaam	Off-site 2019 3D Sand P.	From 2013 3D sandstone	Off-site - 2020 3DP Delta Towe
Steel rods + glazed materials	Concrete material	Sandstone material	Polycarbonate material
Many functions of a conventional wall system structure, insulation, moisture barriers, and cladding. This could lead to zero-waste construction, reduced material (Craveiroa et al., 2019).	An 80 m² lightweight concrete floor slab as part of the House, its highly complex structures are as easy to create as a solid block. In addition, time on site was reduced (Redaktion, 2018).	The computer was a partner in design who proposed an endless number of permutations. This highly ornamental structure is designed entirely by algorithms (Dillenburger, 2017).	The facade is divided into panels, each measuring 1 m². While textural waves and bulges create shadows. Thin integrated tubes allow air circulation from one side to the other, ensuring the best ventilation (barandy, 2019).
5. Future Office,UAE	6. Multi-use B., UAE	7. 3DP. Village, Mexico	8. 3DP. House, Saudi Arabia
Off-site 2016 Winsun3DP. (china)	On-site-2019 Apis Cor (USA)	On-site -2017 ICON's 3DP. USA	On-site2018 Cybe (Netherlands)
(SRC), (FRP), and (GRG)	Concrete and gypsum	Cement mixture	Cement mixture
Fully functional building featuring electricity, water, and systems. It took 17 days in China and was shipped and installed in 2 days. It reduced labour costs by 50 % to 80% and construction waste by 30% to 60% (Craveiroa et al., 2019).	Apis Cor developed a gypsum-based material to run through the printer, which was sourced for a local producer. Reduction in labour and, therefore, reduction in cost (Molitch-Hou, 2020).	In a remote area in Mexico, The printer has been created as a solution to minimise homelessness that caters to the ever-changing social housing sector and housing crisis (Grace, 2019).	Invest in advantages in construction sites from Cost and standardisation of quality, waste minimisation, speed of implementation, reduction of work accidents, and the possibility of implementing forms (MinistryofHousing, 2018).

Table 2: selected International Examples (Project name, on-site or off-site, 3d printer name, material, description, and source)

4.1 International Applicability Overview

The analysis of the international spread of 3DP indicates that there are three categories of countries (as shown in figure 1) that deal with 3DP. Firstly, Countries that developed the machine concept, process, and materialsand are exporting 3D, such as the USA,Netherlands,UK, Italy, Switzerland, Russia, Germany, Slovenia, China, France, Denmark, Australia, Spain, and Belgium (barandy, 2019; Camacho et al., 2018; cobod, 2019; Craveiroa, Duartec, Bartoloa, & Bartolod, 2019; De Laubier et al., 2018; Valdivieso, 2019).Secondly, countries which import technology, are adapting it andseeking to invest in other experiences with local requirements such as the Philippines from the USA, Thailand from Italy, UAE from USA(Camacho et al., 2018; Craveiroa et al., 2019; De Laubier et al., 2018).Thirdly, countries which import technology, such as Saudi Arabia from China, Morocco from Spain, Mexico, and El Salvador from the USA, and Malawi from Denmark(3dprint, 2020; De Laubier et al., 2018; Valdivieso, 2019; worldeconomicforum, 2019).

Previous cases show that many countries were involved in developing 3DP technology and materials usedfor it. 3DP technology is capturing increasing international attention in the building technology field. As shown in fig 2, the technology is distributed all over the world, in developed and developing countries.

4.2 InternationalExamples

To date, there have been many experiments in the field of architecture and construction spread across the world, as shown in Fig 2 regarding mainly the construction of whole (small) buildings with materials such as concrete, bioplastic, and clay, also, manufacturing Elements and Details. 12 international Examples were selected to study aspects based on differences in the project approach.

Fig 3 Selected international Examples (Compiled by the Researcher, Sources are cited for each Examples)

5 RESULTS

The results are divided into three sections. Firstly, outlining the key factors based on the analysis of the opportunities and limitations of affecting factors. Secondly, assessing the strength of the factors of each example with an assessment matrix and thirdly, analysing the characteristics of the affecting factors in the Egyptian context.

5.1 Key affecting factors

Outline of the keyfactors derived from the opportunities and limitations of affecting factors in part 3.

Design Related Factors	Environmental Related Factors	Social Related Factors	EconomicsRelated Factors
Design flexibility Structure functionality Design optimisation Quality issues	Climate change adaptation Lower resources Materials Reduced materials Raw materials Reused or recycled Decreasing the emission of CO2 Less total energy	Reducing workforce Jobs shifting paradigm Safety in extreme environments Fewer accidents rate New job opportunities	Initial cost Reducing materials cost Reducing labour cost Cost reducing Unique architecture Mass customisation Time-saving

Table 3: Affecting factors' pinpoints(by authors derived from part 3)

5.2 Assessment Matrix of Selected Examples

Assessment of the strong points of each example measured by achieving factors at three levels: fully present, partially present, and does not exist as shown in fig 4.

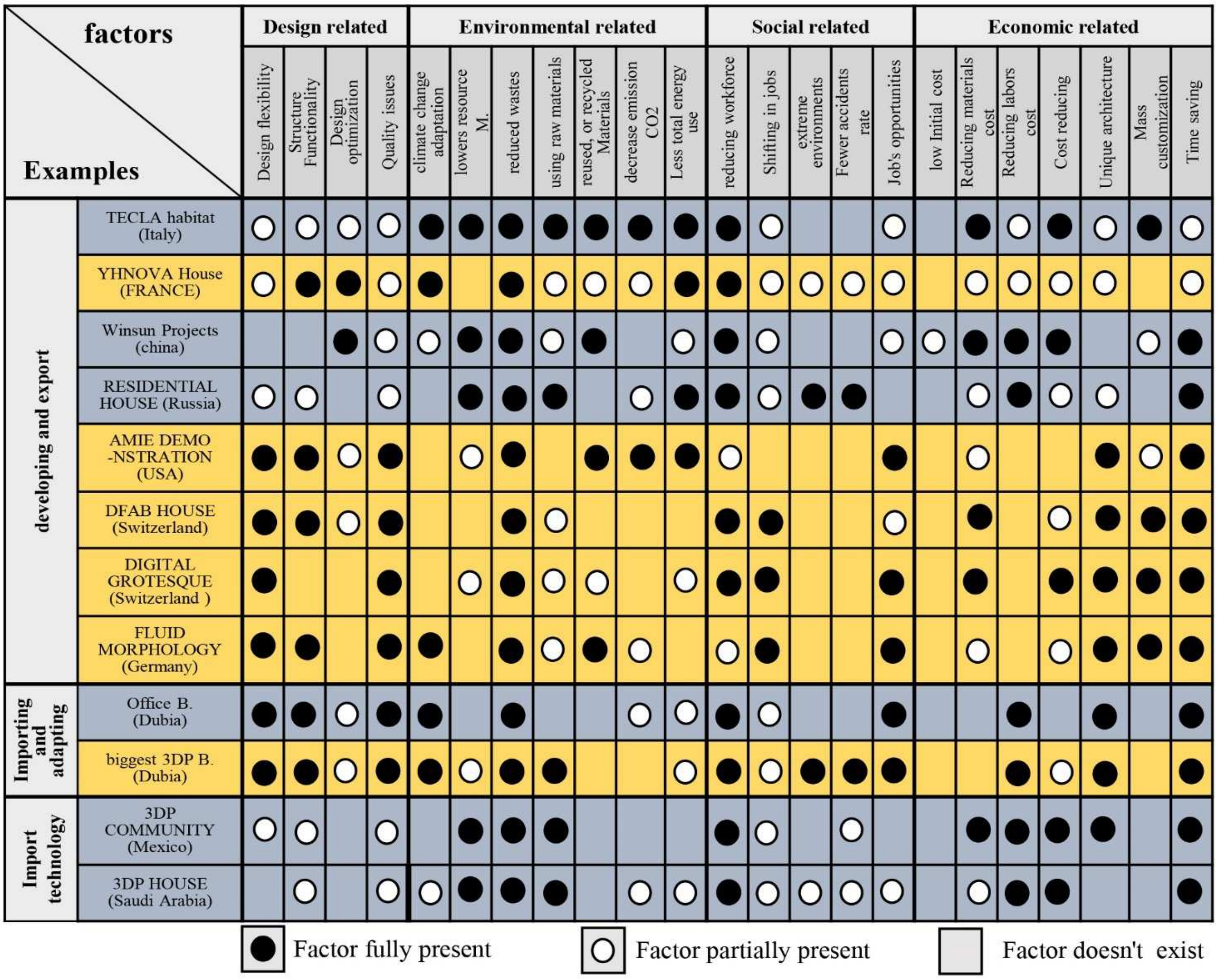

Fig. 4: Assessment matrix for selected international Examples(by authors)

5.3 Analysis of Assessment Matrix

Regarding the strategy of using 3DP, there are two main approaches in the studiedexamples. Optimising the performance, and optimising the production. The former aims to develophigh-performance by analysing the design-related factors and environmental-related factors of printable materials, methods to print unique architecture with structurally optimised shapes; overall,it aimsto achievethe highest possible quality,full customisability both of shape and printed material, and structure functionality. The latter aims at optimising the production, developing technology by considering mainly the economic and environmental-related factors, such as low cost, fast but customised alternativesof traditional construction itwould aim at using local, cheap materials and optimising the construction method in terms of cost and speed. Printing would occur locally (either on- or off-site). Based on the above analysis, the selected examples can be divided into two groups, as shown in table 4.

Examples of Optimising the Performance		Examples of Optimising the Production,	
YHNOVA H., France	Grotesque – Switzerland	TECLA habitat, Italy	Multi-use B., UAE
AMIE, USA	Fluid Morphology, Germany	Winsun projects, China	3DP. Village, Mexico
DFAB H., Switzerland	Future Office, UAE	Residential H., Russia	3DP. House, Saudi Arabia

Table 4: classification of the selected examples(by authors).

The assessment matrix is converted into a visual percentage chart divided into performance and production groups (each group has 6 examples). according to the three levels of assessment: does not exist = 0 X, partially present = 1 X, and fully present = 2 X (whereas X is a fixed number). therefore, every criterionis assessed in 12 X for each group; i.e., the first criterion is the design flexibility in the performance group from the matrix (5 fully present + 1 partially present = 10 X + 1 X = 11 X) therefore, 11 X * 100 / 12 X = 91.7 %, and so on.

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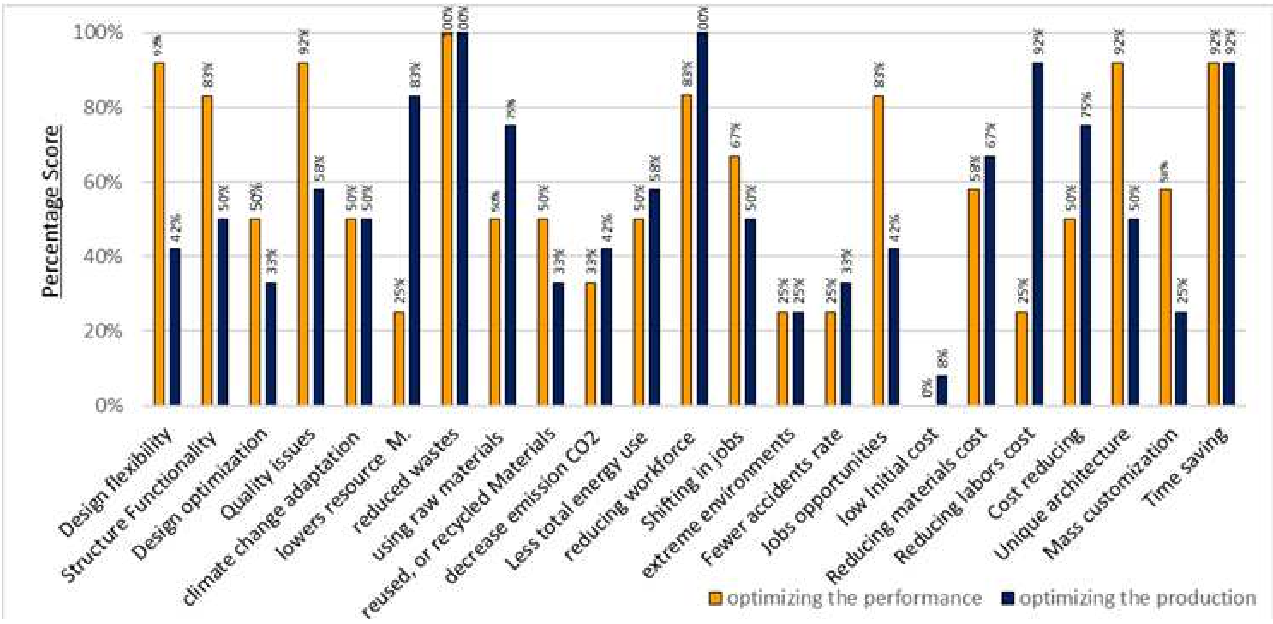

Fig 5: percentage score of assessment criteria in selected examples based on optimizing the performance or the production(by authors).

Although there are still only a few examples around the world, it could be concluded that significant strengthsare found in most of the examples, whether optimising the performance or the production (fig 4): reducing waste in resources and materials, saving time, and reducing the workforce.

The examples of optimising the performance are characterised by:

- Novel forms of design flexibility, a range of customisations and complexity,
- Optimised typology and functionality with high accuracy and quality,
- Developing new applications with new job opportunities,
- Developing a variety of materials, machine layouts, and properties.

On the other hand, the examples of optimising the production are characterised by:

- Mass production buildings by reducing cost and construction time,
- Using in situ resources, reducing material transportation costs and sustainable design solutions,
- Increased accessibility,reduced risks in remote sites and extreme environments.

5.4 Analysis of affecting factors characteristics within the Egyptiancontext

The analysis of the characteristics of the affecting factors within the Egyptian context aimed to determine the potentials and challenges in applying 3D printing in Egypt.

In addition, the construction sector is one of the most conservative fields in Egypt, where building technology development depends on the shareholders who are involved in the current value chain and are avoiding change. Also, regulatory policies have strong technological influences on regulations and building codes. Hampered by bureaucratic factors, integrating new technology into the construction process,which is considered very conservative in changing or development, is very slow. Besides that, there are mainly technological limitations, such as the size of the built object, limited by gantry which determines the options of applicability in Egypt regarding low-rise buildings (ground to ground and two levels), and to the fact that only specific material can move through a 3D printing machine.

Factor	Sub-factor	Characteristics of 3DP factors	The case of Egypt
Design-related F.		Design flexibility Pushing design to change and restrictingregular designs.	As a result of the rapid urbanisation in Egypt, architectural design tends to be more practical and economical. While the architectural flexibility of 3DP technology may push designers to pay attention to environmental considerations and heritage styles.
Design-related F.		Structurefunctionality Building "smart structures".	Opportunity for materials technology. Research &development of printable materials developed locally. Such as desert sand, to add new features suitable for this process.
Design-related F.		Design optimisation Producing specialised molds.	Opportunity to provide flexibility in architectural design, which does not require a standardisation of production elements, saving materials and time.
Design-related F.		Quality issues Increase the execution accuracy.	Egypt is at a medium level of quality due to the size and quality of the workforce, but mistakes are increasing the cost due tothe need for corrections.
Environmental-		Climatechange adaptionand mitigation	The new technology supports thermal mitigation such as wall thickness, the amount of air in the wall section
Environmental-		Fewerresources.	Positive effects to save the natural resources which are the primary source for buildings.
Environmental-		Reducing material waste.	Material waste of timber frameworks averages 13%, and waste of sand is as high as 9% (Garas, Anis, & El Gammal).
Environmental-		Using raw, reused materials	Egypt has many local raw materials suitable for construction, such as sand and clay
Environmental-		Decreases the emission rate of CO_2 remarkable.	Egypt produced 310 m tonnes of CO_2 greenhouse gas emissions in 2016. Thus any reduction in fuel use will be a positive impact (Hannah Ritchie, 2020).
Environmental-		Fewerfossil fuel energyto produce electricity.	This is consistent with Egypt's Vision 2030 to use clean energy instead of fossil fuels.
Social-related F.		Reducing workforce Workers will lose their jobs	This is a threat in Egypt. The construction sector is providing around 3.7 million jobs, representing 20 percent of total workers in the domestic market(according to Planning Minister Hala al-Saeed), although it does not create sustainable or stable jobs, as it is linked to project time (EgyptToday, 2018).
Social-related F.	Jobsshifting	Add more value to the construction phase	It will affect the construction industry, technically, economically, and socially, resulting in the entry of new producers, processors, suppliers, and exporters.
Social-related F.	Jobsshifting	Changing roles and organisational processes.	Using 3D printing In Egypt shortensmany building processes (e.g., design, coding details, training, manufacturing,and marketing).
Social-related F.	Jobsshifting	Impact on supply chain	Using new technology will negatively affect the traditional suppliers in Egypt.
Social-related F.		Reducing exposure to harsh environments.	May be useful in difficult worksite conditions in Egypt, such as the extremely hot desert climate.
Social-related F.		Loweraccident rate Safety in the construction sector, fewer accidents	Alarming statistics indicate that the construction industry accounts for 55,000 fatal injuries each year in Egypt and the construction industry has the highest fatalities and death rates among all industries (ElSafty, ElSafty, & Malek, 2012).
Social-related F.		New job opportunities Reducing the demand for the professional craft.	The traditional labour market has a large number of untrained workers (who do not have a job and work in construction), leading to a shortage of skilled workers, but using 3DP would move technical construction jobs to new opportunities of dealing with technology.
Economics-related F.		High Initial Cost The costs of machines, Specially trained operators, The software packages, Special material types.	Printing technology, like anything new, starts expensive, but over time it is getting more affordable. A machine is a one-time investment that should pay for itself over time replacing computing and healthcare costs. However, the machine cost ranges from 80 000 \$ to 500 000 \$ (Cherdo, 2020), an investment which s the construction market in Egypt would have to bear.
Economics-related F.	ls cost	Reducing materials cost (fewer materials are needed). Reducing waste requiring removal and recycling from building sites.	According to (ECBM),Egypt's exports of building materials, refractory and metallurgy industries was \$1.5 billion during the first quarter of 2020, an increase of 32.8 percent, compared to \$1.15 billion a year earlier.Research indicates that using printing saves between 30% to 70% in materials, which will positively impact the Egyptian economy (egypttoday, 2020).
Economics-related F.		Reducing labour cost (reduces the number and service)	Saving labour costs, transportation, insurance, and health expenses is an economic advantage, especially during a health crises.
Economics-related F.		Reducing construction costs	TheEgyptian construction sector performed strongly during FY 2019, contributing 6.2% to Egypt's GDP. Therefore, any saving in the cost will have a good impact on the economy.
Economics-related F.		Time-savingdue to printers' ability to operate 24/7	Avoiding delays related to deliveries and coordination caused by working requirements for installing utilities will be more cost-effective. One of the main reasons for the high construction cost is delays during the execution period in Egypt.
Economics-related F.		Adding additional value at no additional cost Design flexibility Complex geometries Mass customisation, Thermal insulation, Time reduction.	Value relates to assessing the benefits brought by something regarding the resources needed to achieve it, whichin the case of 3D printing includes design, production, and environmental response, and reducing time without additional cost. In Egypt, using 3DP as new technology is itself consideredto add value.

Table 5: Analysis of the characteristics of the affecting factors in the Egyptian context (by authors)

6 DISCUSSION

This section addresses several points. The international adaptability, Accordingly part 4, countries are divided into three categories. Those which develop and export 3DP technology and consider mainly developed countries are focusing on developing new materials, new applications, restoration and refurbishment, as an alternative method to solve the labour shortage problem in many developed countries, and ultimatelyon exporting3DP to developing countries as commercial technology. The second group of countries import technology andadapt it by developing machine properties and suitable materials to match the local requirements, while the third group of countries imports technology and focuses on affordability by reducing construction cost and time.

Although the selected examples studied are characterized by diversity in applied approaches and the materials used.However, the technology clearly shows that. It is still in the light of experiments and exploration, not consumer technology. Also, the printer's limitations in print just the foundations and entire building walls, but did not include printing other components and need special covering most constructive sites.

Regarding the strategy of using 3DP in international applications, the study found two main approaches among the examples: optimising performance and optimising production. It could be concluded that The application of 3D printing technology can bring many benefits, such as reducing waste of resources and materials, saving time, and reducing the workforce. The approach of optimising performance is characterised by novel forms of design flexibility, typology optimising and functionality, development of new applications, new materials, and machine layout. The approach of optimising production is characterised by mass production, using in situ resources, and increased accessibility which could mainly be used for affordable housing.

There are distinct international experiences that can be investigated in the Egyptian context, whether concern with optimizing the performance and optimizing the production. The following table determines the strength points which be Applicable in Egypt from different international Examples based on the assessment results.

	characterised points	International Examples		Applicable in Egypt
Optimising the Performance	Novel Forms and Design Flexibility	Future Office in UAE, CURVE APPEAL in the USA,	Applications	full or partial free form or luxury buildings,
		DFAB H. in Switzerland		Interiors-designed elements.
	Typology Optimising and Functionality,	Fluid Morphology in Germany		Architectural cladding Adaptable, portable units
	Develop New Application	Digital Grotesque in Switzerland		Print accurate details as Repairing or reproducing historical structure.
	Develop A Variety of Materials. Develop Machine Layout and Properties.	YHNOVA House in France (Polyurethane mold)	Materials	Salt as a raw material GFRC as Permanent formwork GFRP as a wireframe Bioplastic, Spray-foam as a mold Nylon as a light structure
Optimising the Production	Mass Production Concept	Winsun projects 3DP village, Mexico	Applications	affordability housing, prefabrication Building elements, Emergency shelters.
	Increased Accessibility, Reduced Risks in Remote Site	Residential House in Russia		Remote or hazard construction site, Rapid structure for military purposes.
	In-Situ Resources and Local Materials	TECLA habitat in Italy (Clay as a mold) + bio-materials (husks and rice straw) Multi-use Building in the UAE (concrete and gypsum).	Materials	Sand as a construction material Concrete reinforced by, fly ash, silica fume, and nano-silica. Clay is a ceramic material. Glass-fibre-reinforced gypsum (GFRG)

Table 6: Applicable of applications and materials in Egypt (by authors)

According to the available materials suitable for use with 3D printing In Egypt, there are opportunities to use local materials such as sand with admixtures, concrete with additives (such as flash ash, Silica fume, and nano-silica), clay, and salt.

Table 6 provides a synthesis of the outcome of the research; it lists the proposed applications of 3D printing in the construction sector derived from the analysis of selected international examples, it identifies the key characteristics of 3D printing in the field of construction, and it shows the impacts of 3DP as potentials and challenges in the Egyptian context.

Proposed Applications	Key factors	Potentials in Egypt context	Challenges in Egypt context
Full or partial free form or luxury buildings	Design Related Factors Design flexibility Structure functionality Design optimisation Quality issues Environmental Related Factors Climate change adaptation Lower resources materials Reduced materials Raw materials Reused, or recycled materials Decreasing CO2 emissions Less total energy use Social Related Factors Reducing workforce Shifting in jobs paradigm Safety in extreme environments Loweraccidents rates New job opportunities Economics Related Factors Initial cost Reducing materials cost Reducing labour cost Reducing overall costs Unique architecture Mass customisation Time-saving	Taking advantage of the mass customisation design, environmental benefits, and construction speed through materials development such as local sand, GFRC, GFRP, GFRG, biomaterials, and nanomaterials, in addition to the development ofa hyper-technical approach.	Supporting the private developers to afford the new technology, need of updating regulations and codes, lack of stakeholders' interest, dealing with shifting the supply chains, and construction workers'job paradigm
		Medium-term applicability–3DP could be applied projectsin the medium termfor luxury housing with limited floors, such as the future luxurious neighbourhoods in the Administrative Capital and the new al Alamein	
Interiors: designed elements Facade: cladding elements		Exploit reducing waste materials with design flexibility and accuracy without any additional cost. Materials could be used, such as GFRP, GFRC, and GFRG	Supporting small entrepreneurs and training designers to deal with the new design process and software
		High applicability inthe short term	
Adaptable portable units		3DP could be used for emergency medical shelters, to exploit mass production, andreduce constructiontime	The high initial cost and the benefit of speed must be a common application in use.
		Lowapplicability inthe long term	
Repairing or reproducing historical structures		Exploiting digital accuracy could be used to repair accurate details, reproduce a mesh with translucent materials in a historical building, live a new experience, compatibility with a 3D scanner for production of 3D model	Develop regulations and codes with new technology, develop 3D printer scale and machine layout, develop suitable materials, qualify professionals to manage it.
		High applicability in the short term	
Affordable housing		A new housing policy was being drafted to address the serious housing deficit; in the effort to provide affordable housing in a sustainable approach, so take advantages of in-site mass production, cost reduction (reduce wastes, workers costs) in long term,develop hyper technique approach, and using local materials such as desert sand, GFRC, GFRG, Clay, and concrete with fly ash, silica fume, and nano-silica. In addition, reducing the carbon footprint.	It's not suited in the Egyptian Urban context because of the limitations in the current 3DP., high cost of horizontal infrastructure, changes in the supply chain, shifting in workers Paradigm, update regulations and codes, overcome economic constraints, manage new technology risks, preparation in-site printing conditions,and the willingness of the lower and middle-income people to live in printed houses.
		Medium term applicability - It could be applied in the medium-term depending on the government and the private sector in providing affordable housing just in horizontal growth.	
Prefabricatedbuilding elements		Very similar to the construction on-site, except that it is characterised by greater accuracy, and controlling climate conditions.	Need of heavy transfer, disadvantages of fixtures and fittings, inflexible in design, need to qualify professionals to manage it.
		Lowapplicabilityinthe long term.	
Remote or hazardous construction sites		Replacing manual workforce with 3DP at remote and hazardous construction sites.thus reducing risks and labour costs and using raw materials such as sand.	Dealing with the problem of material properties at high temperatures condition
		High applicability inthe medium term	
Rapid structure for military purposes		Exploit construction speed and raw materials such as sand.	Manage new technology risks.
		Lowapplicabilityinthe medium term	

Table 7: potentials and challenges of applying proposed applications of 3DP in Egypt. (by authors)

It can be concluded that 3Dprinting is not a magical solution that can solve all the problems of traditional building techniques. Critical several challenges need to be resolved to achieve the maximum potential of the 3D printing technology, and many more potentials have to be investigated.

potentials	challenges
Increased design flexibility Time-saving Ability to use in-situ materials Variety of raw materials Reduced resources and material waste The environmentally way is to use demolition waste Cost reduction in addition to the minimised cost of storage and transportation cost of materials Reduced workforces and their transportation costs New lob opportunities as a new supplier Reduced health and safety risk on-site. Mass customisation at no extra cost.	3DP is reducing job opportunities for qualified workers. Materials of use for 3DP are limited as they require specific properties 3DP is not suitable for larger-scale projects Specific geometrical possibilities limit the printing method Utilities (electric, plumbing, and door and window) are not yet integrated into the design process Using 3DP also requires a change in the design process It is still a limited and expensive technology. There are no set regulations for using 3DP in construction Lack of knowledge about technology among the stakeholders 3DP requires new skills (installation, operation, control, and maintenance) for workers.

Table 8: Challenges and potentials in applying 3DP. (by authors)

7 CONCLUSION

This study aimed to give insight into applying 3D printing as a new building technology on an international scale and assessing the potentials and challenges in developing and applyingit in countries like Egypt. Based on qualitative data analysis of international examples, the study analysed 3D printing factors, their characteristics, opportunities and limitations. It assessed key factors with theassessment matrix and analysed the applicability of 3DP in the Egyptian Context.

From understanding the role of applied projects and Egypt's economic, social, and scientific situation as a developing nation, Egypt belongs to the second group of countries that import technology and adapt and develop it according to their needs and resources. But there are urgent challenges that need to be dealt with, such as developing local printable materials, updating the regulations and codes, spreading awareness between the different stakeholders and, most importantly, dealing with shifting the job paradigm because 3DP will reduce the need for a significant number of construction workers. While this is considered a benefit for countries with a shortage of labour, it is a disadvantage for countries with a large workforce depending on the construction sector whose jobs are at risk.

Although the technology is still in its infancy, it has continued to gain popularity among researchers and practitioners in the architecture and construction field of some developed and developing countriesworldwide. The future of technology in Egypt is most likely to be a partially built process that allows stakeholders to take advantage of both traditional and 3D printing technologies at the same time. The efficiency of reducing time and waste of materials could be the keys of this technology in the Egyptian context. Moreover, this technology would be applied locally for very limited cases in the near future, such as repairing or reproduction of historical structures, elements designed for interiors, and facade cladding elements. In the medium-term. The construction sector may invest in the mass production potential of 3DPfor affordable housing due to its economic efficiency or invest in flexible design and environmental benefits forfull or partial free forms of luxury buildings.

8 RECOMMENDATIONS

At the level of completing this research, This research provided background and deliberated potentials and challenges of the applicability of 3DP in different cases throughout the world so that future research could match local requirements and properties with the key factors which determine the applicability of 3DP toseveral local contexts. As regardsgeneral 3DP development, further work is needed to explore ways of printing with multiple materials, develop new materials, use in situ resources, faster printing, quality assurance, and mechanical property data, and combine 3DP with other processes such as hybrid techniques to increase the potential of applying it as new building technology.

9 ABBREVIATIONS

Abbreviation	meaning	Abbreviation	meaning
(3DP)	Three-Dimensional Printing	(GFRP)	glass-fibre reinforced plastic
(GFRC)	glass-fibre reinforced concrete	(GFRG)	glass-fibre-reinforced gypsum

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🏆 *reviewed paper*

AScore – Developing a Cockpit for Regional Pandemic Management in Germany with Agent-Based Social Simulation

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1 ABSTRACT

Managing the COVID-19 pandemic is a major challenge for decision-makers in crisis staffs, especially on a regional level. Decisions on intervention measures to contain a pandemic must be made promptly and under uncertainty. The project AScore aims at supporting decision-makers by means of an information management cockpit that intertwines smart city technologies and agent-based simulation. This paper introduces the project, outlines the concept and architecture of that cockpit, and presents first use cases and results. It shows what data and analysis functionality is important in pandemic crisis management and how social simulation can inform decision-makers about what intervention measures to put in place for containing a pandemic on a local level–as well as when and how to lift them.

Keywords: Digital Twin, Smart City, Agent-Based Social Simulation, Pandemic Management, Dashboard

2 INTRODUCTION

Managing the COVID-19 pandemic is a major challenge for leaders and decision-makers at different levels of societies. The main reason for this is that the pandemic affects multiple dimensions of human life, that there are numerous conflicting goals, and that responsibilities are often distributed or unclear. Decisions on intervention measures to contain a pandemic must be made promptly and under great uncertainty. In Germany, federal and state governments set the framework for containment of the escalating infection disease following the Pandemic Plans on federal and state level as well as the German Infection Protection Act. However, districts and their health authorities are responsible for implementating specific measures at the local level to meet federal or state decisions. Thus, municipal crisis management at the county level, with implementation regulations, monitoring of compliance with measures and, if necessary, setting additional county-specific measures, plays a crucial role. This pandemic management must balance the often competing demands of (1) avoiding overload of the local healthcare system, (2) fulfilling social, cultural, and economic needs, (3) maintaining availability of critical infrastructures, as well as (4) protecting public health. This task cannot and must not be carried out "blindly". Rather, it is necessary to have access to decision-relevant data, information, and knowledge about the four areas of demand listed above.

During an escalating infectious disease, this data and information situation, as well as its reliability, precision, or uncertainty, changes constantly: If it is initially uncertain and incomplete, "better" data and new knowledge about the respective disease become available with increasing time. In the rarest of cases, this information is available at the municipal level in a way that supports efficient crisis management. This reveals the current information management dilemma in crisis management: While there is an objectively high demand for information, it is met only inadequately with the existing municipal information systems. The main objective of the AScore project presented here is the design and development of a simulation-based management cockpit for municipal crisis management in the event of escalating infectious diseases. Using the example of the municipality of Kaiserslautern and the COVID-19-Pandemic, AScore employs methods from the field of Artificial Intelligence (AI), particularly smart cities technologies and agent-based social simulation.

In the following, we will first introduce the innovative approach to information management by combining available information of smart cities and agent-based social simulation for infectious disease control. The AScore project, information demands as well as the technical architecture, findings of requirements analysis as well as first steps towards a management cockpit will then be presented. Additionally use cases are discussed for demonstrating the utility of our approach and to identify challenges when integrating, analyzing, and visualizing data for decision makers. The paper concludes with a summary and an outlook on future work.

3 COMBINING SMART CITIES TECHNOLOGIES AND AGENT-BASED SOCIAL SIMULATION FOR REGIONAL PANDEMIC MANAGEMENT

At its core, the AScore project presented in this paper builds upon the foundation of combining smart cities technologies with agent-based social simulation. This approach, while being innovative, is not entirely new. In fact, one fruitful combination of those technologies is demonstrated by the well-known CityScope project for urban planning by the MIT Media Lab City Science group (Alonso et al. 2018).[1] In CityScope, city data, analysis tools, and visualization as used in smart cities projects are combined with an agent-based simulation framework as well as participation elements to allow for interactive and dynamic urban planning. The key innovation here is to interleave static analysis and dynamic simulation in order to provide process-oriented insights into possible changes in the city that follow planning decisions.

Without a dynamic component, it is difficult to anticipate the effects of decisions in a changing world. This is also the case for crisis management in the context of COVID-19. Since the outbreak of COVID-19, various information platforms, data repositories and dashboards have been developed.[2] Most of these monitor the disease on an international or national level. Fewer examples cover individual municipalities, and in many cases, these platforms have a particular focus (e.g., monitoring the number of reported COVID cases, reporting the progress of vaccination campaigns, or informing about interventions put in place in order to contain the pandemic). Nonetheless, these platforms utilize a number of techniques that have been developed in the context of smart cities: Spatiotemporal data retrieval and aggregation methods, storage solutions and analysis workflows, as well as visualization and dashboarding frameworks. And some examples even include a dynamic component which uses simulation to forecast possible future developments and compare different counter-pandemic strategies (e.g., Bortz et al. 2020, Dings et al. 2021).

Such forecasts and comparisons are a valuable tool for decision-makers in crisis management. In an ever-changing crisis situation, it is necessary to anticipate what is likely to happen because available data is always delayed and the effects of decisions will only fully unfold at a future point in time. Consequently, decision-makers have to extrapolate on their available information and decide on potential interventions even before these appear to become necessary. Moreover, they have to strike a balance between the expected benefits of interventions on the pandemic situation and the restrictions they impose on the economy, social and cultural live, and the individual freedom of the population. To that end, the aforementioned tools to compare different available intervention measures are valuable assets for supporting crisis managers.

However, the majority of crisis management responsibilities (at least in Germany) are located on a regional and local level. Each municipality has its local crisis management staff, often led by the local mayor and consisting of experts in the affected public fields (e.g., hospital managers, regulatory and health authorities, fire fighters and civil protection agencies, education and other public service authorities). These members of a crisis staff face the challenge to decide about local measures and make their decisions dependent on the respective local situation. They also have their individual perspectives for interpreting that situation and their specific data sources upon which they base their interpretations. For instance, crisis staff and local council members may have to decide which sports facilities can be opened or need to be closed in order to allow for leisure activities while avoidung to expose the population to unnecessary risks of infection. Supporting this type of decision-making requires tools that focus on the pandemic situation in a particular region, that provide detailed analysis functionalities to compare localized intervention measures, and that allow for integrating analyzes from different perspectives and fields of expertise.

To achieve those three goals, the AScore project complements the existing platforms described above with a localized equivalent that is geared towards regional crisis management. This requires collecting and analyzing data about individual municipalities and modelling local intervention measures in detail for simulation purposes. To that end, existing technologies developed at DFKI are newly combined and extended. On the one hand, data sources about the local population, infrastructure, and public services are

[1] See also https://cityscope.media.mit.edu/ and https://www.media.mit.edu/projects/cityscope/overview/

[2] Examples include, but are not limited to the following platforms: WHO Coronavirus (COVID-19) Dashboard (https://covid19.who.int/), COVID-19 Dashboard by CSSE at Johns Hopkins University (https://coronavirus.jhu.edu/map.html), RKI COVID-19-Dashboard (https://experience.arcgis.com/experience/478220a4c454480e823b17327b2bf1d4/), Bundesministerium für Gesundheit Impfdashboard (https://impfdashboard.de)

made accessible to crisis managers. Using smart cities analytics tools, that data is aggregated and visualized to enable assessments of the actual pandemic situation. This analysis takes various perspectives into account in order to provide a more comprehensive view on that situation. For instance, not only numbers of reported infections are considered, but also the impact of intervention measures on the local economy and public life can be visualized. On the other hand, agent-based social simulation is used to model the behavior and daily routines of the local population and to analyze impacts of intervention measures that have not yet been applied. In AScore, the agent-based model utilizes the aforementioned data to build a digital twin of the municipality in focus. Individual persons are being represented in the simulation by agents that act in a typical manner, e.g., according to a person's age. The model also contains a disease component to represent a potential spread of COVID-19 across the population. Additionally, public and private infrastructure is represented in the model such that the utilization of facilities by agents and the impact of intervention measures (e.g., lockdowns) can be simulated. In this way, AScore brings together DFKI's smart cities toolkit with its agent-based simulation technology developed under the term "Social Simulation for Analysis of Infectious Desease Control" (SoSAD).

SoSAD is an agent-based simulation model based on real-world smart city information and data. It has been in development at DFKI and Trier University since early 2020. In this model, all persons of a population are modeled as agents with their respective family relationships and typical daily routines. The daily routines include occupation, school attendance or leisure activities, during which agents can meet. Combined with a disease model (for COVID-19), the spread of an infectious disease can be simulated depending on the activities of the population. This in turn allows for modeling pandemic control measures that restrict certain activities (e.g., closing schools) and thus change rates and possibilities of infectious contacts. By means of systematical simulation, these measures can be compared with respect to their intended effectiveness as well as potential unintended effects. The results can then be analyzed in the same way as real-world data is handled. In AScore, this provides decision-makers with information about hypothetical developments (what-if-analyzes) to complement information about the current actual situation (what-is-analyzes).

Each agent in SoSAD is a digital twin of an individual person of a particular age in years, a demographic information that is retrieved from the AScore data storage. This allows for a detailed representation of cities and municipalities of up to several million inhabitants in the simulation. Depending on their age, the agents are clustered into three distinct behavioral groups with typical daily routines: Children (including adolescents), workers (including students), and pensioners (i.e., all agents above the age of retirement). Similar to other agent-based modeling approaches (e.g., Huang et al. 2005, Bicher et al. 2020), agents of each group frequent a number of particular locations where they can meet other agents. Workers have a workplace which can represent a private company, a public service agency, as well as a university or other higher education facility. Children instead go to school. Agents of any age have a home where they either live alone or together with other agents. Furthermore, all agents frequent leisure facilities which represent shops as suppliers of essential and non-essential goods as well as cinemas, gyms, stadiums and concert halls as well as any other public place for recreational activities. Real-world information about any of these locations is retrieved from the data storage to generate a digital twin of a particular city's infrastructure for the purpose of social simulation.

Two agents that frequent the same location can meet each other there. Since not every encounter will be potentially contagious, SoSAD only models those contacts that are sufficiently intense to spread the virus. In these instances, contagion takes place with a certain probability if one of the agents carries the virus and is infectious. This is the same basic principle as in most other agent-based COVID-19 contagion models (Lorig et al. 2021). The model of disease states and their progression is analogous to a modified SEIR approach as published by the Robert Koch Institute (RKI), the German government's central scientific institution for biomedicine and public health (an der Heiden & Buchholz 2020).

Any agent that has not yet been vaccinated or infected with the virus is susceptible to it (state S). If the virus is transmitted to such an agent, that agent becomes exposed (E). After a latency period, the agent becomes infectious for a period of time (I) during which it can infect other agents. In the case of COVID-19, an agent becomes infectious before it may develop symptoms of illness. There are six levels of symptoms, one of which is predefined for each agent according to a distribution as observed in sample studies of COVID-19 cases (e.g., Dong et al. 2020, Zhou et al 2020): asymptomatic, minor, moderate, severe, critical, and fatal. Depending on its symptom level, an agent will be unable to even recognize its infection without test, it may or may not stay at home, become hospitalized, require intensive care and eventually either recover or pass away. If agents stay at home or become hospitalized, they will no longer have contacts at work, school, leisure facilities, or at home. Recovered agents will become immune to further infection (R). The same holds for agents that have received vaccination. These become immune with a specific probability that depends on the vaccine's effectiveness.

In addition to vaccination, SoSAD implements several pharmaceutical and non-pharmaceutical interventions to control the simulated pandemic. These can either reduce the infection probability in case of a contact between agents (e.g., by wearing face masks or using air filtration) or the ability for an agent to even meet others (e.g., through contact restrictions and lockdowns). Agents become aware of activated interventions, and they can decide whether to follow the rules or whether to violate them. For instance, if leisure facilities have been closed, agents can still meet in private, and they decide for themselves if they wear protective masks on such an occasion or not. This allows for analyzes of interventions in the presence of non-conformant behavior. In AScore, a library of counter-pandemic measures is provided. Any combination of interventions forms a simulation scenario that can be compared with alternative scenarios in order to gain insights into possible regional strategies for containing the disease. Because implementing these measures can have impacts on, e.g., both the spread of the disease and the local economy (in case of a localized lockdown), such a comparison enables crisis managers to make informed decisions considering multiple perspectives on the situation. Making that functionality accessible to crisis managers is the main goal and the most important innovation of AScore.

4 THE ASCORE PROJECT

4.1 Project Context and Partners

AScore[3] is a consortium project funded from 01/2021 until 12/2021 within the framework of the special programme "Zivile Sicherheit – Forschungsansätze zur Aufarbeitung der Corona-Pandemie" by the German Federal Ministry of Education and Research (BMBF) under grant number 13N15663. AScore brings together partners from AI and smart cities research (DFKI GmbH), mathematical optimization and epidemiological simulation (Fraunhofer ITWM), data science for business (CID GmbH), as well as crisis management (VfS e.V. and mata:solutions GmbH). To realise pilot scenarios, the City Administration of Kaiserslautern joined the project as an associated partner. Transferability of the results is ensured by the City Administration of Trier being a second application partner.

4.2 General Vision of AScore

AScore aims at improving the crisis management such that decision-relevant information is available for assessing potential intervention measures to contain a pandemic. To this end, a cockpit is being designed and implemented, which covers the areas (1) avoiding overload of the local healthcare system, (2) fulfilling social, cultural, and economic needs, (3) maintaining availability of critical infrastructures, as well as (4) protecting public health. For these areas, real world data is collected, analyzed, and aggregated in a pandemic pressure scoring system to visualize and assess the current situation. The same process is also used for integrating synthetic data from simulations of what-if-scenarios, which compare possible effects of different intervention measures. The agent-based social simulation system SoSAD, developed at DFKI and adapted to the Kaiserslautern region, allows for implementing such measures on a detailed level and observing their effects on the interactions and, thus, infection dynamics within a realistically simulated population.

5 ASCORE APPROACH AND ARCHITECTURE

5.1 Information demands

Data in AScore is used for three main purposes:

(a) to provide information about the current status,

(b) as input for and output of the SoSAD Social Simulation, and

(c) as part of the measures-impact repository.

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[3] See https://ascore.kl.dfki.de for more project information.

We will now discuss each of these purposes as well as the data involved in more detail.

5.1.1 Status Information

For all areas to be covered in the management cockpit, information about the status including important news or developments is required. This includes information about the citizens actually infected, capacities in the local health system, availability of critical infrastructure as well as information about impacts on social, cultural, and economic aspects. For all these areas, data sources need to be identified in close exchange with relevant stakeholders from the fields as well as from crisis management. In order to be able to make use of the data sources, a variety of tasks have to be solved. These range from technical accessibility to clarification of data protection aspects.

5.1.2 The SoSAD Social Simulation

The social simulation component takes data as input and produces additional data as output. From the input data, it parameterizes the agent-based model by means of model generators. These generators pre-process and aggregate data from several sources before it can be used in the model.

The most important generator populates the simulation with agents. It uses actual or synthetic demographic data to construct an agent population. In the case of actual data, a municipality’s register of residents is directly fed into the population generator. From this data, an agent with a corresponding age is created for each resident. If several persons live together, their respective agents become connected in the same household. These households are grouped by statistical districts to abstract from addresses and make individual persons harder (or impossible) to identify. To guarantee anonymity, registry data can also be replaced with a synthetic population generated from census data. In either case, the population generator uses as little data as possible to construct an accurate digital twin representation of a municipality’s inhabitants for social simulation.

Furthermore, there are several generators for a municipality’s infrastructure that agents in the simulation can frequent. For instance, children attend schools which are generated from data about the numbers of pupils and classes per grade for each school. This is combined with the population data to assign agents with an appropriate age to school classes. From these assignments, a generator creates schools and classes as locations in the simulation model and populates these with the respective agents.

In order to run the simulation, AScore also stores and provides a library of scenarios. In these, combinations of counter-pandemic intervention measures are specified which can be compared using simulation. The SoSAD component takes the chosen scenarios from the management cockpit, creates the respective parameterized simulation model using its generators and then runs the simulation to produce the required results. Those results are also defined by the scenarios in terms of output variables that will be compared. Thus, simulations in AScore can essentially be run in the form of hypothesis-driven studies that provide comparative answers to questions about the impacts of intervention measures (Lorig et al. 2017).

The results of those simulation studies are finally returned to the data storage. They can come in the same form as real-world observations about the actual situation. This enables the analytics engine and the management cockpit to utilize the same tools and visualizations for comparing hypothetical what-if scenarios as for displaying the current what-is situation. The goal of this approach is to make simulation as an advanced decision-support technique accessible to non-specialists in crisis management.

5.1.3 The Measures-Impact Repository

One of the goals in AScore is to establish structures that allow for analyzing the quality of intervention measures taken during a pandemic. In order to do so, a Measures-Impact Repository is being developed in the project. That repository is meant to store information about which measures had been taken in the past and what effects could be observed with respect to the various dimensions of the Pandemic Pressure Score. This is a complex task, since it is almost impossible to identify, capture, and store all information that constitute the current status in all its complexity, let alone the factors that have an influence on the state and are not simply defined in an official, pandemic-related measure. E.g., factors like weather, mobility or the influence of media can often have a massive impact on the development of a pandemic disease.

Yet, even without the complete picture relevant information can be gathered. On the one hand, this includes all information about the official measures to contain COVID 19. They need to be translated to a common representation allowing for a comparison between different measures (see Section 5.3.2). On the other hand, it contains at least all status information (see Section 5.1.1) provided through the Management Cockpit.

Since data are often corrected over time (e.g., due to delayed reporting of cases of illness), it is misleading to use the corrected figures retrospectively. If one wants to reconstruct which information was available on a certain day within a management cockpit to support decision-making, a much more complex procedure is necessary to enable such reconstructions–also with regard to the resources available for data storage. Consequently, histories of data series are captured in AScore in the exact form that they had at the time of decision about intervention measures, e.g., for the figures on incidences and deaths collected by RKI.

Moreover, the Measures-Impact Repository connects data from different sources to allow for a more complete picture. For instance, the measures themselves can be extracted from official regulations and decrees as publishes by municipalities and states. These are then linked to directories of registered businesses in order to establish how many companies in which business areas or trades are affected by these measures (e.g., in a partial lockdown). Similar connections include directories of schools, sports facilities and other locations with registers of residents to analyze impacts of measures on families, requirements for emergency childcare, as well as physical and mental well-being. Linking data in this way allows for capturing the particular impacts of intervention measures not only on viral spread but also on public and private life in general.

5.2 AScore Infrastructure and Components

One of the aims of AScore is to provide a prototypical infrastructure that illustrates the potentials of the approach and that allows for being used as a basis for further developments by project partners and other stakeholders. In order to realize this, it is possible to build upon several existing DFKI components (cf. Memmel et al. 2017, Sabty et. al 2013) that are being enhanced and adapted for the needs of AScore. This, e.g., concerns data integration, data storage, and interfaces for data provision, simulation model components and generators, as well as components for data visualization. Yet, some tasks require a considerable amount of refactoring or even the development of completely new components. Fig. 1 provides a coarse overview of the AScore infrastructure and main components that will now shortly be introduced.

5.2.1 Adapters & Preprocessing

In AScore, both (quasi)-static and dynamic data are processed. Quasi-static data sets (e.g., municipal registration data, POIs, or data from OSM) change only after comparatively long time intervals and therefore need to be updated less often than dynamic data. The latter are transmitted via service interfaces. In any case, appropriate adapters and connectors for (semi)automatic integration and normalization of both quasi-static and dynamic need to be available.

Furthermore, different preprocessing steps are required that allow for an appropriate access to data (e.g., for the AI analytics Engine and for interactive visualizations), an efficient storage, or the integration into the measures-impact repository.

5.2.2 Data Storage

The data repository is a central component in AScore, combining elements of classic spatial data infrastructures with other modules, e.g., that allow for an efficient storage and management of textual data. The data storage will contain all input data relevant for the tasks described in Section 5.1.1, 5.1.2, and 5.1.3. The data storage will also provide refined data and intermediate results, as well as the metadata, especially also with suitable historization concepts to be able to observe temporal changes.

5.2.3 AScore API

In order to allow accessing the data in the data storage, the communication between different components, and especially the access for the AScore Management Cockpit and 3rd party applications from other stakeholders and project partners[4], an API will be developed.

[4] In the project, two sample applications are covered here: EpideMSE by Fraunhofer ITWM and the Coronavirus Exposure Tracker by CID GmbH.

5.2.4 AScore Analytics Engine

This component holds all methods to analyze data within AScore. This includes aspects such as the calculation of a Pandemic Pressure Score and algorithms to find patterns in the measures-impact repository. The engine makes use of various methods, described, e.g., in (Wang et. al 2018) and (Janowicz et. al. 2020).

5.2.5 SoSAD social simulation

This component encapsulates the agent-based social simulation as described above. The simulation interacts with the AScore API using its input and output data generators. Real-world data is retrieved from, and simulation results are stored in the Data Storage to make the simulation accessible to the AScore Management Cockpit as well as any 3rd party applications. Moreover, this makes simulation data also available to the AScore Analytics Engine for comparing scenarios according to their Pandemic Pressure Scores and further analyzes.

5.2.6 AScore Management Cockpit

The Management Cockpit denotes the visual user interface for crisis managers. It comprises a dashboard for what-is-analyzes to increase awareness of the current pandemic situation as well as scenarios of available intervention measures to compare what-if-analyzes for decision-support. Since there are different perspectives from different fields of expertise present in a crisis management staff, the dashboard and the analyzes can be customized to individual information needs. However, being based on the same Data Storage and analysis tools, the AScore Management Cockpit furthers communication and agreement between staff members.

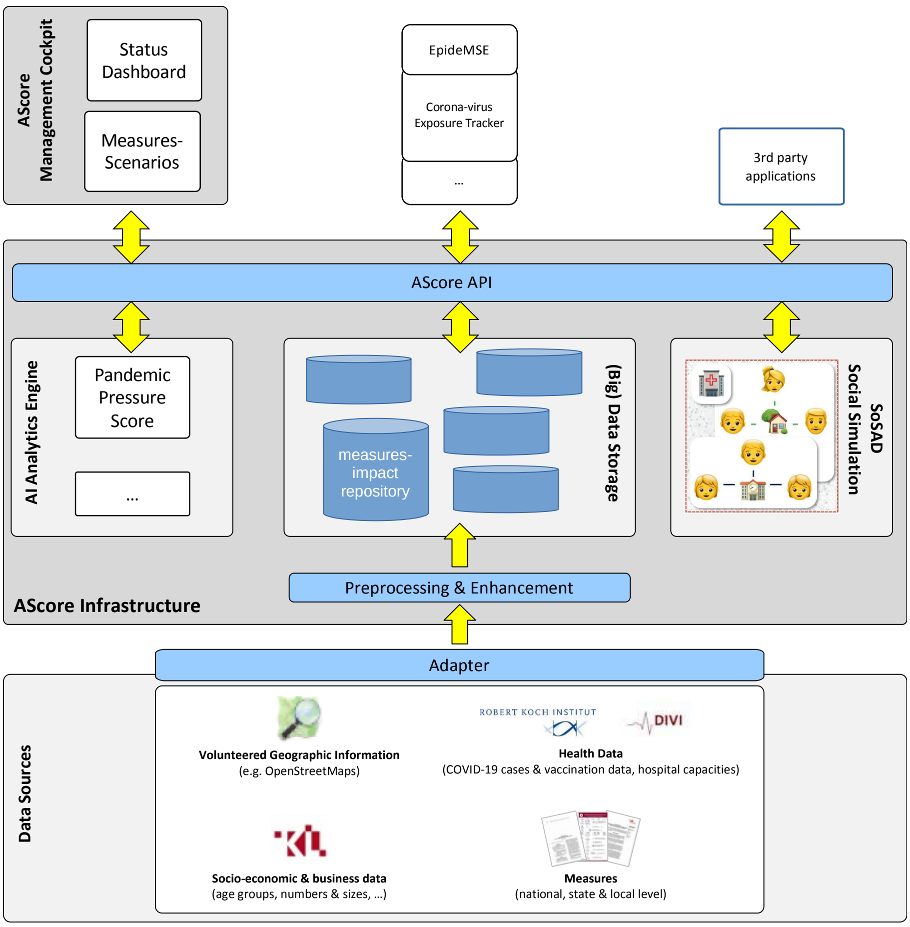

Fig. 1: A coarse overview of the AScore infrastructure and main components.

5.3 Realizing a Management Cockpit – First steps

As a basis for discussing requirements and needs with stakeholders from crisis management and also within the AScore project team, first steps to realize the envisioned management cockpit were already realized. Figure 2 provides an overview of some of the available information as of May, 2021.

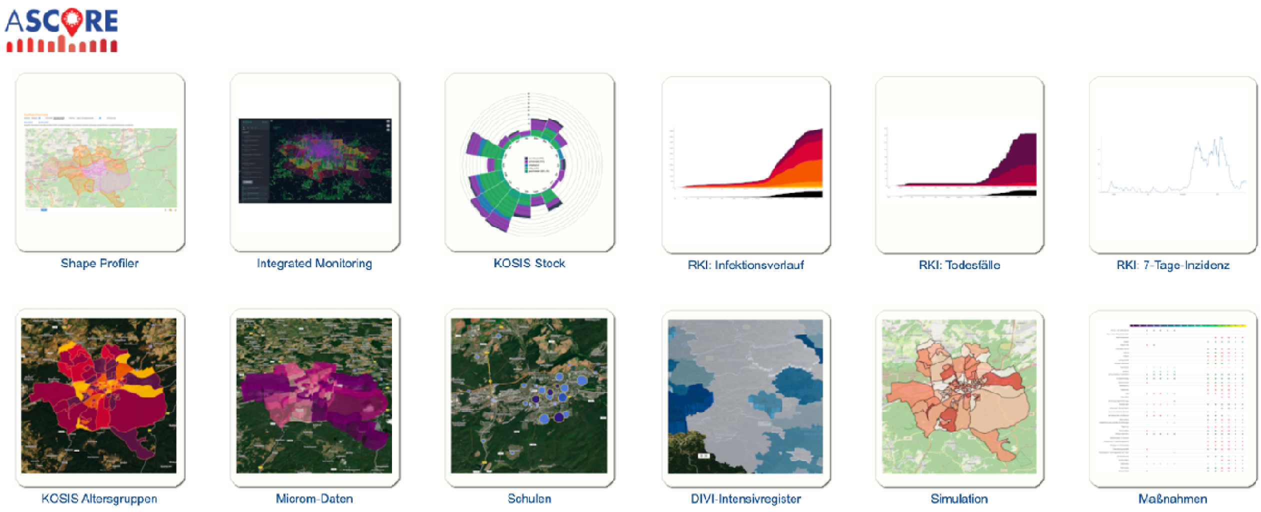

Fig. 2: Overview of information items available in the early development stage of the AScore management cockpit.

5.3.1 Map-based Status Information

Map-based visualisations are often particularly suitable for enabling assessments of different statuses or developments at the regional level or in comparison to other regions. In the context considered here, this applies to many forms of information, some of which are shown in Fig. 3:

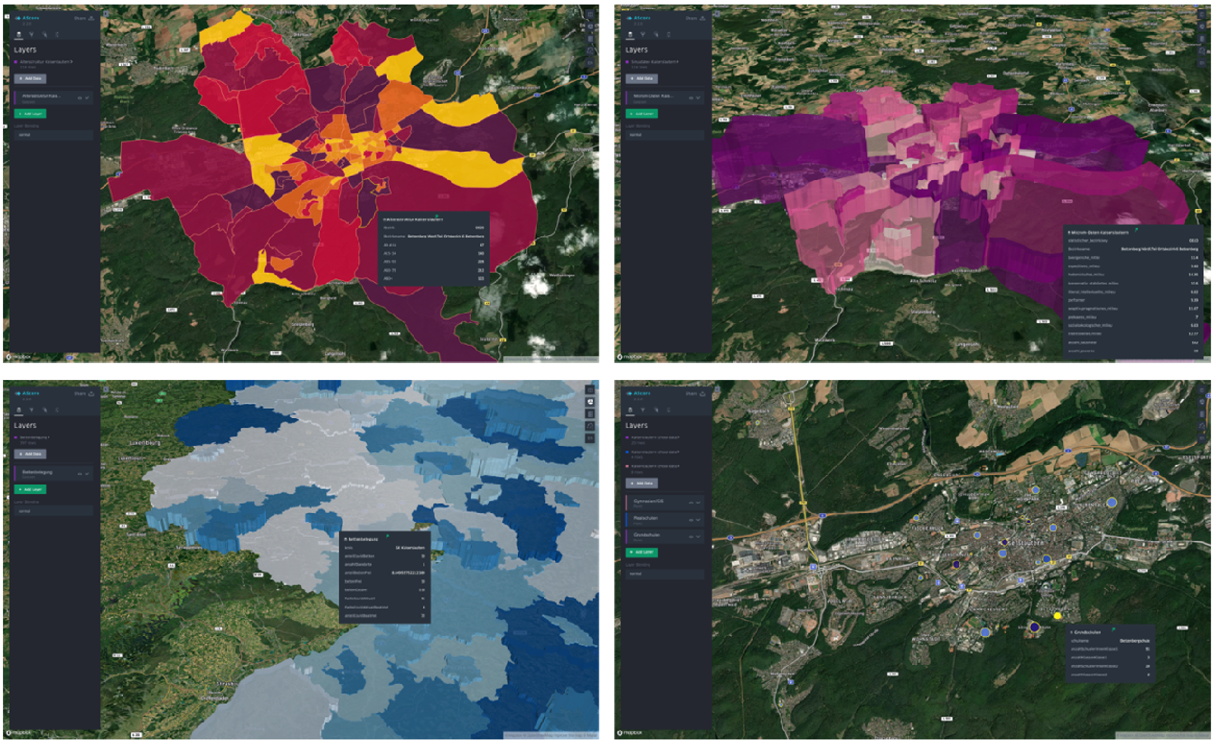

Fig. 3: Interactive, map-based visualization[5] of (a) age groups, (b) business activities, (c) ICU capacities, and (d) schools (clockwise).

(a) The distribution of age groups (and social milieus) can be used, for example, for specifically addressing certain population groups or to put a focus on social groups that may be particularly vulnerable. The age groups shown here are derived from civil registration data that the city of Kaiserslautern provided in a standardized format (KOSIS).

(b) Information on various business activities (in this case provided in microm data about Kaiserslautern) allows to draw conclusions, for example, about the effects of pandemic containment measures.

[5] AScore builds upon an integrated monitoring infrastructure developed within DFKI's SmartCity Living Lab. It is a generic, module-based web application built upon a distributed data storage and offers several means for visualizations. The interactive visualizations shown in Fig. 3 were realized using the open-source software kepler.gl.

(c) Register information about the availablity of hospital capacities allows to estimate the development of the severeness of the pandemic and to react as soon as posible if capacities become scarce. The information depicted here derives from the DIVI Intensive Care Register, a real-time data collection and analysis environment for intensive care bed capacities and aggregated case numbers for Germany.

(d) The representation of schools with information on the age groups taught there allows, for example, adequate mobility planning.

5.3.2 Visualization of Intervention Measures

In the course of the pandemic, various authorities (federal, state, municipal) adopted a wide range of measures to contain COVID 19. These affect a wide range of social aspects in a variety of ways. For example, different rules apply to large events than to trade or schools. In many cases, the rules within individual sectors are also very differentiated and often apply depending on local incidence figures. In order to enable an overview of measures that are currently valid and those that were valid in the past, an interactive visualisation of such measures was developed in AScore (see Fig. 4). On the y-axis, different areas affected by intervention measures are displayed, on the x-axis the measures (grouped by regulation or as a timeline) are shown. The colors indicate how much the respective areas have been affected by the measure: "red" indicates that they have to be completely closed, "yellow" means a medium impact, and "green" indicates that the area was not affected. This tool requires a comparable representation of areas across different measures and has been realized, among other things, based on publicly available readout aids.

Fig. 4: Interactive visualization of pandemic containment measures and affected fields of society in two different modes of presentation: and grouped by regulation (left) and as a timeline (right).

6 SAMPLE USE CASES: SITUATION EVALUATION AND DECISION SUPPORT

Over the course of a pandemic, crisis staffs meet regularly to evaluate the overall situation and to decide whether action needs to be taken. Consequently, use cases of the AScore project can be grouped into two main areas: Those that cover general information interests and those that directly support specific decisions. From general information, crisis staffs can derive the need for action whereas decision support only comes into play as a second step when deciding between several alternatives.

For evaluating the current pandemic situation, crisis staffs require an overview in the form of situation reports. These need to be up-to-date and cover the various areas of expertise of different staff members. To meet these demands, users can customize their view of the Management Cockpit with those detailed analysis components they deem important while still keeping an overview of other areas through the Pandemic Pressure Score. For instance, the local health authority has to report on registered infections and work together with hospital managers to reserve capacity for expected severe cases that will need intensive care. Having a localized and customized dashboard available helps these users communicate with each other. In particular, they can observe the current situation as well as similar ones from the past (if available) to make sure to call for action at the appropriate time. The Pressure Score is their main asset for doing so: If the public health situation deteriorates, pressure on the healthcare system will increase. The AScore management cockpit uses that score to help detect these developments and interplays through indicators, what-is-analyzes and visualization such that intervention measures can be taken in a timely manner.

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However, the Pressure Score does not only help determining when to intervene to contain the pandemic. Since intervention measures exert pressure on private and public life, culture and economy themselves, the score is equally important to detect potential and find ways for alleviating that pressure. This leads to specific decision-making tasks for a crisis management staff. Both putting measures in place as well as lifting them requires decisions about which specific interventions are appropriate and how they can be designed to have the desired impact while avoiding undesired side-effects. To that end, decision-makers use what-if-analyzes to compare hypothetical scenarios of situations that have not yet been observed in reality.

In this role, an early version of AScore has already been utilized for supporting decisions by crisis staff members and municipal councils. Examples cover decisions about when and whether to open or close schools (and how to organize public transport accordingly) as well as whether to open public swimming pools. In that context, simulation scenarios were run in which schools were closed completely, opened as normal, or opened for only half the students at a time with regular rotation of the cohorts. These scenarios were analyzed not only according to the number of expected infections in school but also according to the possible further spread of the disease (i.e., with respect to the role of schools as a multiplier of the general infection dynamics). It turned out that the rotational strategy increases infections across the population only slightly over completely closed schools–while at the same time drastically decreasing the organizational burden upon families. These results were visualized by means of time series plots, scenario heat maps, and geographical analyzes of locations for potential outbreaks of COVID-19. Up to the time of writing, the rotational strategy has been in place for several months and no major outbreaks have been reported in the partner cities that derive from infections in school.

7 SUMMARY AND FUTURE WORK

To summarize, the AScore project aims at developing an information system for crisis managers in the context of pandemics. Its core contribution and innovation is in bringing together smart cities technology for data retrieval, analysis, and visualization with agent-based social simulation. While the former supports what-is-analyzes of the current pandemic situation to identify the need for action, the latter allows for comparing what-if-analyzes of hypothetical scenarios to decide upon which specific action to take. This paper has outlined the overall concept of AScore, introduced its architecture and components, and briefly sketched its uses for practical decision-making. AScore, however, is still being developed and there is still work to do. This implies several challenges that need to be overcome. Firstly, additional indicators for the Pandemic Pressure Score must be specified and implemented. This is challenging because data private life and public institutions is hard to retrieve due to privacy or security reasons. Secondly, presenting analysis and simulation results to crisis staff members in a meaningful way is a non-trivial task. Future work will thus cover customizability of the dashboard and scenario components. Finally, AScore is meant to provide open interfaces for 3rd party analysis tools. These will be developed and tested with sample tools of the project partners.

Beyond the AScore project, the combination of agent-based social simulation and smart city technologies is being further developed for many other urban application areas, such as urban planning or climate protection.

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Assessing the Efficacy of Spatial Planning and Development System in Improving Living Conditions of the Society

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1 ABSTRACT

Globally, spatial planning and development systems have proven to be critical instruments for establishing long-term, sustainable frameworks for improving social, territorial, and economic development conditions. In developing cities, spatial planning and development systems are generally used to enhance the integration between sectors such as housing, spatial justice, transport, energy and industry, and improve people's quality of life. This paper uses a case study research approach to unpack how spatial planning and development systems have contributed to the enhancement of society’s living conditions in the City of Johannesburg, South Africa. Interviews with key stakeholders and questionnaires were used to gather information from the University of Johannesburg, the City of Johannesburg Municipality, and the Housing development Agency. The findings reveal a need to develop institutional and financial mechanisms to improve communities' quality of life and planning tools designed as drivers for spatial change. The paper also highlights the challenges that hinder appropriate living conditions and urban transformation, including high urbanisation rates, poor service delivery, high rentals, and unemployment. The paper concludes with a discussion of the significant gaps in knowledge that concerns the implementation of spatial planning and development systems in urban areas for the purposes of improving the status quo. The work recommends the adoption and implementation of adaptable and regenerative spatial planning as a vehicle for the improvement of living conditions in cities of the developing world.

Keywords: Spatial, sustainable frameworks, urban transformation, quality of life, Johannesburg

2 INTRODUCTION

The spatial injustices of apartheid and rapid urbanisation had a large influence on the spatial structure of Johannesburg, with negative development shortbacks such as urban sprawl, spatial inequalities, fragmentation, limited mixed-use development and people-oriented spatial planning development. Despite, the evidence of spatial rectifications and reconstructive developments that has been introduced in the previous years, the current spatial planning and development systems require extensive reviews in order to match the status-quo of the community needs in the city as well as meeting the future spatial visions. Spatial injustices in the city of Johannesburg remains a definitive element of the quality of life, settlement patterns and urban sprawl. The lack of spatial integration has led to misalignment in locations and concerntration of economic opportunities. The housing-job approach does not match and create inequalities in the city, concerntration of socio-economic activities does not correlate to the location where people live (Bertoldi, 2015).

The present spatial planning and development system introduced known as, Joburg Growth and Development Strategy 2040 is a key priority spatial planning and development strategy that directs spatial growth, defines the type society and development the city intend to achieve by the year 2040. This strategy capacitate the city with institutional powers to resolve the unattended past development and spatial injustices which emerged from apartheid regime meanwhile moving towards a just city, non-prejudiced and developmental city (Harrison & Todes, 2014). Nevertheless, traditional approaches have been adopted in many developing countries to foster effective relationship between the spatial planning, development systems and society, particularly these approaches were imported from North America and Europe. Unfortunately, the adoption of these approaches in developing states led to more isolated land uses, activities, society while they were serving the interests of colonial communities. For instance, sub-Saharan

African communities attempted to improve the standards of living through the nationalisation of resources and all land, while some countries such as Zimbabwe and Delhi have shown limited success in the allocation of such lands for development purposes (Ebrahim, 2017). Across the world, cities are faced with complex spatial planning and development challenges. These challenges threatens the future of cities as they tend to become more uncertain and unpredictable, the spatial development planning paradigm of cities has been altered with anthropogenic drivers. In this regards, city spatial planning strategies must direct the tension between future spatial uncertainities, development growth paths and adequality quality of life.

According to Schensul & Heller (2010), cities in South Africa particularly the city of Johannnesburg, Ekurhuleni, Pretoria and Durban are demonstrating a clear example of spatial inequalities and development fragmentation. The post-1994 spatial planning legislation and development guides were meant to transform social exclusion, injustices and disparities from the apartheid regime- their preliminary objective was to improve the quality of life of society who became victims of land dispossession and spatial injustice using various interventions such as integrated public transport, reconstruction development plan, housing delivery, adequate health, social services, corridor and nodal development. As a result of these interventions, many lives have been transformed through land reforms, delivery of more than four million housing backlogs and development of integrated and inclusive city (The Presidency, 2014). The adequate spatial planning and development system has the potential to influence the urban growth and livelihoods of Johannesburg by addressing major spatial discontinuities and providing sustainable frameoworks that will present significant areas of economic opportunities. This paper assess the efficacy of spatial planning and development systems in improving the living conditions of the society in the city of Johannesburg. The study will specifically focus on the challenges that hinder appropriate living conditions and urban transformation, including high urbanisation rates, poor service delivery, high rentals, and unemployment.

3 LITERATURE REVIEW

Spatial planning and development system can be seen as a transformation of the city fabric that is spatially defined and builds on multifaceted series of resource driven practises, in which the land use form, substance and development implementation of urban space are intentionally altered to show the principles of spatial refrom and equitable social order (Williams, 2000:169). The concept of spatial planning and development systems has gained popularity as tools to redress the past spatial injustices and restructuring of new urban change. However, these space transformation tools can be related to the drivers of living experiences for urban dwellers. Essentially, a more productive, inclusive, well-planned and sustainable city is characterised by residents benefits of high quality of living and close proximity to functional spaces, these elements contribute towards place-making and shaping the city (Max-Neef, 1992). This section provides critical review of contributions made by other scholars in as far as spatial planning and development systems are concerned in terms of legislative and policy frameworks, stakeholder roles, strategies and global experiences.

3.1 Unpacking Spatial Planning and Development concepts

Spatial planning is a prominent function of a public sector to drive the distribution of future spatial activities. This planning tool is responsible to allow more informed territorial allocation of land uses and integration amongst them, to balance the needs for development with the aim of protecting the environment, attain social and economic objectives. Spatial planning intends to improve and manage the effects of various sectorial legislations and policies on land use development, to achieve a more equal share of economic opportunities within regions. Therefore, spatial planning is a critical lever for achieving sustainable development and improving the standards of living of the society. The techniques provided by spatial planning assist the local government to equally distribute the natural resources, communities and spatial activities of different scales to improve the built environment, social and economic sectors of the society.

Spatial planning cut across mutliple disciplines such as land use development, transportation, urban regeneration, regional and community planning. On the other hand, development is closely related with spatial planning. Development is refer to as the process of creating growth, positive transformation and progress with regards to the addition of economic, social, environmental and physical transformation (Todes, 2015). The role of development is to ensure that the spatial planning objectives such as infrastructural development, mixed use development, economic growth etc are measurable and implemented onto practises with relevant policy-guide and developments guide. Development shapes the urban fabric in terms of organising land-uses, responsible growth of urban spaces, enabling accessibility through various transportation modes, enhance adequate human settlements which are resilient to natural disasters and conducive to human quality of life.

3.2 Legislative and Policy frameworks in Spatial planning and Development

European Spatial Development Perspective (1999) was introduced as a policy document to transform the european cities towards a more equitable and sustainable territories of the European union. The objective of this policy is to drive the development towards the three fundamental goals of European policy and ensure are attained equally around the regions of the European Union, which are preservation and effective management of natural resources and cultural heritage; social and economic cohesion; a balanced competitiveness in the territory of the Europe. In essence, the European Spatial Development Perspective is applicable to Johannesburg as it wishes to conduct a balanced and sustainable spatial development policy which is complementary to the spatial planning goals that are outlined in the City of Johannesburg Spatial Development Framework. However, the basic skeleton of this perspective is narrowed down to its exclusion of urbanization as a driver of spatial planning and development which is a true reality in the city of Johannesburg.

Land Use and Spatial Planning Act 925 of 2016 (Ghana), provides for uniform spatial development and land use planning across national, regional and district level in Ghana. This framework established Spatial Development Planning Fund and Spatial Planning Authority that are mandated with functions of providing sustainable development of land and human settlements using a decentralised planning and development systems. This act revise and integrate various legislation on spatial planning and development in order to improve quality of life of the society, enhance economic growth and promote safety and health in human settlements. The LUSP Act prioritize issues of spatial fragmentation, inequality and mixed use development which are preliminary ills of the Joburg spatial planning, despite the efforts for spatial redress this policy draws its setback on exclusion of the marginalised groups in the production and distribution of space.

Spatial Planning and Land Use Management Act 16 of 2013, this act serve as the national law of spatial planning and development in South Africa that was promulgated in 2013. It is mandated to provide a uniform framework for land use managenment and spatial planning in the country, unlock inclusive, developmental and efficient spatial planning across different spheres of government. Amongst one of the key objectives of this law is to address the past spatial and regulatory imbalances that emerged from apartheid government and ensure that there is equitable development across the country. SPLUMA policy becomes relevant to this study as it emphasises redress, social justice, community participation and capacitate public institutions with powers to shape and influence city growth and development. However, the drawbacks of this policy are limited justifications on current pressing issues such as climate change, industry 4.0 and smart city development.

3.3 Strategies in the provision of Spatial Planning and Development

The Municipal Systems Act 32 of 2000 makes a provision for local municipalities in South Africa to produce an Integrated Development Plan, that outlines the future of the cities over the short, medium and long-term period. The Integrated Development Plan consider issues such as spatial planning, economic development, risk management and performance measurement systems. This super plan directs the overall framework of development and attention to a coherent strategies that improve the quality of life for all the society within the jurisdiction of the municipality and look at socio-economic development of an area as a whole including service delivery and infrastructural development. As part of the IDP, there is a component of Spatial Development Framework which makes provisions for future spatial planning and development desirability of cities as well as issuing a directive for coordinated and uniform development.

3.4 Challenges in areas of Spatial Planning and Development

This section outline an overview of key areas that impose various challenges for spatial planning and development, focusing in the City of Johannesburg. These challenges include demographic change, globalization, spatial inequalities and job-housing mismatch, exclusion and increasing informalities.

- Demographic change

The city of Johannesburg metro area is currently having a population of 5 927 000 in 2021 with aa 2.50% increase from 2020. Tracing a year ago in 2020 the city had a population of 5 783 000, with an increase of 2.63% from 2019 (City of Johannesburg IDP, 2020). These demographic trends are a cause for concern to areas of spatial planning and development with regards to coordinated land uses, service delivery and economic development. The growing population in the city give rises to activities such as land invasions, informal erection of dwellings, highjacking buildings, increase criminal activities and pressure on available resources and infrastructure.

- Globalization

The trends of globalization has positive and negative implications for the city of Johannesburg which include the growth of competitive economic markets, limits to the state intervention in developments, the demise to traditional life in the city, economic pressure as the city is benchmarked with international cities, the demand to develop as a world class city which has implications on the environmental sustainability and loss of unique identity of the city.

- Spatial inequalities and job-housing mismatches

In Johannesburg, there are still evidence of spatial inequalities and development fragmentation. The urban poor are still situated in places that are far away from economic opportunities as well as jobs. The large region D of the city which is made of South-Western township (SOWETO) is still undergoing issues of power cuts, lack of connectivity, integrated transport systems and adequate service delivery (City of Johannesburg, 2011). Meanwhile, areas in regions such as Sandton in Region E is kept under constant development and adequate services.

3.5 Stakeholder roles in Spatial planning and Development

Successful implementation of spatial planning strategies and develeopment is largely dependent on the institutional support of all stakeholders including the civil society, non-governmental organizations and public-private sector. Involvement of various stakeholders provides a shared-knowledge, information and skills/support that improves informed decision-making in the processes of spatial planning and implementation of development. The engagement of stakeholder also enhance understanding as well as increased support for proposed policies and strategies. For example, the provincial government of Gauteng in South Africa introduced and implemented the project of e-tolls in freeways of cities including Johannesburg; the systems were developed to fund the R20.1 billion highway upgrade program in 2007-2011, however, due to lack of effective public participation the project is not generating enough revenue as anticipated because of backlash and limited support from the society (National Planning Commission, 2011).

3.6 Review of Experiences (Developed, Transitional and Developing countries)

European spatial planning and development systems are informed by the a document drafted in 1999 called European Spatial Development Perspective (ESDP), which has influenced the spatial planning and development policies in the European Union member states. The European Union emphasised an integrated approach to spatial development planning, and The Urban Agenda calls for an equitable, sustainable and unified approach towards urban challenges, taking into account the Leipzig Charter on sustainable European cities that focuses on major elements of urban development (including social, economic, environmental, cultural and territorial aspects) (European Union, 2008). Furthemore, The Urban Agenda of the EU advocate for a direct relationship with the New Urban Agenda of the UN as well as sustainable development goals to unlock potentials of sustainable urban land use and focus on issues of affordable quality housing, eliminating poverty, limit urban sprawl and social inclusion (Faludi, 2003:09).

In the Federation of Russia, there are various types of spatial planning and development systems adopted by the state: strategic, spatial, socioeconomic and financial. These approaches in all forms of planning are administered by the normative legal acts and legistlave frameworks. Across the spheres of government there are Land use planning schemes of the state Federation that regulate and monitor fields such as federal transport, urban sprawl, quality of life and service delivery (Petrov, 2011).

In the case of Uganda, spatial planning and urban land use are facilitated under the Town and Country Planning Act Chapter 246 of 2000 and the Physical Planning Act of 2010. The urban growth in Uganda is described as unplanned, with high levels of urban sprawl, lack of uniformity between sectoral and spatial planning, poor provision of basic services, significant financial constraints and weak urban management capabilities (Somik Lall, 2012:17). The spatial planning and land use development system in Uganda are closely linked with corruption and political power. As a result, unplanned and chaotic development is prevailing the cities and making it difficult for spatial planners to develop towards urban sustainability and adequate living environments. Over 60.1% of the urban population is found in slum dwellings of poor infrastructure such as poor road network, drainage, sanitation, solid waste and unplanned neighbourhoods that are vulnerable to natural hazards.

3.7 Theoretical Framework

Lefebvre's theory of production of space models the analysis of this study. As a Marxist thinker, Lefebvre (1991) elaborate on the production of space through a three-part system betwen everyday practises and perceptions, representations and the spatial imaginary of time. The primary argument is that the space is a result of a social product which is based on the value and social production of meanings that moulds the social practises and perceptions (Lefebvre, 2014). Therefore, it is reasonable to use this theory as a guide to assess the efficacy of spatial planning and development system in improving the quality of life in the city of Johannesburg because the foundation of this theory assume that that spatial practise, development of space and representations of spaces contribute in various ways to the qualities of the society and as well production of space.

4 STUDY AREA

The city of Johannesburg is classified as the economic powerhouse of Gauteng, South Africa and Southern Africa at large. It was founded in the late 1880s during the discovery of the gold Reef on the Witwatersrand. The metropolitan of Johannesburg emerged in 2000 by the merger of five interdependent municipal areas which covered a total area of 1 644 km2 with a density of 1 963 persons per square kilometre (City of Johannesburg IDP, 2020). Johannesburg is surrounded by the two independent metropolitan areas of Gauteng, namely: City of Tshwane and Ekurhuleni. The city is made up of a 5,92 million population currently spread across 1 434 856 households with an average of household size of 2.8 persons per household (StatsSA, 2013).

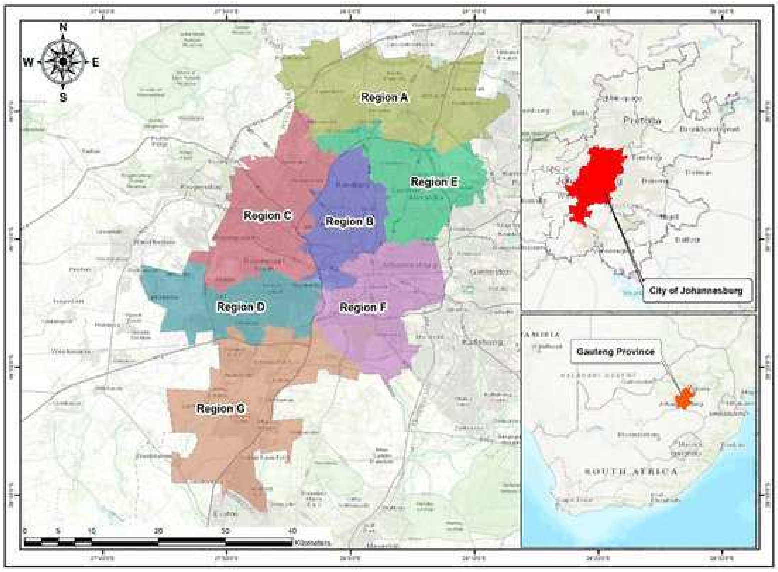

Figure 4.1: Study Area of the City of Johannesburg. Source: City of Johannesburg (2015)

The development in the city is priotised within and spiralling outward from the urban centre with high densities of residents, amenities and economic activities. At the heart of the vision compact polycentric Johannesburg consist of a strong metropolitan core and the inner city. This core embodies the urban qualities that details the spatial transformation themes of building a compact, connected, inclusive and resilient city.

5 APPROACH AND METHODOLOGY

This research adopted a case study phenomelogical design to generate in-depth, multi-dimensional and critical understanding of spatial planning and development system in the city of Johannesburg. The case

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study design allows for the exploration and understanding of complex issues, it can also be regarded as a robust research method especially when a holistic, in-depth and multifaceted investigation is required (Johnsons, 2006). Through case study method, this research went beyond the quantitative statistical results and analysed the behavioural conditions through the actor's perspective. It was noteworthy to note that despite problems in the city such as lack of affordable housing, fragmented pockets of development, limited infrastructure, criminal activities, gentrification and areas of poor living conditions- the Inner City has the capacity to intensify and realise the growth needs through spatial planning and development systems to develop a vibrant core of the city.

Furthermore, this study relied on the mixed methods approach that allows layering of various methods and methodologies in data analysis and collection. It employed both the qualitative and quantitative methods. Purposive sampling was applied to identify key informants from all relevant institutions including the University of Johannesburg, City of Johannesburg and Housing Development Agency. Snow Balling was used for identifying municipal officials that specialize in spatial planning and developmen department of the city. In addition, both the stratified sampling and convenience sampling were also employed to select participants in the human settlement programme and housing delivery for the study in the Housing Development Agency. The city of Johannesburg and Housing Development Agency share housing delivery programmes within the city, currently they have adopted a priority project of closing the housing gap and title deeds backlogs. Therefore, Stratified sampling was then applied to sample each individuals into sub-groups to investigate their consumer satisfaction of housing delivery, tenure security and standards of living within the portions of the city.

5.1 Data Collection methods

Both the primary and secondary data types were collected to inform this study, through employing various data collection techniques including conducting interviews with officials, distribution of survey questionnaires, field observations, desktop study using literature sources and municipal documents to guide the research.

5.1.1 Survey Questionnaires

According to De Vos & Fouche (1998), questionnaires are research instruments that are composed of open or closed questions or statements to which a respondent must react to. For this study, questionnaires were structured in an objective manner and consisted of four sections each, of which were categorised on the objectives set for this study excluding the profiling of demographics for participants. A total 100 questionnaires were distributed electronically to the municipal officials who are responsible for land use planning and development, also 50 questionnaires were distributed to community leaders and citizen within the jurisdiction of the city of Johannesburg.

5.1.2 Interviews

Formal interviews were conducted with relevant key stakeholders of spatial planning and development in the University of Johannesburg, City of Johannesburg and Housing Development Agency. The interviews were conducted through Zoom and Microsoft teams in order to adhere with covid-19 regulations set by the South African government. The interview questions varied across the participants, the first badge of questions were specifically on spatial planning and development within the city and the second badge focused on quality of life, human settlements and service delivery. Professor Trynos Gumbo who is serving as the Head of Department for Urban and Regional Planning at the University of Johannesburg was engaged in this study as the potential spatial planning researcher and involved in consultation stages for development of spatial development policies of the city of Johannesburg. Ms Nokuthuka Thusi (Director: Land Use Development) in the city of Johannesburg was interviewed, whom is identified as the relevant stakeholder involved in influencing spatial planning, land use and management of the city of Johannesburg. Chief town planner in Housing Development Agency was interviewed for his role in human settlement development in the city, Mr Leroy is involved in drafting of Regional Spatial Development Framework for the city.

5.1.3 Literature sources

Extensive reviewof legislative and policy frameworks such as SPLUMA, IUDF, SDF, IDP was conducted to track the efforts taken by the city to improve quality of life through inclusive and effective spatial planning systems. Also, key scholarly journals focusing on areas of spatial planning were used for information relating to studies done previously on the analysis of the city.

6 RESEARCH FINDINGS

This section of the study presents the research results of the efficacy of spatial planning and development systems in improving the standards of living of the communities in the City of Johannesburg. The section further integrates the research results with objectives and aim of the study and apply the research results to draw up conclusions and recommendations. The argument of this study is based on the understanding that the City of Johannesburg is the driving force of economic development in Gauteng, South Africa and Southern Africa, which is why the city is associated with active economic growth, high urbanisation rates, poor service delivery and opportunities that comprehend the quality of life. Johannesburg spaces are hubs for innovation, science, infrastructural development, commerce and culture including challenges that may hinder the city from developing sustainable development frameworks, creating jobs, enhancing quality of life for communities etc. Primarily, Johannesburg continue to prove legacy of spatial segregation, development fragmentation, poverty and exclusion of socio-economic opportunities. Therefore, there is need to assess the extend to which spatial planning and development systems can be utilized to improve the standards of living in the city.

6.1 The current state of spatial planning and land-use development in the city

The regional map of the City of Johannesburg divides the city into seven (7) various regions, however, for the results of this study greater attention is focused on Region F of the city which is made up of the inner city (Central Business District). Below in figure 6.1 is a spatial representation of the inner city and various land uses as well as the current development implementation.

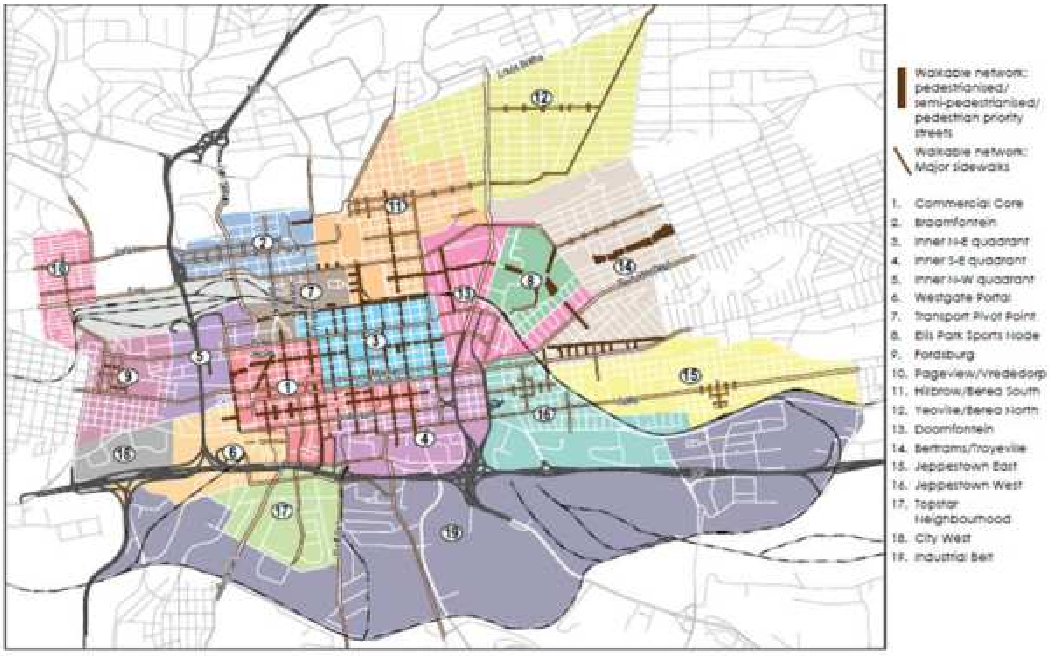

Figure 6.1: The spatial representation of the inner city of Johannesburg. Source: City of Johannesburg Municipal Spatial Development Framework (2016/17)

The inner city of Johannesburg is planned and developed into various land-uses, this is influenced by one of the justifications of municipal spatial development framework which emphasis mixed-land use development in the city to address the past spatial injustices of spatial segregation, development fragmentation, lack of connectivity etc. Above in figure 6.1, it is represented that across various areas of the city there are portions of mixed-use development mainly consisting of residential, business, commercial, recreation, industrial, municipal, transportation etc. This type of development continues to prove the commitment of the city to employ tools of spatial planning and development to improve the quality of life in the city. Over the past years, the city of Johannesburg has been earmarked the most growing city in the SADC region and economic hub of South Africa based on the development systems adopted by the city.

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6.2 Challenges that hinder appropriate living conditions and Urban transformation

The National Development Plan (particularly, Chapter 8: Transforming Human Settlements) and Integrated Urban Development Framework (IUDF) emphasis that spatial planning and space development in cities are the primary priorities for reducing inequalities, poverty, unemployment and managing high urbanisation rates in South Africa. The city of Johannesburg is faced with urban challenges of high urbanisation rates, basic service delivery, high rentals and unemployment (specifically youth unemployment) which require intervention at a city-level and other organs of the state. Prioritizing spatial planning initiatives, targets, development investments, plans and sustainable legislative frameworks can assist the city in strengthening economies, boost quality of life through creation of employment, social inclusion, spatial justice and sustainable development.

Through engagements with municipal officials using interviews and questionnaires, it is safe to conclude that the City of Johannesburg is confronted with massive spatial paradox, where socio-economic development investments tend to intensify existing spatial segregation and developments fragmentations, particularly in urban areas. The city of Johannesburg demonstrates the need for institutional coordination in various parastatals of the local government to enhance the city's spatial transformation vision as envisaged in Municipal Spatial Development Framework.

6.2.1 Service Delivery

The city of Johannesburg through its spatial planning and development tool, Integrated Development Plan (IDP) that is reviewed annually, committed itself to provide adequate access to basic service delivery across all households of the city. The basic service delivery in the city of Johannesburg is currently high with the number of households in both (formal and informal areas) having access to sanitation (96.4%), electricity (92.3%) and piped clean water (98.8%) in 2020.

Service	Households Serviced %	Approximate Backlog in Households	Backlog %
Housing (formal dwellings)	75.1%	448 200	24.9%
Water	98.8%	22 200	1.2%
Sanitation	96.4%	66 601	3.6%
Electricity[19]	92.3%	133 540	7.7%
Refuse removal	92.9%	131 352	7.1%

Figure 6.2.1: Service delivery and backlogs in the city of Johannesburg. Source: City of Johannesburg Integrated Development Plan (2020/21)

The city has a total of 1.8 million households currently in 2021 and of these households, the aforementioned service backlogs have been realised (refer fig 6.2.1 above): formal dwellings (24.9%), Water (1.2%), sanitation (3.6%), electricity (7.7%) and refuse removal (7.1%). These backlogs are a cause for concern because there continues to be evidence of a deficit, specifically in informal settlements in which less than 50% of the households have access to basic sanitation.The following backlogs are manifested by the high population growth in the city and expansion of informal dwellings developing from illegal land invasions which have led to almost 211 informal areas between the years 2016 and 2021 (Oranje, 2014).

6.2.2 Too many Spatial planning and development strategies

There are multiple planning and development strategies introduced at the national, provincial and city-level which may derray the focus of development goals, due to contradiction of one another. For example, the NDP has realised the negative impacts that its inefficient spatial arrangements impose on the urban poor group and introduced the new spatial transformation that transform economic activities and livelihoods for the poor, while reducing high levels of urbanisation (National Planning Commission, 2011). Meanwhile, the city of Johannesburg used the Transit-Oriented Development as a tool to fight spatial inequalities to bridge the gaps of jobs-housing mismatch. The corridors of freedom strategy which is a resultant of the Joburg 2040: Growth and Development Strategy is the spatial vision of the city to allow the urban citizens to have increased freedom of movement and allow people to live closer to economic opportunities and allow accesss to jobs or places of learning to the unemployed groups also bring school learners closer to the schools in the city (City of Johannesburg, 2014). Too many strategies and legislative frameworks of spatial planning and development may contradict each other, address spatial visions differently and introduce different approaches on how to deal with transformation which is a setback for sustainable development goals. There is a need for uniform and single priority strategy that address development and spatial planning across various cities and the country regions.

6.2.3 Proliferation of Informal Settlements

The majority of informal settlements in the city has been developed before the year 2000 with approximately 135 settlements erected already after this record, there were no new informal settlements developed after the year 2003 (Oranje, 2014). Currently, statistics shows that the percentage of the city's households living in informal areas is below 7.51%. According to Housing

Development Agency Status Report (2016), there has been a greater increase in the number of population residing in formal dwelling within the city of Johannesburg since the year 2001. Between 2000 and 2001, almost 77% were residing in formal dwellings, by the year 2011 this number has increased to 81.5%. In addition, the number of households residing in shacks and not backyards has decreased by 8 228 form atleast 125 750 over the period of ten years meanwhile the number of households living in shacks instead of backyards has decrease to 9% in 2011 from 13.1% in 2001 (Gauteng Dept of Human Settlements, 2015). According to Census (2011), the city of Johannesburg has recorded a database of 180 informal settlements across various regions of the city.

6.2.4 Transportation challenges

The city of Johannesburg is faced with numerous mobility challenges. There are key public transport interventions and implementation introduced such as Gautrain system (project invented provincially) and Bus Rapid Transport (Rea Vaya) system (project led by the city), they both play an important role in a new era of inclusive mass public transit between regions of the Gauteng province and at city-wide level. However, the utilization of these modes of transport is relatively low as compared to other existing modes of transport such as the minibus taxi system which consume 45% of the city‘s commuters. Even thou the minibus taxi industry is proven as unreliable, unstable and normally associated with violence, criminal activities and use of poor quality of routes. This effect has resulted in 28% of the residents using their private cars with aorund 4% to 0.5% people using Rea Vaya BRT or metrobus as well as Gautrain (Turok, 2014). In this regard the city's sector for transport continues to lead with 38% in terms of carbon emission as compared to other sectors including the industrial sector with 28% and residential sector with 26%.

6.2.5 Unemployment in the city

Despite efforts of growth over the past ten years and the city of Johannesburg's status as the economic engine of the national economy adding to 16% of the country's GDP, the city economy still show traits of unequal city economies in the world. Formal employment have not matched the standard of the GDP growth, given that only 12% of formal job opportunities were traced in the city and currently the city's unemployment rate is at 32.7% with youth unemployment estimated to be above 40% (City of Johannesburg IDP, 2020).

Based on figure 6.2.5 above, it is shown that unemployment rate in the city of Johannesburg in 2019 was estimated at 26.5%, which has increased with 3.19% in a period of one year from 2018. The unemployment rate in Johannesburg is relatively low as compared to the provincial rate of Gauteng. In 2018, South Africa recorded unemployment rate of 27.18% which shows an increase of 3.59% from 23.60% recorded in 2008. Meanwhile, currently unemployment in Johannesburg is recorded at 32.5% in the year 2021.

6.3 The implications of adopted spatial planning and development systems in the City

The city of Johannesburg first development its Growth and Development strategy in the year 2006 as a strategy for long-term development path for the city. During this time other strategies were in place such as Joburg 2030, Human Development Strategy (HDS), City safety strategy and the Integrated Transport Plan. Currently, the city development the Joburg 2040 Growth and Development Strategy which provides an opportunity for the city to consolidate all the spatial planning and development systems into a single cross-city strategy. This strategy also serve as a guideline to the conceptual foundation of the five-year Integrated Development Plan of the city.

The Growth and Development strategy, 2040 is an effective strategy that seeks to identify the type of the society that the city aspires to attain by the year 2040 (City of Johannesburg, 2011). Nevertheless, The

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Joburg Growth and Development Strategy 2040 is a contemplate for medium-term, strategic and spatially-oriented plans of housing, infrastructure, transport sectors and service delivery. Furthermore, this city Growth strategy does not delegate/outline the functions, operational activities and institutional powers. On the other hand, it directs a set of strategic guidelines that shape the five-year city IDP together with other supporting medium-term plans.

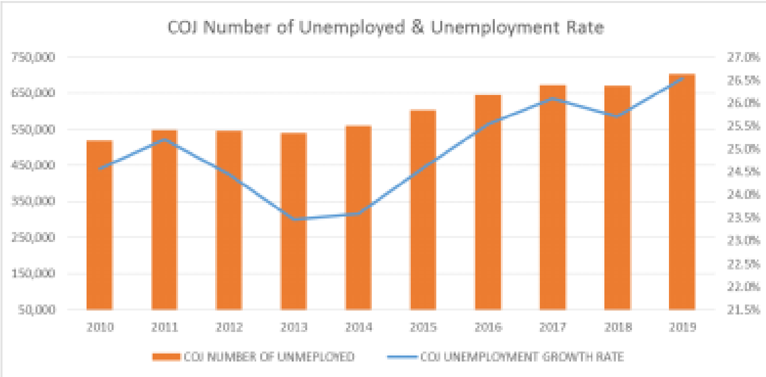

Figure 6.2.5: Unemployment Rate in Johannesburg. Source: City of Johannesburg IDP (2020/21)

The city of Johannesburg Spatial Development Framework 2040 (SDF) is known as an adopted city-wide spatial policy document that outlines the main city challenges and spatial development opportunities derived within the city, sets out a spatial vision of the metro and identifies the strategies to achieve the visions set by the city. This spatial policy document advocates for transformation zones which include the areas that are prioritised for investment to deal with future urban intensification, urbanisation and urban growth. The transformation zone also outlines areas where the development of informed spatial plans and visions will be prioritised, especially previously spatially disadvantaged areas such as townships.

The SDF emphasis the strengthening of the metropolitan core employing various measures such as Inner City Transformation Roadmap, Transit-oriented Developemnt, Inner City Housing Implementation Plan and improvising on the opportunities of the City centre as a congested economic hub of the city and addressing arising challenges such as fragmented spatial development, criminal activities, lack of affordable social housing, delayed service delivery etc. This strategy is based on developing a compact precincts of inclusive mixed use development densification surrounded by public transit and economic opportunities. In addition, the implications of this strategy is to support support economic nodes in the Inner city through different interventions such as investment programmes in engineering infrastructure and social facilities (Ebrahim, 2017).

The Corridors of Freedom strategy as envisaged in the Joburg 2040 Growth and Development strategy prioritize measure of consolidating development and urban growth opportunities around the current and future transport nodes, which are mobility spine to the city starting from the Corridors of Freedom integrating Soweto (South Western Township), through the Central Business District to Sandton (along the Louis Botha Ave and Empire-Perth) and also integrating Turffontein into the CBD. This strategy enhance the focus towards the Transit-Oriented Development nodes such as Rea Vaya (Bus Rapid Transit), PRASA and Gautrain stations. The vision of the corridors of freedom is to transform the entrenched patterns of settlements within the metro which have placed the majoirty of the citizens to the outskirts of the city, where there are no economic opportunities, access to adequate housing, jobs and growth. This strategy aims to increase the norm of people-oriented city where the needs community needs, comfort and socio-economic well-being are at the core planning of the city.

7 CONCLUSIONS AND RECOMMENDATIONS

Spatial planning and development systems shape the urban built environment, on the other hand, the built environment dictates the extent to which cities are sustainable, productive, inclusive and well developed (Harrison & Todes, 2015). This study is centred around assessing the efficacy of spatial planning and development systems in improving the living conditions of the society in the city of Johannesburg, throughout the study the city space was examined closely as the epicentre of understanding the state of the city in terms of the status-quo of quality of life, service delivery, land use planning and development strategies that are applicable to the city. However, the spatial configurations of the city have been altered by various dimensions of development such as inclusivity, finances, governance, productivity and sustainability.

Using various methodologies of data collection, i.e interviews, questionnaires, desktop tools, observations and others; the study realised the immediate urban challenges which require greater attention in the city such as addressing urban sprawl, exclusion, development fragmentation, unemployment, transport issues, proliferation of informal settlements and inadequate service delivery. Therefore, the city need to change the perception of solo-driver in the functions and activities that inform spatial change, there is a need for collaboration across various stakeholders in making decisions of the space as well as development.

The Joburg 2040 Growth and Development Strategy provided an initiative of Transit-Oriented Development (TOD) through the Corridors of Freedom programme, the TOD strategy has the capabilities to consolidate and transform zones around the inner city that requires spatial redress and justice through integrating the peripheral, poor settlements/townships with mixed-use, nodal development of industries where the economic and social opportunities exist. The findings of this study reveals that the land use in the City of Johannesburg is predominantly assigned for residential, industrial, business, commercial, recreational etc, which are nodal development requirements to promote economic growth, improved quality of life and facilitate sustainable development. The Land-use management and spatial planning approaches in the city should facilitate a direction for prioritising human well-being, economy, residential activities and investments.

There is an urgent need to apply measures and empowering instruments that enable participation of the urban communities in finding solutions to their urban challenges through active engagements with the city officials and other relevant stakeholders. In order to address these urban challenges of urban sprawl, proliferation of informal settlements, lack of connectivity, high urbanization rates and poor service delivery; there is a need to reflect on the effectiveness of the current spatial planning and development legislative frameworks and strategies, identify their critical gaps and progress in terms of achieving the desired society and urban development in the city (Integrated Development Framework, 2016).

To improve the standards of living in the city, attention should be given to spatial policies that drives the development of infrastructure, economic growth and social inclusion. This can be attained by making sure there is an adequate public participation in decison-making of developments in their space, also foster relationship between the informal and formal sectors of economy to boost the economy and livelihoods of the urban poor. High urbanisation rates and Proliferation of informal settlements can be dealt with by decentralizing small-scale activities to the outskirts such as manufacturing activities.

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Assessing the Impacts of Urban Determinants on Physical Activity Engagement: An Applied Study on Residents of Alexandria City, Egypt

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1 ABSTRACT

Planning of cities during this decade is oriented to car use, and therefore physical environment that encourages physical activity in the streets is neglected and drastically affected. Studies showed that features that have the strongest effect on residents differ from a community to another depending on culture, social norms and others. This paper identifies the built environment factors that have the most significant influence on engaging residents to physical activity in Alexandria City, Egypt. It also investigates the barriers and facilitators that the residents face while commuting the city. In this study two surveys were conducted, the first (survey I) assessed the value and frequency of participation of residents to physical activity in Alexandria city and identified the specific facilitators and barriers that affects their participation in any kind of physical activity. The second survey (survey II), followed the International Physical Activity Questionnaire – Long Form (IPAQ-LF) to measure the current level of the residents' physical activity. The two surveys are complementary and both revealed the relationship between urban environment features and the associated impacts on physical activities of residents. The results demonstrated the level of physical activity of residents, the satisfaction level of main features with a photo demonstration and locations that affect the ability to frequently engage in physical activity in Alexandria city. It is resulted that urban and street design is the highest motivator that could increase the physical activity of residents. The "availability of open and green areas" has the least satisfaction level from residents, but it is the highest influencing facilitator for physical activity. "Congestion of streets", "lack of time" and "pollution" are from the significant barriers that reduce the engagement of residents in any form of physical activity.

Keywords: Physical Environment Features, Facilitators and Barriers, Satisfaction, Physical Activity Engagement

2 INTRODUCTION

People living in cities are facing various barriers and challenges to being physically active every day. According to Frank and Engelke (2001), urban planning was dominated by a strong focus on cars for decades. The widespread implementation of car-oriented land use and transportation developments have ignored or underestimated the underlying public health consequences. In such environments, where there is heavy reliance on car use, people spend more time on travelling instead of on health-improving activities. This is now changing to a focus on creating cities for people. Today's current concern in cities is to plan urban environments that are responsive to the citizen's everyday needs, improve their quality of life and maintain their health.

Relationships between physical activity and health status are more and more recognized in the literature (Ulijaszek, 2018). The Transportation Research Board and Institute of Medicine (2005), indicated that although individual engagement in physical activity results to some degree from personal choice, it is also a function of the built environment. Researchers and practitioners have come to appreciate the importance of the built environment in facilitating or constraining walking and physical activity (Saelens & Handy, 2008). Salvo, M. Lashewicz, et al. (2018), Ivory, et al. (2015) and Belon, et al. (2014), among other researchers suggest that the physical environment has an influence on the physical activity of people. Thereby, the physical environment can operate as a barrier, a facilitation condition, or contextual influence and the way we build our cities, design the urban environment and provide access to the natural environment can be a great encouragement or a great barrier to physical activity and active living (WHO-Europe, 2006). With the majority of the population living in cities, it is sensible to look at how urban environments have changed, influenced lifestyles, and contributed to the increase in overweight and obesity (Frumkin, 2002). It is challenging, yet essential to develop a better understanding of the features that mostly influence the physical activity.

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2.1 Physical activity status in the Middle East and Egypt

Evidence suggests low levels of physical activity among arab adults living in Middle Eastern countries. According to the WHO (2014), barriers to physical activity in the Eastern Mediterranean Region include competing family demands, such as childcare and household chores; long working hours; heavy school workloads; other competing priorities, such as socializing; lack of affordable leisure facilities; lack of outdoor spaces, such as parks, to be physically active; inadequate public transport systems and heavy reliance on cars; lack of 'walkable' neighbourhoods; feeling unsafe; and climate.

2.1.1 Status in Egypt

In 2009, A Survey of Young People in Egypt (SYPE) by the Egyptian ministry of planning, monitoring and administrative reform with contribution from the Population Council and the Central Agency for Public Mobilization and Statistics (CAPMAS) was conducted for the first time. A second round of the survey was conducted in 2014. The survey concentrated on youth of ages between 10 and 29 and focuses on key aspects of their lives including education, employment, health, family formation, migration, reproductive health, social issues and civic/political participation.

These survey included a series of questions asking about their daily physical activities, including biking and walking, going to a gym, playing sports, or physical work on the job. The results showed that nearly half (45.8%) of SYPE respondents do not engage in physical activities daily. Nearly twice as many young women (59.2%) did not exercise as men (33.3%). SYPE participants aged 13-17 were more likely to indicate daily exercise (66.8%) than the those aged 30-35 (49.0%).

This can be attributed to the lack good streetscape in most of the streets in Egypt as indicated by Rehan (2013), where this adversely affects the behavior of users and esthetic aspects of built environment, and thus deterioration of the visual image of most Egyptian cities. Other reasons for less engagement of physical activity is what Traill (2006) stated, which is that people engage less in physical activity due to urbanization, the sedentary nature of jobs, as well as the speed and convenience of driving rather than walking or biking. All these features promote an unhealthy lifestyle with low physical activity levels specially that being physically active is not common in Egyptian culture. This contributes to a sedentary lifestyle and consequently, to obesity and various non-communicable diseases.

2.1.2 Urban Environment in Alexandria City

According to Elsawy et al. (2017), Alexandria city witnessed an evident shift during the last few decades due to its rapid urbanization. This has contributed to numerous urban, social and environmental issues; such as traffic congestion, environmental pollution, decrease in green areas and degradation of the urban quality of living

As a consequent to rapid urban densification and population growth in the past recent years, the problem of squatting has occurred. The speedy construction of illegal 20-story high rise apartment blocks (Fig. 1) in major cities in public defiance and violation of building laws caused high population density, which jam traffic flows and burden services and utilities beyond their limited capacities. All these problems have had a mass effect on the individual's health (physically, mentally and physiologically) (Zahran, 2014).

Fig. 1: High apartment blocks

Another kind of squatting that appeared fiercely, was the infectious infiltration of venders squatting and invading sidewalks (Fig. 2 and 3), squares, streets, public parks and public land, forcing pedestrians to walk in the streets and to mingle chaotically with cars. The common use of sidewalks by shop owners, cafeterias, coffee shops (Fig. 4), repair shops, and garages had become a familiar scene, compounded by their habitual occupation by parked cars (Fig. 5,6 and 7), by vendors and rural women selling their produce. This congestion is multiplied by unruly car owners who park their cars illegally in two and three rows on street lanes, especially in city centres and near shopping malls, thus causing traffic snarls and strangling jams (Zahran, 2014). All are considered as barriers for physical activity because people experience very hard times to walk comfortably on the sidewalks.

Fig. 2,3 and 4: Invasion of sidewalks by restaurants and vendors

Fig. 5, 6 and 7: Cars parking on sidewalks and pedestrian paths

This study aims to identify and develop a better understanding of the built environment features that have the most significant effect on the residents and accordingly influence their engagement in physical activity levels in Alexandria City, Egypt. The study also explores the barriers and facilitators that the residents face while commuting in the city.

3 METHODS AND TOOLS

According to Welk, G. (2002), physical activity can be assessed using objective or subjective methods. Objective methods such as accelerometer, pedometer, motion sensors, heart-rate monitors, etc are used as they are easy and small wearable monitoring devices that objectively measure physical activity under free living conditions, yet they do not provide information about the type of activity. Subjective methods such as surveys, questionnairs, diaries, etc. are the most commonly used in studies as they are inexpensive, a reliable alternative in a large sample size and they capture more detail about a diverse range of physical activities which enriches more the data collected. Technological advancement devices such as: GPS devices are used in measring physical activity because they track the route of individual and can assess actual travel behavior, yet compimentary methods are needed with it to specify type of physical activity. McKenzie, (2002) point out that direct observation exceeds other measures of physical activity in providing contextually rich quantitative and qualitative data, especially with regard to the what, when, where and with whom it occurs.

Measuring built environment has also been achieved in studies through various methods and tools. Geographic Information System (GIS), offer accurate indicators (Brownson et al. 2009). Observational audits are also from the efficient methods in studies. Lately virtual observational audit tools such as “Visual STEPS ” and “Google Street View (GSV)” were used in studies Steinmetz-Wood et al.(2019), but according to Lafontaine et al. (2017) they do not incorporate sensory inputs such as noise levels, soundscape, and scent that may contribute to a pedestrians experience of a streetscape. Photo-voice methods, focus groups, face to face interviews and surveys are also from the commonly used methods.

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3.1 Adopted Methodology Framework

To fulfil the main aim of the research paper, the methodology framework adopted investigated how the built environment features in Alexandria city can affect the engagement of resident in physical activity. The features selected for this study cover not only urban aspects, but also social (such as: support from family and friends), and safety aspects (like: from crime, injury and accidents). They are proven to have an effect on residents' physical activity in previous studies such as: Bellows-Riecken et al. (2013) and Belon, et al. (2014). Features like "lack of time", "traditional dress" and "cultural lifestyle" are also selected in the study to cover sociocultural aspects because according to Donnelly, et al. (2018) they are also reported as reasons that hinder physical activity.

This study adopts an analytical framework that started by screening the available tool and methods for measuring built environment and physical activity of residents in previous studies. This step was followed by implementing the selected methodology for the study. The selected methodology comprised two complimentary surveys. Survey (I) assessed the value and frequency of residents' participation to physical activity in Alexandria city. It also measured their current satisfaction level towards 9 determinants (e.g.: quality of streets and sidewalk, availability of green areas, opportunity to walk for certain destinations, for leisure and exercising, opportunity to bike, the availability and quality of public transportation). The survey also identified the specific facilitators and barriers that affects the participation in any kind of physical activity in addition to an onsite observation took place to locate the urban environmental features mentioned in the surveys with photo demonstrations. After collecting the responses of residents, relative weighing analysis method was applied in order to: a) Arrange the 9 determinants in order of the residents' satisfaction level, from the determinant with the highest satisfaction level to the lowest, b) arrange the facilitators and barrier features from those having the highest influence on residents to the lowest.

Survey (II) followed the International Physical Activity Questionnaire – Long Form (IPAQ-LF) to measure the current level of the residents' physical activity in Alexandria city. Hagstromer et al. (2005) indicated that most existing questionnaires focus on physical activity during leisure time or at the workplace, which limits the use of these instruments. Only a few of the existing surveys capture physical activty in a variety of daily situations, such as transportation, occupation, household and family care, and leisure time A key feature of the IPAQ form is its ability to provide, in detail, participation estimates for multiple domains of physical activity, including leisure-time physical activity, physical activity for transportation, physical activity in the home and physical activity at work (Craig, et al. 2003). Figure 8 below, is a diagram that demonstrates the adoped methodology framework.

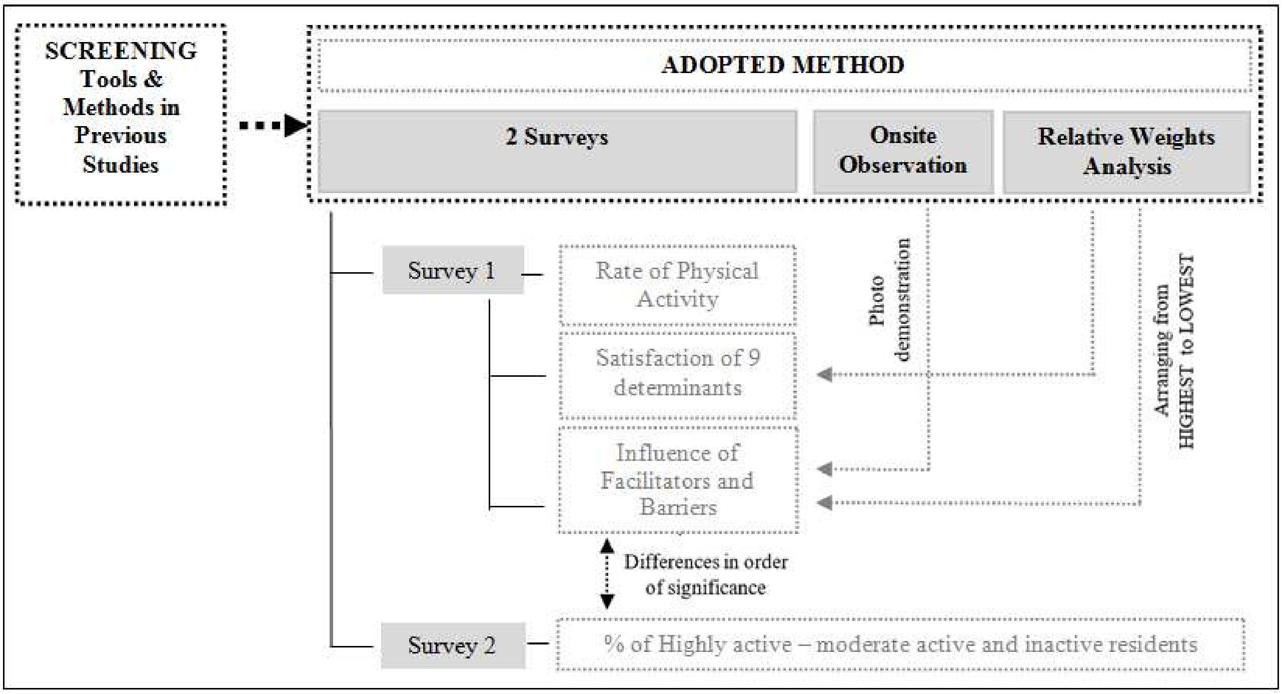

Fig.8: Methodology Framework Diagram of the Study

3.2 Sampling

The Survey targeted Alexandria residents in 6 age groups (>20 years, 22-25 year, 26-30 years, 31-40 years, 41-50 years and <50 years) through online google form (posted in Arabic and English languages) and was spread through social media channels. Most of the responses were from individuals under 50 years old. The survey accepted responses from residents until most variables were covered. Some elderly Alexandrians were intervieved personally.

3.3 Data Collection:

Survey (I) is divided into 4 parts, each part focuses on a particular issue for collecting the data.

- Part 1 is concerned with collecting biodata about the respondents, the value of physical activity to them relative to their other daily activity through a 5 likert scale, data about the respondets' rate of exercising and what motivation would increase that rate.
- Part 2 gathers data about the preferences and satisfaction of residents while commuting. Residents were asked to rate their satisfaction level towards 9 current determinants also on a likert scale from 1 to 5; with 1 for the lowest satisfaction and 5 for the highest.
- Part 3 explores 13 built environment features that would encourage and facilitate the residents to participate more in physical activity (i.e. facilitators)
- Part 4 concentrates on 13 barriers that hinders the residents from participating in physical activity.

Survey II collected data about the physical activity of residents using the IPAQ-long form following the "Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)" in three domains; work physical activity, transportation physical activity and Leisure physical activity. Each domain is calculated separately, to scope the most dominant domain for physical activity of participants, then all domains were merged together to specify the respondents' physical activity levels (High, Moderate or Low). There is a fourth domian in the IPAQ long form which is concerned with the outdoor housework such as: gardening, yard work, shoveling snow and chopping wood. These kinds of housework are not common in Egyptian culture. Hence, Part 3 of the survey is excluded from Survey II.

3.4 Data Analysis:

3.4.1 Survey (I):

Responses of residents were collected, filtered and then analysed. Responses were then calcultated in percentages in order to determine : a) the value of physical activity, b) how often do residents exercise, c) reasons for not exercising regularly, d) motivations that would increase their engagement in physical activity, that were then grouped into 5 clusters (urban, personal, social, safety and economic), d) the satisfaction level of residents towards 9 determinants in the city, and finally e) the influence of facilitators and barriers that residents meet while commuting. The respondents were asked to choose the 5 most significant facilitating features (out of 13 feature) that would encourage them to walk more for leisure and for physical activity (part 4), and to choose the 5 most significant barriers (out of 13 barriers) that they meet while commuting in the streets for leisure or for physical activity (part 5). Then the satisfaction level and influence of facilitators and barriers (part 3,4 and 5) were arranged in order of satisfaction and influence by applying relative weight analysis to arrange them from the highest to lowest using the following equation:

Where, each of the corresponding 5-point scale rating was multiplied by the number of respondents who gave that rating, summing them up, and then dividing them by 5 (the highest point scale) and total number of respodents.

3.4.2 Survey (II) - International Physical Activity Questionnaire – Long Form (IPAQ-LF):

To calculate the total physical activity according to the IPAQ Guidelines for the data processing and analysis of the International Physical Activity Questionnaire (2005), the data were transformed into energy expenditure estimated as the total metabolic equivalent (MET) using published values and recommendations from the IPAQ scoring protocol. To calculate the daily physical activity in MET minutes per week, the number of minutes/day reported in each activity level was multiplied by number of days/week then multiplied by its specific MET score (MET-minutes per week: minutes of activity/day x days/week x MET

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score). MET scores were as follows: walking/light Physical activity = 3.3 METS, Moderate Physical activity = 4 METS, Cycling for transportation= 6.0 METs and Vigorous Physical activity = 8 METS

IPAQ is available in two formats (short and long forms). An important difference between the long and short forms of the IPAQ, the IPAQ long form provides information about time spent in physical activity for each domain, whereas in the short form, the outcome is only a total score for physical activity (Sebastia˜o et al. 2012). The Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) (2005), divided respondents into 3 physical activity levels according to their total score (High, Moderate and Low).

- "HIGH" Physical activity is any one of the following 2 criteria: a) Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week OR b)7 or more days of any combination of walking, moderate- or vigorous- intensity activities accumulating at least 3000 MET-minutes/week.
- "MODERATE" Physical activity is either of the following 3 criteria: a) 3 or more days of vigorous-intensity activity of at least 20 minutes per day OR b) 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day OR c) 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least 600 MET-min/week.
- "LOW" Physical activity (inactive) is when there is no activity reported OR Some activity is reported but not enough to meet the previous 2 categories (HIGH and MODERAT physical activity)

4 RESULTS AND DISCUSSION

Responses recieved from the surveys were 242 responses from both genders. They were divided into 6 age groups as mentioned earlier. Data collection indicates that the most responsive age group are the age from 31-40 years (42% of respondents). 55% of the respondents has a bachelor degree, 31% has master and Ph.D and the rest are university students. Of all respondents, 79% are employed and therefore they commute every day from home to their work locations. And so the results obtained are from an education level that can be relied on.

Motivation type	Responses	
1.Urban *a. Street Design: (35%)*	Availability of suitable sidewalks (flat, wide, continuous/unobstructed and well paved) to walk and exercise Availability of safe wide green areas, open spaces and gardens with pedestrian paths A place providing services and amenities such as seating Cycling lane	Presence of aesthetic mental image Removing vendors and coffee shops that are invading large spaces of the sidewalk Adequate lighting in the streets at nights Cleanliness Trees and shaded areas
b. *Proximity (5.5%)*	Places close from home	Having gym facilities nearby
c. *Traffic (3.3%)*	Less congestion in terms of cars Available of public transportation modes Presence of traffic light signs that allow pedestrians to cross safely	Away from vehicle noise Less car fumes Low speed of vehicles Fixed itineraries
2. Personal *(26%)*	Having more time Good weather Maintaining health, wellness and weight loss No crowdedness and comfortability	Suitable outfit Shopping Presence of places where practising physical activity is fun
Gym facility *(7.1%)*	Privacy and security Cleanliness Gym offering a kids safe area for children	Clean showers Places for girls only Guided classes in the gym
3. Social *(17%)*	Encouragement and support from friends or family	Having company Seeing people exercising in the street
4. Safety *(4%)*	Safe environment Not getting harassed	Keeping away from vehicles for safety
5.Economic *(1.6%)*	Presence of places with reasonable prices	

Table 1: Categorized Responses to Motivations of Physical Activity

4.1 Survey (I):

Results of part 1 of the survey shows that from the respondents, 38% valued the physical activity moderately (value of 3 out of 5), 34% valued physical activity highly (with value of 4 and 5 out of 5). As for rates of exercising, only 22% of respondents exercise regularly, 58% exercise "irregular/sometime" and 20% do not exercise. Results also indicates that men exercised regularly more than women (30% and 17% respectively).

This can be attributed to the traditional roles that women play within society, such as the responsibility for childcare and household chores, which may give them less time to participate in physical activity.

"The lack of time (45%)" and "the lack of places to walk, stroll or run comfortably (24%)" are the main reasons that is preventing the 20% that are not exercising from exercising regularly. "Cafes and restaurants invading the sidewalks by their tables", "not being used to regularly exercise" and "the lack of awareness of the importance of regular physical activity" are additional reasons that were added by the respondents. Table 1 (below) demonstrates some of the motivations that were mentioned by residents, they are grouped into clusters and represented in percentages. It shows that "urban" motivations, specifically the presence of suitable street design, have the highest percentage (35%) that motivate respondents to do more physical activity. This indicates that urban features in the city are the most important driver of physical activity which directly affects the general health condition, mental health and social affairs of residents. Following to Urban features, was the personal motivations as the second important motivator for physical activity.

Results of Part 2, are represented in Table 2 (below). It displays the 9 determinants, the satisfaction level of each and their arrangement in the order satisfaction levels (from highest to lowest) resulting from the relative weighting method. It depicts that the majority of satisfaction levels of respondents were low (varied between 1 and 3 on likert scale) which concludes that the determinants are not in the expected satisfaction level of residents and that futher analysis is needed inorder to identify the reasons for the dissatisfaction.

Fig. 9: Example to Green/open areas in Alexandria

	1 Low satisfaction scale	2	3	4	5 High Satisfaction scale	Relative weights	Arrangement (highest to lowest satisfaction)	
Availability of public transportation	16%	24%	30%	20%	10%	56.8	1	
Walking to a certain destination (near home)	16%	28%	34%	14%	8%	54.4	2	
Opportunity to walk for leisure	21%	32%	26%	14%	7%	50.8	3	
Opportunity to walk for exercising	38%	27%	19%	10%	6%	44.0	4	
Quality of Public transportation	32%	32%	27%	5%	4%	43.0	5	
Quality of streets	35%	31%	26%	5%	3%	41.8	6	
Quality of sidewalks (walking)	43%	30%	14%	8%	5%	40.2	7	
Opportunity to bike in the streets	51%	19%	15%	8%	7%	40.0	8	
Availability of open/green areas	51%	26%	14%	3%	6%	36.8	9	

Availability of public transportation	busses not available in all routes - no prompt scheduling
Walking to a certain destination	crowdedness - vandalism - pollution
Opportunity to walk for leisure	crowdedness –harassment (for girls) – Lack of adequate lighting – presence of obstacles - no green spaces - no spaces to walk freely and feel safe.
Opportunity to walk for exercising	Limited places (cournich street only or inside clubs)
Quality of Public transportation	not clean – no maintenance - people abuse it
Quality of streets	Always crowded – some traffic street lights doesn't work to cross safely
Quality of sidewalks (walking)	Narrow and high - used by shops/cafes - motorcycles uses sidewalks to park - presence of obstacles – no seating available
Opportunity to bike in the streets	Very dangerous to ride it in the streets with cars - can't ride on sidewalk
Availability of open/green areas	The public ones are not safe - not clean and no maintenance

Table 2: Level of Satisfaction of Respondents (%) and Relative Satisfaction Level. Table 3: Problems Faced by Respondents concerning the 9 Determinants

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The 3 determinants that took the highest satisfaction level were: “availability of public transportation”, followed by “walking to near destinations near home” because residents are used to the surrounding around their homes, then the “opportunity to walk for leisure” as the third place. The lowest satisfaction level was given to the “availability of open/green areas” because open and green spaces are limited, and the available ones are either neglected or in remote places. Following to Table 2, some general reasons for the respondents’ rating in Survey (I) are displayed in Table 3.

Results of Part 3 and 4 demonstrates the order of features from highest to lowest influence on residents after applying the relative weighing analysis method (Table 4 below). This ordering helps deepen the understanding of the most significant features that affects the behaviour and physical activity of residents postively or negatively.

Table 4 reveals that the physical activity facilitators that have the highest significance is the “presence of trees and green areas”, this is because they provides a better environment for the residents. It makes them feels relaxed and calm instead of being surrounded by cars and fumes causing constant stress and uncomfartability. Hence, it is urgent to start taking more care and increase the urban and green spaces to raise its satisfaction level and therefore induce the physical activity of residents. Trees are more available in some of the streets to provide shade in sunny days, lower the temperature and gives a good surrounding atmosphere. This is why shaded areas came as the second facilitator. However, trees can act as obstacle at places with narrow sidwalks. The presence of “streetlights” was the third facilitator as some streets in Alexandria are not adequately lit, and that induces an unsafe feeling. “Feeling safe from injury or crime” is the fourth facilitators. The sense of safety is essential for one to move freely and comfortable in the streets. Finally “presence of sidewalk network” is the fifth facilitator as it gives the pedestrians their space to walk and enjoy moving freely and safely. This can also be achieved by: a) widening the sidewalks, because there are some places in Alexandria that have narrow sidewalks, and other places have no sidewalk to walk on, and b) removing the obstacles that are on the sidewalk such as vendors, cafe tables, cars parking on sidewalks



Fig. 10 and 11: Presence of Trees in Streets. Fig. 12: Trees as Obstacles in Narrow Sidewalks.

Significance	Facilitators	Relative weight	Barriers	Relative weight
Highest	Trees and green spaces	38.8	Congestion/crowdedness of streets	25.0
	Shaded areas	30.8	Lack of time	22.6
	Streetlights	27.6	Pollution	18.8
	Feeling safe from injury or crime	25.6	Weather conditions	12.8
	Presence of sidewalk network	25.2	Lack of facilities	12.2
	Presence of traffic signals and safe crossings	21.6	Culture and lifestyle	11.4
	Pedestrian only footpaths	17.4	No habit of exercising	10.0
	Presence of benches and seating	15.6	Dependency on cars	9.4
	Seeing other people walking	13.6	Lack of adequate public transportation	7.2
	Outdoor spaces, plazas and squares	11.0	Fear of Accidents	6.6
	Attractive buildings and views	9.6	Traditional dress dress not convenient for participating in physical activity	5.80
	Presence of shopping streets and restaurants	9.0	Exercise is painful	3.4
Lowest	Children’s playgrounds	5.2	Lack of support from family or friends	0.9

Table 4: Order of Significance of Facilitators and Barriers on Residents from Highest to Lowest

The barriers that have the highest significance is the “congestions and crowdedness of streets”. This is because crowdedness causes alot of noise and car fumes, and therefore stress and discomfort. All that repels people from any kind of physical activity. “Lack of time” is the second barrier. It was mentioned earlier (in part 1) that 45% of respondents chose it as one of the main reasons that is preventing them from doing physical activity regularly. This is due to the pressure and long hours that residents spend at work, also some people do more than one job in order to enance their economic status. Thus, they have no time for any physical activity. “Pollution” is the third barrier, and it is resulted from crowdedness and congestion of cars that already has the highest influence as a barrier.

4.2 Survey II - International Physical Activity Questionnaire – Long Form (IPAQ-LF)

After collecting and calculating the weekly physical activity of the respondents, it is found that 52% of the respondents are “Highly active”. This result was expected because most of the respondents (41%) were aged from 31 -40 years. 32% of the respondents are “moderately active” and 13% were “inactive”. The study explored the distribution of the respondents’ weekly physical activity in each of the 3 domains mentioned in IPAQ-LF (work physical activity– transportation physical activity– recreation and leisure physical activity), Each of the domains was divided into males and females for further analysis (Figure 2).

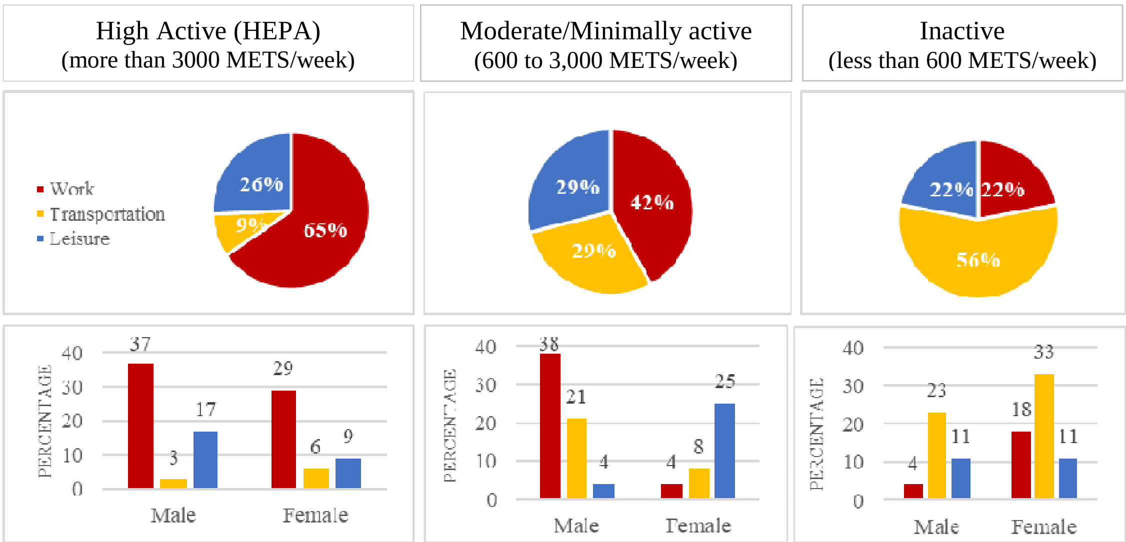

Fig. 13: Physical Activity Distributed on the 3 Domains of IPAQ-LF

From Figure 13, it is shown that most of the physical activity of the “Highly active” respondents are carried out during work by 65%, and the physical activity of males are slightly higher than females (37% and 29% respectively). In addition, the physical activity carried out during leisure and recreational time by 26%. Highly active males spend more time doing physical activity than females during leisure time (17% and 9% respectively) mainly because females already have other responsibilites during day time, such as taking care of children and constant housework, and so their leisure time is limited. Physical activity during transportation is the lowest for the highly active respodents (9%) because the highly active individuals pursue to be in constant movement. Males are less than females in this case, because men commute more than females.

For “Moderately” respondents, activity carried out during work also has the maximum pernentage by 42% of their total physical activities. The difference in physical activity carried out between males and females during work is very noticeable (38% and 4% respectively). Physical activity carried out in leisure time and during transportation were equal for “moderate active” respondents (29%). When comparing physical activity of males and females in both types of physical activity, it was found that males spent more time in physical activity than females during transportation (21% and 8% respectively), while females spent more weekly physical activity activity than males during leisure and recreantional times (25% and 4% respectively).

Physical activity during transportation attained the highest percentage for the inactive respondents (56%), as they do not do any activity willingly. Percentage value of females in work physical activity are more than that of males (18% and 4% respectively) and also in transportation physical activity (33% and 23% respectively).

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When comparing the order of influence of facilitators and barriers between highly active, moderate active and inactive respondents, some differences were found. Figure 3 &4 shows these differences in the order of significance in percentages.

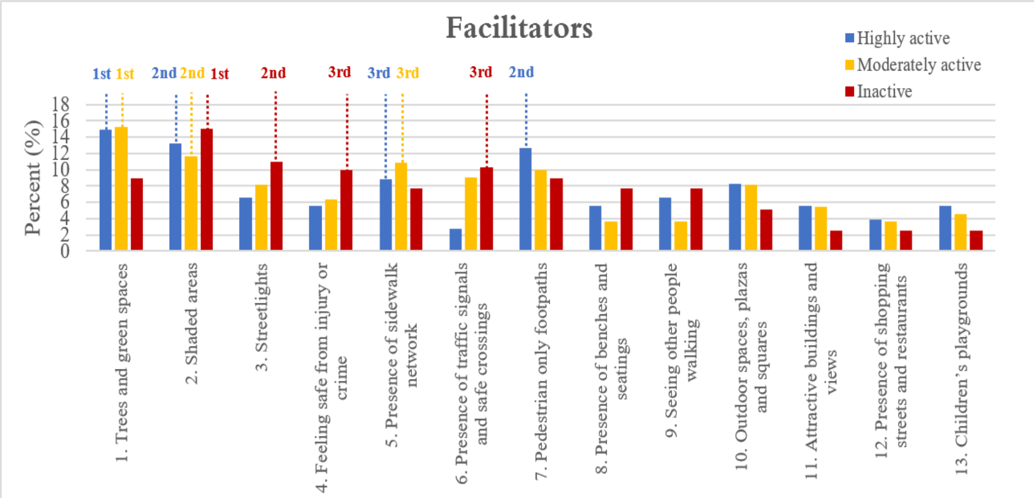

Fig. 14: Order of Significance of “Facilitators” between Highly Active, Moderately Active and Inactive Respondents.

Figure 14, shows that the order of significance of facilitators for the highly active and moderately active respondents are almost close to each other while the order is a bit different for inactive respondents. The facilitators with the highest percentage of significance is “trees and green spaces” for both, the highly active and moderately active respondents. “Shaded areas” received the highest percentage of significance for the inactive respondents, while it is second highest significant facilitator for the highly active and the moderate active respondents. “Pedestrian only footpaths” is also the second in order of significance for the moderate active respondents since people seek to walk around securely. “streetlights” is the second highest significance for the inactive respondents. “Presence of sidewalk network” is the third in the order of significance for the highly active and the moderate active respondents due to the ability of walking comfortably and safely. “Feeling safe from injury or crime” and “Presence of traffic signals and safe crossing” had the third significance for inactive respondents due to the assocaited sende of safety.

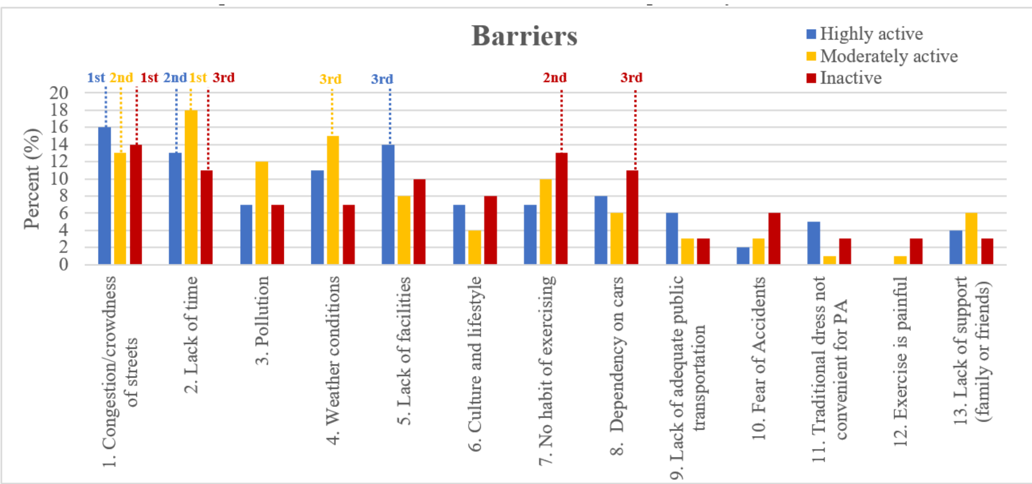

Fig. 15: Order of Significance of “Barriers” between Highly Active, Moderately Active and Inactive Respondents.

Figure 15 indicates that the barrier that has the highest percentage of significance from engaging in physical activity was “Congestion and crowdedness of streets” for both highly active and inactive respondents, it is the second in order for the moderately active respondents. “Lack of time” is from the significant barriers for the three types of respondents, due to long hours of work for residents and other responsibilities. It is the highest in significance for the moderately active respondents, second in order of significance for the highly active and the third in order for the inactive respondents. “No habit of exercising” is the second highest significance for the inactive respondents One of the main sociocultural reasons for that is because most of the parents concentrate on their children’s educational studies and neglect their participation in regular physical activity. “Lack of facilities” is the third in the order of significance for the highly active respondents, because availability of facilities is essential for their regular physical activity. “Weather conditions” is the third in the order of significance for the moderately active respondents, where good weather conditions give a push for physical activity in leisure time. “Dependency on cars” plays an important role for the inactive respondents because they mostly have no time to do any physical activity and so they do most of not all their chores using cars.

5 CONCLUSION AND RECOMMENDATIONS

The results of this paper indicated that walking decision depends mostly on urban motivations, and that urban determinants and built environment features affect physical activity of people both positively and negatively. It also shows that streets design parameters shape residents’ behaviour as they need to experience pleasure while commuting such as good scenaries, natural views, the presence of open and green spaces, network of sidewalks with no obstacles. Residents also seek to avoid any stressful factors such as crowdedness of streets, pollution and vandalism.

There are several features that act either as facilitators that induce individual’s physical activity or barriers that hinders individuals from engaging in physical activity and become more dependent on motorized transportation.

Conclusions of this study were found to be in line with most of the studies related to physical activity and its relation to urban determinants. Several recommendations are produced, and are directed to decision makers in local government. It is recommeded to:

- Consider highly open and green areas, as it has the highest influence as a facilitator for engaging in physical activity.
- Maintain the existing open areas with green spaces, and other shaded areas with trees to lower the temperature and provide a good surrounding atmosphere for residents and thus induce the physical activity of residents.
- Maintain street lights to enhance the feeling of safety while walking particularly in quiet places.
- Construct and maintain sidewalk network to provide the pedestrians with space to walk and enjoy moving freely and safely.
- Pay more attention to sidewalks to be well paved, with no obstacles on it and provide pedestrian footpaths or sidewalk networks for increasing physical activity in the streets.
- Consider highly the problem of vandalism that are invading the sidewalks. Once the sidewalks become walkable, it will attract residents to walk more often
- Increase public transportation to motivate people to use them more and increase their activity routine.
- Install bike lanes to help increasing physical activity, especially among youth. This will avoid risky situations of cycling in the crowded streets of Alexandria city.

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Assessment of the Quality of Urban Spaces in the Context of Child-friendly Mobility

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1 ABSTRACT

Child-friendly urban spaces promote safe, independent and active mobility of children. This paper explores which indicators can be used to assess the quality of urban spaces in the context of child-friendly mobility. For this purpose, indicators from literature, guidelines etc. are collected. In total, 77 indicators are identified, described in terms of their relevance for child-friendly mobility and divided into four categories: (i) traffic situation and traffic conditions, (ii) urban space - infrastructure, (iii) urban space - amenities and other conditions, and (iv) other. For each indicator, very good (grade 1) and very poor conditions (grade 5) with regard to the quality of urban spaces in the context of child-friendly mobility are defined. A weighting is applied to evaluate the indicators according to their relevance for child-friendly urban spaces. In addition, a (more user-friendly) reduced set of 30 indicators is developed. The full catalogue of indicators, the subset and the associated evaluation scheme were used for an on-site inspection of a road section in the city of Vienna. The road section is also inventoried "digitally" based on geodata to analyze to what extent freely available geodata can be used to conduct the assessment without being on-site. By comparing the results (full set versus sub-set as well as manual versus digital assessment), the user-friendliness of the catalogue(s), the possibilities and limitations of a digital assessment of urban spaces in the context of child-friendly mobility are shown. The results show that processed indicator sets are suitable for the evaluation of the quality of urban spaces. In general, it can be stated that the results of the manual assessment agree very well with the entire catalog of indicators and with the shortened indicator set. The digital evaluation with indicator set also leads to comparable results, although outliers can also be identified for many "non-assessable" indicators. Due to a lack of data availability or quality, a (partially) automated digital evaluation is technically feasible, but many indicators have to be analysed or interpreted in-depth, which contradicts an automated evaluation. In the future, an automated evaluation of the quality of urban spaces in the context of child-friendly mobility could be possible and therefore offer a need for further research.

Keywords: child-friendly mobility, transport planning, urban spaces, indicators, children

2 INTRODUCTION

2.1 Starting point

The Federal Constitutional Law on the Rights of Children states, among other things, "Every child has the right to appropriate participation and consideration of his or her opinion in all matters concerning the child, in a manner appropriate to his or her age and development" (BVG Children's Rights, 2011). "Matters concerning the child" also include all those related to children's homes and living spaces. However, in urban or transport planning and related political decisions, children's opinion and specific requirements are usually secondary. Although comparably vulnerable road users, such as pedestrians and cyclists, are becoming increasingly important in cities' strategies (e.g. MA 18 - Stadtentwicklung Wien, 2015), existing spaces have been and continue to be used primarily for cars respectively car users. This contradicts the requirement that children as a particularly vulnerable group must be able to use public space safely and need to access their destinations to play and stay without barriers.

In addition to these ethical aspects, some worrying trends can be observed with regard to young age groups. In fact, one of that is the decline in physical activity: In Austria, only 17.4% of 11 to 17 year olds meet physical activity recommendations of the World Health Organization (WHO) (Maier et al., 2017). These low rates of physical activity are also reflected in the development of everyday mobility of children: Accordingly, results of the Austrian national household survey show that walking decreases by 15 percentage points between 1995 and 2013/14 for the age group of 6 to 14 years old children (Tomschy et al., 2016; Tomschy et al., 2017). At the same time, car-passenger trips increased by 12 percentage points. 36%

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of education trips as car passenger are shorter than 2.5 km. Furthermore, studies in different European countries indicate that children's independent mobility is on the decline (Shaw et al., 2013, Shaw et al., 2015). These developments clearly show that urban spaces need to be designed in a way that active and independent mobility is promoted.

2.2 Child-friendly mobility

The quality of urban spaces in the context of child-friendly mobility cannot be considered one-dimensionally. Many factors simultaneously influence whether children can move, play and stay in urban spaces on foot, by bicycle, scooter, inline skates, or skateboard. This refers, for example to spatial / structural, social, and economic factors.

Spatial characteristics refer to the traffic situation in the vicinity (e.g., speed limits), presence of parked vehicles, existence of barriers such as roads heavily used by motorized traffic within walking distance, or noise pollution, to name a few (Blinkert et al., 2015). They include private areas (e.g. type of house, presence of a garden/(front) yard) as well as public areas (e.g. distance of the front door to the street, existence of green areas, playgrounds). When collecting indicators in this field one can make use of studies on walkability which have recently been published around the globe (e.g., Zuniga-Teran et al., 2017; Kostovasilis, 2013; Wey & Chiu, 2013; Khder et al., 2016; Leslie et al., 2006). However, one must take into account that children and adolescents have different demands on their (built) environment than adults. Exemplarily, while walking trips for adults are primarily relevant for errands and recreation (Leslie, et al., 2006), for children it is playing and meeting friends (Blinkert et al., 2015). This results in different requirements for the design and equipment of public spaces. In addition, child-relevant factors for other travel modes such as bicycle, scooter, etc. must be identified. Several Austrian guidelines are an important basis for the collection of indicators on child-friendly mobility in this study. Those guidelines contain recommendations, mainly in the spatial context; they are, however, not exhaustive. The guidelines "RVS 03.04.13 - Child-friendly mobility" (FSV, 2015) and "RVS 03.04.14 - Design of the school environment" (FSV, 2016). Another guideline on child-friendly transport planning and design, was published by the former Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW, 2014). Another important basis is also a study of Blinkert et al. (2015) which has investigated how areas can be described and evaluated in terms of their qualities for children and what influence the residential environment has on children's play and everyday life.

Besides spatial characteristics, social and economic aspects influence the amount of free time spent outside by children, most of them indirectly via selection/distribution to favorable or unfavorable residential areas. These include f.e. the parents' level of education and the social climate in the neighborhood. In addition, the economic resources of the family, the family status of the parents (single parent or both parents), the employment of the parents, and an existing migration background all influence the unsupervised time spent outside the home.

It can be summarized that there are many factors which are difficult to capture in their entirety. In this work, only spatial and structural characteristics are considered.

2.3 On-site inventories

Spatial characteristics to assess child friendly mobility can be collected by on-site inspections / inventories conducted by observers (see for example Blinkert et al., 2015). Maps and photos can also be used to support the data collection. However, walk-throughs are time-consuming. Therefore the question arises, to what extent it is also possible to obtain information on the basis of existing geodata on a small scale. It could also be helpful to make assessments by combining objective data (GIS, open data) with data from on-site inventories. The development of automated evaluation tools would help cities to address the challenge of assessing socio-ecological qualities of urban spaces and to promote livability.

2.4 Objectives

Based on the starting point and challenges described, this paper deals with an evaluation of urban spaces in the context of child-friendly mobility. The main objective is to investigate which indicators can be used to assess the quality of urban spaces in the context of child-friendly mobility. A user-friendly set and evaluation scheme should be developed. Bases on on-site inspections in the city of Vienna the applicability is to be tested. In addition, it is analyzed to what extent freely available geodata can be used to conduct the assessment without being on-site. By comparing the results (full set versus sub-set as well as manual versus digital assessment), the user-friendliness of the catalogue(s), the possibilities and limitations of a digital assessment of urban spaces in the context of child-friendly mobility are shown. The paper is structured as follows: In section 3 the approach is described. In section 4 the full catalogue of indicators is presented, the weighting procedure and the limitations. Based on that, the sub-set of indicators and the digital evaluation are presented. Section 5 presents the results of the application of the evaluation procedure. In section 6 conclusions are derived.

3 APPROACH

A multiple step approach is used to address this complex topic:

In a first step, relevant factors are researched based on guidelines and other literature. This results in a compiled list of indicators for assessing urban spaces in terms of child-friendly mobility. These factors can have an impact both directly and indirectly by influencing each other. The majority of the indicators have an effect through the reduction of motorized traffic, the reduction of motor vehicle speed and the creation of good visibility conditions in urban areas. In addition to road safety, some indicators also have an impact on subjective perceived social safety, but also on other aspects such as aesthetics of urban spaces. This, in turn, affects parents' decisions to let children go outside unsupervised.

In a second step, the list is summarized and shortened to a sub-set of 30 indicators to make it possible to evaluate individual street sections quick and simple.

In a third step, this sub-set of indicators and the associated evaluation scheme are applied for three different road sections in the city of Vienna. The application is carried out both "manually", that is, by walking and assessing the conditions on site, and "digitally", that is, by means of available data and computers.

4 INDICATORS

4.1 Catalogue of indicators

Based on literature, 77 indicators were identified. Two thirds of them are mentioned in several sources and largely overlap in content. Although studies contain a description on the positive or negative effect on child-friendly mobility, in the majority of cases no detailed information can be found regarding the indicator’s expression in order to lead to this effect. This leaves a lot of room for interpretation as well as for the evaluation of the indicators. Although there are indicators that belong at least partially to private space (e.g. "type of house", "presence of gardens") they are nevertheless included in the catalogue.

The collected indicators are divided into four categories: (A) traffic situation & conditions, (B) urban space - infrastructure, (C) urban space - amenities and other conditions, and (D) other. Tables A1-A4 (Appendix) contain the description of all indicators, references, and (if available) specific recommendations. Most of the recommendations found in literature are qualitative; only occasionally (additional) quantitative information can be found. In principle, the aim should be to evaluate each indicator as objectively as possible. It seems, however, sometimes unavoidable to subjectively assess the indicators. For the evaluation, a five-part rating scale was used. The scale points were defined with 1 - very good, 2 – good, 3 – average, 4 – poor, 5 - very bad. For the endpoints (very good and very bad conditions with regard to child friendly mobility) a verbal description is given (Tables A1-A4, Appendix).

4.1.1 Category A: Traffic situation and traffic conditions

Current traffic conditions are summarized under this category; this concerns information on cross-section design (e.g. dimensioning of cross-section elements), traffic organization (such as legal regulations like the speed limit) and the prevailing traffic situation (e.g. compliance with the speed limit, traffic volumes, share of trucks). The indicators of this category can be considered together as "k.o. "-criteria for child-friendly mobility - conditions that must be met in order to achieve desired goals. This means that a majority negative rating in category A, cannot be outweighed by indicators of other categories. In total, 19 indicators are assigned to this category (Table A1, Appendix).

4.1.2 Category B: Urban space - infrastructure

This category contains 26 indicators regarding the infrastructural design which can promote safe, independent and active mobility of children (Table A2, Appendix). In contrast to category A, indicators of category B have a supporting but not decisive effect on child-friendly mobility. Examples include selective elements such as crossing aids, traffic light signal systems with green times adapted to the walking speed of children, floor markings, pictograms, or the combination of structural measures for traffic calming. Many indicators identified in literature differ only slightly. For example, four different indicators for the implementation of crossing aids can be found.

4.1.3 Category C: Urban space - equipment and other conditions

Indicators of category C allow to evaluate the local conditions that are not directly related to traffic. A total of 27 indicators are assigned to this category (Table A3, Appendix). The equipment of the urban space can especially contribute to child-friendly mobility, if indicators of categories A and B are evaluated positively. For example, private spaces such as the type of house (e.g., single-family home), or the presence of a yard may have a positive effect on children's unsupervised time spent outdoors (Blinkert et al., 2015), and thus particularly on active and independent mobility. In addition, low air pollution, low noise pollution, and seats in public space may promote active, independent mobility. However, if traffic conditions or infrastructure (A, B) are otherwise poor, these criteria have little influence on children's freedom of movement.

4.1.4 Category D: Other

This category includes 5 criteria that cannot be assigned to any other category, but find mention in literature several times (Table A4, Appendix). They include many different effects at the same time - for example, opportunities for interaction with peers, or the connectivity of the urban space. Strictly speaking, the expression of these indicators results from the effect of other indicators.

4.2 Weighting

A weighting procedure was applied to be able to evaluate the indicators according to their relevance for child-friendly urban spaces. We propose (i) an intra-category rating of the indicators and (ii) a category weighting. For the intra-category weighting, each indicator is assigned a weighting factor of 1 to 10, with 10 representing the strongest weighting based on the findings collected in the literature and a subjective assessment of Neuhauser (2020). These weighting factors are used to determine the percentage by which the respective indicator is included in the overall category result. The indicator "traffic volume (motorized)" receives the highest weighting with a prioritization of 14% in category A. In category D, all five indicators are considered equally important and are therefore all assigned a weighting factor of 1 (corresponds to 20% each). The weighting factors are included in Tables A1 to A4 (Appendix). A category weighting is additionally introduced. According to Neuhauser (2020), the findings of the literature review underline that the traffic situation and traffic conditions have the greatest influence on the child-friendliness of urban spaces. Urban space infrastructure is less significant, but still has a stronger impact on child-friendly mobility than urban space amenities. Other indicators only have a minor impact on the overall result. Thus, the proposed weighting clearly prioritizes category A (Traffic situation and conditions) with 55%, followed by category B (Urban space infrastructure) with 25%, category C (Urban space amenities and other conditions) with 15%, and category D (Other) with 5% (Neuhauser, 2020).

4.3 Limitations of the catalogue

4.3.1 Number of indicators

An attempt was made to include all indicators evident from the literature in the catalog. This leads to a complex list of 77 indicators. This contradicts the demand for a tool for “quick” and “easy” assessment of urban spaces.

4.3.2 Similarity

Since all indicators based on literature are included in the catalog, some of them differ only slightly. As an example, “curb extensions as crossing aids” and “roadway narrowing” are mentioned. Both serve mainly to improve the visibility of other road users, although narrowing the carriageway can also lead to a reduction in speed. By grouping similar indicators together, multiple mentions in the list can be countered, although care must be taken not to lose any relevant information.

4.3.3 Qualitative information

It is striking that there are much more indicators in category B and C than in A, although the traffic conditions are much more important in the assessment of the child-friendliness of urban spaces. It is equally striking that there are only qualitative recommendations and descriptions for most of the indicators. Only for six indicators specific recommendations for measures are discovered. This is logical in that urban areas differ greatly from one another. There are only a few recommendations for traffic regulation and infrastructural design and equipment that are valid for different urban areas. For example, it can be stated as a general rule that a speed limit of 30 km/h is better than a speed limit of 50 km/h in terms of child-friendly mobility. The situation is different, for example, with the indicator "presence of planting (e.g. trees, hedges)". Thus, it makes no sense to assume that a tree every 20 meters is "better" than a tree every 50 meters. Many indicators interact with each other and can only be evaluated in their entirety. It follows that the assessment of many indicators must be made subjectively and the urban space must be considered as a whole. However, this makes it difficult to derive specific recommendations or to assign the indicators to individual user groups such as pedestrians or cyclists.

4.3.4 Impact assessment

It is difficult to distinguish whether indicators affect children's safe, independent and/or active mobility. It is assumend, that if an indicator has a positive effect on safe mobility, children move more independently because they are allowed to. If children move independently, this inevitably leads to higher level of active mobility. It is not examined if children in better rated urban spaces have higher rates of active mobiliy. It is only evaluated based on literature whether the expression of the respective indicator has a theoretically positive/negative effect on child-friendly mobility.

4.3.5 Loss of information through "digital" evaluation

Additional information may be lost through the digital assessment. For example, if the presence of a pavement is determined via a digital data, no statement can be made about its quality. It is possible that the pavement is not sufficiently dimensioned so that vehicles can drive over it and it does not lead to more child-friendly conditions. This circumstance can only be taken into account by on-site inspections.

4.3.6 Incompatible combinations

Some of the indicators are interdependent (e. g. "presence of playgrounds" and "playground equipment"), but not all of them can be combined with each other (e. g. "presence of median islands as structural crossing aid" and "pedestrian zone"). In this case, the respective indicator must be removed from the evaluation. By creating different lists for different frameworks, incompatible combinations of indicators could be avoided. For example, separate lists could be created for pedestrian zones, one-way streets, the school environment, or possibly also for different user groups such as pedestrians, cyclists, or scooter riders, which are equipped with different indicators and weightings.

4.3.7 Indicators not assessable

With each indicator that drops out of the evaluation as "not assessable", the weights of the remaining indicators change. A direct comparison of two urban areas/road sections is only possible based on indicators that form the "lowest common denominator". How many indicators must remain as the lowest common denominator is not investigated. It should be noted, that the omission of too many indicators can lead to a distortion of the results.

4.3.8 Transferability

In their present form, the indicators can only be used for the city of Vienna. The definitions of the indicators take into account the specific cityscape, the infrastructure and the legal framework. For the use of evaluations in other cities, countries or in the rural area, the indicators must be modified accordingly and adapted to possibly different circumstances. It must be checked, to what extent data are available for a digital assessment outside Vienna.

Full catalogue	Indicator	Subset
A1+A2	Restricted motorized traffic	A1*
A3	Existence of one-way streets	A2*
A4	Existence of through roads	A3*
A5	Existence of speed limits	A4*
A6	Compliance with the speed limit	A5*
A7	Traffic volume (motorized)	A6*
A9	Existence of adjacent busy roads	A7*
A13+A14	Bicycle path/lane	A8*
A18+A19	Sidewalk/walkway	A9*
omitted	A8, A10, A11, A12, A15, A16, A17	

Table 1: Subset of indicators in category A: Traffic situation and traffic conditions.

Full catalogue	Indicator	Subset
B4	Consideration of children's point of view	B1*
B7+B8+B9+B10	Structural crossing aids	B2*
B19	Existence of crosswalks	B3*
B11+B12+B13+B14	Structural traffic calming	B4*
B16	Existence of traffic light systems	B5*
B17	Traffic light system - green phases for pedestrians	B6*
B18	Traffic light system - turning traffic and pedestrian traffic separated	B7*
omitted	B1- B3, B5, B6, B15, B20, B21- B26	

Table 2: Subset of indicators in category B: Urban space – infrastructure.

Full catalogue	Indicator	Subset
C5+C6	Playgrounds	C1*
C7+C8+C9	Open spaces	C2*
C10+C11	Retreats	C3*
C12	Lighting	C4*
C16+C17	Water	C5*
C19	Existence of planting (e.g. trees, hedges)	C6*
C20	Existence of larger green areas (e.g. meadow, forest, park)	C7*
C26	Air pollution	C8*
C27	Noise pollution	C9*
omitted	C1-C4, C13-C15, C18, C21-C25	

Table 3: Subset of indicators in category C: Urban space – equipment and other conditions.

Full catalogue	Indicator	Subset
D1	Harmlessness	D1*
D2	Reachability/accessibility	D2*
D3	Opportunities for interaction	D3*
D4	Diversity/designability	D4*
D5	Connectivity	D5*
omitted	-	

Table 4: Subset of indicators in category D: Other.

4.4 Subset of indicators

Based on some of the limitations mentioned above, the full catalogue is shortend to create a more suitable set of indicators for faster application. The most relevant indicators for child-friendly mobility will be retained; rather unimportant indicators are omitted. If possible, similar indicators are combined. This favors having fewer very similar or incompatible indicators in the list. However, the problem that mainly qualitative information is available and no statements can be made about the actual impact of indicators cannot be counteracted by creating the shortened indicator set. Likewise, the loss of information due to the “digital” evaluation and the problem of non-assessable indicators remains. The subset of indicators contains 30 indicators (Tables 1 to 4).

4.5 Digital evaluation

For the “digital evaluation” based on the indicator subset, different sources for free available geodata are used. Almost all indicators are assessed digitally via ViennaGIS. Only the indicators “sidewalk/walkway” and “noise pollution” are partially assessed using information from other data sources (data.gv.at; maps.learminfo.at). In addition, for each indicator, the quality of the data is reported. This includes whether the data can be assessed automatically and whether all information necessary for the assessment is included. The better the quality of the data, the faster and more accurate the assessment can be performed. Based on the quality of the data, indicators can be evaluated directly, after further analysis, or not digitally at all. Three quality levels are described:

- Level 1 data can be displayed automatically, i.e. “at the click of a mouse”: The data contain all information and details. An example is the indicator “presence of speed limits”; speed limits can be displayed clearly and directly for the entire urban area.
- Level 2 data are available, but need to be interpreted in more detail to allow an assessment. The data contain only partial information and/or need to be further processed or analyzed in more detail for the evaluation. This applies exemplarily to the indicator “structural crossing aids”. For example, sidewalk extensions or median islands are visible via ViennaGIS. However, these are not automatically displayed, but have to be identified piece by piece on the map. It may be necessary to review level 2 data again by performing a “virtual walk-through” (e. g. Instantstreetview.com) in order to be able to give a valid assessment. Another example is the indicator “playground” which includes not only the presence, but also the equipment of playgrounds. However, via the available data, it is only possible to determine where playgrounds are present, but not how they are designed.
- Level 3 data is not available or cannot be evaluated on a digital basis. For example, no data can be found on the lighting.

5 ASSESSMENT

5.1 Case study

The evaluation scheme is applied for three inherently homogeneous road sections in the city of Vienna by using the full catalogue as well as the subset on-site (Neuhauser, 2020). In this paper, only one example is presented. In a second step, the assessment is also conducted “digitally”. The use case described in this paper is Köstlergasse – a one-way street about 200 meters long.

Figure 1: Köstlergasse, Maps data: ©2021 Google Street View

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It is located in the 6th district of Vienna and connects Gumpendorfer Straße with Linke Wienzeile. The on-site inspection took place in January 2020 and lasted about 120 minutes.

5.2 Results

Table 5 includes the average values of the assessment of the indicators per category (with intra-category weighting and unweighted) as well as the number of assessable indicators. The results are distinguished between on-site assessment (full catalogue, subset) and digital assessment (subset). For the digital assessment also the data quality is displayed. It should be noted that, strictly speaking, averaging across the indicators in the categories is not permissible. However, the median represents a strong coarsening, so that the mean is used as a good approximation.

<table>
<tr><th colspan="2">Indicator category</th><th colspan="2">On-Site Assessment</th><th colspan="2">Digital Assessment</th></tr>
<tr><td colspan="2"></td><td>Full catalogue</td><td>Subset</td><td>Subset</td><td>Data quality**</td></tr>
<tr><td rowspan="3">A</td><td>unweighted</td><td>2.65</td><td>2.89</td><td>2.71</td><td rowspan="3">L1: A1-2*, A4*
L2: A3*, A7-9*
L3: A5-6*</td></tr>
<tr><td>weighted</td><td>2.95</td><td>3.08</td><td>3.06</td></tr>
<tr><td>nr of indicators</td><td>17/19</td><td>9/9</td><td>7/9</td></tr>
<tr><td rowspan="3">B</td><td>unweighted</td><td>2.74</td><td>2.43</td><td>1.50</td><td rowspan="3">L1: B5*
L2: B2-4*
L3: B1*, B6-7*</td></tr>
<tr><td>weighted</td><td>2.67</td><td>2.65</td><td>1.50</td></tr>
<tr><td>nr of indicators</td><td>23/26</td><td>7/7</td><td>4/7</td></tr>
<tr><td rowspan="3">C</td><td>unweighted</td><td>3.83</td><td>3.67</td><td>3.57</td><td rowspan="3">L1: C7-9*
L2: C1-2*, C5-6*, C8*
L3: C3-4*</td></tr>
<tr><td>weighted</td><td>3.58</td><td>3.29</td><td>3.56</td></tr>
<tr><td>nr of indicators</td><td>23/27</td><td>9/9</td><td>7/9</td></tr>
<tr><td rowspan="3">D</td><td>unweighted</td><td>2.40</td><td>2.40</td><td>1.67</td><td rowspan="3">L1: -
L2: D1-2*, D5*
L3: D3-4*</td></tr>
<tr><td>weighted</td><td>2.40</td><td>2.40</td><td>1.67</td></tr>
<tr><td>nr of indicators</td><td>5/5</td><td>5/5</td><td>3/5</td></tr>
<tr><td rowspan="3">Total</td><td>Average unweighted</td><td>2.90</td><td>2.85</td><td>2.36</td><td rowspan="3">-</td></tr>
<tr><td>Average weighted (incl. category weighting)</td><td>2.90 (2.95)</td><td>2.86 (2.97)</td><td>2.45 (2.68)</td></tr>
<tr><td>nr of indicators</td><td>68/77</td><td>30/30</td><td>21/30</td></tr>
</table>

Table 5: Average scores of child-friendly mobility, 1 (very good)-5 (very bad). **Quality level of data level 1 to 3, see chapter "digital evaluation"

The results show, that based on the on-site assessment, 88% of the full catalogue indicators and all of the indicators in the subset can be evaluated. The digital assessment is based on 21 out of 30 indicators. Overall, the selected road section is rated "good" to "average" regarding child-friendly mobility. The worst conditions are achieved in category C (Urban space – equipment and other conditions). Due to the tight space conditions and the inner-city location, Köstlergasse lacks open spaces, green zones, seating areas, retreats and the like. The results appear plausible, especially when compared to the results from applying the evaluation procedure to other road segments, e.g. a pedestrian zone (Neuhauser, 2020). Comparing the total scores, the results of the on-site assessments agree well. With the full catalogue of indicators, values of 2.90 to 2.95 are determined; with the shortened set of indicators, values of 2.85 to 2.97. The overall results of the digital evaluation based on the sub-set are 2.35 to 2.68 and therefore differ by about 7% from the "on-site" result. This can be attributed to the higher scores in category B and D with rather low numbers of assessable indicators. The results in category A differ only slightly from each other; this category has the greatest influence on the overall result with 55% if the category weighting is applied. In fact, the data for the digital evaluation is only available to a limited extent (70% of indicators). In addition, some indicators could only be assessed inaccurately digitally. In total, level 1 data (highest quality) can be found for six indicators, level 2 data is available for 15 indicators. No usable data (level 3) can be found for nine indicators. Due to the poor availability and quality of the data, there is a large margin for interpretation. However, it should also be noted, that the digital assessment could be completed in about 30 minutes. Thus, the "digital approach" is 75% faster than the walk-through (120 minutes; arrival and departure not included). However, it has to be considered that the street section had already been walked before from the same observer and therefore the digital assessment could possibly be more time consuming for an unknown urban space. The walk-through is therefore significantly more time-consuming, although more precise results can be determined as a result.

6 CONCLUSION

The current study reflects the complexity of the assessment of the quality of urban spaces in the context of child-friendly mobility. Lots of indicators and criteria have been gathered from literature; some of them could be added in the Austrian RVS guidelines. As a result, a catalogue describes 77 indicators which are relevant for child-friendly mobility. However, the application of the full indicator catalogue is associated with limitations. By defining a subset (30 indicators), some limitations can be counteracted, but some remain. Comparable results are achieved, however, it should be taken into account, that this reduction of the catalogue is made subjectively. In addition, only the small-scale theoretical effects of indicators are evaluated. Effects outside the selected road section are not taken into account. More research is needed to test the assessment method for different road sections. This can help to verify the results stated above. As the weighting can have a significant influence on the results of the evaluation, experts could be involved to refine the weighting process. Furthermore, before-and-after evaluations (e.g. change of use of travel modes, of the share of independent mobility of children, of attitudes) in the course of the implementation of road redesign measures could help to assess the direction of action respecitvely the effectiveness of measures. Future research could also lead to more specific (quantitative) recommendations for the dimensioning and design of elements in the urban area.

The current study also shows that it is possible to evaluate urban spaces in the city of Vienna by indicators both manually by means of inventory and based on digital data. According to the subjective assessment of the observer, the results of the manual evaluation reflect very well the conditions found on site with regard to child-friendly mobility (Neuhauser, 2020). Although the evaluation based on geodata lead to comparable results, it seems, however, necessary to critically review the results determined in this way. In particular, the availability and quality of data is a challenge as most of the data belong to quality level 2 or 3 and cannot be used without further ado. Decisive influencing variables can possibly be considered only insufficiently or not at all. Therefore, it should be kept in mind that a digital assessment brings not only opportunities but also risks.

Given sufficient availability of data, in the public sector, “child-friendliness” could be taken into account in the future, for example, in urban and transport planning with a similar collection of indicators or used to prioritize investments. By visualizing the quality of urban spaces in the context of child-friendly mobility in the entire urban area, it may be possible in the future to bring this to the attention of decision-makers. But also for the private sector, additional data may be available in the future and processed accordingly. Subsequently, it would be conceivable to weight the indicators online according to one's own preferences and to display the results for the entire urban area. In this way, parents and children could use smartphones to find out about child-friendly areas in their neighborhoods. Possibly, these results could also be linked to traffic models and real-time data. For parents, this could be decisive for choosing the location of their residence and thus subsequently also influence rents and real estate prices.

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8 APPENDIX

The appendix is available in the online archive version of this paper:

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Barriers and Opportunities of Community Participation in Informal Settlement Upgrading Projects: A Case Study of Slovo Park, South Africa

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1 ABSTRACT

The Upgrading Informal Settlement Programme (UISP) has been identified as an approach to improve the lives of informal settlement dwellers with minimal interruption to their livelihoods and social networks. In addition, it has been recognised as a progressive approach in human settlements that moves away from the traditional approach of providing housing in the periphery of the city. This approach requires community participation to be at the centre of the development taking place within the settlement. Recent studies reveal that commonly, the state lacks institutional capacity to conduct effective community participation. The paper presents the results of an assessment of community participation in the upgrading process of informal settlements, as implemented at the Slovo Park. The study was conducted using a qualitative approach by means of in-depth interviews with the residents of Slovo Park to gather information on the possible impact of ineffective community participation during the UISP process. The paper reveals that community participation was ineffectively facilitated and this is reflective in the residents' lack of information pertaining the design layout of the future projects to be implemented in the settlement. Moreover, the paper highlights that ineffective community participation hinders residents of informal settlements from accessing self-provided adequate housing and results in provided basic services such as electricity, inaccessible to the beneficiaries due to their known socio-economic status. Results in this paper can be used to emphasise the importance of meaningful community participation for a successful UISP process.

Keywords: Community empowerment, community participation, informal settlement, in situ upgrading

2 INTRODUCTION AND CONCEPTUALISATION

Globally, the urban population is predicted to reach 6.5 billion by 2050 (Feleki et al., 2018). UN-Habitat (2010/2011) indicated that in sub-Saharan Africa, approximately 14 million people migrate to urban areas annually. According to Ragheb et al. (2016), of this number, about 61.7% live in informal settlements. It is acknowledged that in most developing countries, the existence of informal settlements is a representation of poverty trap. Residents of informal settlements often exist in conditions that expose them to health risks, lack of prosperity, unsafe and undignified way of life and over the years, this has been justified by their illegal occupation status (Talukdar, 2018). Despite over 3.6 million new houses built since 1994 through housing strategies such as Reconstruction and Development Programme (RDP) or Breaking New Ground (BNG), development and expansion of informal settlements have been a recurring problem in South Africa (Brown-Luthango et al., 2017). The growing demand for housing and urban infrastructure has been exacerbated by the sudden influx of people into urban areas especially in large metropolitans such as Cape Town, Johannesburg, and Ekurhuleni (Møller, 2007). It is undeniable that the various strategies to eradicate informal settlements including demolitions and evictions have failed to cease the development of informal settlements.

According to Huchzermeyer (2014), BNG projects under the National Housing Subsidy Scheme also came along as informal settlement eradication strategy in which households qualifying for the once-off capital subsidy were often removed from the informal settlement and relocated to an identified suitable land where completed units were allocated. Although this programme provided many poor communities with low-cost housing, residents were disadvantaged due to the relocations to the peripherals of the city, where economic opportunities are scarce. It was recognised that this housing subsidy strategy was only dedicated for developments on vacant land, which presented a policy gap in terms of the availability of subsidy system designed to facilitate in situ upgrading of informal settlements (Huchzermeyer et al., 2014). Although Upgrading of Informal Settlements Programme (UISP) was initially launched in 2004, together with the BNG, implementation has been insufficient because it lacked political support. However, it was considered the most progressive housing policy to achieve integrated sustainable human settlements with minimal interruption to people's livelihoods. Implementation of UISP become apparent five years later, after the programme was introduced as Chapter 13 of the National Housing Code and National Upgrading Support Programme (NUSP) was incorporated to promote and support the implementation of UISP (Huchzermeyer et al., 2014).

Not only was this an attempt to close the policy gap, it was also an acknowledgement that informal settlements are a part of the urban topography and have the potential to address the increasing housing backlog (Wekesa et al., 2011). In situ upgrading of informal settlements has been regarded as an approach with minimal disruption to the livelihoods and social networks of informal settlement residents while improving their living conditions. Any upgrading intervention including UISP should consider the socio-economic status of the informal settlement to enable provision of basic services that can be accessible to the beneficiaries. UISP requires that there be a proactive community involvement in addressing their own developmental needs (Del Mistro & Hensher, 2009). The role of community participation in the UISP process is to ensure better planning and increase efficiency during the project, ensure that communities' real needs and issues are reflected upon, resulting in better cost recovery after the completion of projects. Furthermore, it enables skills transfer, ensure effective use of resources and ensure affordability (Marais & Krige, 1997; Marais & Ntema, 2013 and Wekesa et al., 2011).

Community participation in the planning process of in situ upgrading goes beyond just allowing community members to make decisions on the suitable product (Meredith & MacDonald, 2017), it can also be a key tool to enhance the community's self-reliance which could encourage innovative self-built or upgrade of their housing structure (Georgiadou & Loggia, 2016). However, Ziblim et al., (2013) observed that in practice, community participation is an administrative façade comprising of arranged meetings, with experts already designed and finalised plans, thus allowing little room for community participation and influence. Public officials often avoid real participatory processes in project planning, because they assume that these are not only "time-consuming," but also, can be "unpredictable" and "messy" (Ziblim et al., 2013).

Recent literature (Mathekga & Buccus, 2006; Ntema et al., 2018; Wekesa et al., 2011; Ziblim et al., 2013) only focuses on the lack of institutional capacity to facilitate real community participation which results in unsuccessful in situ upgrading of informal settlements. However, there has not been enough attention on the impact of ineffective community participation on the beneficiaries of upgrading processes. Given the gap in literature, the study assessed the barriers and opportunities of community participation and possible impact of ineffective community participation, with specific focus to the upgrading process of Slovo Park informal settlement. Subsequent sections of this paper highlight the review of related literature, the methodology adopted, the results, and based on the findings conclusions are drawn.

3 LITERATURE REVIEW

3.1 The history of South African housing and informal settlement upgrading

The South African post-apartheid government inherited a housing backlog from the apartheid regime. However, since 1994, the housing backlog has worsened and continue to grow especially in the major cities (Moola et al., 2011). A democratic South Africa resulted in the sudden influx of people into urban areas especially in large metropolitans such as Cape Town, Johannesburg, eThekwini and Ekurhuleni. With growing population, the demand for housing and urban infrastructure accelerated beyond the metro's capacity to keep up with the pace (Møller, 2007). The first approach to curb the housing backlog under the new democratic South Africa was through the RDP which focused on ownership and delivering starter home on a plot of land for the poor, with the target to deliver 1.6 million units by 2004 (Ojo-Aromokudu, 2013). According Esteri (2018), the first 1 million housing units were targeted to be delivered in the first 5 years since 1994. This appeared to be too much concern on the quantity of housing delivery while quality was compromised. The launching of BNG in 2004 was a shift from quantity to quality, presenting a comprehensive plan to developing sustainable human settlements. The key objective of BNG was to eradicate informal settlements, yet in 2018, 14 percent of the urban population was recorded to be living in informal dwellings (Esteri, 2018). Despite over 3.6 million new low-cost housing built since 1994 through the traditional subsidy-linked housing programme, development and expansion of informal settlements have been a recurring problem in South Africa (Brown- Luthango et al., 2017). In 2014, South Africa had a housing backlog of 2.3 million, this backlog was further estimated at 2.3 million in 2018, increasing with around 178 000 units yearly (Esteri, 2018).

It is argued that RDP and BNG have had unintended housing policy outcomes as it is evident that they are not successfully curbing the housing backlog, there is slowdown in delivery; inadequate housing has been delivered and continued growth of informal settlements in the major metropolitan cities (Ojo-Aromokudu, 2013). Both policies haven been largely criticised for their lack of inclusion of community participation and common practice of relocation of residents of informal settlements. These housing policies have undermined the livelihoods and existing fragile social networks of the poor and have perpetuated the apartheid urban planning strategies which have marginalised the poor (Cirolia, 2017). It became clear that the conventional model and largest subsidised housing programmes were not cost effective, inflexible and environmentally unsustainable and this presented a policy gap in terms of the availability of subsidy system (Huchzermeyer et al, 2014).

Upgrading Informal Settlement Programme was regarded the first progressive housing policy which promote in situ upgrading of informal settlements in suitably located land with minimal disruptions to livelihoods, social networks and minimal relocation while enhancing community participation (Huchzermeyer, 2014). Although UISP was introduced in 2004 through the BNG, there was insufficient political will and consensus to operationalise the incremental upgrading approach. Yet, through UISP, incremental provision of essential services for informal settlements can achieve immediate relieve residents of informal settlements are in desperate need of and it is cost effective (Misselhorn, 2017). However, since the incorporation of UISP into the Chapter 13 of the National Housing Code and NUSP in 2008, the country has witnessed pilot projects of in situ upgrading aiming at achieving National Development Plan 2030 (NDP) Outcome 8 'Human Settlements' – upgrading of 400 000 households in informal settlements by 2014 (Huchzermeyer, 2014). NUSP's main task is to promote and support the implementation of the UISP in terms of co-ordination with sectors and partners involved as means to ensure that government's capacity and professional practitioners is strengthened to implement community-based incremental upgrading, mainly in the metropolitan cities (NUSP, 2015). When implemented, UISP can benefit many amongst the 2700 informal settlements that have been developed over 2 decades ago as temporary transit camps or reception areas and have since been awaiting formalisation and incremental provision of basic services (Huchzermeyer, 2014). Nonetheless, it is evident that the target to upgrade 400 000 informal settlements in well located land by 2014 could not be achieved and it is argued that ineffective community participation and partnership have been a major impediment to effective in situ upgrading (Misselhorn, 2017).

3.2 Community participation in in situ upgrading process

3.2.1 <u>Developing countries context</u>

Developing countries such as to mention but a few, Egypt, Nigeria and Kenya have undertaken an initiative to achieve the UN Millennium Development Goals (MDGs), Goal 7 Target 10, to expressively enhance the lives of more than 100 million informal settlement dwellers by the year 2020 (Ziblim et al., 2013). Egypt's approach to informal settlement was the incorporation of Participatory Development Programme in Urban Areas (PDP) on the Informal Settlements Development Facility (ISDF) in 2008. The PDP promotes the implementation of participatory practices in urban upgrading between local government and civil society organisations (including residents of the informal settlement) to ensure adequate service provision (Khalifa, 2015). However, ISDF review conducted by El Maabady (2015) indicated that there was no real community participation in the ISDF process. According to El Maabady (2015), although this upgrading programme was only focused on providing funding for the construction of housing units for the residents, this was done without taking into consideration the needs and socio-economic circumstance of the beneficiaries. As such, living in the provided units was a high-priced option for the poor and the non-provision of power supply resulted in many reinstating illegal electricity connection in the newly provided housing units (El Maabady, 2015).

Ineffective community participation in the Nigerian Re-development project has been a contributory factor for poor response to informal settlements. Although the re-development policy was focused on improving the quality of life of the residents of informal settlements, beneficiaries were largely dissatisfied with the standard of housing provided. As such, the government's purpose was defeated by the selling and renting out of the provided housing units. It was argued that the re-development project was a top-down initiation, thus a size one fit all strategy not precisely suitable for the informal settlement upgrade of Port Harcourt.

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Furthermore, the upgrading project was planned and implemented without involving the residents as an important part of the project (Obinna, et al., 2010).

Kenya's Slum Upgrading Programme (KENSUP) of 2003 also suffered from the barriers and missed opportunities of community participation which consequently reflected disregard for the existing socio-economic circumstance of the beneficiaries. Although the initial project was to upgrade the Kibera-Soweto village, the housing units that were prearranged were accommodative to the middle-class standard and posed affordability challenges to the intended beneficiaries. The provided housing units consisted of a two-bedroom and a multi-story single unit unsubsidised mortgage that was intended to be rented out for beneficiaries to afford mortgage repayments. Many recipients leased their units and found alternative and affordable accommodation elsewhere, in poor living conditions. It is argued that the redevelopment "upgrading" strategy undermined aspects of affordability and tenure security, therefore, it is perceived as a suspension to addressing informal settlements and not a solution (Huchzermeyer, 2008).

3.2.2 Defining community participation and its significance

It is important to note that the shift to informal settlement upgrading is stimulated by mainly the growing demand for adequate housing and expansion of informal settlement. The urban poor have nowhere else to go and have found an alternative affordable accommodation commonly closer to their workplace. Over the years, they have managed to turn informal settlements into a functional space, often through illegal connection to water and electricity supply. When providing incremental upgrading of basic services, the municipality is building on what has already been built by the community in order to integrate the settlement into the town or city. For this to be achievable and sustainable, residents are to be made partners in the upgrading process and stakeholders in the town or city. Thus, community participation is a pre-requisite (Misselhorn, 2017). Community participation can be defined as a process where the concerned individuals are consulted, empowered, and influence the change that is meant to better their life (El Menshawy et al., 2011).

Although community participation is a process politician find to be forced on them and unfruitful because in many occasions, it becomes a platform for complaints and protests against non-delivery of services, but if conducted effectively, it can benefit politician too (Misselhorn, 2017). Meaningful community participation is crucial for the sustainability of the in situ upgrading post-implementation (El Menshawy et al., 2011). It also has the potential to achieve an everlasting collaboration between communities and government (Simone et al., 2005). Thus, community participation is a key principle of UISP, as such, funding is made available to municipalities and are encouraged to apply for additional funding for external capacity to support participation processes (NUSP, 2015). According to El Menshawy et al. (2011), capacity building, both on leadership skills and technical knowledge is imperative for an effective community participation.

3.2.3 Stakeholders in in situ upgrading initiatives

According to NUSP (2015), participation must be undertaken through ward committees, and or Community Development Workers (CDWs), ordinary members of the community and other relevant key stakeholders (e.g. NGO's and or expects in the field). It is from such a structure that community participation process can lead to municipalities making well informed decisions that are based on the real needs of the community they serve. Simone (2005) highlights that in situations were varied interests are to be delivered, community consultation presents an opportunity for invloved stakeholders to openly bargain or negotiate and renegotiate functional compromises allowing greater flexibility, creativity and effeciency in the planning process. There will be better understanding of government's intentions and resource limitations it works under and gain community's buy in into the project through inclusive decision-making. Although not everyone within the community may have interest in participating, but for the purpose of meaningful participation, it is necessary that everyone be afforded an opportunity to do so (Burns & Heywood, 2004). The involvement of the vulnerable groups in the key stages of the upgrading can promote community empowerment and capacity building, develop sense of ownership in the project rather than being passive beneficiaries (NUSP, 2015).

3.2.4 Good practice and stages of participation process

Whenever a development strategy is considered, including for informal settlements, government must consider the following participation practices that have emerged from court cases in South Africa; respect and partnership, meaningful engagement, individual engagement, mutual consensus, adequate consultation and active participation. Although all the other practices must be considered, meaningful engagement is at the core of UISP as it encourages that all parties involved (community and municipality) have an open discussion to reach favourable decisions. As such, it is no longer considered meaningful if decisions were taken before the discussion took place because community members would not have been treated as partners in the process (NUSP, 2015).

Participation is an ongoing activity that may vary based on different stages but must be included in the entire UISP process. However, it is most crucial during discussions about development plans of the community. There are 4 phases in the UISP process that require participation. Phase 1: Application – an opportunity for grassroot development where gathering information to assess and categorise of the community can be provided by the community members to form part of the pre-feasibility report. Thus, shared control or collaboration between municipality and community is required. Phase 2: Initiation – submission of the business plan will require cooperation from both the municipality and the community to ensure that the real needs of the end users are reflected. This can also be achieved at minimal consultation unless the community is of the opinion that unneeded project or business plan is drafted. Both application and initiation phase require all parties involved to participate because they involve much negotiation and decision-making, this is an important stage of participation. Phase 3: Implementation – due to the technical complexity, active community participation is rarely expected unless in a case where community involvement is optimal. Thus, the municipality takes full control of this stage. Phase 4: Consolidation – depending on the consolidation undertaken, participation will differ. If housing is provided through the subsidy, informed participation will apply but if there will be People’s Housing Process, the community will take full control (NUSP, 2015).

3.2.5 Participatory methods and techniques

Participation methods are not a size one fits all. The best method to choose depends on the purpose, the desired level of participation and the guiding principles. With respect to upgrading, community-based planning method is commonly recommended, but action planning method has proven to work successfully. Action planning has elements of community-based planning, therefore, goes beyond community-based planning. The aim of action planning method is to empower communities to design their project layout, undertake implementation process and manage their own upgrading projects (NUSP, 2015). This method is highly recommended on a re-blocking process, which is another approach to upgrading. Re-blocking has been a common practice under UISP as an initial indicator for interim intervention for informal settlements. Re-blocking aims at addressing issues of safety and unhealthy living spaces especially in very dense informal settlements (Tshabalala & Mxobo, 2014). Re-blocking process is a community-driven exercise which results in the reconfiguring or rearranging of shacks according to the community-drafted spatial framework. The community members are in full control of the process of negotiating floor sizes, tearing down shacks and creating a community-based plan, subsequently building a stronger social cohesion and solidarity (Moreschi et al., 2012). During this process, officials and other involved stakeholders have the privilege to gain wisdom and better understanding of the community’s perceptions by listening to stories, which form a significant part of a meaningful community engagement (Pinfold, 2015).

3.2.6 Challenges in the South African context

The South African challenges of community participation are not on the policy guidelines, but implementation. The principles of participation for informal settlement upgrading are clearly stipulated. Build common ground and knowledge between institutions and communities. This includes internal knowledge (life experience and skills) from the communities and external knowledge (technical and specialised knowledge) by municipalities and or specialists. Build mutual trust, make and deliver realistic promises. Stimulate engagement and communication that goes beyond the specific project deliverables, especially because post-implementation there is a continuous operating, maintenance, and urban management issues to address. Establish transparency during the entire process where the municipalities share information with the communities about problems, obstacles and challenges encountered including delays with funding or development approvals and do so as they arise. Perhaps some of these challenges can be dealt with collaboratively. Ensure that there is a community-based partner to effectively represent the community as this plays a key success factor (Misselhorn, 2017).

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However, in practice these principles are not implemented, and this has a negative effect on beneficiaries. According to Mathekga & Buccus (2006), lack of community participation has characterised the post-apartheid South Africa over the years. Common reasons for the recurring culture have been the issue of lack of technical skills and lack of adequately trained personnel at local government level. However, this has been largely viewed as an indication that government undermines the importance and effect of active citizenship as crucial elements in a democratic setting, in which citizens should be recognised beyond just customers of social services. The numerous protests within communities are an indicator of dysfunctional relationships between citizens and government. Citizens are not well informed, particularly regarding participatory governance and public officials are yet to be educated on how to facilitate the process (Mathekga & Buccus, 2006). Thus, communities are not empowered with the knowledge and understanding necessary to make informed decisions. As such, instead of a meaningful community participation, in practice, communities play an advisory role. Top-down decision-making and planning of service delivery approach remains unchanged as participation by ordinary people is perceived as interfering with effective delivery of basic services (Thwala, 2009). In practice, community participation is an administrative façade comprising of arranged meetings, with experts already designed and finalised plans, thus allowing little room for community participation and influence. Public officials often avoid real participatory processes in project planning, because they assume that these are not only "time-consuming," but also, can be "unpredictable" and "messy" (Ziblim et al., 2013). An example would be the implemented in situ upgrading in the community of Makhaza (Khayalitsa) and New Rest (Gugulethu) Cape Town. The City of Cape Town only focused on the quantity of houses needed to be built and leaving little opportunities of open spaces for cooking stokvel, shop spaza, sewing groups, cultural activities, burial societies and socials which women in this community used as survival strategies, social interaction, communication and reciprocity. This was evidence of lack of participation and consultation with the community during the planning process and the City of Cape Town also admitted that designs commonly do not put additional consideration of women and their social networks (Massey, 2013). Informal settlement upgrading projects that were supported by NGOs such as Shack Development International (SDI) have been more bottom-up, grassroot approach of participation and have better responded to the needs of residents (Cirolia, 2017).

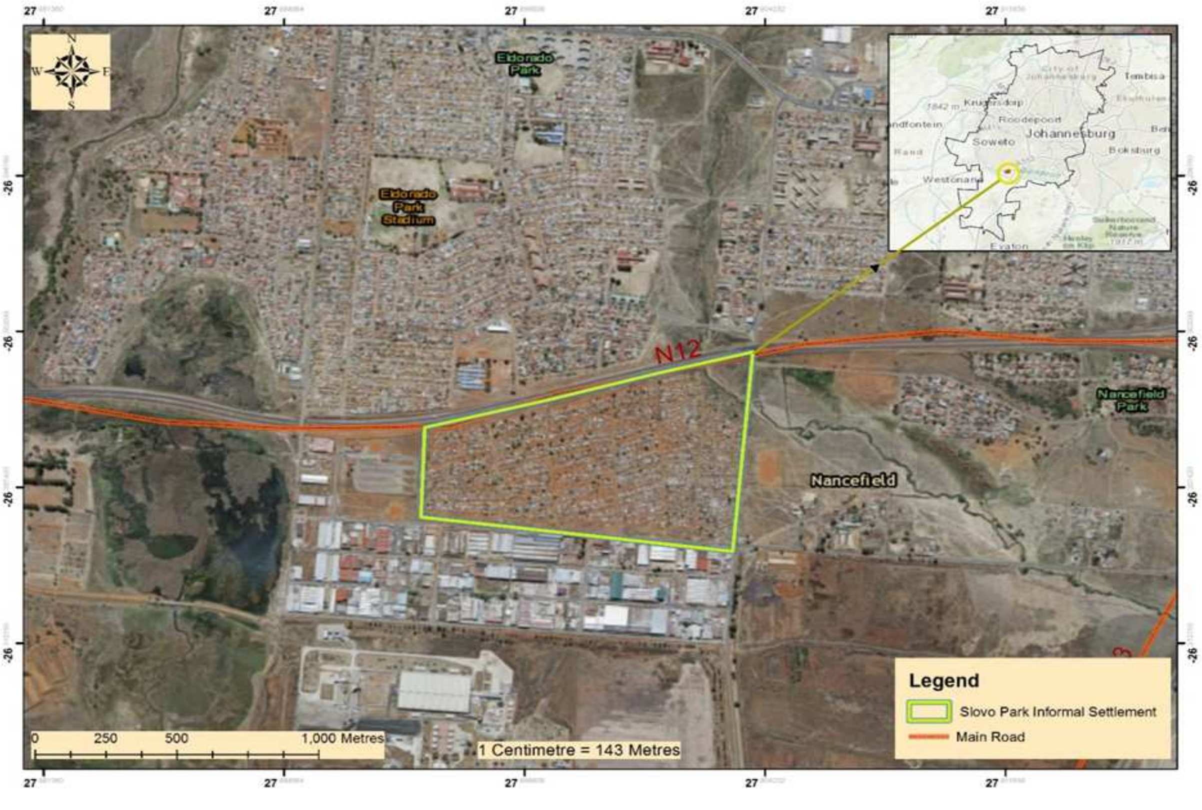

Fig. 1: Location of Slovo Park, Gauteng, Johannesburg.

4 UNPACKING THE CASE STUDY

Slovo Park informal settlement is in Johannesburg, Region G, next to the Nancefield Industrial area between Nancefield, Eldorado Park and Bushkoppies. The settlement was established in the early 1990s by mainly individuals seeking accommodation closer to their workplace and it has since been expanding (Tissington, 2012). In 2011, Slovo Park consisted of a population of more than 5000, about 1600 households amongst the 1 050 stands. There are no recent statistics of the total number of the population currently living in Slovo Park. Figure 1 below, displays the location of Slovo Park informal settlement within the Gauteng Province, Johannesburg.

Justification for this study area is that it is one of the oldest informal settlements in Johannesburg and recently received a favourable court ruling to have the settlement upgraded through the UISP. City of Johannesburg (CoJ) has submitted a business plan in application for UISP funding from Provincial Housing MEC. Nonetheless, Slovo Park is at Phase 3 of the UISP because incremental provision of basic services such as water supply, pit toilets, electricity and weekly refuse removal have been implemented. Therefore, "moving towards bulk engineering service provision which includes sewerage and storm water drainage, housing provision and roads" Respondent 1. As discussed in the previous section, phase 1 and 2 of UISP process are the most important stages requiring community participation and by the time in which the study was conducted, these phases have been concluded in the study area. This research focused on exploring the barriers and opportunities of community participation that took place during these phases as well as phase 3 and implications of ineffective community participation on the beneficiaries of the upgrading.

5 RESEARCH METHODOLOGY

The research objective is set out to assess the barriers and opportunities of community participation and the implications of lack of real community participation in the UISP process, studying Slovo Park informal settlement upgrading. This study is qualitative, thus, explores the objective of the study under investigation in the natural setting in terms of behaviours, varied perspectives, and life experience. In this study, in-depth interviews and field observation were conducted. Snowball sampling was utilised to identify ten interviewees that participated in the study, targeting specifically individuals older than 20 years, preferably the elder in the family, until sample saturation was reached. The researcher had purposefully selected ten interviewees consisting of ordinary community members, a community leader who is a local church pastor and member of the community development forum, and an additional two municipal officials. The collected data was analysed through latent content analysis, through which theme development from the interviews was applied. Interview questions were written in English but the interviewees were interviewed in the participants preferred language, which was mostly Southern Sesotho and IsiZulu. Translation from English written questions to these indigenous languages was simplified by the researcher's understanding of the language, cultural norms of the participants and elaborations were necessary. This is because the researcher avoided compromising the quality of the response, thus, this approach helped in preserving high quality in the answers provided by participants. Within 24 hours of the interview sessions, the recorded interviews were translated into English by the researcher and a transcription of each interview was created. Through the transcribed interviews, the researcher established several themes that emerged consistently. Including the following:

Officials' incapacity to facilitate community dialogue

Uncertainty about tenure security

Unaffordability of the provided services

6 STUDY FINDINGS AND DISCUSSIONS

This paper provides details of views emerging from interviews and the literature, with an emphasis on the barriers and opportunities of community participation and the impact of ineffective community participation in the UISP process.

6.1 Officials' incapacity to facilitate community dialogue

In the study conducted in Slovo Park informal settlement, ordinary community members did not seem to be actively involved in the participation process because they formed a community development forum named

Slovo Park Community Development Forum (SPCDF) to represent them. As such, the committee members consisting of a small proportion of the entire community generally consult and compile a list of the community's needs to present them at core meetings with other stakeholders. From interviews conducted with the CoJ municipal officials, it was discovered that the meaning of community dialogue as an important part of UISP process was not fully understood. The officials were not fully capacitated to handle challenges that arise when engaging a community that commonly have different opinions. This was indicated by Respondent 1 when he said "groups of political infighting whenever department conduct meaningful consultations with entire community blocks. Frivolous interruptions with planning processes especially during engagements with each and every stakeholder. Stakeholders availabilities during critical decision-making points in order to move forward with project plan. For instance, layout plan was objected against at a very late stages process after agreeing about it earlier. Earlier agreements on contents of draft layout shaped the following activities, any amendment changes entire complexion of previous agreements".

This was also admitted during an interview with Respondent 2 who is also a municipal official from CoJ. When the participant was asked to identify challenges in planning and implementing in situ upgrading, he expressed his views and indicated that "….lack of understanding of the programme by government… lack of skills and interest by government".

From what had been said, it is clear that understanding of the UISP process, particularly the aspect of community dialogue where planning process is consent was lacking. Thus, presenting a barrier for effective community participation. There were no capacitated agents from the municipality to facilitate community dialogue that will result in mutual agreements. NUSP (2015) indicated that phase 1 of UISP process thrive on meaningful community participation as these are the key stages were negotiations and decision-making occur concerning the development plans of the community. This presents a missed opportunity to understand the real needs of the end-users and open discussion to allow better understanding of government's resource limitations. This is also evident to Mathekga & Buccus (2006) argument that public officials are yet to be educated on how to facilitate community participation process. Marais & Krige (1997) argued that community participation to an effective and successful project is complicated, as such cannot be accomplished without conflicts, however, it is essential to lead to effective resource utilisation. According to Wekesa et al. (2011), it remains the officials' responsibility to educate and build capacity to enhance their participation, liaising between the community, local authority, and landowners to decide the most appropriate intervention strategy. Ziblim et al. (2013) urged that in practice, community participation is an administrative façade. Officials tend to create false expectations and subsequent disappointments in the minds of community members, who thought their views, could significantly shape decision-making in the upgrading of their settlement. This is because earlier to arranged meetings, experts would have already designed and finalised plans, thus allowing little room for community participation and influence. Ziblim et al. (2013) further indicated that public officials often avoid real participatory processes in project implementation, because they think that these are not only "time-consuming," but also, can be "unpredictable" and "messy". Unfortunetly stakeholder's unwillingness to create space for bargaining or negotiation within broad base interaction is not an attitude only seen in South Africa but in many African cities. Local authorities tend to avoid the degree of technical frameworks that comes with community consultation (Simone et al., 2005). Thus, the likelihood to implement top-down decision-making where planning and design is concerned and treating people's participation as an advisory role as indicated by Thwala (2009). However, effective community engagement and participation where ordinary community members are actively involved is necessary and can be benefiacial to both the community and the municipality. Besides it being a good practice, scholars (Burns & Heywood, 2004; Misselhorn, 2017; Moreschi et al., 2012; Pinfold, 2015 and Simone et al., 2005) observed that it has the potential to build a stronger social cohesion and solidarity, presents a privilege for stakeholders involved to gain wisdom and better understanding of the community's perspective, and develop sense of ownership amongst the beneficiaries. Most importantly, it has the prospects to achieve an everlasting collaboration between communities and government beyong the project.

6.2 Uncertainty about tenure security

Despite the confidence that eviction is no longer a threat for stand owners, it was also discovered during interviews that some residents needed more than just stand numbers and electrification to have their tenure security guaranteed. Participants indicated that despite the formalisation of the settlement and acquired land tenure security, they are unable to improve their housing structure. Respondent 3 expressed the following views "if we were to be aligned properly in a sense of sharing the plan with us where the installation of sewerage pipe will be, this would enable us to start investing in our properties in a form of building formal structures. Until then, we are compelled to stay in shacks because we don't want to risk our limited financial resources in building where we will be forced to demolish…". Another participant in the study who indicated that the settlement has been regularised and have access to basic services they previously did not have indicated that other community members have started improving their housing structure, if resources were available, she would do the same. These were expressions made by Respondent 4, who said "I have a stand number that reassures me that I will not be relocated. Even if they change these numbers every 10 years, no one can claim my stand. In the yard, I have electricity cable connected only to my house, as such, rentals are not a threat because it is clear to them too that the stand belong to me. If I had financial resources, I would build a formal structure just like some of the community members who have already started".

These are clear effects of missed opportunity for community participation during the planning phase of UISP process. Although the settlement has been formalised and land tenure security is attained, the community is unable to improve their housing structure in order to improve their overall quality of life. This is presnets a clear indication that the community was not actively involved in the layout design of this settlement. Usavaovitwong (2012) indicated that in cases where the community receiving an informal settlement upgrading programme is involved in the planning of the project, such important information is readily available. According to Arimah & Branch (2011), land tenure security should encourage beneficiaries living in informal settlements to improve their housing structure given their organisational skills and resourcefulness. However, this is not the case due to lack of crucial information pertaining the sewerage pipes sites and housing layouts. Residents anticipating housing demolition become discouraged from beginning processes of housing improvements including accumulation of financial resources because only people with good tenure security want to hold better control of their property (Nakamura, 2016). Furthermore, the omitted crucial information underpins the lack of support for Enhanced People Housing Process (PHP). Enhanced PHP policy is an important instrument for informal settlement upgrading to harness community driven initiatives to improve their top structure using own funding or social capital, but it is generally under-utilised (Misselhorn, 2017).

6.3 Affordability of the provided services

During the interviews, it was revealed that although residents have access to electricity, using it comes at a higher cost. It was indicated that most of the community members are unemployed, they do not afford to constantly top-up electricity units. As such, they often have no choice but to go back to using unsafe options for lights and cooking. Respondent 5 and Respondent 6 who were participants in this study had this to say "access to electricity improved our lives because when we could afford to buy the electricity units we are able to charge our phones but because most of us are unemployed, electricity is expensive. As such, if one could not top-up the electricity units we go back to square one, use candles and cook with paraffin stove. Therefore, access is still a problem because of our socio-economic status" Respondent 5. Respondent 6 also highlighted that government provided free electricity in the ealier stage of installation. However, when a charge was implemented it was oberved that the units cost more compared to the rural areas. These views were expressed as follow "electricity is costly and I have come to realise that the units we get are not equivalent to the units people from rural areas get for the same amount of money. We do not get government subsidy towards electricity, yet initially we had free electricity for about 3-4 months".

Without social inclusion, tenure security cannot be achieved through in situ upgrading if the UISP process does not incorporate the enhancement of socio-economies of beneficiaries by means of community empowerment and skills transfers. Based on the statements made by the above respondents, it is evident that the implementation phase of this project missed an opportunity to empower the beneficiaries so that they can be less dependent on state subsidy. According to Huchzermeyer (2006), informal settlement interventions that are not accessible to beneficiaries will result in their displacement to housing options that offer affordability and, in many cases, these are new or existing informal settlements, irrespective of the inclusiveness of the initial allocation procedure. Huchzermeyer (2008) highlighted that displacement due to unaffordability was the reason for ineffectiveness of the Kenya Slum Upgrading Programme and key

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contributory factor was lack of meaningful community participation. According to El Menshawy et al. (2011) and NUSP (2015), meaningful community participation is crucial for the sustainability of the in situ upgrading post-implementation. Thwala (2009) observed that commonly communities are not empowered with the knowledge and understanding necessary to make informed decisions while Mathekga & Buccus (2006) also made the same observation that citizens are not well informed about participatory governance. On the other hand, local government perceives citizens as mere recipients of service delivery. This presents a barrier of meaningful community participation and empowerment in which socio-economic status of beneficiaries could be matched to the delivered services to ensure sustainability of such services.

7 CONCLUSION

The objective of this paper was to highlight the impact of ineffective community participation in the UISP process. A qualitative study was conducted using Slovo Park informal settlement as a case study. In-depth interviews were conducted with the residents of Slovo Park in order to gather views on the phenomenon. The following were the findings of the study. This paper has highlighted the lack of real community participation in the planning process of in situ upgrading implemented in Slovo Park informal settlement. This was indicated by the various community members interviewed in the study. Conflicts are unavoidable in an effective community participation because they form a crucial platform for negotiations and community buy-in into the project. However, public officials lacked capacity to handle disagreements which arised during engagements with the relevant community representatives. This implies that the final layout design of the project was not concluded with the involvement of community members. Therefore, a top-down decision was made in this regard and this was reflected on views participants in this study had regarding lack of information about where sewerage pipe sites will be. The importance of active citizenships and good participation practice was not upheld in this upgrading process, as such, it is concluded that meaningful community engagement was not achieved.

The paper reveals that some of the residents have the financial resources to build a formal top structure but due to lack of information of the plans for engineering services such as sewerage pipe, are unable to invest in their property and build adequate housing for themselves. Some households have taken the risk for potential demolition when they built formal structures subsequent to acquiring land tenure. Adequate housing influences the environmental domain of the quality of life, as such it is no surprise that some residents of Slovo Park are eager to improve their housing structure. This is also an indication that availability of information pertaining sewerage pipe sites might encourage many others. Even if the consolidation plan for Slovo Park is not PHP, given the current housing backlog, discouraging PHP approach is a missed opportunity to curb an already burdened housing backlog.

The paper also reveals that ineffective community participation has resulted in the provision of services that are inaccessible to the beneficiaries. Community dialogue could have highlighted the socio-economic status of the residents of Slovo Park and ensured that the provided services matches the needs of the community. Since most community members of Slovo Park are unemployed, UISP process should have identified that electricity is an expensive commodity that required service providers to consider community empowerment by means of skills development. Community empowerment during the implementation process is essential, especially where the socio-economies of the poor have a direct impact on the sustainability of the upgrading post-implementation. The impact of unaffordability of services will ultimately result in the displacement of beneficiaries to new or existing informal settlements where affordability is guaranteed. Moreover, the fact that at phase 3 of UISP (implementation), minimal community involvement is expected, limits the community empowerment to cheap labour, rather than skill transfers and large-scale action planning approach where the community can undertake implementation process and manage their own upgrading projects.

8 LIMITATIONS OF THE STUDY

Most of the residents of Slovo Park informal settlement do not understand the English Language fluently. As such, the researcher had to translate interview questions from English to either IsiZulu or Southern Sesotho during the interview in order to accommodate the interviewee. This limitation contributed to time consuming task of translation of all transcripts to English. Fixing of appointments with the relevant municipal officials proved to be another limitation to the study. The researcher had to postpone the interview because municipal officials were unavailable on dates or times previously arranged. Additionally, the research had limitation by methodology, as such further study can be conducted using quantitative approach with a larger sample and in other informal settlements to get a broader view of the topic.

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Behavioural Studies in Spatial Planning

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1 ABSTRACT

The main strategic planning policy in Flanders has in view to reduce the growth of the net settlement area. It is important to enthuse people to live closer together in the centres of villages, towns or in more dense urban areas to preserve open areas. The question is how to achieve this.In the last few years, there has been a growing awareness of the importance of convincing citizens to change their behaviour voluntarily. A crucial question is which behavioural change we can expect from the population, whether this can be met at once by everyone and what a government has to change or needs to provide to make the change possible.

In recent years, the Flemish Planning Bureau for the Environment and Spatial Development commissioned several behavioural studies, conducted by Endeavour. It concerns two studies carried out on compact housing, on travel behaviour, on choice of residence in relation to facilities, and a new study on the behavioural influencers of housing. Thanks to an approach that combines the fields of architecture, urban planning, sociology and design Endeavour created a methodology of participation and co-creation with citizens, aiming at different segmentations of the population. This method successfully brought a multitude of experiences to the surface by means of a variety of people who sufficiently represent the diversity in Flanders. Insights into attitudes and motivations of a broad public are the key to understanding how to change certain aspects of behaviour into something more sustainable.

This paper focuses on two themes. The first reflects on practices, tools and knowledge that are nowadays common in (regional) spatial planning and how they relate to human behaviour. The second introduces insights from qualitative research for behavioural change that focuses on how to approach different target groups within the population. The aim is to guide behaviour in function of an inclusive and sustainable spatial transition. As the paper shows, it is important that in this transition process people do not get the feeling of 'losing' something. such as comfort or choice.

Keywords: social innovation, inclusive and sustainable spatial planning, behavioural study, participation, lifestyle

2 INTRODUCTION

The Flemish territory is characterised by large urban sprawl to which great social costs are attached (Vermeiren, Poelmans, Engelen, Loris, & Pisman, 2018). Even over the last years, an additional 6 hectares of undeveloped space is being built on daily. As a consequence open space is highly fragmented in Flanders. Regarding regional planning in Flanders, the main strategic policies have in view to reduce the growth of the net settlement area (Departement Omgeving, 2018). At the strategic level, the Flemish government has decided that the land take should decrease to 0 hectares per day and that development is best done close to facilities and public transportation.

Spatial planning policy in Flanders is mainly based on a hierarchical system. In the past decades, the Flemish government for spatial policy has evolved from a controlling government that supervises the lower government levels (e.g. in the process of granting building permits), to a government that mainly defines the strategic lines in co-creation with the same lower governments. The Flemish government still takes the overall strategic decision on spatial transition, but it gives a lot of freedom to the lower levels on how to shape this transition. However, the Flemish government has not given itself much authority to implement this decision. For many years, the Flemish government's main target group for communication on spatial planning has been municipal authorities and spatial professionals[1], whose role is actually to translate

[1] Spatial professionals are people who are professionally active with spatial policy, planning and implementation: active in governments, research, design and development.

strategic objectives into (municipal) policy and implementation. The Flemish government thus adopts a top-down approach, and does this also in order to tackle big challenges regarding sustainable spatial transitions.

In the last few years, the role of convincing citizens to change their behaviour voluntarily (e.g. by nudging) is getting more important internationally but also in Flemish policy. Examples of strategy for behavioural change in Flanders have been developed with a view to immediate behavioural change, namely to changing a habit (e.g. nutrition, waste, exercise, means of transport). Convincing people to change their behaviour is not an easy task, especially when it means breaking an ingrained habit.The accumulation of know-how on behavioural change is only at the beginning in the field of Flemish spatial planning.So far, this new target group, the citizen, is still strongly approached with the means employed by municipalities and spatial professionals. Spatial planners assume that the highly needed behavioural change is the change of housing behaviour. But, changing one's housing behaviour requires a real location move, something that most Flemish people seldom do: it is a decision that requires reflection (Slabbinck, 2017; Van Den Bergh, Aelterman, Mouton, & Engels, 2018). It requires a different approach than changing a regular behaviour.

Closing that knowledge-gab is why the Flemish Planning Bureau for the Environment and Spatial Development outsourced research to bring in knowledge from behavioural change specialists.There are several (research) questions waiting to be answered.

With these studies, the Flemish Planning Bureau for Environment and Spatial Development explores the potential and possibilities of a behavioural change strategy as a complementary strategy to the more familiar financial, rational and regulatory government initiatives. The first two studies have been completed. They provide first insights to shape such a strategy. A third study is ongoing. At this moment, the actual roll-out of such a strategy within the policy frame has not yet been decided.

3 TOP-DOWN VIEW AND BEHAVIOURAL CHANGE: PRACTICES AND TOOLS

For its regular target groups, the professionals and municipalities, the Flemish government focuses mainly on offering tools, research, information and example projects. In recent years, much spatial planning research has been done to determine the 'best' places to live near facilities and public transportation through modelling: transit node value and facility level (Verachtert et al., 2016) and walkability (Vervoort, D'Haese, Verdeyen, & Van Acker, 2019; Vlaams Instituut Gezond Leven, 2018). The used criteria are population density, diversity of facilities and average bikeable or walkable distance. Municipalities are urged to direct development to the locations with the best scores. Next to that, a lot of effort has been put into design research and good practices selection to address densification on a qualitative way, with respect of Green Blue Networks (Smets & Stevens, 2019) and healthy living environments (Atelier Romain, Osar, & P.PUL, 2020). The Flemish government also provides information about participation methods in spatial policies and implementation projects (Devisch, Huybrechts, & Stieglitz, 2017).

Various campaigns are largely built around showing possible, desirable futures, based on overall policy goals, modelling (e.g. transit node value and facility level) or design. These futures are suitable for the spatial professional and appeal to rational reflection. Three examples of campaigns launched by different parts of the Flemish government illustrate this. The first is a four-year commitment of the former Flemish Government Architect Leo Van Broeck (2017-2020) to preach in the media the often-repeated message: "denser and more compact housing protects open space". He illustrated this statement by designs or picture of –for Flanders– rather dense development with appartements. The second is an online awareness-raising survey (for the campaign "At home in the future? Do the housing test") (Vlaamse overheid, 2020). After completing questions about housing preferences, the respondent gets a picture that corresponds to its answers. This image differed greatly from the existing situation in most parts of Flanders. The third is the Mobiscore(Van Den Bergh et al., 2018), an online tool to determine whether a housing location is 'sustainable' in terms of nearness to facilities and public transport. The tool gives the users a few possibilities to include their own behaviour in the score.

While the intentions are good, offering a picture of a possible and better future and giving scores to an actual spatial situation seem to strike a nerve. When the campaigns were picked up by the media, they evoked a lot of public resistance. It led to a polarised debate between urban and rural residents, older and younger generations and progressives and conservatives, good and bad. From a behavioural standpoint, people's frustrations are not surprising: a housing choice is one that people seldom make, and can even be a choice they do not have. For many, it is a behaviour they cannot change easily.

All this recent attention to personal behavioural changes, raises some ethical questions within the Flemish planning community too. To what extend should citizens take the responsibility for systemic transitions? Van Eenoo argues that people do not always have the free choice to live somewhere or to use a certain means of transportation and that 'Urban Sprawl' is not just the result of a sum of individual –wrong– choices (De Maeyer et al., 2021; Van Eenoo, 2020). The 'ill-considered use of space' is according to several policy document analyses and expert opinions (from different fields, such as spatial planning, mobility,…) in significant part due regulatory instruments, built environment and financial mechanisms (Ryckewaert, Van den Houte, Brusselmans, Hubeau, & Vermeir, 2018). Current legal and fiscal policies work against sustainable spatial use. Another argument against the strategy of expecting too much from citizen behavioural change is, according to Van Eeno, that people do not always act consistently and that the place of residence is not the only aspect of sustainable (residential) behaviour.

4 FRAGMENTARY KNOWLEDGE ABOUT BEHAVIOUR IN AND PERCEPTION OF THE LIVING ENVIRONMENTAT THE START OF THE RESEARCH APPROACH

These discussions triggered the Flemish Planning Bureau to commission a first behavioural study: "The Experience study about compact living" (De Maeyer, Deprez, Cherroud, & Bambust, 2020). The aim was to call in external behavioural expertise. The literature section examines existing research on moving and residential motives in Flanders through the lens of behavioural insights. Besides a lot of images of possible physical forms, people have to experience it, to make that experience their own, so it becomes a lived story. For this, they not only need to see 'the' future and its imagined or calculated benefits, but also the path to and the connection with their own future, with empathy and guidance for the sometimes difficult decisions that need to be made along that path. To this end, the 7E/12E model for behavioural change (Bambust&Vanhove, 2015) is used as a theoretical framework and supplemented with theory on constructing narratives and using frames. A crucial question is which behavioural change we expect from the population, whether this can be met at once by everyone and what the government has to change or needs to provide to make it possible.

The literature reveals that there is some knowledge about the importance of life stages and housing career. Behaviour can be very different over time. So a lot of young adults are attracted to the range of aspects that are part of city living (e.g. cultural and social events). There is a lot of research showing that households with (a desire for) children move to a more suburban environment. Housing preference research also shows that a majority of the population prefers less compact forms of housing. Little attention is paid to the results of those who express a different housing preference and/or live in a different type of housing. This leads to the dominant discourse of "Mr./Mrs. Average" who think of a house with a garden in the more 'child-friendly' suburban periphery as the most ideal place to live. There is also research that shows that Flemish people are not inclined to move once they are settled. As a result, the focus of research and policy efforts on housing is often (one-sidedly) on young people and young adults for whom an alternative to the suburban home is sought.

Subsequently the literature section of the second study "The Behavioural study on proximity of facilities versus travel behaviour" (De Maeyer et al., 2021) summarises the existing knowledge about the topic. It is clear that the presence of facilities, travel behaviour and place of residence choice are interrelated. The higher the density, the closer the possible destinations are to each other and the more opportunities people have, the easier it is to choose a sustainable means of transport. Although the spatial condition plays a role in people's choices, it will not automatically lead to sustainable behaviour. Reality is much more complex.

In spatial planning and mobility practice in Flanders the effect of the built environment (occurrence and distribution, density, distance) (Van Den Bergh et al., 2018; Van Meeteren, Boussauw, De Kool, & Ronse, 2013; Verachtert et al., 2016), socio-economic and demographic factors (gender, age, family composition, education level, wealth, income …), and car ownership –nowadays still encouraged in Flanders by company and salary cars– are widely accepted determinants of that complex reality. Whether or not people own a car and/or are attached to its use influences their choice of where to live in favour of residential areas that are easily accessible by car and where parking is easy and inexpensive. In literature this is referred to as the concept of 'residential self-selection': people select a residential environment where they can best get around by the mode of transportation they prefer. However, existing data on all these relationships are rather scarce in Flanders. Some data hardly exist (e.g. frequency of visitors to facilities), others are not available on a relevant spatial scale for reasons of privacy.

The literature review in both researches reveals that collecting data on spatial behaviour in relation to those psychosocial factors is still in its infancy. Qualitative experience research is an interesting method to gain more insight into these relationships. The behavioural studies on compact housing and facilities are intended to contribute to this knowledge.

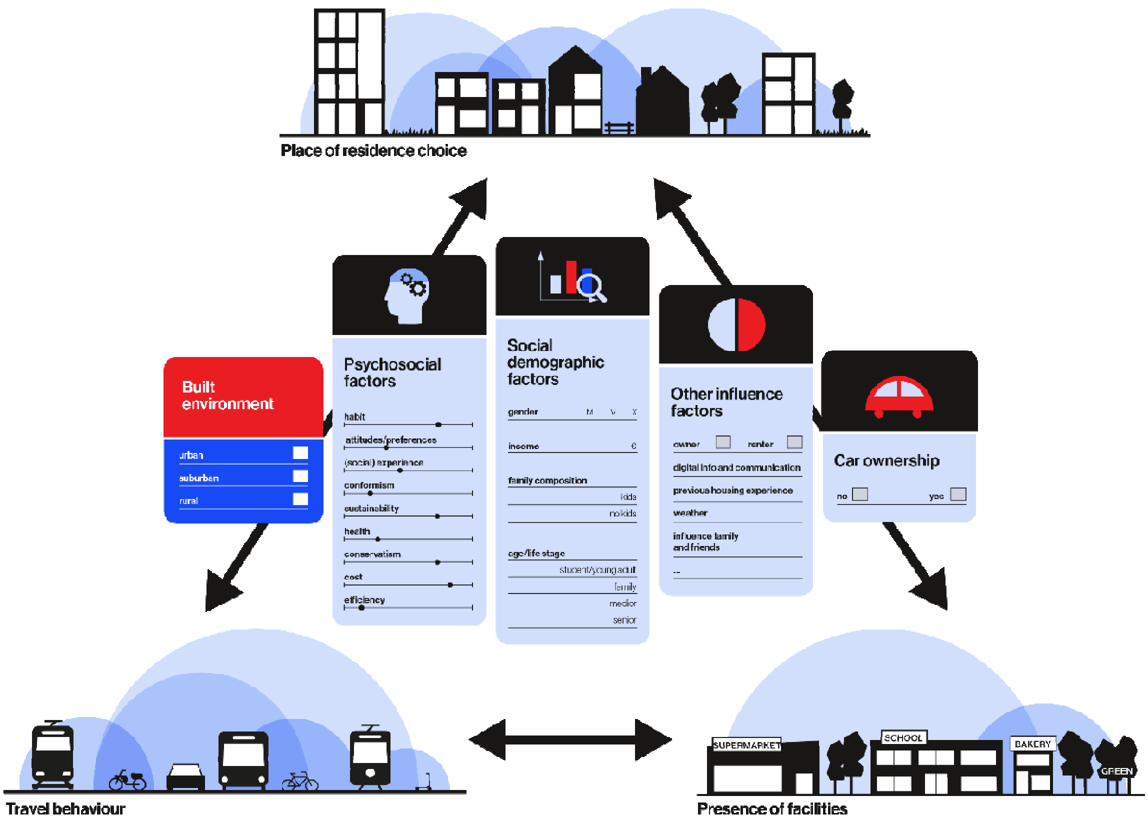

Figure 1: Summary of the different factors that influence people in their travel behaviour and housing choice

5 QUALITATIVE EXPERIENCE RESEARCH

Qualitative experience research is a bottom-up technique used to analyse knowledge of behaviour with the aim of integrating it into top-down planning policies for sustainable spatial transitions. In recent decades, participation has become inevitable in urban transitions in Flanders as people demand it more and more. While traditional public participation takes place through a public enquiry when the government has provisionally decided on a plan, the current trend is to consult those affected before the provisional decision is taken. In this way, the diversity of experiences and opinions of people participating in the pathway can help in customising decision-making. For more generic measures, instruments and policies in spatial planning that affect spatial transitions, the use of public participation is still less developed. By using interviewing techniques integrated into playful workshopsaimed at an audience that is as representative as possible of the population, the research attempts to transcend social desirability and reveal people's real preferences. In both studies, qualitative experience research was used through different methods.

The first study on housing aimed to understand the positive experience of compact housingbetter. Workshops were organised with local residents living in different typologies in five different compact neighbourhoods in Flanders and their experiences were translated into narratives and images of desirable living environments. A next round of workshops tested the appreciation of these narratives to a public living in spacious and sprawled areas and tried to understand how behavioural change could be implemented through storytelling.

Thetranslation ofqualitative data into useful communication and narratives are important. People have different values that can conflict with each other. Our choices do not always conform to the particular values we pretend to uphold (which is called 'cognitive dissonance'). That is why we want to legitimise our choicesboth to others and to ourselves. Narratives are used for this purpose. If people need narratives to legitimise or validate their behaviour, they can be helped by providing (existing or new) narratives. For people who act against the values of their peers or against their internalised values, cognitive dissonance can be anticipated and the likelihood of intrinsic motivation increased. This can be done by framing the behaviour within the Values, Themes, and Concrete situations ('VTC framing') of the target group. For individuals where the values are already aligned with positive behaviour, stories can be offered as reinforcement as a means of self-telling. This framing cannot be just fiction, but needs to be built on true experiences to be successful, so that new choices must also fulfil the promises told in these stories.

For the second study qualitative experience research was used in two rounds. In the first round, as much personal information as possible was collected about past and planned residential choices, regularly used facilities and services, and the movements to these facilities. In between, we drew up hypotheses for psychosocial segmentation in the behaviour of citizens. In the second round, these hypotheses were tested, as was the willingness to undertake personal actions related to goals of Flemish policy. When testing actions and policies, this qualitative experience research comes close to the principles of a deliberative democracy (Bessette, 1981) and experiments with citizens panels like the G1000 that took place in Belgium and the Netherlands over the past decade.

6 A ROADMAP FOR SPATIAL TRANSITION

The research of the behavioural series has already envisioned that the transition needs both governance, including policy action and citizens behavioural change, but also the collaboration of shapers of our environment and society (De Maeyer et al., 2020, p. 93). In the first study, 'handles for behavioural change towards compact living' were elaborated in which both are linked to each other. One type of recommendations concerned communication and policy. Other recommendations were addressed to local authorities and spatial professionals who stressed the importance of qualitive neighbourhood- and housing developments from a user perspective. The study also formulated a working method based on psycho-social insightssuggesting to translate the strategic vision of the Flanders Spatial Policy Plan into Roadmap, a (operational) work plan supported by a motivation plan(De Maeyer et al., 2020, p. 89). The work plan is equivalent to an approach in terms of governance, the work that the government itself has to take up, changing laws, rules, mechanisms, etc. The motivational plan is necessary to keep (especially) citizens on board. The roadmap consists of 10 phases and going through them will take years.

The experts in behavioural change confirmed that the polarised debate and current campaigns will not be sufficient to get enough people on board to make the necessary transition. In the current phase of policy making, it is too early to show images, or to give people the feeling that they are not compliant. It is time to wait until the government has decided about what is necessary and acts accordingly, so that change is actually possible or easier, and that the first initiators have gained experience.

In the current phase of policy-making about the transition (first and second phase), De Maeyer et al. (2020, p. 94) advises to work with prognostic and motivational frames: asking for help with ideas of what the future may look like. This could be a higher-bar approach: accepting the challenge and even raising the bar. Or an additional approach that counters fear of loss, identity, quality of life and therefore emphasises that multiple interpretations will be possible. In these frames, the emphasis is much more on preserving and strengthening residential quality than on higher density. Maybe it is interesting to show what people (the next generations) will lose without transition. In motivational frames, people are not framed as co-problem owners, but as solution selectors.

7 GETTING STARTED WITH PEOPLE WHO HAVE TO CHOOSE ANYWAY

Since a transition towards a more sustainable choice of transportation and of housingfor a large part of the population can only take place step by step, it would be rather counterproductive to mobilise everyone at once. The roadmap takes into account that the spatial conditions are not yet ready for a rapid transition. Pilot projects for resettlement and reorganisation of mobility to more desirable spatial conditions are already being implemented and will be scaled up step by step. Regarding Roger's adaptive model (Rogers, 2003), Innovators and Early Adapters are needed to mobilise a broader population in time, meaning the early and late majority and laggards. In addition, the behavioural studies have taught that not every innovative or desirable product (in this case, a house or a mode of transportation) will be equally attractive to different segments of the population. Behavioural theory additionally teaches us that behaviour is usually consistent.

Breaking moments can trigger new behaviour. Preference for a new home and housing type is strongly influenced by life stage, which often goes hand in hand with age. Life stage factors such as graduation, starting work, moving in together or getting married, having children, etc. are often the cause of a move (De Bruyne&Iserbyt, 2011).

The "Experience study about compact living" discusses a socio-demographic segmentation not just by life stage (which is a frequently used method in literature) but via four important breaking moments that give rise to choosing a new home, often in relation to a specific target group. For each of these target groups, narratives were constructed. The first group is looking for independence. This usually involves young adults leaving their parents or adults dealing with a relationship breakup. The second group is looking for more space. This group consists mainly of young and new families who are expanding. A third group is looking for community and free time. This group of people is faced with more free time as children grow up or one retires while still living in spacious single-family homes and social life again takes more place outside. The last group is looking for security and accessibility to health care. This group usually consists of the elderly and those in need of care. Generally less drastic are the breaking moments that can cause a change in travel behaviour. A new job or having children are often triggers though that can influence this behaviour (e.g. picking up the children on the way to work). But apart from that, a choice of transport mode is a result of a complex system of factors that acts on the choice process. Acting on behavioural change, big choices like a new house are therefore important moments to nudge or inform people. To gain more insight in the key-factors that determine the decision making regarding housing, the new research that just started will collect more knowledge. Regarding the change of transportation habits, insights in breaking moments will be crucial as this type of decisionmaking is less drastic and easier to implement.

8 THE AVERAGE PERSON DOES NOT EXIST: ABOUT SEGMENTS AND MOTIVATIONS

If the Flemish government wants to encourage citizens to behave in a more sustainable way, it has to know what actions it must or can take with respect to certain segments of society. Not everyone acts for the same reasons or encounters the same barriers. What is an obstacle for one person is a motivation for another to live in smaller space or to change his/her mode of transportation. By taking into account the diversity of persons and better connecting to the living and mobility behaviour of the Flemish people, measures can be used more efficiently to stimulate certain choices. A better understanding of behaviour can therefore be an important factor in a spatial transition in Flanders.

Whereas with a socio-demographic segmentation, it is already known and broadly accepted, which persons should be addressed to make behavioural changes possible (e.g. young adults), it is much more difficult from a psychosocial point of view. Merely targeting behavioural change according to a socio-demographic segmentation would not be sufficient to capture the complexity of choices. An extensive segmentation based on psychosocial factors makes it possible to also focus on changing the behaviour of persons on the basis of their underlying motivation (whether or not unconsciously) that plays a role in making choices. In the second study a psychosocial segmentation three types of motivation are discussed that can lead to behavioural change, in relation to some specific target groups: socially motivated people, intrinsically motivated people and extrinsically motivated people.

By allowing policy measures to respond to these motivations, the framework through which people look at the world can be adjusted in order to establish new consistent behaviour. This is also called frame bridging. These measures are particularly important for intrusive questions such as finding a home or determining a lifestyle, but accompanying circumstances can also have a major influence. Behavioural studies conducted in recent decades have shown that these accompanying circumstances, which cannot be traced back to any of the above motivations, are more important than previously estimated. People do not always get around to testing the dilemmas or the possibilities against their value hierarchies, even when making important choices, because getting to the bottom of all the effects of choices takes a lot of energy and time. It requires a form of ‚meta-intrinsic motivation‘ to give priority to this. People prefer to be led by the path of least resistance. Thus, nudges do not interfere with motivational measures, but help them.

9 AN INITIAL PSYCHOSOCIAL SEGMENTATION FOR CHANGE OF RESIDENTIAL BEHAVIOUR AND USE OF FACILITIES

The behavioural studies not only allowed us to paint a more complete picture of a complex reality, it also gained us more insight into the relations between different factors for different people. The barriers experienced by the various persons were noted as well as the levers for making more sustainable choices. Because positive perception is an important lever for future behaviour, the focus is primarily on the motivations behind those choices, as social, emotional and cultural motivators can ultimately determine or impede someone‘s choice. The analysis of psychosocial factors led to very different groups of people motivated according to different categories; namely intrinsic, extrinsic and/or social motivation. Of course, special attention still needs to be paid to the various breaking moments in a person’s life.

First of all, it is important to recognise a group of people that is not yet motivated for the time being. This group may eventually find its way within other motivations but it is not easily persuaded to change its habits. We can find this attitude in Rogers' late adopters. Similarities can be found with a group of people that is more conservative, but can be guided by intrinsic motivation. The living environment where these persons grew up is often a crucial factor in the choice of a place to live. The home is preferably located near friends and/or family and in a quiet area with its own garden, where one feels secure. These people attach importance to traditions and conventions in which they are embedded and often see these as part of their identity. This behaviour is also often expressed when moving to facilities, usually using the most familiar mode of transportation, interwoven with their identity, even though it may not be the most efficient way. They prefer to go to already known facilities: "I feel comfortable in stores that I know and where I automatically know the layout. The same store can look totally different in another town, which makes me feel a slight panic". Because these people often show resistance towards what they can lose, it is important to frame (ENLIGHTEN) what they also lose within the non-engagement of the strategic objectives. The levers for choosing where to live and sustainable travel behaviour are therefore best explored within the 'Nudging area' as well as within motivation: we want to bring about a disruption within the identity of this target group and immediately present an alternative, consistent story. An example of this is making it impossible to drive your car up to the school gate (ENFORCE) while telling people that they will be fine with this because they are concerned about the safety of their children (ENTHUSE).

Besides that also other intrinsic motivations can be decisive in determining one's behaviour. People who value sustainability for example are concerned about the ecological and social consequences of their behaviour. In many everyday actions they make critical choices in favour of the environment in terms of mobility, type of (online) facilities but also place of residence. For another (and often partly overlapping) group, health is the most decisive factor. For this group, the (proximity of) a green and healthy residential environment is often a determining factor in the choice of a place to live. In terms of the home, criteria such as peace and quiet, air quality, availability of a (collective) garden and/or the proximity of green spaces therefore play a role. Health is also a factor in the choice of certain facilities and more effort will be made, for example to purchase organic products. This behaviour continues when moving to facilities where active modes of transport such as cycling are consciously and consistently chosen: "I really enjoy cycling immensely, because it's pure relaxation. It's a lifestyle which I also carry through into everyday life". These individuals are best persuaded by designing healthy urban living environments with proximity to facilities (ENABLE). The lack of this today often prompts them to choose more peripheral locations. With good and safe bicycle infrastructure (ENABLE), they are often willing to travel sustainably and cover long distances anyway. Mapping sustainable mobility options or technology to make goals measurable can help them do so (ENLIGHTEN).

Social motivations also determine location choice as well as travel behaviour. We distinguish two social motivations that differ greatly in their spatial behaviour today. The first group to which social motivation is important is that to which experience is the core of the behaviour. For this group, travel behaviour is often socially determined. Running into people, the chance to have a chat, discovering something new, etc are important to them: "We love cafés and restaurants, which is why we wanted to live in the city. We also like to walk because on the way we always meet someone we know.“ They are therefore more likely to use active forms of travel and public transport and are more likely to live in city and village centres. With this group, it is important to capitalise on that experience and also to highlight expectation (ENLIGHTEN).

The fact that today in Flanders a majority does not live in village centres or urban areas means that people who are easily influenced by others, have limited reason to make that choice.This second group are people who seem to strongly conform with their peergroup and it contains persons who are strongly group oriented and who consciously or unconsciously allow themselves to be influenced („FOMO“) by the opinions and/or choices of their peers with regard to choice of transport mode, type of (online) facilities and choice of place to live. Behavioural changes occur in the context of the peer group and in imitation of role models, influencers and opinion leaders. If picked up by the "right people" they may be able to be steered. The timing of moving this group is important here: they may be difficult to address as a first sub-target group, but often come up in a second or even third phase, when we can show that 'others like you' are doing it too, an attitude that we find especially in Rogers’ early and late majority.

In addition to social motivation, extrinsic motivations also play an important role for certain people. For example, cost is for many the most decisive factor in making choices. Cost plays a role in the choice of a home and place of residence but for some can also be quickly seen as an investment rather than "a home". It offers better value for money, so it is worth looking at the total cost (energy and travel costs, location, subsidies, etc.). For this group of people, this behaviour is also seen for movements to facilities, where cost savings usually take preference over comfort or time: "I regularly use 'Toogoodtogo' because it is cheaper. However, there is not so much choice in my own neighbourhood so I drive further for this. 15 km is the maximum though because otherwise it is no longer profitable." They seem to be late rather than early majority (unless there are economic triggers), and sometimes laggards - with a relatively low degree of reflection on their own behaviour patterns. This segment is most susceptible to extrinsic motivation linked to financial incentives (ENCOURAGE) such as a bicycle allowance. In addition, their behaviour can be steered by informing them about the financial benefits of desired behaviour or also by helping them visualise future profits (ENLIGHTEN).

For another group however, efficiency is the most crucial factor. The location of the residential environment is therefore often important in choosing a place to live so that family and work life can be organised well. The home is preferably located near an easily accessible centre with different facilities and work. 'Efficiency above all else' is their motto. This behaviour also sets in when moving to facilities where the easiest and fastest (or combination of) mode(s) of transportation is always chosen. These persons will also take other factors into account (travel time 'from door to door', parking space, infrastructure, ...) and often visit linked facilities so that time loss can be avoided. 'Win-win situations' such as exercising or working during a commute are nicely taken into account to make good use of their precious time: "I always try to look at where I need to go and how I can combine it so I can do it as efficiently as possible." This group is most sensitive to extrinsic motivation linked to time savings/convenience (ENCOURAGE) and, in addition, can be steered in its behaviour by informing it on the benefits of desired behaviour through data (ENLIGHTEN). Flexibility of the car pushes many in this group today towards unsustainable travel behaviour. Public transport is often impractical, the bicycle too slow and alternative sharing systems still too limited. By removing these barriers, the desired behaviour can be more easily achieved than the undesired behaviour (ENABLE). Efficiency often goes hand in hand with comfort, for example by making public transport sufficiently high quality (e.g. Wi-Fi) so that time can be used usefully but also by making car facilities (e.g. parking) less accessible. At certain breaking points, such as having children, this group is being 'pushed' into being efficient. At such a breaking point, it is important to be able to offer solutions quickly. Change causes discomfort and stress, which often causes people to hold on even more to what they do have. The panic button –named for the user's underlying sense of panic– then ensures that we not only unburden them by offering other solutions in this one area but also help them to integrate those solutions into their lives. Therefore it is advisable not to propose one single solution (the bicycle) but also multiple ones (car sharing, bus, car...) in search of what better suits them (ENTHUSE) and their social middle and status (ENGAGE).

10 CONCLUSION

Aspatial transition needs abehavioural change.This is a process that takes time and the ambitions must growstep by step, together with the group of people that is able and motivated to step into that process. To help politicians with this complex task we suggest the creation of a detailed roadmap for sustainable spatial transition. It contains a systemic approach in which a (operational) work plan is supported by a motivation plan. Every step within the plan has to be well defined and measured. To reach the next step the goals of the previous have to be reached. We suggest an extension to the roadmap presented in the perception research of ‘compact living’.At the same time it should also contain at least aspects regarding mobility and the provision of facilities and services. This roadmap should take into accountthe following advice:

(1) Which behavioural change by whom?

Which behaviour people need to change remains a complex question to answer, and relates to the wishes and situation of each individual. In today's reality, there are many people who have no immediate role to play in reducing urban sprawl, e.g. because they live in a city or village centre or in a home that is adapted to the size of their household. Other people(still) live alone or with their partner in a house that is suitable for a family. In their case, the behavioural change could be to move to a smaller house. Other people dream of moving to a newly built, open house in a non-urban environment. The behavioural change for them could be to buy an existing house instead of a greenfield. Situations differ among people and psycho-social factors also do. How to address the right people at the right time and facilitate desired behavioural change in an appropriate way is not yet clear in the current state of research. It will be addressed in further researchin order to feed policy.

(2) The choice of place of residence and mode of transport are two behaviours that are intertwined and ask for an integrated strategy

The concept of residential self-selection teaches us the intertwining of two behaviours. Understanding that the choice of a home is a long-term issue and is made less frequently than that of a mode of transportation means that we can assume that efforts to achieve more sustainable mobility behaviour will lead to more desirable spatial organisation in the long run. A focus on the accessibility of facilities and services can work complementarily to this approach to enable more sustainable choices.

(3) Positive experiences are key

Recent efforts to encourage people to cycle to work or use co-mobility (car or bicycle combined with public transport) may, through positive experiences, increase the general appreciation for sustainable modes of transport. Positive experiences can then influence the long-term choice of where to live. We need to emphasise "positive" in positive experiences. Bad experiences are detrimental to a sustainable transition. While today electric bikes are widely promoted, qualitative perception research taught us that many perceive it as too dangerous given a lack of safe or adequate bike infrastructure. Bad experiences with overcrowded and delayed public transport would also have that effect. The perception research also confirmed that quality control of new development is important in order to compete with the successful suburban alternative. Non-quality densification can even create resistance to desirable spatial transitions.

(4) Political courage is needed to create a financial shift

How does a strategy on voluntary behavioural change fit into the overall policy to bring about the transition? Behavioural science clearly shows that the government cannot expect a change in behaviour if there are great difficulties to overcome for the desired behaviour.Policy will have to remove the obstacles to make the demand for behaviour change credible. A financial shift will be crucial to create a multi-shift in our behaviour towards mobility and housing. If transport-oriented development is to be encouraged, the capacity, frequency and network of public transport and cycling infrastructure must also be significantly expanded and desirable housing conditions will need to be affordable. Next to that, financial incentives for unsustainable behaviour will have to be phased out while nudges for sustainable behaviour will need to increase. That means an overall consistent policy from different fields: all legal and fiscal policies (mobility, housing, salary cars, …) must work together to achieve a sustainable spatial use. A good deal of political courage will therefore be needed to implement changes that could provoke resistance, not least because these decisions will limit some acquired privileges of a broad population.

(5) Diversity in the modes of participation in the transition is needed

To convince politicians to make such drastic changes, a significant part of the population must already be convinced. Therefore it must be possible for everyone to be able to become part of this transition process. Contributing to sustainability sometimes risks being a story of the privileged creating aversion among a broader group. Therefore every small contribution counts and can be a stepping stone for a larger transition over time. By gaining good insights into the values, themes and concrete situations of different segmentations in the population, policies can work in a more targeted way and offer everyone opportunities to get motivated and contribute to the change. Therefore, pilot projects should not always seek the extremes, but also find common ground for everyday people. Within different segments it is also important to focus on all ages. A focus on different breaking points in people's lives will initiate a broad transition over time.

(6) Communicate empathetically

Accusing people of making the wrong decisions works counterproductively.Not everyone will or can be motivated to change his/her behaviour at an early stage of the transition process (cf. Rogers). Judging behaviours of the late majority and laggards will encourage demotivation and a sense of loss.It is better to give people opportunities and support to change aspects that they themselves can control and to communicate with them empathetically at the right times. It is important to understand that change can be difficult for certain groups of people: policies and context must help people understand that they do not lose but win something.

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Bringing Research on City Resilience to Relevant Stakeholders – Combining Co-creation and Standardization in the ARCH project

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1 ABSTRACT

City resilience has gained increased recognition due to the COVID-19 pandemic situation and thus the topic has become one of great research interest, with several research projects focusing on city resilience within the last few years. However, in order for the project results to have an impact, meaningful stakeholder involvement needs to be centered. Acknowledgement of this need has lead to the use of different approaches in research, such as the use of co-creation activities and standardization, which aim to integrate city resilience stakeholders in the development processes of different tools and methods. This paper assesses the approaches of two city resilience-related research projects (Smart Mature Resilience or 'SMR,' and Climate Resilient Cities and Infrastructures or 'RESIN') and suggests an enhanced approach for combining co-creation and standardization – in a model called a Mutual Learning Framework – that is being used in an ongoing project called Advancing Resilience of Historic Areas Against Climate-related and Other Hazards, or 'ARCH.' The outcomes of this research will support the development of robust stakeholder engagement within city resilience, particularly in tool development and validation processes; ensured by a mix of co-creation and standardization methods.

Keywords: stakeholder engagement, city resilience, standardization, co-creation, research projects

2 INTRODUCTION

The topic of resilient cities is not new (Rockefeller Foundation and ARUP, 2014). However, the COVID-19 pandemic has put city resilience in the spotlight, more than ever (e.g. McCartney et al., 2021). This applies also for all city stakeholders and especially citizens, who also see the urgency of (climate) resilience. But involving all relevant stakeholders in research activities for the development of resilience-enhancing tools has not been simple thus far. The European Commission identified this issue a few years ago and requires the integration of research relevant stakeholders and end-users in the dissemination and exploitation of research projects: As noted by the Commission, intended audiences of research and tool development often includes groups such as city representatives (European Commission, 2015). One approach to bridge this gap, proposed by the European Commission within European Framework Programmes (FP) such as Horizon 2020 and Horizon Europe, is the tool of standardization, which can be used to actively support the exploitation and dissemination of FP projects (European Union, 2013; European Commission, 2018).

However, when reviewing FP projects, dissemination and exploitation activities during the implementation phase remain shallow and seldom reach affected stakeholders in a meaningful or actionable way. Only a few research projects have made specific progress on this topic and successfully integrated relevant stakeholders to enhance city resilience tools. The integration of cities within FP projects is key if the goal is to involve relevant stakeholders in achieving the common goal of becoming resilient cities in the future. This is primarily because a city cannot be resilient without the resilience of its critical infrastructures, citizens and network of cities to which it is connected in various ways. However, successfully involving the stakeholders and cities into projects depends very much on the approaches chosen, and depends heavily on the ways used to bring the theory of research into practical future uptake by cities. Different approaches are available, such as co-creation or standardization, but these approaches remain under-examined.

Therefore, the aim of this paper is to propose an approach for combining the methods of standardization and co-creation in research projects. To achieve this, the two EU-H2020 projects SMR 'Smart Mature Resilience' and RESIN 'Climate Resilient Cities and Infrastructures' on city resilience were assessed, with special focus on the success and impact of co-creation and standardization activities. The results of this assessment are used within the EU-H2020 project ARCH 'Advancing Resilience of Historic Areas Against

Climate-related and Other Hazards' to develop a methodology for enhanced stakeholder engagement by co-creation and standardization.

The aim of ARCH is to make areas of cultural and historic value more resilient against climate-related and natural hazards and risks (ARCH, 2021). To this end, the ARCH team will develop a suite of tools to: (1) collect existing and new information about hazards and vulnerabilities; (2) assess risks and resilience of historic areas under different scenarios; and (3) identify effective pathways and action plans to increase resilience. These solutions are developed using a co-creation method combining mutual learning activities, co-creation workshops and standardization activities. The city-focused project includes partners from the cities of Bratislava, Camerino, Hamburg and Valencia, who will co-create project tools in efforts of helping their respective cities and others to protect their historic areas from the effects of climate change. From the outset of the project, the co-creation method included different principles such as equality, openness, transparency, flexibility, inclusiveness and reflexive/iterative learning, as well as trust, accountability and credibility (ARCH, 2020). Based on the co-creation activity, a Mutual Learning Framework has been set up to foster direct knowledge exchange and experiences among the partners of the four initial project cities, which are also called the Foundation Cities, and a larger group of European cities called the Keystone Cities who aim to increase the resilience of their historical areas.

The paper is structured as follows: the topic of city resilience is further introduced and some approaches for using co-creation and standardization are presented in Section 2. Section 3 describes the methodology used for this research, and Section 4 includes the results of the assessment of the two projects to support the methodology used in the ARCH project. Finally, Section 5 summarizes the research and provides an outlook for further research.

3 CITY RESILIENCE WITH SUPPORT OF CO-CREATION & STANDARDIZATION

Research done in EU-funded projects has intensified over the last decade and has shown that while negative impacts of climate-related hazards (such as heavy rainfall, heat waves and earthquakes) and human-induced ones (such as industrial pollution, radiation, toxic waste or transport accidents) on urban areas are widely discussed their impacts and cascading effects are not yet understood to their full extent. All of this, in addition to the layered impacts of the COVID-19 pandemic, remain a gap in our shared understanding.

In existing literature, several frameworks have been developed to describe city resilience, tools have been suggested for the enhancement of city resilience, and the importance of stakeholder engagement and interaction for city resilience has been identified (e. g. Kontokosta & Malik, 2018; Hernantes et al., 2019; Mourshed et al., 2016).

The need to transform our societies towards climate protection and sustainability has become more urgent due to climate change and the overuse of natural resources. The global COVID-19 pandemic has caused an economic crisis and made long-standing social inequalities within and between our societies more visible (e. g. Blundell et al., 2020). By working on resilience, cities may ensure that a functioning local and regional economy and a just urban society respect planetary resource boundaries, while remaining driven by solidarity and cooperation. Work on city resilience seems therefore not only urgent, but inevitable. Moreover, increased attention and efforts in the area of resilience lead to sustainable development in cities, towns and municipalities. To do this, cities need to safeguard and protect their critical infrastructure and assets (e.g. historic areas), often while simultaneously dealing with pressing chronic social and economic stresses.

To further understand and work with the topic of city resilience, a common definition is needed. Derived from the SMR project, city resilience can be defined as: the ability of a city or region to resist, absorb, adapt to and recover from acute shocks and chronic stresses to keep critical services functioning, and to monitor and learn from on-going processes through city and cross-regional collaboration, to increase adaptive abilities and strengthen preparedness by anticipating and appropriately responding to future challenges (Maraña et al., 2019).

In order to achieve city resilience, standardization is one approach for transferring outcomes of research projects into practice; especially attractive as an option because it follows a transparent and open process. In this regard, it has to be noted that standardization can be conducted twofold: The first and most common process for standardization is formal standardization within technical committees. In these committees, experts of all relevant fields are part of developing different kinds of standards for the benefit of everyone

(ISO, 2021). However, these committees address many different subjects, so not all possible relevant research and innovation activities can be easily integrated and adopted in this technical committee system. As a result, a second route has been developed for standardization deliverables, such as Workshop Agreements. This method provides an additional tool for bringing research and innovation outputs into standardization (Poustourli, 2016). On the European level, CEN Workshop Agreements (CWA) can be used for research projects (CEN, 2021). Figure 1 shows the different steps of initiating and conducting a CEN Workshop to develop a CWA.

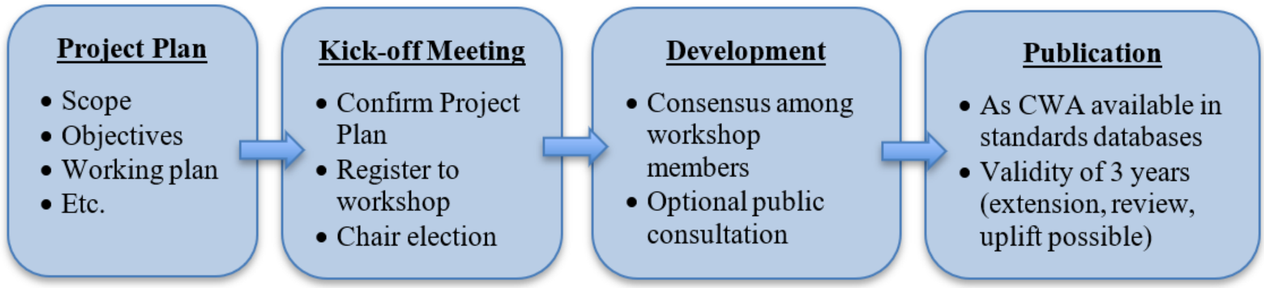

Fig. 1: Process of a CEN Workshop to establish CWAs

Due to the different process steps to develop a CWA, several possibilities to involve relevant stakeholders for the topic of the standard can be exploited and fostered. For example, as the CWA project plan is made publicly available for at least 30 days, interested stakeholders (even from outside of the project) can join and give input during the process. Also during the development phase of the CWA, relevant stakeholders can be easily and quickly integrated (CEN, 2021). However, the later that the stakeholder integration takes place, the more difficult it becomes to reach consensus among the workshop members. As standardization activities generally rely on developed tools and methods of a specific research project, the CEN Workshop process can also be used for co-creating the envisaged project outcomes.

Several references on co-creation methodologies for research and innovation projects in general, as well as on resilience exist. For example, Weichselgartner and Kasperson (2010) assessed successes and failures in collaborative knowledge production within the domain of resilience, based on 20 scientific assessments. With regard to research projects, the action research method of co-creation is of major interest. Here, the consideration of co-creation of the inputs and outputs of the research translates into practical outcomes, such as an example of a study with the public and governments (Cook et al., 2013). The benefits of participatory research approaches, in which we include co-creation, are that these bring the scientific process closer to decision-makers, enhance the perception of research outcomes and facilitate interaction among relevant stakeholders (e.g. Cvitanovic et al., 2019). Furthermore, existing literature on general co-creation activities refers to the objectives of the co-creation method itself and the influence factors and the outcomes of co-creation; whereas the discourse in this literature is limited as it relates to the eventual outcomes of the co-creation processes (Voorberg et al., 2015).

Standardization processes can adopt a co-creation approach. For example, in the practice of creating standards for city resilience, city officials and other experts come together to share their views and input in co-developing standards. Standardization around city resilience tools and processes can add to the co-creation process, as detailed input is requested from experts and stakeholders in a guided and facilitated way, where each workshop builds on the work that is done in the previous ones. This does not mean that the process is not flexible, but rather the opposite; one in which all voices have the opportunity to be heard and ideas the chance to be addressed. However, existing literature is lacking information on how co-creation and standardization activities can be combined successfully.

The presented research overcomes this gap and provides details on how both approaches can be successfully used within research projects to transfer theory to practice; and with regard to city resilience, to provide the cities with resilience-enhancing tools - ones that are especially easy to identify with, understand and adopt thanks to the fact that they co-developed them. Furthermore, as the inclusion of standardization in research projects is currently not addressed in the state of the art research, the link to standardization as a supportive tool for co-creation activities has not been well investigated. Therefore, it is important to review projects having successfully implemented standardization in the context of co-creation activities.

4 METHODOLOGY

This research was conducted by using the action research methodology. Chein et al. (1948) suggested the four dimensions of action research: diagnostic; empirical; participatory and experimental. Thus, they define participatory action research as a method in which researchers and practitioners actively participate in all stages of research. Furthermore, participatory action research has been verified as a method to make scientific findings useful for practitioners (Ottosson, 2003).

The information flow between research and practice, and vice versa, is crucial. This is especially true when it comes to achieving applicable resilience-enhancing tools for cities. Thus, this method can be a win-win relationship: firstly, for the researchers, as their tools will be directly brought into practice and be applied to the research projects assessed in this paper; and also for the practitioners, like city representatives who gain access to tools for which they provided essential input. In this way, action research has previously been used in other research projects.

In the framework of this action research, the RESIN and SMR projects have been assessed through the direct participation of the researchers in these projects. RESIN was an interdisciplinary, practice-based research project, funded under Horizon 2020, investigating climate resilience in European cities. The project was completed with direct co-creation activities involving the cities of Bratislava (Slovakia), Bilbao (Spain), Greater Manchester (United Kingdom), and Paris (France) and knowledge brokerage with 17 additional European municipalities. The project developed practical and applicable tools to support cities in designing and implementing climate adaptation strategies appropriate for their local contexts. RESIN also compared and evaluated methods that can be used to plan for climate adaptation to move towards formal standardization of adaptation strategies.

SMR was also a Horizon 2020 project, the objective of which was to develop a European Resilience Management Guideline (ERMG) consisting of a set of resilience-enhancing tools such as a Maturity Model, Resilience Information Portal and Risk Systemicity Questionnaire. These were intended to support city decision makers in developing and implementing resilience measures. Therefore, the project used a co-creation method to involve further cities and stakeholders. Furthermore, SMR implemented within the co-creation process their tool development, validation and, finally, approval by city councils. In order to ensure the usefulness and reliability of the results, the SMR project involved the cities of Bristol (United Kingdom), Glasgow (United Kingdom), Kristiansand (Norway), Riga (Latvia), Rome (Italy), Donostia-San Sebastian (Spain) and Vejle (Denmark) in the project consortium and adopting a co-creation approach throughout the project to foster the integration of project-external cities in the tool development, verification and future application.

The lessons learned during the course of the co-creation and standardization activities conducted in these two projects have been gathered in this paper, setting a specific focus on the stakeholder involvement and the impact the conducted activities provided. The results of this assessment are being implemented, reflected upon and further enhanced in the ARCH project to successfully combine standardization and co-creation activities. Thus, the findings lead to the development of an improved approach in ARCH. The outcomes of this research will support the development of robust stakeholder engagement within tool development and validation processes, as ensured by a mix of a co-creation and standardization approach.

5 COMPARISON AND DISCUSSION OF COMBINED CO-CREATION AND STANDARDIZATION APPROACHES

This paper analyzes RESIN and SMR projects separately and provides information on how the standardization and co-creation activities were conducted. The lessons learned in these assessments are integrated in a comparison table. Table 1 outlines the general setup of each project, as related to co-creation and standardization, as well as post-project reflections on success factors, challenges and impacts.

5.1 RESIN project

Generally, the RESIN project employed multiple co-creation approaches tailored to the individuals and organizations involved in different tasks. This resulted in variations in conducted activities, timing of activities and depth of co-creation. Initially (i.e. during project design), RESIN planned a more traditional development process, with finite and separate stages for development, testing and user feedback, where each stage would conclude in the 'handover' of a formal report containing relevant results. Separate stages were envisaged to be guided by close cooperation between technical partners and city partners. However, shortly after the start of the project in November 2015 this approach shifted to focus more on the co-creation of knowledge due to the needs of the city partners and advice from the project's external scientific advisory board. The aim was to align development activities even more closely with the ongoing issues at the local level in the partner cities. Subsequently, the more traditional development process shifted to a more agile process with more frequent and iterative testing and feedback loops between the technical partners and city partners.

The project design (prior to the shift mentioned above) envisaged that city partners' engagement with research partners in the development of tools would be guided through different activities, including: Process Management Workshops to foster an understanding for resilience building; development of a 'City assessment report' to communicate the state of local adaptation work in each city; and bi-monthly webinars between cities and tool developers to provide regular progress reports to one another. Additionally, different workshops, stakeholder dialogues and webinars were conducted in RESIN to integrate additional city practitioners into the project and to support co-creation of the resilience tools (RESIN, 2018a). Thus, the above activities provided a framework for co-creation of the tools. The co-creation processes between tool developers and city partners differed between the three different solutions developed by RESIN and based on the resources available in the cities. For example, while full risk analyses using the new method developed in RESIN were conducted with the cities of Bilbao and Bratislava, only a qualitative assessment was conducted for Greater Manchester, while the city of Paris followed the development processes more loosely. While standardization was originally envisaged as a cross-cutting exercise spanning all city cases, it was not consistently implemented in all the co-creation activities with city partners. Instead, standardization was often pursued from the viewpoint of technical partners developing tools and methods, with city partners being consulted infrequently (see RESIN, 2018a; RESIN, 2018b). For example:

- A survey on city viewpoints on standardization was conducted
- City partners were involved if dedicated standardization sessions were conducted during bi-annual project meetings

Instead, individual partners pursued standardization activities on international, European, and national levels (e.g. via memberships in ISO / CEN / national committees and working groups). An originally foreseen CEN Workshop Agreement was not pursued. Instead, RESIN produced recommendations for future standardization activities, based on the final project results (RESIN, 2018b).

5.2 SMR project

The co-creation approach used in the SMR project ensured the active involvement and engagement of stakeholders in the production of knowledge. This included experts from local, regional and national governments, academic and scientific entities, and public and private companies. Several methodologies such as workshops, surveys, the Delphi method and semi-structured interviews were used to foster co-creation in the development of the five tools that support the ERMG. The standardization of the tools and ERMG was also undertaken as a co-creation process in a transversal way throughout the project. In fact, the standardization activities were envisaged from the very beginning, integrating sessions dedicated to standardization in the co-creation workshops for the development of tools. Once the tools and ERMG were developed, the SMR partners assessed the standardization potential of each solution, which resulted in the development of the CWA 17300 series on 'City Resilience Development' regarding the ERMG, Maturity Model and Information Portal (SMR, 2021). The development of these CWAs enabled further input from other project external stakeholders such as representatives from other cities or other resilience-focused research projects.

The SMR project defined a Circle of Sharing and Learning for the involvement of, and dissemination to cities. The three Tier 1 cities (Glasgow, Kristiansand and Donostia) were the earliest adopters, which implemented the ERMG and served as a testing ground for the pilot tools. Tier 2 included the other four partner cities (Riga, Bristol, Rome and Vejle), which acted as peer reviewers in the pilot implementations, providing advice. Tier 3 included the cities already considered active with regard to resilience, e.g. those who participate in the UNDRR resilient cities campaign or have been selected to participate in the 100

Resilient Cities of the World network pioneered by the Rockefeller Foundation. In the SMR project, the following cities were part of the Tier 3 group: Athens (Greece), Greater Amman Municipality (Jordan), Greater Manchester (United Kingdom), Malaga (Spain), Malmö (Sweden), Reykjavik (Iceland) and Thessaloniki (Greece). Finally, the Tier 4 level of cities is represented by those cities potentially interested in the project tools (SMR, 2021).

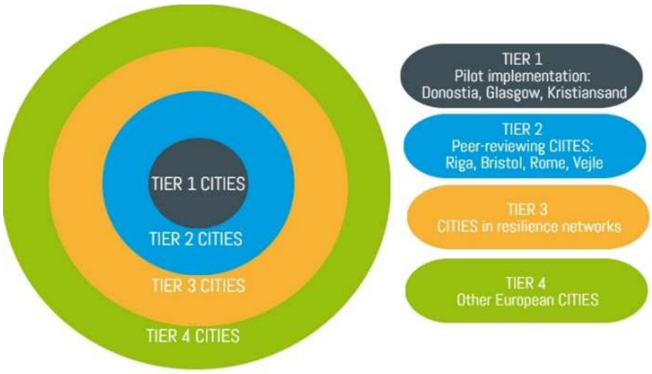

Fig. 2: The four different tiers of CITIES within the SMR project

During the co-creation activities and especially during the conducted stakeholder dialogues, all tiers of cities have been invited to participate in the standardization activities. However, due to the process of standardization, further cities and organizations interested in city resilience and the envisaged standards that are not related to the SMR project joined the standards development. Thus, the standardization activity increased the number of organizations and cities that validated the project's city-enhancing tools.

5.3 Comparison of RESIN and SMR projects

The results of this assessment of the RESIN and SMR project supports the development and enhancement of the co-creation and standardization activities within the ARCH project.

5.4 Combining the lessons learned in the ARCH project

Co-creation is at the heart of the ARCH project, and takes place in two contexts: within technical developments that are led by tool developers with the support of city partners; and in local activities that are spearheaded by city partners with the support of research partners. This twofold approach originated from the aim to make space within the project for not only research-driven developments, but also practical, "on the ground" development of solutions at the city scale. Accordingly, project partners worked to align tasks to ensure that technical developments and methods were appropriate or useful in confronting local challenges.

As an additional part of the co-creation aims of the ARCH project, the Mutual Learning Framework is an opportunity for exchange and sharing between the four cities that are part of ARCH's Consortium (Foundation cities) and a larger group of selected European cities, called the Keystone cities. These cities were selected because of their common interests in increasing the resilience of their historical areas. Both Foundation and Keystone are able to offer up and receive expertise during a series of four Mutual Learning Workshops (MLW), the main result of the Mutual Learning Framework. These interactive and dynamic workshops blend shared plenary discussions with more locally specific breakout sessions in city clusters that strategically match Foundation and Keystone cities with shared goals or challenges.

In addition to this co-creation approach, the ARCH project incorporates standardization, integrating it into nearly all of the other project tasks. To start, standardization-focused project partners have been included in tasks as "observers," and have led collaborative standardization activities during biannual project meetings and the activities of the Mutual Learning Framework, as mentioned above. To support the standardization activities in ARCH, the project will set up a liaison with relevant standardization committee(s) to ensure the uptake of the standardization outcomes of the project directly within the standardization system.

Altogether, co-creation and standardization are central to the methods of the ARCH project. In fact, early on in the project, co-creation tasks were bundled into a dedicated Work Package to ensure ease of coordination. This varied and strategic approach has ensured ongoing cooperation in the work of ARCH partners, and helped project outcomes to stay true to the aforementioned project principles of equality, openness, transparency, flexibility, inclusiveness and reflexive/iterative learning, trust, accountability and credibility (ARCH, 2020).

	RESIN project	SMR project
General		
How was standardization integrated in the project (resources, etc.)?	Standardization Work package Context: Only some technical partners (as well as ICLEI) and none of the involved cities had resources for standardization	Standardization Work package Context: All partners, including cities had resources for standardization Standardization addressed since project start, thus became more 'understandable' by all partners (despite their lack of previous experience)
How was the exchange with relevant (city) stakeholders organized?	Co-creation Work package with tasks focused on general process management, assessment reports, testing and documentation. Inclusion of stakeholders in standardization work only via (ad hoc) project meetings	Co-creation, pilot implementation and testing Work Package with tasks that focused on co-developing the tools having the input by all cities, development of manuals and handbooks to accompany the tools. Inclusion of external stakeholders through project meetings, training workshops and external events.
Reflection on conducted standardization and co-creation activities		
How successful was the stakeholder involvement approach (process)?	No explicit inclusion of (city) stakeholders in standardization processes. Where there was input, it was generally more indirect, coming in the form of results from the co-creation approach between researchers and city stakeholders, which then were transferred either to standardization work conducted by technical partners (e.g. inclusion of city perspective when commenting on the draft of a standard) or reported during project standardization meetings (i.e. meetings conducted for the standardization Work Package as part of other project meetings or as stand-alone meetings).	A number of cities and stakeholders were included in standardization activities, attended workshops and actively contributed to shaping three CWAs.
Which difficulties and challenges have been tackled?	Co-creation approach was not meant to be aligned with the standardization approach, as the standardization approach was more focused on technical partners (in part due to the initial project setup, wherein a less intensive co-creation approach was planned. Instead, a more traditional development and testing approach was planned. Identifying suitable results to standardize was difficult. Even when assigning personnel resources for standardization to city stakeholders, going the route of (individual) participation of organizations in standardization committees and transferring results this way was a challenge, as partners need to allocate time for these actions over a long period (potentially going beyond the project lifetime) which might conflict with their "business as usual."	Identifying which tools and processes would be standardized was a long process and demanded coordination with all partners. The CEN workshop participants made efforts to ensure the reliability and accuracy of the technical and non-technical content of all CWAs, but this does not guarantee the overall correctness of input, as it reflects their way of working and cooperating in their cities or organizations.
Impact of standardization outcomes		
How stakeholders benefit from the standardization activities, their results (impact of results)?	As some RESIN results were transferred to at least one international standard (although after the end of the project) applying these approaches makes sure that processes and methods in cities are aligned with other approaches, and also follow these aforementioned standards.	The SMR results were transferred into three CWAs on 'City Resilience Development' and then introduced to at least one international standard. More specifically, the indicators included in ISO 37123 'Indicators for Resilient Cities' were mapped along the five steps of the operational guidance cycle of CWA 17300.
Which are implications for the future?	Depending on what the desired outcome is (e.g. a "guideline" for a process vs. a more "technical" standard; a direct application in cities vs. a "blueprint" for methods or tools aimed at researchers), a direct alignment between standardization and co-creation would be desirable. This would include standardization tasks being specifically designed in a way to make use of co-creation. However, this can also require very coordinated timing of technical developments in the project, which might not be possible in an adaptive and agile co-creation process (e.g. in RESIN the focus switched from tool to method development).	With the publication of the CWA 17300 series, the topic of city resilience gained visibility. Due to the COVID-19 pandemic, this becomes even more timely. However, the SMR project has shown that, besides the classical research on existing standards and the development of research results out of standards, other benefits arise from the integration of standardization. Among these benefits is the standardization network of experts within the technical committee and the different options to support standardization work, which allows all relevant stakeholders to contribute to standards.

Table 1: Comparison of RESIN and SMR project

6 CONCLUSION AND OUTLOOK

The research on city resilience can only be impactful when all relevant stakeholders are included throughout the development of tools or processes. In recent years, standardization has come to have a major role in many research projects (especially those in Europe), where it is employed to support the dissemination and exploitation of project results. However, the ways in which a project can best exploit standardization to foster the integration of all relevant stakeholders has not yet fully researched. This paper provides practical examples of how co-creation and standardization can be conducted jointly, as reflected in the context of the ARCH project. The lessons learned of the RESIN and SMR projects were used via participatory action research to support the methodology of co-creation linked with standardization activities in ARCH – specifically within the ARCH Mutual Learning Framework. RESIN and SMR both have successfully integrated standardization in their respective project work, of which the SMR project was deemed by the European Commission as a success story for using standardization in an FP project (European Commission, 2019).

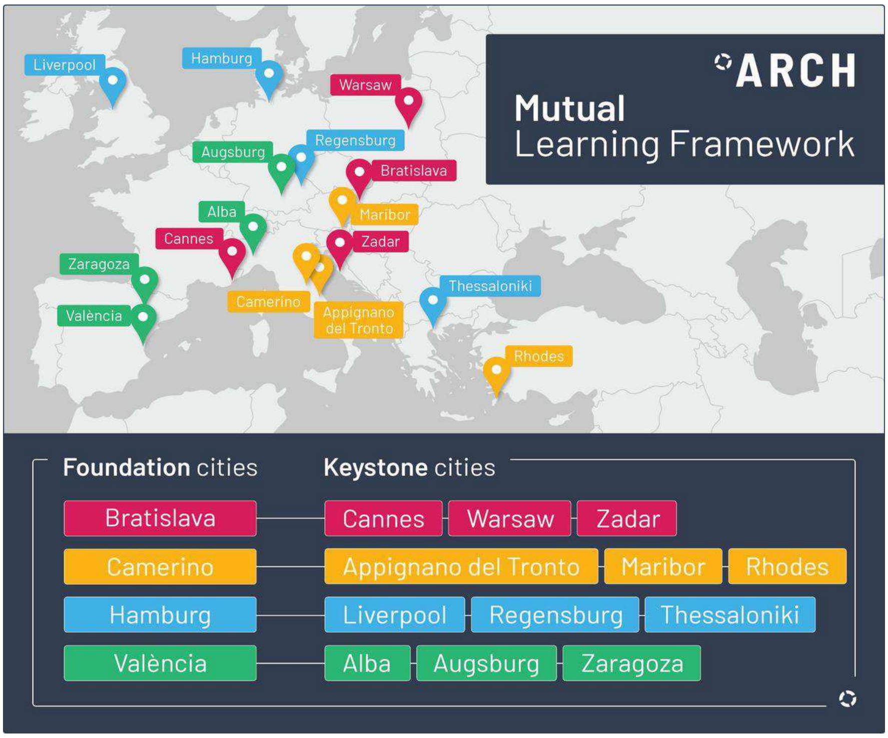

Fig. 3: Overview of cities involved in the ARCH Mutual Learning Framework (ARCH, 2021)

This research has some limitations, as few projects have thus far combined co-creation and standardization; and few among these with a focus on city resilience. The outcomes of this research will be important for the future activities to complement the CWA 17300 series on 'City Resilience Development,' with more resilience supporting standards. In this regard, the ARCH project is currently initiating further standard development within the frame of a CEN Workshop that is called 'City Resilience Development – Framework and guidance for implementation with a specific focus on historic areas' (ARCH, 2021).

The implications of this research should be part of future research on how to successfully integrate standardization in research projects, combining it with co-creation as well as on city resilience approaches in general.

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Can Church Gardens Represent a Valuable Recreation Alternative in Cities?

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1 ABSTRACT

Urban green infrastructure is a key element in improving quality of life and creating an appropriate framework for sustainable, resilient and inclusive cities. Also, achieving a coherent spatial planning based on development of urban green infrastructure can be an useful solution to negative changes related to environmental quality, segregation and ecosystem services. We use church gardens in Bucharest as a case study to understand how these small green spaces can be integrated into urban planning.

The paper aims to analyse the potential of church gardens as recreation areas at city level in Romania. The analysis focused on three major aspects – the spatial distribution of churches, the accessibility of green spaces located in church gardens (calculated both for adults and elderly people as most important groups accessing the gardens) and the characteristics of those gardens in terms of facilities, use and problems (based on a field survey filled for a 20% sample of the 287 churches in Bucharest).

The results showed that the homogenous spatial distribution of churches with green gardens makes them accessible for residential areas located far from traditional green recreational areas. In Bucharest, the service areas of churches with green spaces cover 84% of the residential areas when accounting for the adult's walking speed and 61% when accounting for elderly people. Green spaces in church gardens amount to over 25 ha in Bucharest, with an average of 1737 square meters per garden, representing a surface which could be designed to respond better to the population needs. The major challenges identified in the church gardens are (a) the use of green space for other purposes than recreations, such as storage space for construction materials (31.5%), waste (17.5%), temporal constructions (12.3%) or car parking (21%), and (b) quality of vegetation.

Our study highlights that through their number and distribution church gardens can represent an alternative to large green areas if they are opened to the population and used for organising activities and events. Their importance and potential could be increased if designed for such purpose. Such analysis can be useful in the planning process of small urban green areas in order to integrate them into urban management process.

Keywords: recreation, accessibility, church gardens, green infrastructure, inclusion

2 INTRODUCTION

The new 2030 Urban Agenda and the Sustainable Development Goals SDGs (specifically SDG 11) reveal the need for public green space interventions to achieve sustainable urban development (UN, 2015). Such actions are required in order to achieve sustainable, resilient and inclusive human settlements which is the goal of multiple international initiatives.

Urban green spaces are highly important both from ecological and social perspectives (Kabisch and Haase, 2013). From an ecological point of view, they provide regulating and supporting ecosystem services, such as climate mitigation (de la Sofia et al. 2019; Jarosińska and Gołda, 2020), regulating the temperature of the indoor and outdoor environment (Liberalesso et al., 2020; Wang et al., 2014), flood control (Latinopoulos et al., 2016; Sun et al., 2019), noise reduction (Sakieh et al., 2017), pollution control (Ariluoma et al., 2021), and providing a habitat for urban biodiversity (Tzoulas et al., 2007, Jabben et al., 2015). The social benefits provided by urban green spaces are related with opportunities for recreation, nature observation, socialisation, artistic, educational and scientific activities, sports and their role in improving both physical and mental health (Dickinson and Hobbs, 2017; Kabisch et al., 2017). Moreover, urban green spaces increase aesthetics and quality of life (Enssle and Kabisch, 2020; Razak et al., 2016).

In the past decades, many studies have focused on the analysis of large urban green spaces, mainly parks and urban or periurban forests, addressing various topics such as the services they generate (Demuzere et al., 2014), their potential to control pollution (Saaroni et al., 2018), their role in promoting social cohesion (O'Brien et al., 2017), the planning principles behind them (Gradinaru & Hersperger, 2019) and administrative aspects (Meerow and Newell, 2017). There are also studies related to the connectivity of urban green spaces and the integration of these areas into spatial planning (Langemeyer et al., 2020) in order to increase the green surface within the cities.

The new paradigm of urban growth promotes compact cities as solution for reducing the human impact on the environment by controlling urban sprawl, preserving natural and seminatural areas around cities and minimising the need for private transportation (Artmann et al. 2019). However, these cities have to include enough green areas to compensate for the deep human transformation and the pollution generated. The development of compact and green cities faces many challenges, such as the existing high density of previously built areas, the high number of inhabitants and the property regime of urban spaces, with many falling under the realm. In this context, small urban green spaces could represent a viable alternative to parks and urban forests and a potential solution for environmental issues in urban areas, especially since they can be developed both independently and complementary to other urban functions (e.g. institutions, commercial areas, residential areas). Peschardt et al.(2012) defined small urban green spaces as places that must have at least some vegetation, their own entrance, and distinguishable boundaries which separate them from surrounding public space. Also, Peschardt and Stigsdotter (2013) mentioned that for a green space to be considered small it must have an area less than 5000 square meters.

Small urban green areas include categories such as pocket parks, residential green areas, playgrounds (Olsen et al., 2019), institutional gardens such as school gardens (Ioja et al., 2014) or church gardens, green roofs (Langemeyer et al., 2020; Shafique et al., 2018) and green walls (Fastenrath et al., 2020). The scientific interest in these areas varies a lot according to the intensity of their use, the targeted population, their frequency in urban areas and the challenges related to their inclusion in a coherent network. Playgrounds, for example, are a hot topic, many studies are focusing on their role, both positive (place for physical activities and contact with nature) (Cohen et al., 2020; Raney et al., 2019) and negative (spaces which may contain chemical contaminants or parasites from other species) (Berman et al., 2018) in children's health.

Church gardens are not a frequently discussed topic in the scientific literature. There are several publications which analyse more widely subjects like church gardens, cemeteries or sacred forests (Byers et al., 2001; Rae, 2021). Most of the publications focus on their contribution toward increasing urban biodiversity (Skorka et al. 2018) and recreational and regulation functions of the cemeteries. Also, they provide valuable information regarding their evolution, floristic characteristics and socio-cultural use (North et al., 2017).

Since in Romania church gardens are considered a distinct type of urban green areas within the broader category of institutional gardens (Romanian Parliament, 2007) we explored their potential to improve the residents' quality of life through cultural ecosystem services. A study in Poland showed that church gardens could perform new functions related to recreation and education, they could contain playgrounds for children, secular exhibition and animal cribs related to traditional holidays (Kaczyńska, 2020). As yet the cultural services provided by urban sacred sites have not been examined in urban sustainability debates, they require investigation because urban sacred sites are often managed for different objectives then other formal urban green spaces.

Only few studies have focused on the potential of small green spaces in increasing the connectivity and multifunctionality of urban spaces (see for example Ioja et al., 2014). Our study will focus on church gardens with the aim to fill the gap related with the assessment of their potential to represent a valuable recreation alternative in cities. The objectives of the paper are to: (1) assess the spatial distribution of church green spaces in Bucharest, (2) evaluate the accessibility of church green spaces for the local community and (3) identify the characteristics of church green spaces and their potential for representing valuable recreation alternatives.

3 STUDY AREA

Bucharest is the capital city of Romania, the largest city in the Central and Eastern Europe. It has a population that exceeds 1.83 million inhabitants (Eurostat, 2019) and a surface of 242 square km. Bucharest was a capital for the past three and a half centuries and this status is visible in the planning and design of the city. After the fall of the socialist regime in 1989 the centralised planning system was replaced by chaotic development and urban sprawl due to the shift to private ownership of land and the weak legislative system (Grădinaru et al., 2020).

After 1989 the surface of urban green infrastructure in Bucharest diminished as a result of land conversion into commercial and residential areas (Iojă et al., 2014). Urban parks have lost around 60 hectares between 1989 and 2019, currently covering around 790 ha (Badiu et al., 2019) but small green areas have been equally threatened especially due to the restitution process that affected pocket parks, neighbourhood greens and other areas which once transferred into private property were transformed into built areas (Onose et al. 2020). Due to public pressure related to urban green spaces, in the last years emerged a tendency of creating new green areas, most of them located on previously abandoned land within or near residential areas.

Many churches in Bucharest are centuries old and represented a vector of urbanisation preceding the building of the residential areas they are currently serving. During the socialist era, in the context of an outspoken opposition between state and church, many churches in Bucharest were demolished, moved or their gardens were diminished making place for the socialist blocks of flats or major transport infrastructure. Most of the churches in Bucharest are Christian orthodox, they are usually physically separated from other urban functions and not always open for the public.

4 METHODOLOGY

We developed a spatial database containing the location of the churches in Bucharest, including all categories of churches (e.g., orthodox, catholic, protestant) located in independent buildings. We used two sources of information: the website of the National Heritage Institute (CIMEC, 2008) and the Open Street Map database (retrieved online from the Geofabrik website). The location of each church was validated using the satellite base map provided by ESRI in ArcGIS Pro (ESRI, 2018). The spatial database contained the build-up area within the church garden and the green space (excluding cemeteries) and information regarding the names, confession, categories of green areas and vegetation coverage and surface.

We identified and validated 287 churches in Bucharest, most of them belonging to the following confessions: Christian orthodox (77%), Christian catholic (3.14%), Baptist (4.53%) and Adventist (5.92%). We also identified 25 places of worship of other confessions. We included in the analysis only the stand-alone locations and excluded the ones arranged inside residential buildings or multifunctional ones.

In order to perform the accessibility analysis, we built a Network dataset based on the open access street layer provided by Open Street Map. The network was configured for walking and included two alternative modes – for adults and elderly people, these two categories being the most probable to use church green areas since they visit these places more often. Based on a literature review, we used an average walking speed of 0.8 m/s for elderly people (Montero-Odasso et al, 2004) and 1.42 m/s for adults with normal weight (Browning et al, 2006). We performed the accessibility analysis using the Service Area wizard in ArcGIS Pro 10.2 and highlighted areas at 5-, 10- and 15-minutes walking distance (see Table 1) from the churches having a green area in their garden. We also calculated the surface or collective and single-family residential areas located in the delineated service areas to highlight the share of urban population having access to these objectives and the potential they have to represent recreation areas.

	Distance walked in 5 minutes (m)	Distance walked in 10 minutes (m)	Distance walked in 15 minutes (m)
Adults	240	480	720
Elderly	427	854	1282

Table 1: Distances used in the accessibility analysis derived based on the average walking speed for adults and elderly people

To identify the characteristics of the gardens, we conducted a field survey to a sample of 57 churches, representing 20% of the total number. The field work was carried out during the summer season (June-July 2020) so aspects related with the green areas could be observed. The survey included items addressing (1) general information about the church (i.e., confession, surroundings, establishment period), (2) characteristics of the gardens (i.e., endowments, use of the garden) and (3) green space characteristics (i.e., categories of green spaces, floral composition, vegetation problems). Statistical analysis was used to analyse the information.

5 RESULTS

5.1 Spatial distribution of church green spaces in Bucharest

Our analysis highlighted the concentration of churches in the old central part of the city, almost half of the identified churches being located inside the first ring of the city, a surface of around 28 square km representing less than 10% of the city's surface.

Only 52% (149 locations) of the churches identified in Bucharest have green spaces within their gardens, with great variations between confessions (Fig. 1). Christian orthodox churches represent 92% of the 149 locations that have green spaces and 62% of those which don't (85 out of 138). The orthodox confession is the only one for which the churches with green spaces are in greater number (almost 60%) than those which don't.

It is interesting to notice that, contrary to the confession, the location of the church doesn't significantly influence the presence of the green space. Therefore, 53% of the churches located inside the first road ring of the city, and 50% of those located outside, have green spaces within their gardens.

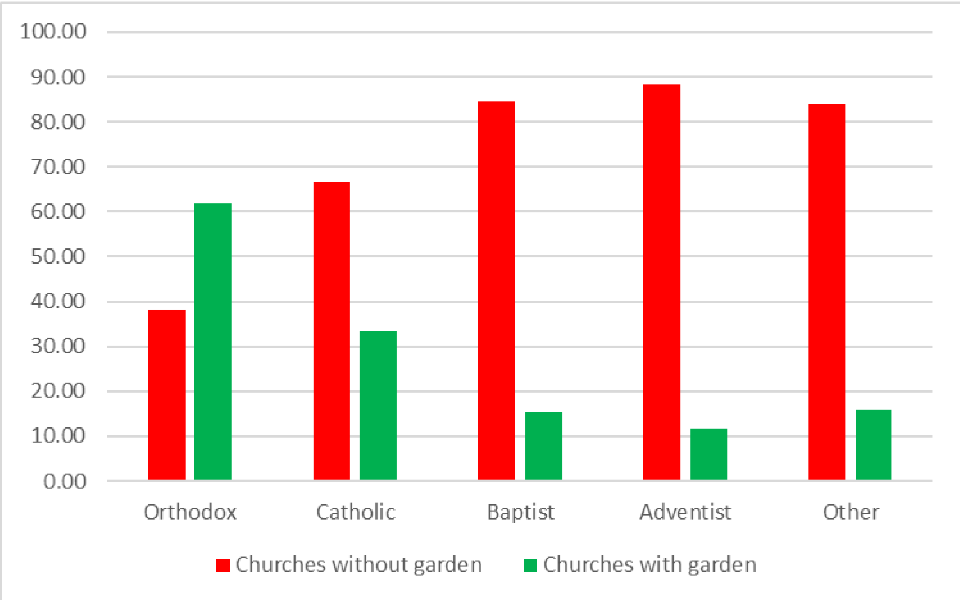

Fig. 1: Distribution of green spaces between churches of different confessions

The surface of the green spaces located within the gardens varies from a few square meters to 1.84 ha (18400 square meters), with an average value of 1737 sqm of green space per garden. Overall, green space located within church gardens in Bucharest have a surface of 25.71 ha.

5.2 Accessibility of church green spaces for the local community

The accessibility analysis highlighted the high potential church gardens have as recreation alternatives for the local population. Even if only half of the identified churches have green areas inside their gardens, they are homogenously distributed at city level and could serve as recreation areas for an important number of residents.

There are significant differences in terms of accessibility between the two groups included in analysis. Adults, who walk faster, enjoy a good accessibility to churches with green areas inside their gardens across the city. Only far peripheral areas lack churches with green spaces, some of them actually lacking churches at all. The situation changes when taking into consideration the limited mobility of elderly people. Apart from the old central part of the city, which is enclosed by the first road ring, almost all neighbourhoods have areas without access to churches with green spaces from the point of view of elderly people (Fig. 2). Their limited mobility heavily restricts the distances they can cover in a given amount of time and also their resistance to effort.

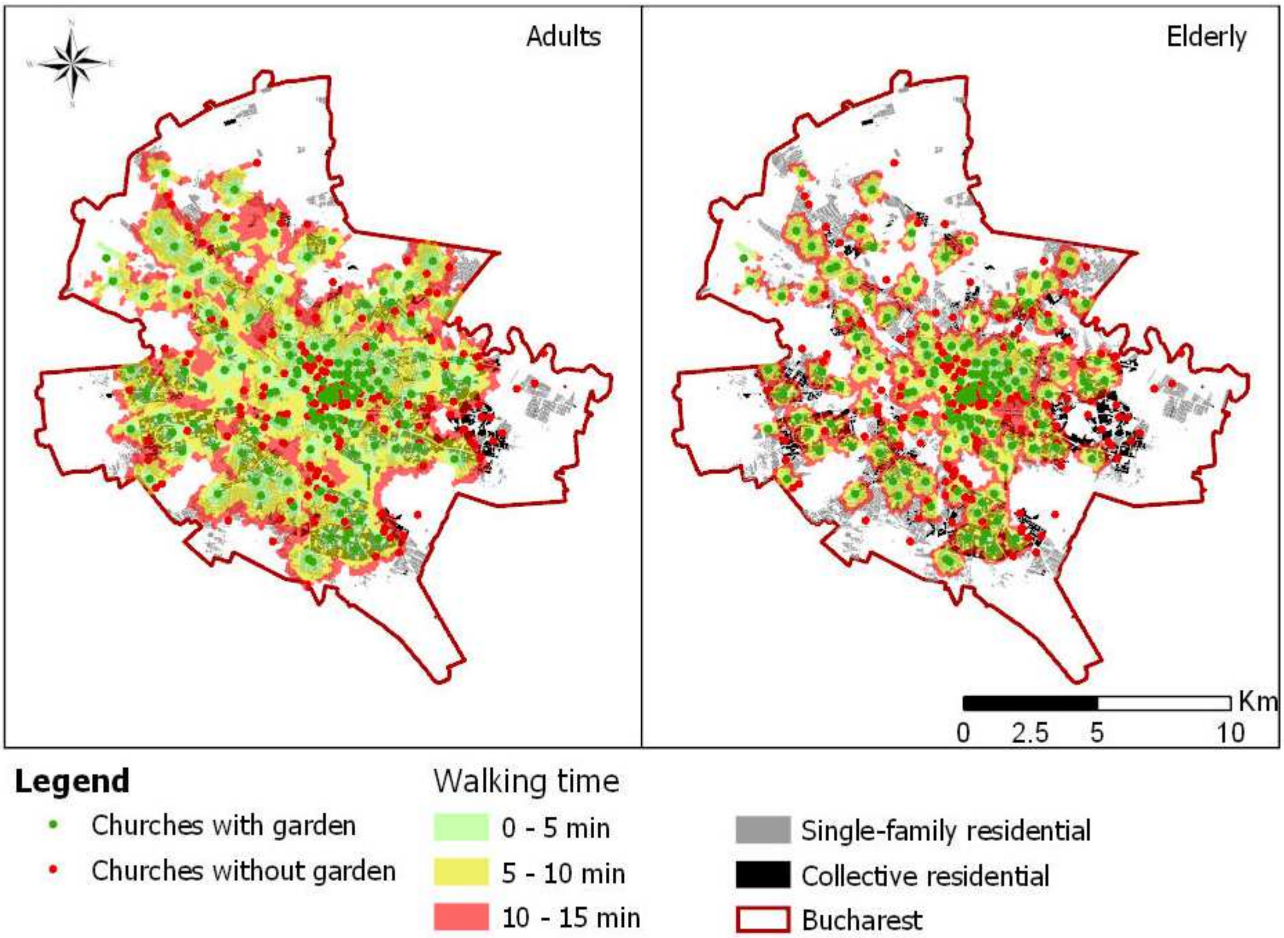

Fig. 2: Service areas of churches with green spaces in their gardens (calculated for adults (left) and elderly people (right))

We assessed the surface of residential area located in the proximity of churches with green spaces in their gardens as measure of the percent of population with access to them (Table 1). The analysis showed that in case of the services areas established for adults, only 13.79% of the residential areas had very low or no access to green areas in churches gardens. Collective residential premises have a better access to green areas in church gardens then single-family homes, 93% of the former having very good (less than 5 minutes), good (5-10 minutes) and satisfactory (10-15 minutes) access compared with only 82% among the latter. It is interesting to highlight that, for both categories of residential areas, the larger surfaces are found in the immediate proximity of churches, with double or triple extension in the first two areas of access (under 5 minutes and 5-10 minutes) compared with the third one (10-15 minutes).

Walking time	0-5 min		5-10 min		10-15 min		over 15 min		Residential surface
Unit	ha	%	ha	%	ha	%	ha	%	ha
Adults									
Collective residential	942.03	37.30	1021.943	40.46	378.34	14.98	183.287	7.26	2525.6
Single-family residential	1258.91	32.06	1287.5	32.79	674.11	17.17	706.37	17.99	3926.89
Total	2200.94	34.11	2309.443	35.79	1052.45	16.31	889.657	13.79	6452.49
Elderly									
Collective residential	418.36	16.56	689.1	27.28	645.22	25.55	772.92	30.60	2525.6
Single-family residential	652.77	16.62	788.78	20.09	747.1	19.03	1738.24	44.27	3926.89
Total	1071.13	16.60	1477.88	22.90	1392.32	21.58	2511.16	38.92	6452.49

Table 2: Surfaces of residential areas located inside the service areas of churches with green spaces in their gardens

In the case of the service areas established for elderly people, the distribution of the residential areas is more balanced. An important share of the residential areas doesn't have access to green spaces in church gardens – 30.6% in the case of collective residential and 44.27% in the case of single-family residential. The results showed that around 17.5% of total residential areas (20.7% of collective residential and 15.4% of single-family residential) has very good access to green spaces in church gardens for adults, but not for elderly people (Fig. 3). The same situation is also characteristic for 12.9% of residential with good access (5-10 minutes walking distance) in the case of adults, but not in the case of elderly people. In contrast, the residential surfaces with satisfactory (10-15 minutes walking distance) and low access (over 15 minutes walking distance) are larger in the case of elderly people.

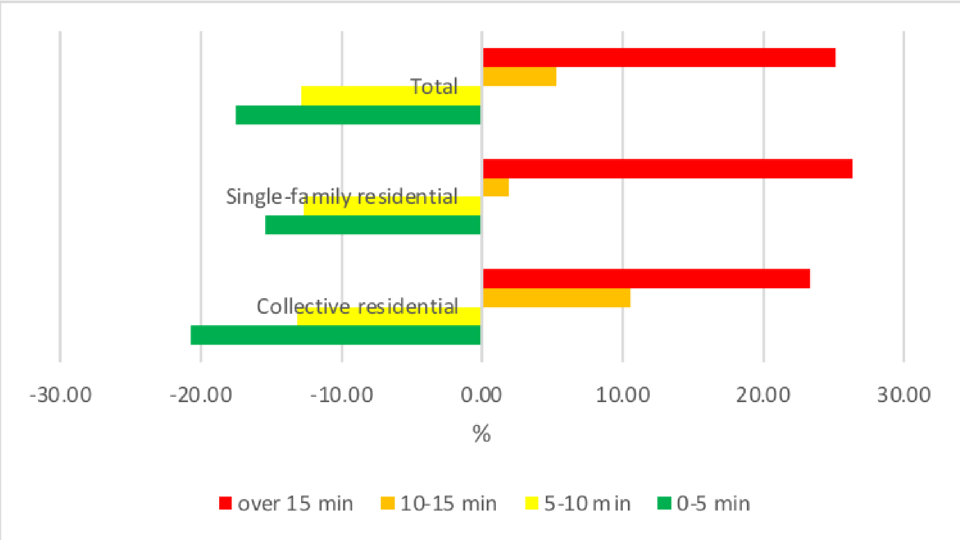

Fig. 3: Difference between the shares of residential areas inside the services areas calculated for the elderly and for the adults

5.3 Characteristics of church green spaces

The field survey highlighted that the most common urban functions found in the proximity of churches in Bucharest are collective residential (86%), single-family residential (51%), commercial areas (42%) and parking lots (37%).

Beside the main building, church gardens enclose a variety of land uses within their perimeter, such as buildings used for rituals (e.g., outdoor worship, weddings, burials, shrines and so on), bell towers, alleys, parking lots, green spaces, statues and playgrounds. The diversity of these elements depends on the church confession and age, the available surface and the protection regimen of the location. The majority of the surveyed churches had a private garden (85%), but these gardens did not always include green areas. Some of the churches without garden are located within cemeteries which generally can't be associated with recreational activities.

The vegetation in church gardens is diverse, the majority including hardwood species (82%), coniferous (58%) and shrubs (79%) and sometimes very dense. Commonly, shrubs can be used as a green alignment which separates alleys and green spaces or are used as a replacement for hedges. The lawn is another common green element, encountered in 74% of the surveyed cases. The grass areas cover between 0 and 90% of the gardens' surface and from case to case the degree of maintenance varies. Almost half of the sample is characterised by the presence of flowers, both in flowerbeds or in hotchpotches. Church gardens are characterised by the presence of some random recreational elements like benches and playgrounds.

The major issues identified in the church gardens are (1) the use of green space for other purposes, such as storage space for construction materials (31.5%) or waste (17.5%), presence of temporal constructions (12.3%) or car parking (21%) and (2) low quality of vegetation. Around half of the gardens have problems related with dry vegetation, either advanced (43%) or medium (7%) and 11% host invasive plant species (e.g., Ailanthus altissima). Almost 20% of the gardens don't have any problems and 23% are facing other categories of problems (Fig. 4).

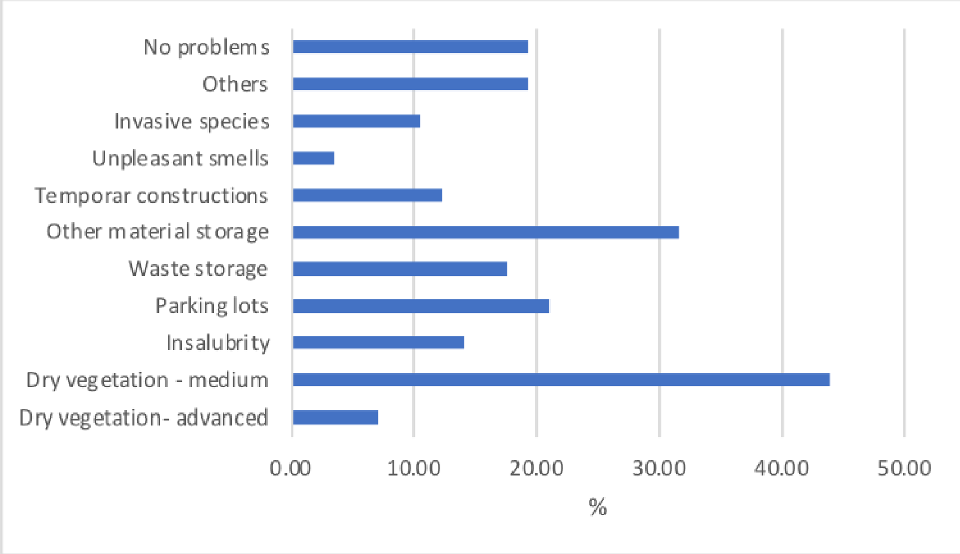

Fig. 4: Percentage of church garden issues

6 DISCUSSION

Using Bucharest as a case study, we showed that church gardens can represent a valuable recreation alternative. Currently, only around 50% of the churches in Bucharest have green spaces in their gardens. This is partially due to the transformations suffered in the socialist era, but also to the financial capitalization of all resources, to the changes in legislation and consumption patterns of the society and to the lack of awareness related with the determinants of a high quality and healthy urban environment. In the last years many administrators chose to transform the green spaces in chapels since the need for this category of services has increased.

Collective residential has the highest accessibility to green spaces in church gardens. This is due to the fact that these areas were almost entirely built during the socialist era and therefore planned from the beginning to include all necessary services. They were usually built on older single-family residential areas from which churches were the only preserved buildings. Single-family residential areas can be planned (especially the historical lots) or unplanned, especially the newly built ones and therefore their access to churches widely varies.

The high number and the homogenous distribution in the city, could make church gardens an interesting and feasible option for recreation and social activities despite their small surface (approximately 3% compared with urban park surface in Bucharest). The accessibility analysis showed a high potential of church gardens to represent a nearby and easy to reach green area especially for adults. The limited mobility of elderly people makes this option suitable only for around half of them, but it is important to mention that some residential areas with good and very good access to church gardens are located outside the area of influence of urban parks. Therefore, the green areas in church gardens could represent the places where elderly residents from these neighbourhoods could experience nature.

Church gardens can provide both regulatory and cultural ecosystem services. Depending on the gardens' arrangements and endowments, they can host a wide variety of recreational activities (e.g. playgrounds, lecture clubs, places for boardgames, places for meditation, social spaces), but they can also improve the aesthetics of the neighbourhood and population wellbeing (de Lacy and Shackleton, 2017). Currently there is almost no infrastructure meant to increase the role of these spaces in social activities. Less than half of the gardens have such infrastructure and it is mainly represented by benches. Financial aspects are generally directly related to the design and activities carried out inside church gardens. The greatest challenge related to church gardens is to stop their transformation into artificial areas and to reverse the process in those areas where it is still possible. Another important aspect is related with the fact that part of the church gardens is only opened to the public during service, which seriously affects their potential of representing places for social interaction.

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Our study highlights that through their number and distribution church gardens can represent an alternative to large green areas if they are open to the population and used for organising activities and events. Their importance and potential could be increased if designed for such purpose. Our findings are in line with research conducted on other small urban green spaces, such as school green areas (Ioja et al 2014) and pocket parks (Nordh and Ostby, 2013). Information on their distribution, accessibility and characteristics can be useful in the planning process of small urban green areas in order to integrate them in urban management process.

Greening the church gardens could contribute, beside the already discussed socio-cultural role, to increasing the amount of regulatory ecosystem services these areas provide minimising the negative effects produced by rainfall water (Saaroni et al, 2018), the level of noise generated by outdoor services and the heat island effects. These improvements could also contribute to minimising the potential of conflict occurrence involving churches.

One of the limitations of the study is the lack of spatial representation of the population number which was replaced by the surface of residential area by category. Also, the study didn’t consider the availability or reservation of people to use green areas in church gardens as recreation areas nor the fact that church gardens are sometimes private property and therefore not necessarily available for public use.

7 CONCLUSION

The surface of green areas inside church gardens is rather small in comparison with urban parks, urban forests or other categories of green areas within the city. However, due to their number, the good position they have in relation with the residential areas and their high accessibility, this category of small green areas has the potential to become an important element within the city if properly designed and maintained. The aesthetics and management of church gardens must comply with certain regulations if they are to be integrated in a coherent spatial urban planning.

Church gardens may represent an alternative to traditional green areas through the services they could provide since they could be designed to fulfil spiritual and religious needs ensuring a peaceful environment. Such needs aren’t properly satisfied in crowded urban parks where the surface is often insufficient to host all categories of activities.

Our study could represent a starting point in planning and designing church gardens as part of the urban green infrastructure and in giving them a higher importance from a socio-cultural point of view.

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Can Gamification be Used for Spatial Energy Data Collection? Experiences Gained from the Development of the HotCity Game to Collect Urban Waste Heat Sources

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1 ABSTRACT

Availability of reliable data is one of the most important elements for fact-based decisions. Urban planning and spatial energy planning often suffers from a lack of availability of good, validated and up-to-date data sets. Furthermore, integrated spatial and energy planning needs to incorporate new spatially distributed energy sources and understand how these sources can be used in the future to meet climate protection targets. These new energy sources can be, for example, waste heat from industrial food production, local industrial/commercial enterprises, data centers, or urban infrastructure such as tunnels and metro stations. The utilization of such waste heat sources in heating networks has been demonstrated several times, however, their proper identification in an urban environment can be challenging, especially for smaller and unconventional sources (Schmidt, 2020).

Gamification as an innovative way to collect the needed data was investigated within a national funded research project called "HotCity". Gamification builds on the use of game mechanics in contexts that are, by nature, unrelated to the game (Deterding, 2011). Within the project the HotCity-App was developed enabling users to spatially report and evaluate different sources of waste heat. The gamification of data collection was also intended to raise awareness of waste heat and energy use on the one hand, and to facilitate the collection of data from small energy sources on the other. For the first time, the game framework is secured using a blockchain and mapped by means of a token[1] system. The HotCity-App was tested in the Austrian cities Vienna and Graz as a proof of concept to analyse if and how the gamification approach can deliver valid results.

The HotCity-App, the game, makes it possible to identify and georeference also smaller sources of waste heat in order to use the available energy. Two test runs were each conducted in Graz and Vienna, which provided helpful feedback from the testers regarding promising features as well as showed barriers reducing the success of this data collection approach. An interactive web-application for the data collected with the HotCity-Appwas further developed to visualize the reported potential waste heat sources and to interactively evaluate the economic feasibility of using the waste heat sources under different frame conditions.

The paper will elaborate the game development, discuss the gamification approach and the lessons learned during the proof of concept project. We will further give an outlook of additional data types for integrated urban energy planning, which could be collected by this approach.

Keywords: mobile app, waste heat, energy planning, data collection, gamification

2 INTRODUCTION AND CHALLENGE

The energy system of the future will consist most likely of many different decentralized units (e.g. rooftop PV panels, individual heat pumps etc.). For the development of districts with high energy efficiency and

[1] https://en.bitcoinwiki.org/wiki/Token, tested 07.06.21

increased use of locally available and sustainable energy sources, a detailed spatial identification of possible energy potentials is necessary in order to plan cost-efficiently and future-proof. In particular waste heat from industry (foundries, food production...) and commerce (data centers, supermarkets...) as well as urban infrastructure (tunnels[2], metro stations[3]) can make an important contribution to heating and hot water production in plus-energy districts. While "low-hanging-fruits" such as waste heat from large scale industrial plants are already widely used, the identification of smaller sources is associated with various difficulties (Schmidt, 2020). Many larger cities already have a data set, e.g., Open Government Data, which is usually not up-to-date enough, not sufficiently detailed (spatially) and often does not contain all necessary data. Due to the often chosen top-down methodology for the identification of the waste heat potential, i.e., using a survey of the largest pollutant emitters (e.g. Brueckner etal., 2014), smaller sources are not recorded, which therefore do not appear in these databases.

Gamification, on the other hand, offers the possibility of generating targeted incentive systems for data collection (crowdsourcing/crowd collecting). Games like "Pokemon Go" have shown which undreamt-of dynamics can be created.Within the project HotCity funded by the BMK[4] a Game (the HotCity-App) was developed, enabling users to spatially report and evaluate new potentials of waste heat. The application to collect waste heat was chosen to be exemplarily for other spatial energy data. The gamification of data collection for waste heat was also intended to raise the general awareness of the topic and to facilitate the collection of data from small energy sources that are normally not considered in top-down methodologies.

2.1 Gamification as a bottom-up method for identifying energy-oriented data

The massive distribution and market penetration of digital games (approx. 37 billion dollars in sales in 2020 in the USA alone as stated by Statista, 2021) is impressive. For example, 510 million people are currently actively playing games (5.3 million in Austria as stated by ÖVUS, 2019), with an average age of 35. Gamification is based on the use of game mechanics in contexts that are, by nature, unrelated to games (Deterding, 2011). The aim of gamification usually is to apply the motivational and feedback techniques that have been tried and tested in games. Games provide clear goals (Hunicke et al., 2004; e.g. quests), they reward (Vorderer et al., 2004; e.g. badges, level-ups), they allow to compete or cooperate with others (Yee, 2006; e.g. in the form of rankings, multiplayer elements) and they provide an interactive framework for different experiences and skills (Ivory & Kalyanaraman, 2007; Jansz, 2005).

Gamification has already been successfully used in various application areas to promote participation, such as in the context of civic courage (Coronado & Vasquez, 2014), citizen participation (Thiel & Lehner, 2015), e-learning (Barata et al., 2013) and e-government (Al-Yafi & El-Masri, 2016). The application of gamification has also yielded positive results in the mobility sector, e.g. in terms of promoting sustainable forms of mobility (Kazhamiakin, Raman et al., 2015).

Pfeiffer et al. (2020) coined a new definition of Gamification: “Gamification is the use of game mechanics as a further dimension within and around both gaming and non-gaming contexts, in an endeavour to nudge participants to perform certain actions, by adopting a playful attitude”. This definition shows that gamification can also take place within games, whenever further elements outside the core mechanics and the core storyline are used to get the players to explore certain content. Furthermore, the definition also shows the relation to the principle of nudging and that gamification can be seen as one of the tools to trigger behaviourchange.

2.2 Blockchain Technology as a transparent way of handlingreward systems

Due to its decentralisation, transparency and security is the blockchain technologyoften part of technological and social discourses (Buhl et al., 2017) and is being treated as a disruptive innovator for a wide range of applications: from transaction processing to land registry entries to logistics chains, the intermediary is to be eliminated in the future (Hopf & Picot, 2018). Previous crypto technologies such as Bitcoin and Ethereum rely on "proof of work" and reward "miners", who keep the entire network alive and validate all transactions, for solving randomly generated computing tasks. The computing power required for this increases linearly

[2] https://sciencev1.orf.at/science/news/154441.html tested 07.06.21
[3] https://www.reuseheat.eu/berlin/tested 07.06.21
[4] Federal Ministry Republic of Austria for Climate Action, Environment, Energy, Mobility, Innovation and Technology

with the difficulty of the computing tasks and consumes more and more resources. This is where new blockchain technologies such as "Ardor" or "NXT" come into play, which are based on a "proof of stake" algorithm and are much more energy-efficient. Here, it is not about computing power in the form of graphics card performance or CPU-power, but about holding a certain stake in the network-maintenance token, other aspects like the total time of taking part as a verification node and a certain aspect of randomness. Regardless of the approach, the peer-to-peer principle, the strong encryption and the permanent and validatable storage of information represent an opportunity for diverse industries - including, of course, the gaming industry (Pfeiffer et al., 2020).

Ardor offers the possibility to generate utility tokens on the child chain Ignis. Approval models can be set up around these created tokens and therefore the set of rules can be specified. Furthermore, there is the possibility to develop smart contracts. As a bonus, there is also a ready-made marketplace that can be used within the scope of the decentralised applications (DApps) generated using the Ardor blockchain and its child chain Ignis.

In HotCity, the blockchain was used to prevent cheating on the one hand and to ensure transparency for the players on the other. It was used to automate the management of redeemed prizes and rewards and to reduce the administrative effort to a minimum. The concept involved incentives (such as coffee vouchers) - mapped on a blockchain token - that could be redeemed at project partners. Double spending or counterfeiting of vouchers can thus be avoided. In addition, the accounting settlement can be automated. For example, similar to a current accounting system, the partners could send the tokens to our billing account on a monthly basis, thus triggering the transfer of Euro funds from the game operator to the prize provider.

The blockchain system for the HotCity-Apphad to meet the following basic requirements:

- It must be a fully decentralised public blockchain.
- Users can, if they want, run a node of the blockchain on one of their devices, such as a laptop or mobile phone.
- We can use approval models to ensure that various conditions are met. One of these conditions is that the tokens cannot be transferred to other unregistered wallets.
- Identity management can potentially be implemented. In our case, this would be a possible connection of decentralized identifiers[5] (DIDs).
- Users do not need cryptocurrencies to pay network fees, we can take care of this as an operator with bundling accounts.
- Individual transactions must be manageable in terms of costs, even if the crypto market fluctuates massively.
- Messages attached to transactions must be encryptable.
- However, it must be possible to generate shared keys. To make the information readable for authorised parties.
- It needs the possibility to programme lightweight smart contracts, in our case it is the exchange of the different token classes, as part of the game mechanics.

3 THE HOTCITY APP

3.1 GameMechanics &Dynamics

The basic idea of the HotCity App is that users can move through the city and identify possible waste heat sources. In the past, a good understanding has been developed of possible waste heat sources and their characteristics. Chimneys indicate the location of (industrial) processes using combustion and might therefore generate waste heat; and recooling units indicate large waste heat potentials from data centres or other cooling processes. Users of the HotCity App can identify chimneys and recooling units by taking a photo or doing some internet research, e.g. using Google Mapssearch.

[5] https://www.w3.org/TR/did-core/#dfn-decentralized-identifiers tested 07.06.21

The user (the player) can take a photo in the HotCity App to identify the object of a possible waste heat source. Additionally, the user also needs to provide information about the type of object (chimney, recooling unit). The user can then mark the exact GPS position of the object on the map. The last step for the user is to crop a satellite image of the set GPS position only showing the waste heat source. After that the potential waste heat source is saved to the map of the game and the user is rewarded with heat tokens. Now every user can give additional information about this specific waste heat source andverify the object,its size, height and number of units.

The cities where the game can be played are segmented in areas through a grid. Each area can be conquered by a single player or a team. The player or team with the most identified waste heat sources wins the area.

The gamification concept is also extended through a high score system for single players and teams based on their heat score (a number calculated based on the user's earned tokens – see next paragraph). The heat score from earned tokens also unlocks numerous badges (e.g. "Heat Runner", "Heat Scout", "Conqueror") inside the app. The head score also puts gamers into a ranking system (e.g. "Rookie", "Amateur", "Master")

The app also incorporates a basic voucher incentive system, where earned tokens can be redeemed for voucher of partners (such as coffee to go).

All those features add additional layers of gamification elements to the app (see also next paragraph).

The gamification framework consists of three utility tokens realised within the blockchain Ardor and its child chain Ignisthat represent points: bronze, silver and gold tokens. Users receive bronze tokens for simple tasks such as uploading unconfirmed images and later receive points with higher value, when heat sources are confirmedby other payers. These tokens can later be redeemed for incentives, with better incentives distributed for gold tokens than for bronze tokens. As a further game mechanic, tokens can be exchanged for each other, e.g., 10 silver tokens result in 1 golden token. Furthermore, all badges are displayed as tokens.

3.2 App Development

3.2.1 Frontend of the HotCity App

The HotCity App uses a hybrid app technology with a single code base based on the hybrid app framework Ionic including Capacitor[6] as container, which delivers the app to different platforms (in this project iOS and Android).

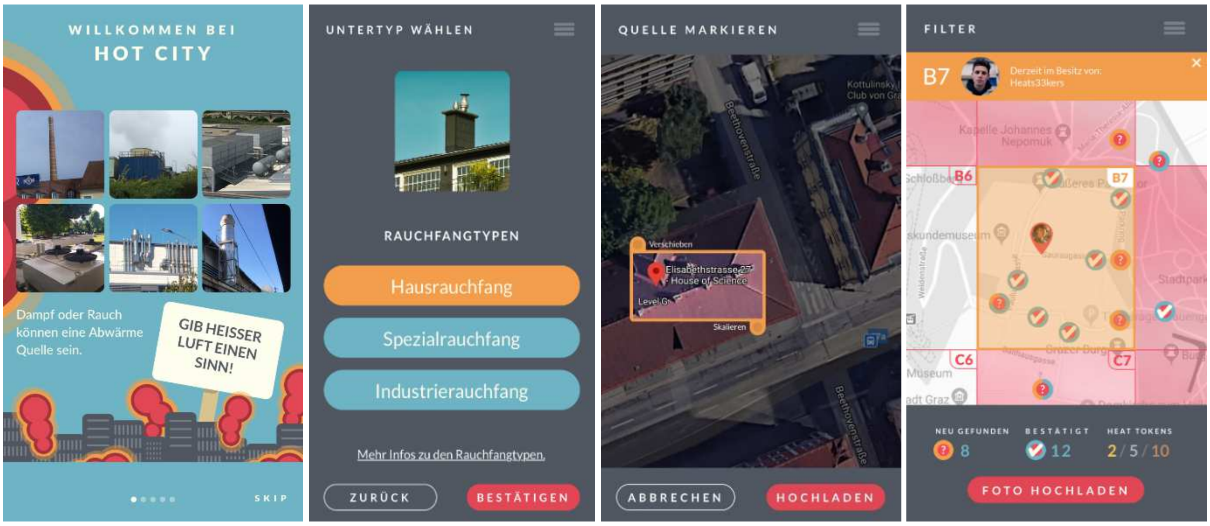

Fig. 1: HotCity App Screens

The structure of Ionic is web-based (HTML5, CSS3 & Sass[7]), based on Angular (JavaScript/TypeScript) and uses an open-source mobile user interface component toolkit as well as several plugins to bridge native functionalities with the web-based code base. As a framework, Ionic offers a cross-platform delivery feature set to address the native functions of the operating systems such as camera, GPS or memory. In addition,

[6] Capacitor is a cross-platform native runtime for web apps and provides native app container for packaging and deploying Ioinic apps to various mobile and desktop platforms. https://capacitorjs.com

[7] https://sass-lang.com/

native SDKs can be easily integrated. This serves as a solution for smartphones of newer generations (Android > 4.4, iOS > 10). Another advantage is the development using web technologies, so that the apps developed in Ionic can also be made available as a PWA.[8]

The app is connected to a backend via an API to process data collection, data enrichment, user profile information and blockchain related verification mechanisms for gamification (see next paragraph). The following figure shows main screens of the HotCity App.

3.2.2 Backend of the HotCity App

The actual transfer of the respective assets takes place entirely on the blockchain. A lightweight contract (cf. smart contract) was developed for this purpose, which, in conjunction with the API, ensures that the assets are transferred correctly.This contract is initially triggered by the backend and contains, for example, information about which "heatspot" has triggered an asset transfer. The lightweight contract then calls the API and checks whether the entries and information are valid and correct and then transfers them. In a freely definable period of time, the API checks whether the asset transfer was successful. If, for example, the transfer of the assets fails due to technical circumstances or insufficient fee, a new process takes place.

The Ardor node primarily manages and executes the lightweight contracts for the transfer of the application. As already mentioned, the API acts as a validation unit for this contract and only transfers assets or badges if the correct information is available.

In summary, blockchain technologies in the HotCity project secure those relevant parts of the game where values for the players or project partners are affected. On the one hand, tokens, badges and vouchers earned and, on the other hand, the accounting modalities. All other data, such as the description of the potential heat sources, are saved in a conventional database, which is continuously backed up. Transactions on the blockchain, as accessed from the graphical interface of the main account full-node as well as a triggered badge are displayed in figure 2.

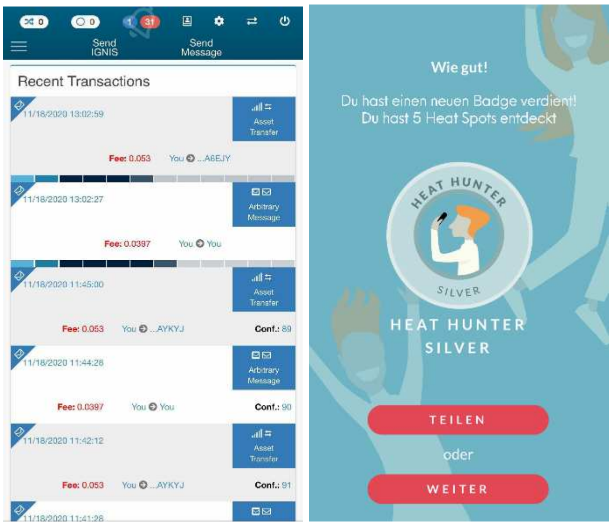

Fig. 2: Blockchain token transaction& visualisation of a triggered badge

4 HOTCITY FIELD TEST

The field test took place in two different phases during the winter 2020/2021. The first phase was performed in November 2020, while the second phase was launched mid of February 2021 for 2-3 weeks. For a part of the test persons, fees were awarded for at least 5-8 hours playing time. All participants received a briefing in advance in the form of a tutorial on the app and in the form of marked districts that showed a high potential in terms of waste heat sources. The responses were collected in anonymous form with a request for open

[8] PWA = Progressive Web Apps are web applications based on modern web browser standardswith additional features for desktop and mobile similar to mobile apps (e.g. notification system). Users can therefore put those web apps to the home screen of their smartphones. https://en.wikipedia.org/wiki/Progressive_web_application

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critical feedback. A total of 836 tokens were sent out for a) heat sources, divided into bronze, silver and gold and b) badges.

After a 2-3 week test phases, an online questionnaire was created and submitted using the "Survey Monkey" software. The item collection contained both open and closed questions with dichotomous and rating scaled gradations.A total of 31 people took part in the test and filled out the online questionnaire. The majority of the test persons (almost 68%) tested the app in Vienna, the rest (32%) in Graz.

4.1 Usability Score & Acceptance Rating

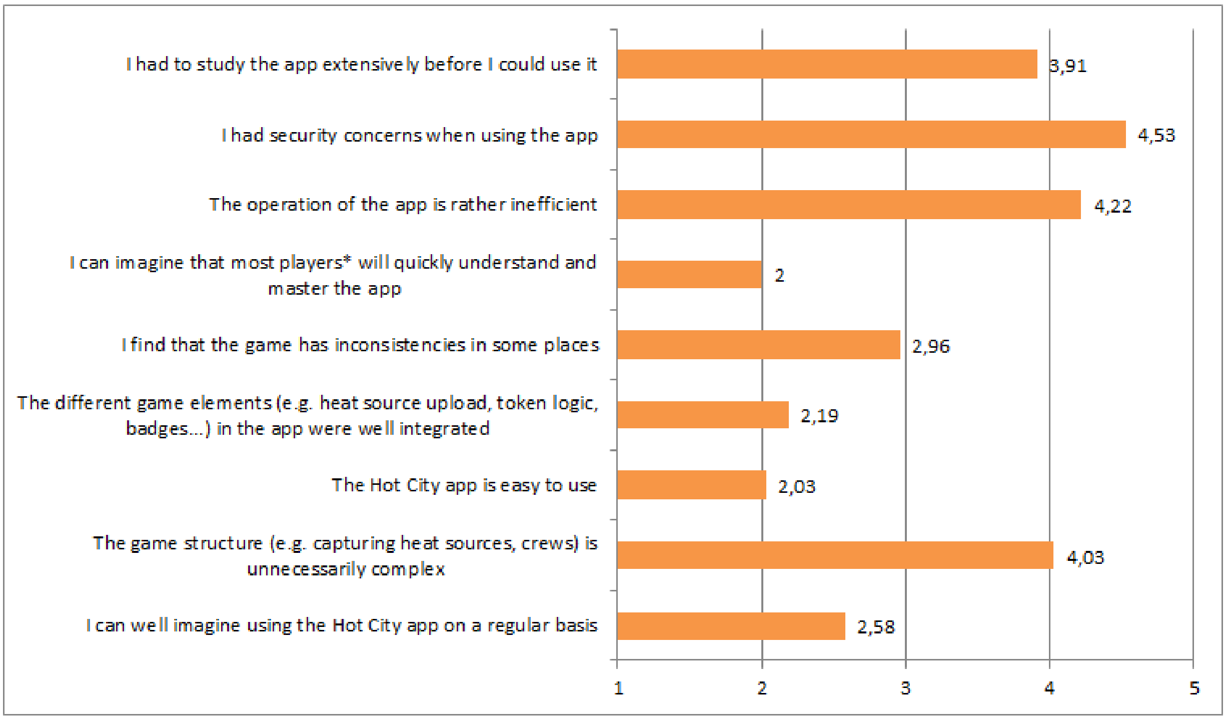

Fig. 3: Usability & Acceptance Score; low values are equal to high levels of agreement

Satisfactory values could be reported with regard to the usability & acceptance of the app. The usability is subjectively high (mean values from 2.0 to 2.58). The simple user interface (M=2.0) and the assessment of the comprehensibility for other users (M=2.03) are particularly noteworthy in this regard.

The normalised SUS (system usability scale) score is 79.675, which corresponds to an above average value (maximum = 100, minimum = 0).

4.2 App testing lessons learned

The results of the field test show high values for the acceptance of the app. The fun of play and the level of difficulty were also rated as appropriate. The standardised SUS score is in the upper fifth, a high subjective usability is thus evident.

The core functionality of the app - the search for waste heat sources, which was designed and integrated in accordance with the project goals - is seen as motivating by the users; compared to other game features, the entertainment value is particularly high.

With regard to the qualitative aspects, the design of the app, the game idea and the ease of use were praised by the test persons.

Problems were encountered with regard to GPS positioning, which sometimes did not work immediately and had to be corrected manually.[9] In addition, as the first phase of the field test in particular showed, it was sometimes difficult for the users to find suitable heat sources, and chimneys from private households, which are no valid waste heat sources, were often photographed. Through clearer communication and tutorials, this problem was alleviated in the second test phase.

[9] A technical problem here is that automatic GPS positioning reduces the duration of one battery load, thus a compromise has to be chosen, or using manual GPS postioning, which reduces the usability experience.

Suggestions for improvement mainly refer to an improved tutorial (phase I) and an automated location on the map of the potential waste heat sources.

Recommendations:

- Provide an optional tutorial video and a half-hour webinar to introduce and explain the app. As user segmentation in the future could include regular users, experts as well as community experts.Such a webinar is an efficient method for onboarding and providing the necessary skills to assess waste heat sources according to their potential.
- Simplify the registration process by publishing it in the app stores. The current process requires several steps, which cause a time delay for users and thus make "seamless onboarding" difficult. In addition, the release had to be done manually due to restrictive settings on company devices. A release in the app store would prevent such problems.
- Integration of a button to update one's GPS position within the app. This function facilitates correct positioning, and a "double-select" interaction for uploading photos should be introduced so that users can enter or readjust their GPS position correctly.
- Switching the map view to a satellite view. This makes it easier to recognise waste heat sources, and it is also possible to estimate the height of objects/heat sources using Google Earth 3D, for example.
- Integration of notifications for finding heat sources and invitations to groups. This also regularly encourages users to use the app, but a good balance must be struck so as not to exert a disruptive influence.
- The token logic should be adapted so that the confirmation of heat sources is only possible between different groups/crews. The "report" function for uploaded heat sources should be reframed to create a positive connotation and thus encourage use by users.

5 RESULTS

The current results have been established due to two test phases with a very small amount of payed testers, and thus can not enable to elaborate the total waste heat potentials in Vienna and Graz. The 31 test users found about 230 individual spots with a possible waste heat potential, and for about 10% of them, detailed information was collected. It has to be noticed that the test users werepayed for about 5-8 hours of testing including the survey and thus it can be assumed that only very limited time for searching was aquired.

The results have been evaluated on different levels: First the images uploaded by the testers have been checked by waste heat experts within the HotCity project team for validity (is it according to what we are looking for –as explained in the tutorial–,correct classification, correct GPS position). Second, the detailed input data to derive the waste heat potential were also validated by waste heat experts.

5.1 Visualisation and Economic feasibility evaluation of results

The data stored on the backend was accessed via the developed API, pre-processed and filtered to eliminate the waste heat proposals reported by the players, to be most likely wrong.Therefore R-Scripts have been developed which makes it easy to analyse the data after each test run.

5.1.1 Visualisation

A simple web-application was developed to simplify the evaluation process for experts and visualise the collected waste heat proposals by the tester.The following figure shows exemplarily one of these waste heat proposals, a re-cooler on the roof top of a building in Vienna.

5.1.2 Economic feasibility evaluator

Based on a limited amount of input parameters, a simplified economic feasibility calculation of waste heat utilisation is carried out in order to evaluate if the waste heat sources identified by the users can be actually used. Here, the characteristics of the waste heat sourceand possible heat consumers (e.g. nearby buildings) were compared with regard to: energy supply and demand, available and required temperature level (including the requirements for the integration of heat pumps if the source temperature is lower than the consumers temperature), economic factors, a possible pipe routing and substations. The economic evaluation of the utilization of the different waste heat potentials found by the users is done on the basis of the two key figures "profitability" and "payback time" and is indicated in the form of a "profitability score".

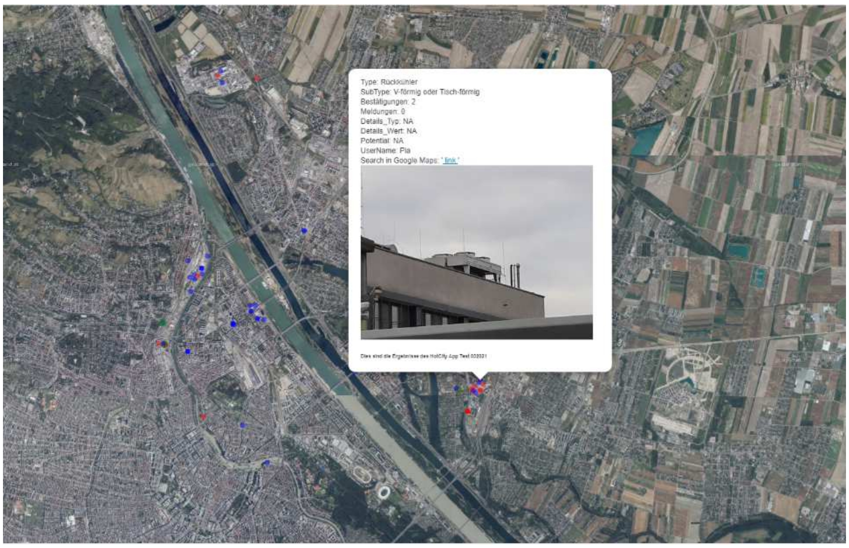

Fig. 4: Waste heat proposals result visualisation web-application screenshot

The results are displayed with help of "economic efficiency scores" i.e. a traffic light system (green, yellow, red), a comparison with a reference system for providing the heating service (e.g. gas boiler) is possible. It should be noted that these estimates are based on partly idealised assumptions. Nevertheless, the results indicatesif an economic use of waste heat sources seems to be realistic.

The developed method was implemened with R-Shiny[10] into an interactive web-application enabling users to evaluate, by chooosing the location and pathway, where the waste heat source would be needed. The following example shows the application (left side) as well as an example of evaluationfor a choosen pathway (right side).

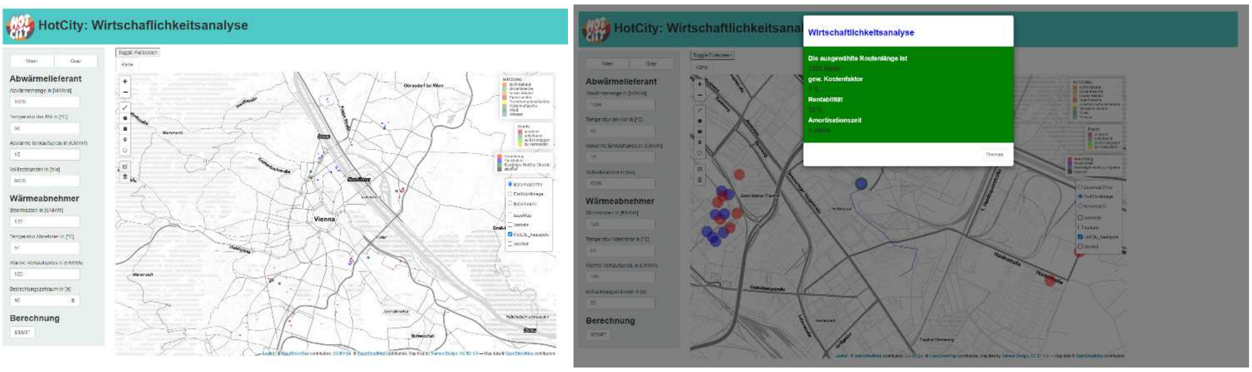

Fig. 5: Screenshots of the Economic feasibility evaluator web-application

6 CONCLUSION AND OUTLOOK

Gamification can be a promising way to identify urban energy data such as waste heat. The reward system could be secured in a transparent way using the energy-efficient proof of stake blockchain Ardor. The HotCity App has been sucessfully developed and tested in two Austrian cities. The two test phases have shown that the app seems to be very promising from a user point of view as the usability score shows. The lessons learned from the two test phases demonstrate that a good briefing (tutorial material) is important to gain useful results within the respective context. Compared to the already existing waste heat data for Vienna and Graz new promising waste heat proposals could be found, which have not been in the data sets so far and for some existing data sets an increased accuracy of the GPS position could be established thanks to the crowdsourcing approach. Interestingly even with the relatively low amout of testers a significant number of valid waste heat proposals could be found. However the tests also helped us to identify potential obstacles especially regarding details attached to heat spot entries which can be used for estimating the amount of

[10] https://shiny.rstudio.com/

waste heat for each waste heat proposal. The results indicate that these are hard to collect with the current app, thus more advanced users (experts) or higher incentives are needed to collect this information. The developed interactive evaluation tool (web-application) seems to be a very good starting point for experts (not necessarily players) in order to filter the most promising waste heat proposals and to estimate their actual potential.

6.1 Further data collection possibilities

The HotCity project aimed for a proof of concept if gamification is a valid method to collect useful spatial energy data in an efficient way, waste heat was only one example for this the following section discusses other possible use cases for the Game/App. The project also investigated conceptually which data and which methods are needed to collect energy-relevant data by means of gamification. In the project, the focus is basically on the topic of determining waste heat potential. However, in order to make more general statements about which energy-relevant data can be collected over-all via crowd-based methods, further data and possible sources were analysed.

The following core questions were addressed:

- How can the game be generalised and used to collect a wide range of energy-relevant data and applications?
- What data can be collected?
- How can the effort for the players on the one hand, and for the software developers with the greatest possible benefit be reduced?

When comparing the results from the players' point of view with the software developers' point of view, it is noticeable that the data that is easy to collect for players is quite difficult to implement for the software developers. For many of the data sets to be collected, the players can upload photos in the app, which is possible without much effort. The photo provided shouldthen be analysed using automated methods in order to derive energy-relevant data from it. Algorithms for image recognition should be applied or developed, which considerably increases the effort for the (software) developers.

The method of "self-assessment" is again time-consuming for players or only possible with expert knowledge anyway; on the programming side, this is implemented through forms so that the findings can be entered as free text or by means of guided questions.

In the course of the app development, a way was found to keep the complexity of the app as low as possible for the players, but still to design the functionalities for data collection and to choose the features of the app in such a way that the programming effort remains justifiable.

The gained results and the additional use cases discussed above vote for a further development of the prototype, especially as it seems that many of these still open issues can be solved with relative low effort and the applicability in different regions and contexts are high.

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Capturing Customer-Centred Functions of Local eCommerce Platforms

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1 ABSTRACT

The COVID-19 pandemic fuelled the trend of linking online consumption to local interests (such as buying local or localising production). In Austria, the pandemic fostered local eCommerce platforms offering local goods or goods from local retailers. This concept of local digitalism (Fuentes-Bautista, 2011) focuses on the spatial aspects of consumption and production. However, it is difficult for local eCommerce platforms to achieve sufficient online traffic next to internationally established eCommerce platforms. Therefore, evidence-based knowledge on essential customer-centred functions of eCommerce platforms supporting local retail is required. In this study, we screen a sample of local eCommerce platforms in Austria (n=40) and derive a list of customer-centred functions resulting in more than 100 customer-centred functions. A revision procedure with local retail experts helps to condense and categorise the listed functions. Based on a typology adaptation of Standing, Standing & Love (2010) and Bakos (1998), the functions ultimately comprise six categories: (1) performance parameters (i.e., all functions indicating platform performance such as website traffic, mobile optimised implementation, app availability, platform reach and types of products and services offered on the platform, (2) information and connection (i.e., all functions supporting information retrieval on the platform, its vendors and products as well as product search and product filtering), (3) matching (i.e., all functions enabling the matching process between buyer and seller after product selection), (4) customizability (i.e., all settings on the platform to be individually changed by the customer), (5) transaction and fulfilment (i.e., all functions enabling the transaction process and fulfilment services for product purchase and delivery), and (6) sustainability (e.g., information on product materials, product origin, product delivery, or quality seals).

Subsequently, independent platform visitors analyse the platform sample (n=40) using the consolidated list of customer-centred functions and a binary coding scheme (0 = function not available on the platform, 1 = function available on the platform). This evaluation results in customer-centred perception matrices for each local eCommerce platform. Based on the matrices, we derive the overall implementation degree for every customer-centred function. Also, we conduct Fisher's exact test to determine whether there is a significant association between website traffic and function range. Out of the long list of customer-centred functions, we finally extract and discuss the most relevant customer-centred functions for local eCommerce platforms.

Keywords: COVID-19 pandemic, local retail, local eCommerce platforms, customer-centred functions, online consumption

2 INTRODUCTION

On large international eCommerce platforms, such as Amazon or eBay, the boundaries between business-to-business (B2B) and business-to-consumer (B2C) are blurring and regional, national, or international barriers tend to disappear (Pan, Shankar & Ratchford, 2002). With the emergence of local eCommerce platforms, a countervailing trend of platforms bringing the location back into the focus of their business models is becoming visible. Local eCommerce platforms sell the existing range of goods from local shops through their platform and try to gain time advantages in delivery by having the participating local shops act as decentralised shops for households in the neighbourhood (Wirtz et al., 2019). On the one hand, this approach seems promising as it supports local shops in their digital transformation and in overcoming to participate in eCommerce (Stockdale&Standing, 2004 and Sandberg& Håkansson, 2014). On the other hand, challenges arise in getting local retail to cooperate and use shared services between competitors. Studies show that local retail businesses, like other small and medium-sized enterprises, are still hesitant to adopt eCommerce channels (Bollweg et al., 2020 and Pantano&Viassone, 2014) or participate in existing international eCommerce platforms. Thus, the phenomenon of the hesitant digital transformation of local retail businesses is linked to numerous internal (e.g. financial circumstances, lack of knowledge) and external (e.g. lack of standards, lack of subsidisation, lack of marketing) framework conditions (adoption barriers). For local eCommerce platforms to be competitive next to internationally established eCommerce platforms, evidence-based knowledge about the most relevant customer-centred functions on such platforms is crucial.

3 METHODOLOGY

This study identifies relevant customer-centred functions for local eCommerce platforms. As shown in other studies (Radziszewska, 2018 or Jhingran, 2000), local eCommerce platforms are not exclusively those offering product purchase and fulfilment, but also product finders, store finders, and social media channels. Thus, we define four different types of local eCommerce platforms in the first step. With the help of an explorative web search and expert suggestions from the Austrian Retail Association, we compile a manifold sample of eCommerce platforms for each platform type. General eCommerce platforms and, in particular, those with a focus on local retail are taken into account. The sample includes international and Austrian eCommerce platforms (n=40). Visiting and screening the platforms results in a long list of customer-centred functions. An expert talk with participants from the economy, local retail, and science leads to a final and content-evaluated list of customer-centred functions.

Additionally, we define and collect performance values for each platform (i.e. website traffic, page loading time, app availability, mobile optimised implementation). Subsequently, four independent coders visit and assess each platform using the list of customer-centred functions and a binary coding scheme (0 = function is not implemented, 1 = function is implemented). As a result, four independent assessment matrices are available for each platform. The assessment matrices enable the degree of implementation and perceptual values for each function and platform type. We conduct Fisher's Exact Test (Li, 2014) to describe a possible relationship between function range and website traffic. Out of the long list of customer-centred functions, we finally extract and discuss the most relevant customer-centred functions for local eCommerce platforms.

4 LOCAL E-COMMERCE PLATFORMS: THE SAMPLE

Based on a typology adaptation of Nickerson (2002), Bärsch et al. (2019) and Hübner et al. (2020), we define four types of local eCommerce platforms: marketplaces, product finders, store finders, and social media channels. Marketplaces provide full functionality from product search to transaction and fulfilment, whereas product finders and store finders help users find or locate a product or store. Respectively, product finders and store finders require less functionality than marketplaces but can potentially foster the local aspect of product search. Social media channels play a specific role when it comes to trendsetting, influencing, and product choice. Ideally, social media channels promote local stores through advertisements and product promotions (Ravi&Joel, 2019). In this study, social media channels are a substantial part of eCommerce but will not be assessed regarding their functionalities. The compiled platform sample considers international and Austrian eCommerce platforms, general eCommerce platforms and eCommerce platforms focusing on local retail. The sample consists of 24 marketplaces, 13 product finders, and three store finders.

5 CUSTOMER-CENTRED FUNCTIONS FOR LOCAL E-COMMERCE PLATFORMS

The functions implemented on local eCommerce platforms are not uniformly structured and differ significantly in their range. By screening the platform sample, we create a list of customer-centred functions for each platform type. Customer centred-functions are analysed and discussed in Bärsch et al. (2019) and Hwang& Preiser-Houy (2012). In this study, the list of customer-centred functions is based on Bärsch et al. (2019) in its structure but offers a broader range of functionalities.

Information and Connection: This category comprises all functions supporting information retrieval on the platform, its vendors and products, and the product search and product filter process. Customer support (i.e., all functions enabling the customer to contact the platform operators or retailers) and platform reviews are part of this category.

Matching: Matching refers to all functions enabling the matching process between buyer and seller after product selection. The category includes detailed product information, product comparison (regarding price, payment options, duration of delivery), product reviews, store or retailer reviews, and loyalty programme (such as free delivery or special offers).

Customizability: Customisable functions can be changed individually (i.e. registration, account settings and privacy cockpit).

Transaction and Fulfilment: Transaction and fulfillment refer to all functions enabling the transaction and fulfilment services for product purchase and delivery. The category comprises payment options, delivery options, and return options.

Sustainability: This category checks whether the platform provides sustainability information on the platform itself, the products, or the delivery process (e.g., information on product materials, product origin, product delivery, or quality seals). Table 2 represents the categorisation scheme for the identified customer-centred functions.

Performance Parameters	**Information and Connection**	**Matching**	**Customizability**	**Transaction and Fulfilment**	**Sustainability**
Type of platform Platform performance Platform reach Types of offers	Transparency & Trust Customer support Product search and product filter Platform reviews	Product details Product comparison Product reviews Store or retailer reviews Loyalty programme	Registration Account settings Privacy cockpits	Payment options Delivery options Return options	Sustainability information – platform Sustainability information – products Sustainability information – delivery

Table 2: Categorisation scheme for customer-centred functions

In total, we create a list of 103 customer-centred functions. The functions are not always equally relevant for each marketplace type, so marketplaces are assigned 103 functions, product finders 72 functions and store finders 68 functions.

6 PLATFORM ASSESSMENT: RESULTS

Four independent coders visit each platform and use a binary coding scheme to check whether the listed function is implemented on the platform or not (0= function not implemented on the platform, 1=function implemented on the platform). The assessment matrices enable the degree of implementation to be determined for each function and platform type (table 3 to table 8).

6.1 Implementation degrees

PLATFORM PERFORMANCE	**Marketplaces** n=24	**Product finders** n=13	**Store finders** n=3
Platform performance			
Website traffic indicated	45,83	30,77	33,33
Available as an app	37,50	23,08	33,33
Mobile optimized implementation	100,00	100,00	100,00
Platform reach			
regional	4,2	0,00	33,33
national	45,8	46,15	0
international	45,8	38,46	66,66
Types of offers			
Products	100,00	100,00	100,00
Services	13,00	30,77	66,67
Jobs	0,00	23,08	33,33
Real Estate	0,00	23,08	0,00

Table 3: Implementation degrees [%] for platform performance parameters. NR indicates that the function is not a required function for the respective platform type.

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Website traffic is an important performance indicator for eCommerce platform evaluation (Singh &Kumari, 2019). In this study, we use open-source software to identify website traffic on each platform. This measurement goes along with limitations as the tool can only report very high website traffic. Thus, for platforms with low website traffic, no data is collected. In our sample, 11 out of 24 marketplaces show high website traffic (45,83 per cent). Website traffic on the recorded marketplaces ranges from 164.650 to 498.730.000 monthly visits. Website traffic on recorded product finders ranges from 344.210 to 21.870.000 monthly visits.

Regarding store finders, one platform out of three shows website traffic of 144.960 monthly visits. All examined platforms are implemented for mobile use. When it comes to app availability, 9 out of 24 marketplaces are available as an app (37,50 per cent), 3 out of 13 product finders (23,08 per cent) and 1 out of 3 store finders (33,33 per cent).

INFORMATION AND CONNECTION	**Marketplaces (n=24)** 31 functions	**Product finders (n=13)** 28 functions	**Store finders (n=3)** 27 functions
Transparency and Trust			
About	87,50	61,54	66,67
Payment information – desktop	62,50	NR	NR
Delivery information – desktop	33,33	NR	NR
Return information – desktop	29,17	NR	NR
Customer support			
E-Mail	70,83	76,92	33,33
Hotline	70,83	69,23	33,33
Contact Formular	54,17	38,46	100,00
Chatbot	20,83	7,69	0,00
WhatsApp, Messenger, Telegram	8,33	7,69	0,00
Q&A	75,00	30,77	33,33
Social Media	91,67	69,23	66,67
Product search and product filter			
Search field for product search	70,83	76,92	0,00
Product category	100,00	84,62	66,67
Keywords/tags	95,83	92,31	33,33
Availability	58,33	38,46	0,00
Availability in local store	8,33	7,69	0,00
Payment options	0,00	7,69	NR
Sale	70,83	38,46	100,00
Latest Products	66,67	38,46	0,00
Latest Stores	4,17	0,00	33,33
Sex	66,67	38,46	0,00
Brand	50,00	46,15	0,00
Distance from current location	16,67	23,08	0,00
Price range	83,33	61,54	0,00
Product review	54,17	23,08	0,00
Local retailer	50,00	76,92	66,67
Duration of delivery	25,00	30,77	33,37
Current position//region/province	29,17	53,85	66,67
Platform review			
Comments	4,17	0,00	0,00
Stars	4,17	0,00	0,00
Only as registered visitor	4,17	0,00	0,00

Table 4: Implementation degrees [%] within the category "Information and Connection". NR indicates that the function is not a required function for the respective platform type.

On average, marketplaces implement 14 out of 31 functions (45,16 per cent) within the category "Information and Connection". Product finders average 11 out of 28 functions (39,29 per cent), and store finders 7 out of 27 functions (25,93 per cent). Transparency and trust play a significant role in building a trusted relationship between customer and platform. Indicating the payment, delivery and return options directly on the desktop is essential information for the platform visitor. For marketplaces, a Q&A rubric on the platform is an essential function for customer support. This function is not yet implemented on all marketplaces. Functions for product search and product filter differ in their implementation degrees. Filter functions for payment and delivery options are missing. Customer-generated content (CGC) can help platform operators to improve the platform successively. Review options for the platform itself as well as for products and retailers help to identify gaps and existing problems. Not only for platform review but also product and retailer review, the implementation degrees are low.

MATCHING	**Marketplaces (n=24)** 29 functions	**Product finders (n=13)** 27 functions	**Store finders (n=3)** 27 functions
Product details			
Product location on map	8,33	23,08	33,33
Product visualisation	100,00	100,00	33,33
Social media inspiration	0,00	0,00	0,00
Textual description of product	95,83	76,92	0,00
Availability	83,33	53,85	0,00
Availability in local store	12,50	38,46	0,00
Duration of delivery	70,83	46,15	0,00
Product ID	58,33	23,08	0,00
Quality seals	20,83	7,69	0,00
Materials/contents	79,17	53,85	0,00
Manual	0,00	0,00	0,00
Information on local retailer	75,00	100,00	33,33
Local retailer: contact information	54,17	84,62	66,67
Indication of delivery options	50,00	61,54	0,00
Product comparison			
Other customers also bought…	41,67	NR	NR
Similar products	66,67	61,54	0,00
Price at other retailers	12,50	61,54	0,00
Availability at other local retailers	12,50	53,85	0,00
Spatial proximity of product	0,00	0,00	0,00
Duration of delivery	4,17	38,46	0,00
Product review			
Comments	54,17	15,38	0,00
Stars	62,50	23,08	0,00
Only as registered visitor	45,83	15,38	0,00
Retailer review			
Comments	37,50	15,83	0,00
Stars	41,67	30,77	0,00
Only as registered visitor	41,67	15,38	0,00
Loyalty programme			
Vouchers	91,67	NR	NR
Customer retention	87,50	46,15	66,67
Ask question about a product	20,83	15,38	0,00

Table 5: Implementation degrees [%] within the category "Matching". NR indicates that the function is not a required function for the respective platform type.

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On average, marketplaces implement 13 out of 29 matching functions (44,83 per cent). Product finders implement 10 out of 27 matching functions (37,04 per cent) and store finders 2 out of 27 matching functions (7,41 per cent). For product details and specifications, the integration of social media inspiration has not yet been implemented on any of the analysed platforms. Also, the digital availability of documents such as manuals has not yet been implemented on any of the platforms. Regarding product comparison, the indication of delivery duration at different retailers shows a low implementation degree. Product reviews show a higher implementation degree than retailer reviews, and stars occur more often than comments as review elements. Regardless of whether reviews are made publicly visible, the opportunity to give feedback on the platform, the product, the retailer, and the delivery are an essential element to successively improve the platform implementation and the processes along the customer journey. Marketplaces implement loyalty programmes in the form of vouchers to 90 per cent. Other customer retention strategies (such as customer card, personalisation options, special offers when subscribing to the newsletter) are implemented up to 87,50 per cent.

CUSTOMIZABILITY	**Marketplaces (n=24)** 20 functions	**Product finders (n=13)** 13 functions	**Store finders (n=3)** 10 functions
Registration			
Registration possible	95,83	61,54	33,33
Registration via a third party (Google etc.)	16,67	23,08	0,00
Classic registration	91,67	53,85	66,67
Purchase as guest possible	37,50	NR	NR
Account settings			
Define payment preference	25,00	NR	NR
Define delivery preference	8,33	NR	NR
See order history	91,67	NR	NR
Define preference for product origin	0,00	0,00	0,00
Define preference for local retailer	20,83	0,00	33,33
Import digital ID	4,17	0,00	0,00
Define recurring orders	4,17	NR	NR
See customized offers	25,00	15,38	0,00
Shopping Cart/Wish list	95,83	61,54	NR
Shopping cart/wish list divisible	20,83	7,69	NR
Shopping cart/wish list remains saved after closing the browser	50,00	38,46	NR
Indication of the warranty period	4,17	NR	NR
Deposit of all invoices	8,33	NR	NR
Avatar creation possible	4,17	0,00	0,00
Network character between users	16,67	0,00	0,00
Privacy Cockpit			
Privacy Cockpit available	20,83	7,69	0,00

Table 6: Implementation degrees [%] within the category "Customizability". NR indicates that the function is not a required function for the respective platform type.

Marketplaces average 7 out of 20 customisable functions (35,00 per cent). Product finders implement 2 out of 13 customisable functions on average (15,38 per cent) and store finders 1 out of 10 customisable functions (10 per cent). Personalisation options show low implementation degrees regarding the specification of a preferred product origin, delivery preferences, and recurring orders. Importing an existing digital ID (for example, from another platform) and avatar creation seem to be relatively rarely implemented functions. The same result applies to storing product-specific documents, such as warranties or invoices, within the private account.

TRANSACTION AND FULFILMENT	**Marketplace (n=24)** **18 functions**	**Product finder (n=13)** **0 functions**	**Store finder (n=3)** **0 functions**
Payment			
Multiple payment options	83,33	NR	NR
Delivery			
Multiple delivery options	54,17	NR	NR
Cost comparison between delivery options	62,50	NR	NR
The day of delivery is indicated	62,50	NR	NR
Different delivery speeds possible	37,50	NR	NR
Time comparison of delivery options	37,50	NR	NR
Specification of desired delivery day possible	4,17	NR	NR
Indication of the delivery time for each product	45,83	NR	NR
Free delivery	12,50	NR	NR
Free delivery from the specific value of goods	45,83	NR	NR
Greeting card	8,33	NR	NR
Gift	12,50	NR	NR
Same-day delivery	29,17	NR	NR
Pick-up stations	33,33	NR	NR
Collect directly in the shop (click & collect)	50,00	NR	NR
Order cancellation possible	70,83	NR	NR
Return management			
Free return	33,33	NR	NR
Return/change good directly in the shop	12,50	NR	NR

Table 7: Implementation degrees [%] within the category "Transaction and Fulfilment". NR indicates that the function is not a required function for the respective platform type.

Transaction and fulfillment functions only refer to marketplaces. Within this study, we define 19 functions for this category. Marketplaces average 8 out of 19 functions (42,11 per cent). Interestingly, within the category "delivery", the indication of the desired delivery day is not yet implemented often.

SUSTAINABILITY	**Marketplace (n=24)** 5 functions	**Product finder (n=13)** 4 functions	**Store finder (n=3)** 4 functions
Platform			
Quality seal	29,17	23,08	0,00
Product			
Type of production (e.g., handmade)	8,33	0,00	0,00
Product origin	16,67	7,69	33,33
Sustainability features	41,67	15,38	0,00
Delivery			
Sustainability comparison between delivery options	12,50	NR	NR

Table 8: Implementation degrees [%] within the category "Sustainability". NR indicates that the function is not a required function for the respective platform type.

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On average, marketplaces implement 1 out of 5 sustainability functions, and product finders and store finders do not implement sustainability functions.

6.2 Fisher's Exact Test

To examine whether there exists a significant relationship between website traffic and function range, we perform Fisher's exact test. Table 9 shows the distribution of website traffic and function range for marketplaces. The average function range for marketplaces is 42 out of 103 functions. Thus, Marketplaces with more than 42 functions are assigned a high functionality range. Fisher's exact test will indicate whether the sown distribution between function range and website traffic is subject to randomness.

Marketplaces	Low website traffic	High website traffic	Total
Low functionality range (<42)	9	0	9
High functionality range (>42)	4	11	15
Total	13	11	24

Table 9: Distribution of website traffic and function range for marketplaces

The table suggests that marketplaces with a high function range are more likely to have high website traffic. The null hypothesis for Fisher's Exact Test states that website traffic and function range are independent. The two-sided p-value for this distribution results in .001, leading to a rejection of the null hypothesis. Thus, we have evidence that there is a significant association between website traffic and the function range of marketplaces. The effect size (phi coefficient) is .713, indicating a strong positive association between the variables.

6.3 Making the difference: Functions emphasising the local aspect

Completing a comprehensive list of customer-centred functions for local eCommerce platforms enables the definition of functions that particularly emphasise the local aspects of product and store search. Table 10 illustrates relevant functions for the enforcement of local retail on eCommerce platforms.

Information and Connection	**Matching**	**Transaction and Fulfilment**	**Sustainability**
Transparency and Trust	Product details	Delivery	Product
Payment information – desktop	Product location on a map	Same-day delivery	Indication of product origin
Delivery information – desktop	Availability of product in local store	Pick-up stations	
Return information – desktop	Information and location on local retailer on the map	Collect product directly in the shop (click&collect)	
	Contact information of the local retailer		
Product search and filter	Product comparison	Return management	
Availability of product in local store	Availability of the product at other local retailers within a specific distance band	Return or change product directly in the shop	
Spatial proximity of the product to the current location of the user	Loyalty programme		
Possibility to filter products by local store/retailer	Possibility to directly contact the local retailer regarding product questions		
Possibility to filter products by current location, region, province	Possibility to have a product repaired in a local store		

Table 10: Relevant functions for the enforcement of local eCommerce platforms

Seven functions within the category "Information and Connection" have relevance to strengthen local retail: payment information (desktop), delivery information (desktop), return information (desktop), availability in a local store, product distance from current location, selection of local retailer, product selection by current positions, region, or province. As the implementation degrees for these functions show, there is a particular need for action in implementing spatial components such as visualising the product location on a map or indicating the distance of the product from the user's current location.

Also, ways to contact local retailers or to pick up and change local products directly at local retailers are relevant when implementing local eCommerce platforms. Thus, a direct contact link to the local retailer should always be available.

Regarding product comparison, the availability of products at other local retailers, the comparison based on the spatial proximity of the product to the current location of the user and the differences in duration of delivery at different retailers show low implementation degrees.

Relevant functions regarding local eCommerce platforms within the category "Transaction and Fulfillment" are same-day delivery, pick-up stations, collection of good directly in the shop and return and change of good directly. These functions are implemented in less than 50,00 per cent of the examined platforms but can make local eCommerce platforms stand out from established international eCommerce platforms.

The designation of product origin (e.g., regional products) and the resulting traceability of, for example, regional products can be regarded as a vital function to be implemented in local eCommerce platforms.

7 LIMITATIONS

Certain limitations must be taken into account when interpreting the results of this study. First, the platform sample includes a country-specific bias as the platform sample primarily consists of Austrian eCommerce platforms. International platforms are included as a counterpart to the Austrian platforms. Therefore, future studies should consider the integration of other international platforms. As for calculating the implementation degree of the customer-centred functions, an optimistic procedure is applied: implementation degree for each function results from the analysis of four independent coders. If one coder rates a function as 1 (=implemented) and the other three coders rate it as 0 (=not implemented), the function is still reported as implemented. Therefore, the follow-up study needs to intersect implementation levels with perception values.

8 CONCLUSION

This study outlines that, as with eCommerce platforms, the implemented customer-centred functions are not standardised and strongly differ. Thus, the study suggests a thematic scheme to structure customer-centred functions and assign them to different eCommerce platforms. The analysis of 40 different eCommerce platforms indicates the potential for local eCommerce marketplaces to integrate specific location-related functions. Fostering the implementation of location-related functions can be regarded as a significant issue to make local eCommerce platforms more competitive next to internationally established eCommerce platforms. The study also indicates a significant relationship between function range and website traffic, which we will further explore. Also, the study's results provide the basis for a subsequent priority assessment of customer-centred functions for local eCommerce platforms by blending implementation degrees with perception values.

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🏆 *reviewed paper*

Categorizing Urban Structural Types using an Object-Based Local Climate Zone Classification Scheme in Medellín, Colombia

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1 ABSTRACT

Climate change is reshaping societies. As we see more and more people moving to urban areas an ever-increasing number settles in low-cost and more hazardous areas. However, due to the rapid growth and sheer scale of informal settlements, knowledge gaps often exist on location or quantity. In this sense, Earth Observation combined with machine learning techniques allows to generate reliable geo-information. In this study, we classify the morphologically heterogeneous entire urban area of Medellín, Colombia into urban structural types. We do this by the Local Climate Zone (LCZ) scheme. Our specific focus is on one structural type, i.e. informal settlements. We test whether it is feasible by the LCZ concept to localize and quantify these vulnerable areas. The LCZ scheme is generic, replicable, neutral, and has become widespread in urban studies. We use urban blocks to perform a scene-based image classification into nine LCZs. We refer to multi-modal remotely-sensed data: high-resolution multispectral image data and elevation data. We apply an optimized random forest algorithm using shape metrics, as well as spectral and texture features. In general, we find the LCZ classification, measured with an overall accuracy of 82%, shows a reliable representation of urban typologies and functions across the city. Specifically, we compare the urban blocks classified as the LCZ lightweigth low-rise to the informal settlements provided by the city of Medellín. Here we reach an agreement of 86%. Besides, our approach complements the official dataset by including recently developed areas which are not yet considered by the city.

Keywords: Earth Observation, Machine Learning, Informal Settlements, Random Forest, Local Climate Zone

2 INTRODUCTION

Climate change and upgrading living conditions are two well known push and pull factors of the rural-urban movement and migration between countries. Urban areas are now home to the majority of the world's population and are expected to record a continuous flow of migrants (UN, 2019). Cities have a higher economic growth, more opportunities, better access to education, health, employment, and in general, many services that makes moving to a city seem attractive (Glaeser, 2011). But it can also be disadvantageous, since cities are more unequal than rural areas, i.e. wealth coexists with severe deprivation (UN, 2020). Besides, climate change displaces people due to a higher frequency of natural hazards like wildfires, storms, or droughts, and making some places less livable and productive, which results in an ever-increasing number of people migrating to cities (Adger et al., 2020).

The Sustainable Development Goals (SDGs), set by the United Nations in 2015, pursue a sustainable future for people and the planet by ending poverty and addressing social needs, while protecting the environment and fighting climate change (UN, 2015a). Cities as a habitat for more than half of the world's population are crucial for the successful implementation. Thus, the functioning and evolution of urban systems have been in the spotlight for planners, policymakers and researchers (e.g. Lobo et al., 2020; Oliveira, 2016), and several studies have been conducted in this regard. For instance, the impact of the morphology and functions of a city on many different factors, such as heat distribution and ventilation performance (e.g. Zhao et al., 2020; Jin et al., 2018a), air and noise pollution (e.g. Han et al., 2018; Edussuriya et al., 2014), or resilience in case of natural hazards (e.g. León & March, 2014). Moreover, a recent study evidenced that spatial structure in cities is indeed related to the quality of life and sustainability, the configuration of urban structural types within cities is linked to socio-economic functions (Sapena et al., 2021).

Within the urban conglomerate informal settlements are underdeprived neighborhoods, which lack basic services (UN, 2015b) and are often located in low-cost and more hazardous areas of the city as a result of low urban planning capacities and failing formal land markets. Especially in the Global South they are part of the persistent contemporary urbanization process (Stark et al., 2020; Kuffer et al., 2016; Lall & Deichmann, 2012) and even though they often represent a large proportion of the population, there is a general lack of understanding about their role within the city (Patel & Baptist, 2012). Besides, due to their high dynamic and rapid growth rates (Kraff et al., 2020), frequent monitoring in near real-time and high resolution data is necessary (Mahabir et al., 2018) in order to produce valuable information for governance, risk assessment studies, etc. (e.g. Wurm et al., 2019; Kuffer et al., 2018).

Earth observation (EO) enables the creation of up-to-date, consistent and extensive information on urban environments with a high degree of objectivity, transferability and automation (Voltersen et al., 2014). The characterization of large-scale urban morphology relies on remote sensing data and methods. Depending on available satellite images and objectives, different classification methods, e.g. parametric/nonparametric supervised/unsupervised, pixel-/object-/scene-based (Tsoeleng et al., 2020; Liu et al., 2017; Phiri & Morgenroth, 2017; Zhang & Du, 2015), can be used to classify the urban land cover. However, regarding informal settlements, their intra- and interurban variability makes their identification sometimes difficult (Stark et al., 2020; Taubenböck et al., 2018; Kuffer et al., 2016).

Image classification into land use types is an important source of information for urban studies, however, it often lacks three-dimensional information (Wentz et al., 2018). Therefore, the characterization of cities into urban structural types and land cover with the Local Climate Zone (LCZ) classification scheme (Stewart & Oke, 2012) produces high-level semantic data by adding information on urban form and function to traditional land use legends and it has great potential that is worth exploring. LCZs represent the strcutural appearance of cities in a conceptually consistent manner, is intuitive and replicable. The classification scheme comprises ten built-up structural types and seven natural land cover types with uniform surface cover, structure, material, as well as human acitivity, having inherent information on the physical composition of cities, by their density, building types, heights, greenness, and land cover (Taubenböck et al., 2020; Bechtel et al., 2015; Stewart & Oke, 2012). Even though LCZ were originally created for urban temperature studies, now the concept is becoming popular in many other research areas. Some examples are: urban planning, risk assessement, building energy consumption or human health, to name a few (Xue et al., 2020).

With this background, in this study we aim to physically characterize the complex urban agglomeration of the city of Medellín, Colombia. We specifically focus on the identification of informal settlements using high-resolution EO data and additional geospatial datasets based on machine learning techniques. In doing so, we test the suitability of the LCZ concept to locate and quantify informal settlements.

3 MATERIAL AND METHODS

In this section we introduce the study area, describe the datasets used as well as their pre-processing steps and explain the methodology and validation proposed for the classification of urban structural types using EO data.

3.1 Study area

Medellín is the second largest city in Colombia, the capital of the Department of Antioquia and of the Metropolitan region of the Aburrá Valley. The latter forms a political and administrative unit of ten municipalities (Garcia Ferrari et al., 2018). The municipality of Medellín had around 2.4 million inhabitants in 2018 (DANE, 2018). Our area of interest (AOI) is represented by urban and expansion areas, as well as the urbanizing regions outside of the official urban border (Fig.1). Urban expansion areas are in the process of being added into the administrative urban border within the current planning period (2014 – 2027), but are not yet fully included (Alcaldía des Medellín, 2014 a, b), while urbanized areas are defined in this study as the regions at the border of the city, which are urban but not yet included in the official urban and expansion areas, characterized mostly by informal settlements in the official rural part of the city (Fig.1, in blue).

3.2 Data

This section introduces the data used for the classification into urban structural types (detailed methodological explanation in 3.3.1) and for the validation of identified informal settlements (detailed methodological explanation in 3.3.2).

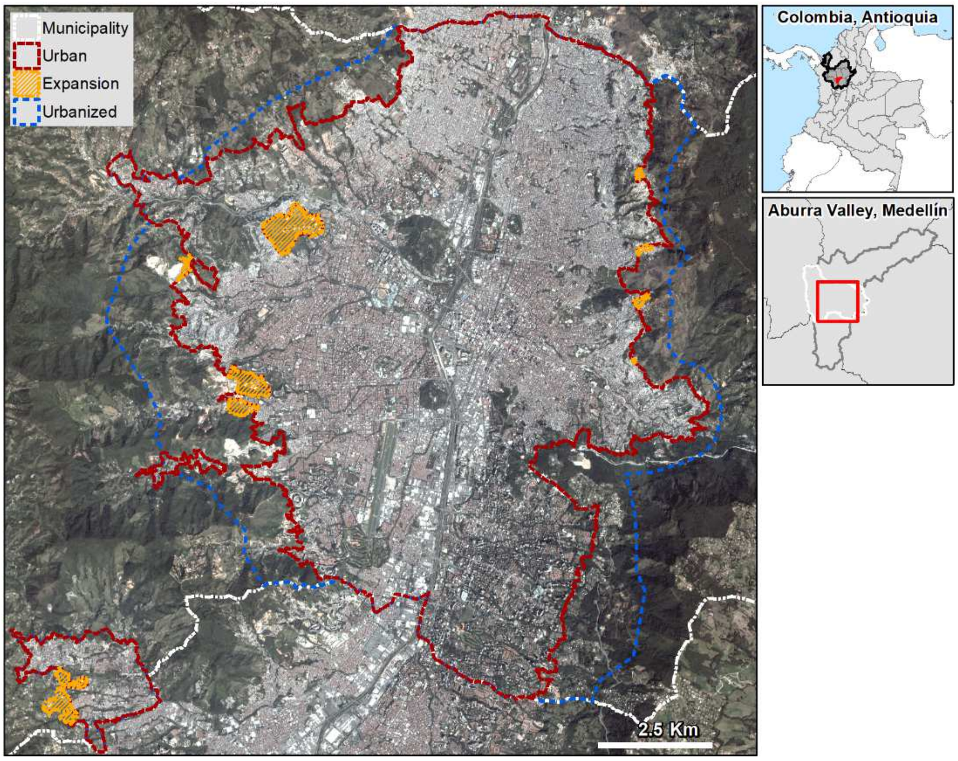

Fig. 1: Location of the study area: Urban, expansion and urbanized areas in the Municipality of Medellín within the Aburrá valley in Colombia. A PlanetScope image is used as background (Planet Team, 2019).

3.2.1 Input data and pre-processing steps

The first objective of this study is to classify Medellín into urban structural types with the LCZ concept. Therefore, we combine satellite data, elevation data, and open administrative geo-information. First, we use high-resolution image data (3m/pixel) from the PlanetScope constellation (approximately 130 satellites) launched in November 2018 and scanning the earth's surface every day, providing scenes with four spectral bands: red, green, blue and near infrared (RGB NIR; Planet Labs Inc. 2021). We acquire 13 scenes with 0% cloud coverage from the 1st of January 2019 to build one image mosaic covering the Aburrá valley (Table 1). By combining the different bands, we initially calculate the Normalized Difference Vegetation Index (NDVI), a spectral index showing the normalized difference between the red and infrared bands and providing spectral information on vegetation greenness (Rouse et al., 1973). This index has been widely used in land-use/land-cover (LULC) classifications to improve the performance of the classifier (Weigand et al., 2020; Jin et al., 2018b). Thereafter, we calculate the Grey Level Co-occurrence Matrix (GLCM) for each visible band (RGB), a method proposed by Haralick et al. (1973), and we extract eight textural features: mean, variance, homogeneity, contrast, dissimilarity, entropy, second moment and correlation. The use of texture improves classification results since it mitigates confusion between spectrally similar classes (Li et al., 2014a; Vadakkenveettil et al., 2012). Secondly, we use an open digital elevation model (DEM) from the year 2019 covering the Aburrá valley with a spatial resolution of 10m that provides the height for each pixel (Table 1). The DEM is utilized to calculate the slope for each pixel, used as additional feature in the classification. Thirdly, we use the boundaries of the urban blocks from the administrative planning department of Medellín (Table 1) as polygons to perform a scene-based image classification into the urban structural types (see section 3.3). Compared to the spatial units of pixels and objects, scenes as a collection of different objects have the ability to provide high-level semantic information on urban functions, land use patterns and environmental issues, additional to LULC information (Liu et al., 2017; Zhang & Du, 2015). For each polygon from the urban blocks (i.e. scenes), we compute two well-known shape metrics: the compactness and shape index. The former indicates the compactness of a polygon, and the latter gives information on the overall shape complexity, both are calculated following the formulas by Jiao et al. (2012). Finally, we combine the four spectral bands, the NDVI, the twenty-four texture features (eight per band) and the slope with the urban blocks for the scene-based image analysis. We use the polygons as spatial reference to extract ten statistics for each scene: the mean, median, standard deviation, minimum, maximum, range,

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variance, minority, majority and variety. To summarize, each scene stores 302 features composed by 50 spectral, 240 textural, 10 topographical and two shape metrics.

3.2.2 Informal settlements reference data

The second objective of this study is testing the ability of remote sensing to identify the specific structural type of informal settlements using the LCZ scheme. As reference data for the validation we use the Land Use Treatments (Table 1) from the official Land Use and Zoning Plan 2014 (Plan de Ordenamiento Territorial, POT) published by the city of Medellín. The POT 2014 defines the economic, environmental, urban, and social future of the city from 2014 till 2027. The treatments are homogeneous morphological areas that have different management strategies. For the validation we use two specific treatments: Comprehensive improvement (Mejoramiento Integral, MI) and Consolidation level 3 (Consolidación Nivel 3, CN3). The former are areas of incomplete and inadequate development, located on the edges of the city with low living conditions due to marginality and socio-spatial segregation, poverty, limited development opportunities and access to essential public services. CN3 areas already show a more stable development trend, but still have a deficit of several indicators like public space and services, or road infrastructure (DAP, 2014). We use the treatments MI and CN3 as a reference data since the city administration considers them as precarious settlements (Alcadía de Medellín ISVIMED, 2019, p.116). In this study this is taken as a proxy for informal settlements since "precariousness" or "precarious settlement" are often used as a characteristic or synonym of informal settlements (e.g. Furtado & Renski, 2021).

Dataset	Description	Resolution	Year	Source
Classification input data				
PlanetScope mosaic	It is a satellite image mosaic with four bands (red, green, blue and near infrared).	3 meters/pixel	2019	(Planet Labs Inc., 2021; Planet Team, 2019)
Elevation	It is a digital elevation model covering the Aburrá valley.	10 meters/pixel	2019	(AMVA, 2019)
Urban blocks	It consists of the lower administrative level and usually covers buildings, green space and pavement.	-	2019	(DAP,2019)
Informal settlements reference data				
Land Use Treatments	They define the objectives of development in the municipality, guide the actions required to achieve the policies and objectives established for the land and occupation model of the territory in the framework of the Land Use and Zoning Plan (POT 2014).	-	2014	(POT, 2014); (DAP, 2014)

Table 1: Description of datasets used for the classification and validation.

3.3 Methodology

In this study we perfom a scene-based LCZ classification by means of the machine learning algorithm Random forest (Breiman, 2001). For the classification we use the LCZ concept adapted to Medellín. Initially, we identify eight built-up LCZ classes in the AOI, as shown in Fig. 2 (1- 8). Moreover, to meet the local conditions, we adapt the standard LCZ scheme: we create a new LCZ consisting of coexisting high-rise, midrise and low-rise compact structures within one urban block (Fig. 2, 9). In a second step, after the classification, we extract and compare the lightweight low-rise LCZ (Fig. 2, 7) against the reference data (section 3.2.2). The lightweight low-rise class represents informal settlements from a morphological perspective. It is defined mainly by lightweight construction materials (bricks, wood and metal) with one to three stories in compact arrangements. The land cover often consists of paved or hard-packed soil and few trees.

3.3.1 Random Forest classification and validation

Random forest (RF) is a supervised and nonparametric ensemble classifier that has been shown to produce high accuracies for LULC classifications (e.g. Weigand et al., 2020). The classifier uses decision trees to apply the class membership by the majority rule. The number of trees must be sufficient to get high accuracies; therefore, we use the default value of 500 (Maxwell et al., 2018). In this study we use the 'randomForest' package in R (https://www.r-project.org/). The RF algorithm relies on ground truth sample data to train the model and validate its performance. The quantity, quality, and representativeness of the sample data is decisive for the accuracy of the classification (Li et al., 2014b). In this study, we manually create 1,120 blocks with ground truth information by means of Google Street View image interpretation. The number of samples per LCZ is determined depending on their representation in the city. The number of samples is shown in Fig. 3 (top right). To measure the accuracy of the RF model we split the sample data into training data (50%) to fit the model and test data (50%) for the validation. However, the splitting into training and test data is done randomly, as well as the generation of the decision trees; therefore, the impact of randomness has to be considered. For this reason, we follow the steps proposed in Weigand et al. (2020) and create 100 different RF models (with different sample splittings and trees), and select the one with the highest Overall Accuracy (OA; Congalton, 1991) measured with the test samples. Then, we calculate the Producer's (PA) and User's accuracies (UA), these statistical measures provide information on the performance of each individual LCZ. We also remove features from our set that lower the accuracy. After quantifying and reporting the accuracies, the best performing model is applied to all urban blocks (in total 10,515) to create the final LCZ classification map.

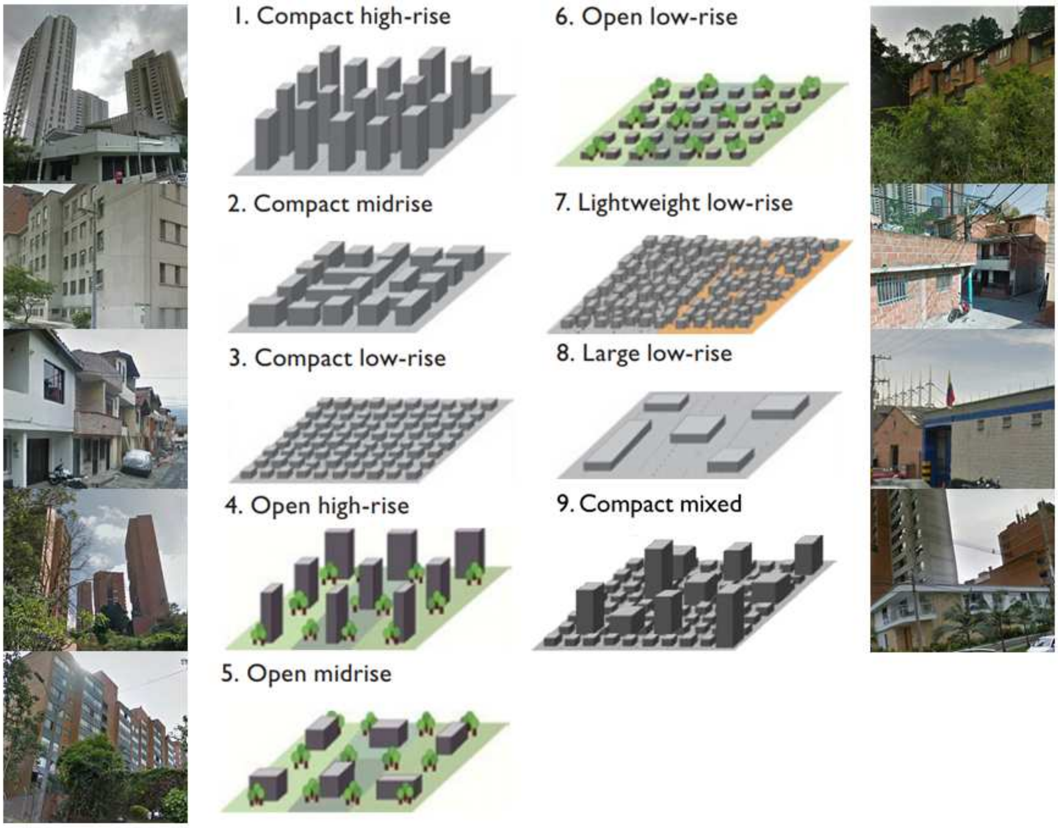


Fig. 2: The nine Local Climate Zones (LCZ) present in our AOI. The photos (from © Google Street View 2021) are examples for the physical expressions of the LCZ classes in our AOI, while the 3D representations are the definitions based on Stewart & Oke (2012).

3.3.2 Evaluation of informal settlement identification

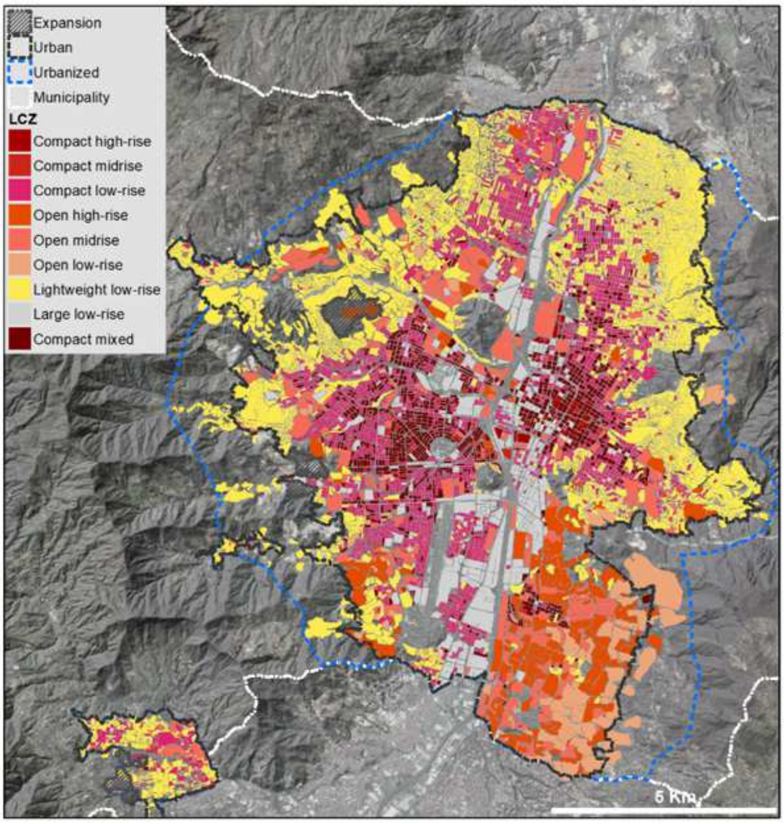
On one hand, we assess the ability of the model to detect informal settlements by means of the UA and PA of the lightweight low-rise (LLR) class. On the other hand, we compare the area and spatial distribution of the LLR urban blocks to the informal settlement reference data. This evaluation is conducted by overlaying the area of the LLR urban blocks with the area of the reference data and deriving the confusion matrix and accuracy statistics.

4 RESULTS

This section explains the results of the accuracy assessment of the LCZ classification and the operability of the LCZ concept to remotely detect informal settlements.

4.1 Classification of LCZs

The classification of the urban blocks into LCZs using the best performing RF model has an OA of 81.9%. The resulting map, shown in Fig. 3 (left), separates the morphology of the city into different urban structural types. The distribution shows a cluster of commercial and production site urban blocks along the Medellín river comprised of large low-rise areas as well as a cluster of compact high-rise, mid-rise and mixed structures in the heart of the city. Open high-/mid- and low-rise structures are predominant in the southeast of the city, where the social status is comparably higher, and LLR areas are located mostly in the (north-)eastern and (north-)western edges of the city in increasingly hilly and steep terrains (Garcia Ferrari et al., 2018). The accuracy assessment for each individual class (Fig. 3, bottom right) shows that more than half of the LCZs have a UA of above 70%, up to 90%, which indicates that only in around 10% to 30% of the cases the classification result deviates from the sample data, i.e. the actual LCZ is different to the predicted class. The PA shows fairly high values for the same LCZs. The highest PA is measured for LLR with over 96%, meaning only 4% of the sample data was underestimated and not classified as LLR. The high UAs for compact high-rise and compact midrise LCZs originate from zero missclassifications, as can be seen in Table 2. But the results have to be interepreted together with their PAs, which are very low. This indicates that a large amount of sample data representing these two LCZs were not correctly classified by the model, which can be interpreted as underclassification. These contradictory accuracies result from the class underrepresentation in the city, and therefore having particularly small sample sizes, making it difficult to distinguish them from other classes. Especially the LCZ compact mixed is classified instead of compact high-rise and midrise (see Table 2). A similar problem occurs for the LCZs open midrise and low-rise. For the UA and PA, having both rather moderate outcomes, Table 2 reveals confusions with other LCZs.



Local Climate Zone	Samples (train/test)
1. Compact high-rise	22 (11/11)
2. Compact midrise	37 (19/18)
3. Compact low-rise	254 (127/127)
4. Open high-rise	56 (28/28)
5. Open midrise	65 (33/32)
6. Open low-rise	57 (29/28)
7. Lightweight low-rise	448 (224/224)
8. Large low-rise	76 (38/38)
9. Compact mixed	105 (53/52)
Total	*1120 (562/558)*

Local Climate Zone	UA	PA
1. Compact high-rise	100%	9.1%
2. Compact midrise	100%	11.1%
3. Compact low-rise	84.2%	88.2%
4. Open high-rise	90.9%	71.4%
5. Open midrise	59.3%	50.0%
6. Open low-rise	75.0%	32.1%
7. Lightweight low-rise	84.8%	96.9%
8. Large low-rise	87.2%	89.5%
9. Compact mixed	69.7%	88.5%
	OA	**81.9%**

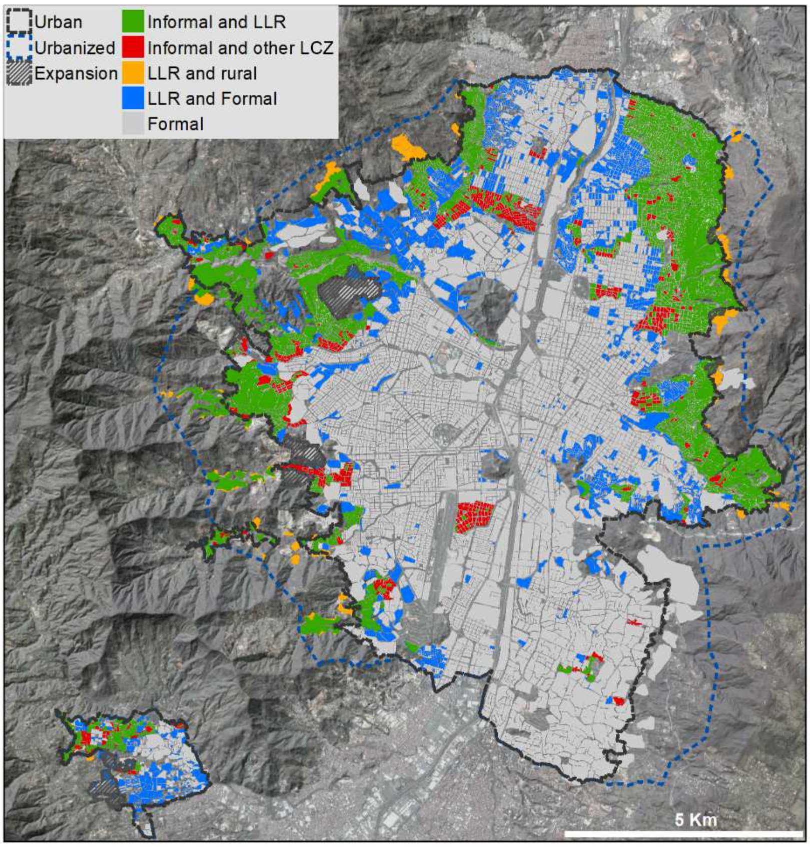
Fig. 3: Left: Local Climate Zone (LCZ) classification of Medellín, Colombia. Top right: Count of samples per LCZ class, determined based on their representation in the city. Bottom right: Accuracy assessment of the LCZ classification, represented by the User's (UA), Producer's accuracy (PA) as well as the Overall accuracy (OA).

		Sample data (ground truth)									
	LCZ	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**total**
Classification	**1**	**1**	0	0	0	0	0	0	0	0	1
	2	0	**2**	0	0	0	0	0	0	0	2
	3	1	5	**112**	0	2	4	4	2	3	133
	4	0	0	0	**20**	2	0	0	0	0	22
	5	2	1	0	1	**16**	7	0	0	0	27
	6	0	1	1	0	0	**9**	1	0	0	12
	7	1	2	9	5	12	7	**217**	2	1	256
	8	0	0	1	1	0	0	1	**34**	2	39
	9	6	7	4	1	0	1	1	0	**46**	66
	total	11	18	127	28	32	28	224	38	52	**558**

Table 2: Confusion matrix of the best performing model. The test data is used to create the table.

4.2 Comparison between LLR and informal settlements

Results regarding the suitability of the LCZ classification scheme to identify informal settlements show that our method is able to correctly identify 86% of the official delimitation of informal settlements (Fig. 4 in green, PA), and has an underestimation rate of 14% (Fig. 4 in red). From the point of view of the LLR informal settlements, 57% of the identified area corresponds to the official informal settlements (Fig. 4 in green, UA), while 43% are not correctly classified in regards to the reference data, composed of 38% formal and 5% rural areas (Fig. 4 in blue and orange respectively). This shows that even if our method is capable to recognise most of the informal areas in the city, it also overestimates informality that is not officially considered as such even if the morphology and building structures are very similar to other precarious neighborhoods.



Classification LCZ (ha)	Reference data (ha)			
	Informal	Formal	Rural	*Total*
LLR	1638.9	1101.0	153.7	*2893.5*
Other	272.7	4559.3	0.0	*4832.0*
Total	*1911.6*	*5660.3*	*153.7*	*7725.6*

	UA	PA
Informal	57%	86%
Formal	94%	81%

Fig. 4: Left: Overlay of the urban structural type of informal settlements (lightweight low-rise, LLR) extracted from the Local Climate Zone (LCZ) classification with the informal settlements reference data. Right: Confusion matrix in hectares and User's (UA) and Producer's accuracies (PA). The color used in the table shows the same area in hectares that is shown on the map.

5 DISCUSSION AND CONCLUSION

In general, we can state that with our approach - multisensory remote sensing data, machine learning techniques, and the LCZ concept - we are able to derive the complex settlement area in its morphological variability with high accuracy. This means the maps do have a high usability in the panning context. The LCZ classification scheme is standardized and thus shows to be very applicable to Medellin. Nevertheless, due to the special structural situation, we had to add an additional mixed class to the standard wheel in order to be able to adequately describe the urban body. The reached probabilities of a scene to actually represent the LCZ given is considerably high for most of the classes, based on the UA. The PAs are good for most classes as well. The approach proves to be feasible for urban structural types and land cover classification and is therefore an adaptable and good basis for urban analyses. Since the accuracies are affected by the sample count, especially evident for compact high-rise and midrise structures, future applications should consider more ground truth data for these two LCZs if possible, to improve the discrimination between morphologically similar classes. Alternatively, a combination of classes with similar characteristics (compact high-rise, midrise, mixed) might improve the performance of the model, since the confusion between classes will be reduced.

Moreover, this study had a particular interest in assessing the ability of the LCZ classification to identify the specific thematic class of informal settlements based on a morphological foundation. In a broader context, this information is especially relevant for risk assessment, as informal settlements have a higher vulnerability compared to the rest of the city and are often located in low-cost areas and steep slopes with a higher probability of natural hazards (Müller et al., 2020). The LLR class had good accuraccies in the RF model, showing low missclassification rates. Regarding its comparison with reference data, we were able to correctly identify 86% of the reference informal settlements, while the rest is attributed to other LCZs. And even though many urban blocks classified as LLR are officially formal or located in the rural area, our approach using EO data allows to extend the official urban border and include up-to-date information, which let us to identify 154ha of informal settlements that are related to fast and unplanned urbanization in the city edges and thus, are areas not yet officially considered by the city administration. In this case, remote sensing allows to look at the bigger picture and provides a more recent view of informality in the risk-prone hilly areas of the city. Besides, the classification of formal areas as LLR might partly arise from the different underlying conditions between morphological and official informal settlements. For a large part of the scenes classified as LLR, that are officially formal, the morphological definition of informality is still evident in Google Street View images. A possible explanation is an improvement of the social status with remaining morphological conditions and therefore, the classifier is not able to identify the correct class. Another factor, which has to be considered, is the misdetection of informal areas that have a morphologic formal appearance (i.e. structured housing rows or ordered street network). The official informal areas that were not detected by our RF model (Fig. 4 in red) are often loacted in the core of the city and are, according to Google Earth and Google Street View images, morphologically rather structured. To summarize, the identification of informal areas with EO data has its limitations and local knowledge is needed to better understand the reasons for misclassifications. Nevertheless, our model is able to detect a large amount of officially informal areas and furthermore, gives a more realistic and recent picture of the vulnerable areas at the city's edges. It can be concluded that the LCZ concept is a valuable instrument to identify not only urban structural types in general, but also informal settlements in particular.

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reviewed paper

City Afoot – What the State-of-the-Art Walkable City Looks Like

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1 ABSTRACT

Walkability has been the subject of research for quite some time now. There are solid findings from a wide range of disciplines, and yet in reality the realization of pedestrian-friendly urban areas is rare. Why is that? Urban planning is a highly political undertaking; only a few politicians dare to incur the displeasure of the car lobby, the conservative economy and the - in their opinion - still car-driving and car-owning majority of voters. Rarely do decision-makers, like Anne Hidalgo or Leonore Gewessler at present, act seemingly free of fear of the next election. Regardless of this fact, the question arises: What would the state-of-the-art walkable city look like?

In addressing this question, this article not only provides a comprehensive research on walkability across the disciplines, but above all attempts to examine the findings to see whether they are suitable for implementation at all. For this reason, the second part of the text deals with the attempt to translate theoretical knowledge into the real-physical world within the chosen perimeter of the Vienna Westbahnhof site. The research by design method was chosen in order to transfer the partial knowledge about walking as a basic function of traffic science or as a leisure-immanent behavior, or about the parameters of quality of stay in public space into an inclusive planning basis. The aim was to detach planning from conventions and instead force a development of the built environment based exclusively on current walkability research.

Keywords: Public Space, Urban Development, Ground Floor, Mobility, Walkability

Fig 1: Part of the walkable city design at the Westbahnhofareal in Vienna © Tobisch

2 INTRODUCTION

“Stop counting and comparing! We have all the necessary facts at the table and we already know what needs to be done. Let's finally do it now.” With these words, Ute Schneider, the new professor of urban planning, began her first studio supervision at TU Wien in spring 2021. In this sense, this paper follows this call and tries to translate a well-founded factual situation into design: how must walkability be designed?

2.1 Relevance of Walkability as a Topic in Urban Design

Cities around the world advertise the walkability of their town centers as a special feature in the quality of urban life. However, it is important to notice that the roots of pedestrian friendly structures are to be found in pre-automobile times, when pedestrians represented the primary user group of public space. With the rise of individual motorized transport urban development started failing to meet essential life quality standards. But since the matter of the finite nature of our resources has become a critical concern in recent years, the walkable city has once again developed into a major focus in urban planning–primarily due to its resource efficient and sustainable land-use and its low-emission transportation. In order to meet the needs of pedestrians, a number of concepts have been implemented, based primarily on the restoration of walkable historic structures.

But what would a new state-of-the-art walkable city look like today?

Walkability is a heavily discussed topic and covered in various research fields. A plethora of studies across the fields have found a relevant link between mobility behavior and the built environment. Mode choices and therefore also walking seem to be closely associated with it. While there are some interdisciplinary approaches, the bulk of the studies are within the borders of one field of research.

As urban structure researchers/architects/urban planners we seek to shine light on what a "most walkable city" would look like nowadays, by aligning interdisciplinary results from scientific walkability studies with the real built environment.

2.2 Research Questions and Methodology

2.2.1 Questions

Considering the abundance of established and new research material and the resulting theoretical knowledge on the topic; but the – comparatively – rare attempts of practical integration of the state-of-the-art walkable city, the paper is addressing two main questions.

First of all, the fundamental question arises as to whether currently valid research results in relation to walkability can be applied at all in a practical design process and thus implemented in a real reference field. Secondly, the question of the implementation problems that arise in this context are to be clarified.

In order to be able to address these questions, i.e. to assess which implications for the design of real urban structures can be derived from scientifically recognized valid findings, this paper provides a comprehensive, cross-disciplinary overview of findings from walkability research.

2.2.2 Methodology

Scientific Literature Study

An extensive literature study on walkability was conducted in various research fields. Walkability research is pursued in fields like urban planning, transportation research, spatial planning, public health, economics, psychology, sociology, geography, ecology, architecture and more. The amount of available material varies widely, with urban planning, transportation science and public health easily being the most productive disciplines. These three disciplines use different approaches: while traffic planning focuses on the length and availability of routes, public health emphases on the amount of time spent walking and the constitution of environment that encourages physical movement, not unlike urban planning which is also dealing with the constitution of public space and its influence on the walking and staying behavior of users. The scale of the analysis is similar in the first two, being on an urban or district level, while urban planning seems to go much more into detail down to street or building level.

The findings are then categorized into the so-called D-variables, which reflect the state-of-the-art in walkability research–and originate in the field of transport research– there they are described as the primary influences on walking: Diversity, Design, Destination Accessibility, Distance to transit. (Cervero and Kockelman 1997, 199; Ewing and Cervero 2001, 114) The study includes two additional variables: Demand management and Demographics. Both are treated distinctively in research literature because, although they are not part of the physical, built environment, they still have an undeniably significant influence on walkability. (Ewing and Cervero 2010, 267) Substantial correlations and cross-causal relationships between the individual influences are analyzed in order to better assess the relationships between the D-variables. Thus, walking is being studied as a basic function in transport science, and equally as a leisure-immanent behavior, and in connection with this, of course, the quality of stay of public space is being analyzed.

- Research by Design

Research by design is used to investigate spatial solutions for a research area in an iterative design process to produce new knowledge or practices considering the area or the objective in general. (Roggema 2017) The results from the theoretical treatment of the topic are thus translated into parameters that allow the development of a built environment that is detached from conventions and instead based exclusively on current walkability research. The parameters developed in this way are then applied to a research area in

Vienna. The multitude of different design benchmarks that influence walkability, from regional coherence and urban structure to the arrangement of seating and surface design, are all taken into account from the beginning of the planning process. The result of that process is then reflected upon concerning the utility of the previously developed techniques in achieving a pedestrian friendly urban structure as well as the overall walkability of the design. Furthermore, the processes and tools that are available in urban planning at the moment are examined concerning their ability to ensure the development of walkable structures.

2.3 Objective

The objective of this study is to investigate what the state-of-the-art walkable city looks like by conducting an extensive literature research and developing a design process based on the priorly obtained knowledge. The multidisciplinary, research-based approach to walkable city design is expected to reveal weaknesses and underrepresented issues in both theory and practice. The aim is to challenge and rethink common practices and existing frameworks in urban planning to build the foundation towards high walkability in the city of the future.

3 WALKABILITY RESEARCH

Research on walkability was initially conducted in transportation research and was therefore mainly considering influences on walking for transportation, while the leisure aspect of walking was originally not included in the definition. (Saelens and Handy 2008) Only when other fields of research engaged in the topic walking for leisure and – since they are inextricably linked – the quality of stay of public spaces were added. The term walkability is no longer only limited to pedestrians, but is often used to describe an environment that is suitable for other non-motorized transport like cycling and various leisure activities as well. (Kerr 2014, 131)

4 D-VARIABLES

As described earlier, the D-variables are outlined in the following and checked for their applicability.

4.1 Density

The most widely used parameters population density, employment density and building density are good indicators for the amount of urban activity in the city. They are easily assessed and therefore most widely used, but they cannot offer definite statements especially not in single use environments.[1] Variations of the factor network density – either considered for the general network (streets) or for the pedestrian network (sidewalks, crossings and passageways) – stated in network meters per square meter of area - are also often used.[2] The term attractor density was introduced in an effort to clearly describe the connection between the density of certain uses in the ground floor of buildings and the walkability of the adjacent street environment.[3] While parameters like building density and network density can directly be applied to a planning area, this is not possible for those relating to the amount of functions or people that populate the city. These need to be implemented in combination with other D-variables.

4.2 Diversity

From walkability's perspective, the key-uses in the city are living, working, supply, leisure and education. The connection between them is ensured by the sixth use, which is traffic. Spatial segregation of the uses (e.g. because of functional zoning that intends for large, single-use areas) increases the need for traffic and the distances covered, which results in a high degree of macro-mobility. Diversity of uses however ensures short distances between different functions, which makes walking, cycling and public transport feasible for

[1] That is why they could be considered as poxy variables for walkability. (Forsyth et al. 2007, 682)

[2] This does not seem to be taken into consideration in most newly planned areas, block dimensions are usually large to be able to accommodate big individual developments, the resulting street networks can therefore not be considered walkable.

[3] Functions in the ground floor of buildings are highly influential for the amount and type of activity in the public space in front of them (see section 4.3.2). While living and certain workplaces are only intended for a limited user group, other functions are able to attract additional people, whether that might be as pupils, customers or visitors. Those functions are responsible for a large part of activity in the public realm and therefore a direct indicator of the walkability of that environment. (Tobisch 2021, 37)

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most everyday travel; thus, it generates a public space that promotes urbanity, i.e. a lively city life – which in turn, experience has shown, further increases walkability.[4] In practice, both the urban structure and the design of the buildings themselves need to be suitable for various different functions to enable a sustainable development of mixed-use environments.

Fig 2: Single-Use business district “Viertel Zwei”; Mixed-Use neighbourhood along the Märzstraße in Vienna © Tobisch

Uses outside of buildings, whether they might be in private or public spaces are usually not included in walkability research. Considering that these are most directly perceived when walking, their importance is evident and more attention needs to be placed both on the research and planning of these functions.

4.3 Design

Considering the multi-faceted effects of design aspects on walkability, the following sub-categories are introduced:

4.3.1 Functional Design

Functional design includes all design aspects that have the potential to shorten routes measurably. Because of the limited reach of pedestrians[5], permeability is one of the major restrictions of walkability, it is described by the factors intersection density and street connectivity. Pedestrian reach must be determined along the street network and not by linear distance, therefore the geometrical reach varies widely depending on network characteristics.

Fig 3: Permeability of different urban structures in Vienna, illustrated by the comparison of a 800 meters radius and the actual network covered with a travel distance of 800 meters in each structure respectively © Tobisch

An important statement is that intersections and street networks can only be equated with the walkable network in a pedestrian-only or shared space environment. In conventional street layouts where the different traffic strands are spatially separated, the pedestrian network does not consist of streets, but rather of sidewalks, intersections and passageways. Pedestrian sensitivity to detours at intersections and vertical routes such as under- and overpasses is high and further limits their reach, hence pedestrian connectivity must be carefully considered. The arrangement of buildings within the block and with that its permeability is highly

[4] While the number of individual activities seems to be the deciding factor for a space to be considered “active” the spread of those activities around the clock (Jacobs 1961, 154; Speck 2018, 14) and the length of the activities themselves (Gehl 2012, 72) are the key influences on the perception of the space.

[5] Various studies show that the willingness to walk decreases rapidly after only a few hundred meters. (Gehl 2012, 139; Walther 1973, 58-64) Precise statements about the reach of pedestrians are often made, but since they are dependent on a variety of factors (like walking environment, cultural and individual conditioning and availability of other modes of transport) and vary widely, they cannot be considered generally valid.

relevant for the length of the path that has to be covered to reach a destination, but also for the legibility of the public space and the perception of the functions on the ground floor.

4.3.2 Qualitative Design

Beside the distance factor, the environmental aspect is the main reason for encouraging walking: the path has to be attractive![6] What can be considered an attractive environment is determined by two factors, firstly the amount of space provided to pedestrians, which is in conventional street layouts indicated by the width of sidewalks.[7] The second factor results primarily from the circumstance of the comparably low speed of pedestrians and the resulting thorough sensory perception of the surroundings when walking.[8] Therefore, the public space needs to meet certain qualities and a and it needs to be interesting.

Fig 4: The two sides of the Wassergasse in Vienna display different structuring and information density; a configuration of a ground floor that enables interaction with the public space, and one that makes interaction impossible © Tobisch

Conventional urban maps portray only the public space but do not give any information beyond the building perimeter. But apart from the design of the public space itself, the ground floor of the adjacent buildings is the major factor of the perception of the city form a pedestrian's point of view.[9] This includes uses as well as the structuring and permeability of the façade that enable interaction between those vital spaces.

4.3.3 Quality of Stay

Walking is not a strictly linear activity and is often accompanied by stopping or longer periods of time staying at one place, consequently streets cannot be considered as places for traffic only, but must also be viewed as a place to stay.[10] Places to stand and sit, and factors like the soundscape, thermal comfort and protection from weather effects need to be taken into consideration. If a high quality of stay is provided people tend to engage into various other activities, which – through witnessing it – encourages more people to engage in activities themselves.[11]

4.4 Distance to Transit

Since walking as a mode of transport is especially practical for short distances, a network of public transport that is both dense[12] and offering frequent service is needed to cover longer distances at any given time. The density of the stations and therefore the coverage of the public transport system can only be determined by taking into account the characteristics of the street network, not by linear distance (see 4.3.1). A high availability of public transport also decreases the dependency on individual motorized traffic; This means

[6] An attractive walking environment can increase the distances pedestrians are willing to walk for travel reasons by up to 70% (Knoflacher 1996, 133) and has an even higher significance concerning walking for leisure. (Gehl 2012, 5)

[7] The width of sidewalks and them being free from obstacles reducing their width is relevant for traffic purposes – i.e. people walking next to each other or passing each other without having to step off the sidewalk – and also for quality of stay. (see section 4.3.3)

[8] Relevant are the visual, auditory and haptic perception of the environment as well as thermal comfort.

[9] The treatment of the public space, the ground floor of the adjacent buildings and private open space as one continuous entity is brought to attention under the concepts of the Stadtparterre (Urban Parterre) (Psenner 2014a, 5) and the City at Eye Level (Karssenberg and Laven 2016, 15)

[10] In Austria obstruction of traffic is prohibited and stopping without cause is not permitted on the sidewalks (§78 StVO) this legal situation shows that the streets are often intended as transit spaces. (Psenner 2017, 76/81)

[11] Research around the standards for quality of stay and the consequential social life has been conducted in various countries and the findings seem to be universally valid. (Whyte 1980, 94; Gehl 2012, 17; Kato et al. 1978, 2-6,38,46-65; Jacobs 1961, 35-37; Jonge 1967, 10–11)

[12] For low rank public transit like busses and streetcars, a distance of 400 meters from the point of departure to the nearest station was found to be tolerable, for high rank public transport like metro and city trains up to 800 meters of walking distance are deemed acceptable. (Walker 2012, 68)

less moving and stationary traffic, which ultimately improves the quality of the street space and thus the commitment to walking. In addition to public transport, shared mobility and mobility as a service concepts are also suitable to cover larger distances and encourage multimodal mobility.[13]

Fig 5: Quality of stay ensured by places to stand, sit and engage in various activities in different public places © Tobisch

According to the equidistance principle[14] the nearest station of the public transit system or nearest shared mobility vehicle and the parking spot of the private vehicle need to be at least equidistant to the users point of origin to ensure equal opportunity between the different modes of transport.

4.5 Destination Accessibility

There are two different types of Accessibility, firstly local accessibility, which mainly includes destinations that can be reached within a certain walking time or distance, this factor provides information on the walkability of a neighborhood or district. Secondly, regional accessibility, which encompasses all destinations out of reach for pedestrians, and therefore characterizes the connection to other centers or even cities.[15] Polycentric city structures are generally the most successful in providing both local and regional accessibility to all its inhabitants. Effective Accessibility is not often mentioned in walkability studies, but was found to be an important factor during the research. Several design parameters like sidewalk coverage, location of the entrance and barrier free access contribute to that.

4.6 Demand Management

While availability and costs of traffic infrastructure are not directly part of the physical, built environment, they still have a highly significant influence on walkability and are therefore included in this study. There are two control mechanism to decrease individual motorized transport (IMT) and increase pedestrian traffic. The first one is the principle of induced traffic – the increase of availability of traffic infrastructure directly followed by an increase in demand and vice versa.[16] This is true for moving as well as for stationary traffic. The second one is true-cost pricing for IMT.[17] Recent political efforts for the mobility turnaround are now starting to take the external costs of IMT into account with measures like carbon pricing (i.e. in the EU's Green Deal).

A general reduction of IMT liberates significant financial resources that can be redirected into walking developments and increases both the amount and the quality of public space that is available for other road users and for various activities.

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[13] While station based shared mobility concepts can be treated similar to public transport considering the coverage of the service—the city of Vienna aims for a bike sharing station within 300 metres and a car sharing station within 500 metres for 40% and 50% of its inhabitants respectively until 2025 (MA 18 2015, 14)—concise statements about the coverage of free-floating models are not possible without site-specific analysis.

[14] (Knoflacher 1996, 214)

[15] Studies have shown that the two types of accessibility counteract each other to a certain degree, the effect of high levels in one category is most significant when the other one is low. (Handy 1993, 58)

[16] (Kent 2020; Knoflacher 1996, 35–37; Thomas 2013, 14; Speck 2018, 108)

[17] This includes the elimination of subsidies both direct (commuter allowance, tax benefits) and indirect (free or low-cost parking, required construction of parking space on private properties) as well as the consideration of all external costs (construction and upkeep of infrastructure, climate damaging emissions, noise pollution and additional costs in the healthcare system). (Frey 2007, 41; Shoup 2005, 2; Lewis and Adhikari 2017)

Fig 6: Public space in a typical secondary street that is primarily provided to stationary and moving motorized traffic; public space in a redeveloped street of the same width that provides space for various travel and leisure activities © Tobisch

A possible third mechanism is the supply of shared mobility as an addition to the already mentioned public transport. It represents a form of individual transport that needs less parking space because it displays higher levels of circulation and also decreases the need to own a private vehicle for occasional use.

4.7 Demographics

Various demographic aspects – like age, gender, educational level, level of income, lifestyle, ethnicity and cultural background - have an influence on walking behavior. Therefore, demographics are considered a confounding variable which means that their collection is important for the subsequent comparability of different places. From a design standpoint, sociodemographic influences are to be considered in an effort to develop structures and public spaces that cater to the diverse needs of various user groups.

5 RESEARCH BY DESIGN

Where:

The chosen research site–Wien Westbahnhof–used to be one of the major stations in Vienna, it is located on the western border of the city center. Its connection frequency was drastically reduced when the main railway station was opened in 2014, so that most of the structure has already been shut down. The Westbahnhofareal–which includes the station itself as well as the upstream track system and several maintenances buildings–covers an area of 0,3 km². It is situated directly in the compactly built and densely populated city center and has fairly good public transport connections. This provides all the necessary conditions for a high level of walkability, which could not be developed from scratch in an area of this size.

A generous perimeter was set for the area to be studied around the Westbahnhofareal in order to determine the status quo in terms of qualities and deficits and to locate possible effects on the site itself.

Setting:

The development of a framework for a walkable environment on the Westbahnhofareal was based on the findings of the literature analysis. Since the D-variables correlate heavily, parameters for each variable were put in place, analyzed and tested against interdependencies with the other variables and adjusted accordingly afterwards. The resulting iterative process of design, analysis and redesign considered all design benchmarks that influence walkability from the beginning of the planning process.

Stadtparterre–Urban Parterre:

The urban parterre–i.e. the zone that describes the parterre of the city and includes the ground floor, street space and inner courtyards (Psenner 2014a)–is given special attention in the chosen approach. Not least because recent studies have proven its undisputed relevance for the urban system. (Psenner 2021) It plays a special role with regard to the walkability aspect. In the extended study area, the given zoning was compared with the actual use of the ground floor zone and no significant correlation was found. Which suggests that the current system of zoning does not have a significant impact on actual use and therefore may not be the right tool to ensure functional diversity. In addition, the problem of under-utilization on the ground floor and vacancy is prevalent.

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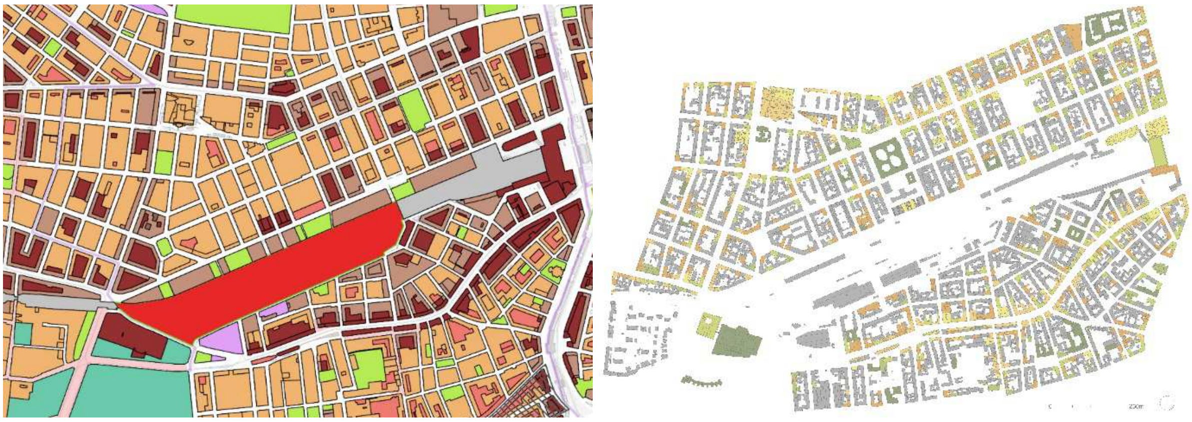

Fig 7: left: Zoning Plan of the Westbahnhofareal; right: actual ground floor uses (colour codes indicating different attractor uses like public, retail, business etc./non-attractor uses marked in grey) © Tobisch

The distribution of public space in the perimeter is characteristic for Vienna, most of the surface area is designated to IMT, both moving and stationary. Typical Streets are transit streets and offer low-cost parking continuously on both sides of the street.[18] With few exceptions, the streets dedicate more than half of the available space to cars, some even up to 80%[19], the remaining percentage is split between pedestrians, cyclists, public transportation and a few trees and leaves little to no room for activities other than traffic. Against this background, the urban parterre in its current state cannot be considered suitable for a walkable city.

5.1 Design

Since the chosen area poses several challenges – i.e. a remaining train connection, a steep topography and, as a local air channel, far reaching importance for the urban climate – and exhibits deficiencies – i.e. insufficient connection of the southern and northern part of the district – a design that increases both walkability on the site itself and provides improvements for surrounding area was pursued.

Thus, the existing street network and block size were taken into consideration when developing the corresponding counterparts on the site. The continuation of streets through the area was ensured wherever possible and additional paths were introduced where necessary, to provide optimal pedestrian connectivity. The building blocks were aimed to be 60-90 meters in side length to provide frequent route choice while still keeping the blocks big enough and suitable for building arrangement that can accommodate various functions as well as reasonable courtyards.

A large park located in the middle of the Westbahnhofareal keeps the local air channel intact; its vegetation provides an additional cooling effect on the urban climate; and moreover, it compensates the general lack of green space and space for recreational walking, sports and relaxation in the area.

Fig 8: left: Site plan, the block size provides frequent route choice and the park provides cooling and space for recreation; right: The pedestrian network provides optimal connectivity considering the topography and remaining train connection © Tobisch

The coverage by public transport is considered suboptimal for both, high and low rank traffic. Consequently, the designed street network is optimized for transit access and two additional stops are added to an existing

[18] Low cost on-street parking is in high demand, while more expensive parking facilities on private property and in garages are underutilized.

[19] Only exceptions found in the area are streets with public transportation and the few existing pedestrian zones.

bus line to ensure full coverage on the site and its surrounding area. In addition, a mobility concept for IMT and shared is developed. Collective garages located in close proximity to public transport stations represent the only parking possibilities for private cars and thus ensure equidistance.[20] Three shared mobility points are introduced to provide adequate alternatives to car ownership.

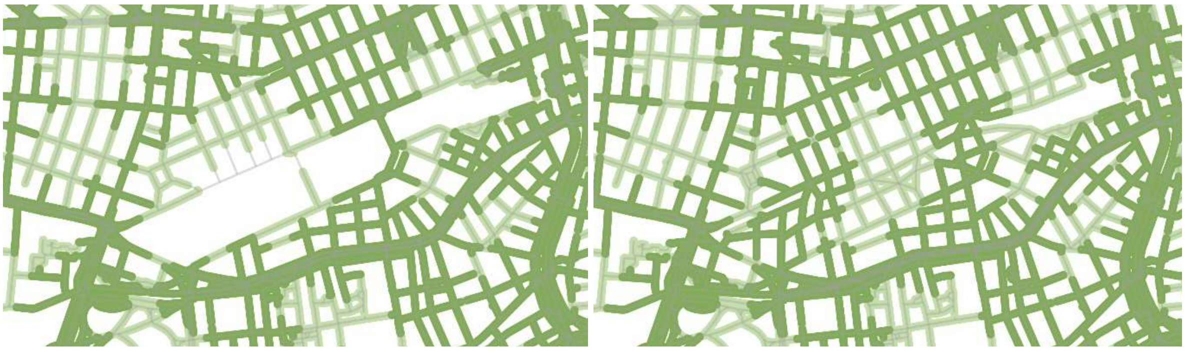

Fig 9: Isochrone map for low rank public transport for 200 and 400m distance, left: Status quo, right: Design © Tobisch, Hetzenecker

The top priority for the street design was a (re)distribution of the public space in favor of pedestrians and other non-motorized road users. They are not meant to be used for traffic only but also for lingering, therefore, all streets (with one exception) are residential streets. Seating, trees, water elements, bicycle parking and additional free space for various other activities invite residents and passersby to make the street a space to be lived in. Generally, one-way car access is limited to supply and delivery, there is only a single two-way transit street in the area which is sufficient to facilitate both access to the collective garages and the operation of public transport.

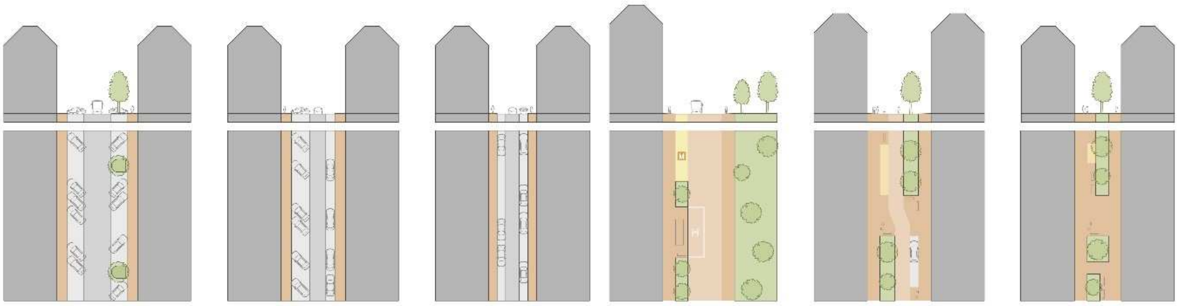

Fig 10: left: Status quo – more than 50% of the space in the streets is designated to stationary and moving IMT, right: Design – all new streets are designed as shared spaces that offer seating, trees, bicycle parking, generally limited one-way car access is possible, streets with public transport are two-way transit streets © Tobisch

Considering the size of the area and walkability as the only design objective for this study the results of planning further qualities to detail without additional data[21] would tend to get more arbitrary than scientific. Therefore, implementation of further planning steps was not carried out to detail but rather formulated in a list of qualities that includes: the positioning of buildings at the edge of public space, pedestrian pathways, semipublic courtyards, small plot size, visual and haptic permeability of ground floor façades, small size of functional units, treatment of ground floor as semipublic space (Psenner 2018), structuring of façades, arrangement of uses and seating in public space.

5.2 Comparison to Historic Structures

Since historic inner-city centers are what walkable environments mostly look like at the moment, the comparison of results of the design process conducted here and those known walkable structures were of interest. The designed structure offers wider streets and intends for generous semipublic courtyard areas with a direct connection to the public space, but the indisputably most notable difference is green spaces and vegetation. It is known that the high degree of sealing in traditional city centers causes a micro climate that is not compatible with the thermal comfort of pedestrians needed for high walkability – even more so in

[20] This does not comply with legal requirements in Vienna, which call for the construction of parking spaces on the property, the amount of parking spots required is derived by the use of the building and the square meters of floor space.
[21] Additional data might be objectives on an urban level (i.e. regional centers), target values (i.e. for uses like social housing, or population and jobs created) or specific uses on a block or plot level (i.e. schools, event locations) etc.

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Vienna, where the 19th century city structure was mostly laid out without any trees at all. (Psenner 2021) Therefore, the developed structure offers trees in every street and a generous large park both for a cooling effect on the urban climate and as a place for recreational walking, sports and relaxation for the residents.

5.3 Learnings form the Design Process

The hypothesis that walkability can only effectively be established when it is considered at all planning steps was confirmed during the planning process. Which also means that existing structures cannot reasonably be adapted to reach the all mentioned qualities, though significant improvements are possible. Walkability as a concept is highly adaptive, deficiencies in some aspects can be compensated for by providing other qualities (i.e. steep topography limits the reach of pedestrians but can provide interesting views). It is quite clear though, that compensation of deficits is only possible to a certain point and potentially not for all aspects that contribute to walkability.

5.4 Weaknesses and Problems

Although the D-variables are highly influential on the walkability of urban environments, they are not properly differentiated from each other and correlate heavily. Therefore, it is not possible to assess the relevance of each one of them separately and quantify their precise influence on the walkability of a built environment.[22] In this study several aspects that are not originally included in certain variables have been added to draw a more complete picture of all of the influences on walkability.[23] Green spaces and trees are scattered through several of the D-variables and might therefore be easily overlooked. Given the great importance of vegetation for walkability (in atmosphere of surroundings, leisure walking, sports and relaxation, micro and urban climate) this can be considered a genuine flaw.

While the D-variables are highly usable when analyzing existing structures and categorizing research, they did not provide a linear framework for planning, the design process was therefore conducted in an iterative process of design, analysis and redesign along the various benchmarks but with the D-variables also in mind.

Several of the mentioned needs of pedestrians do not correspond to the legal situation in Vienna. This mainly involves the use of the street as space to linger, ground floor use and zoning in general, and the construction of parking space. (Psenner 2014b) In some instances, the appropriate tools to ensure a pedestrian friendly development are not available, i.e. when it comes to the permeability of ground floor facades. The implementation of walkability-concepts can therefore only be successful if appropriate policy changes are made.

6 CONCLUSION

The conducted scientific literature research and research by design process revealed that the theoretical knowledge on walkability can indeed be applied in a practical design process. The D-variables proved useful in categorizing the abundance of established and new research material and the resulting theoretical knowledge. They also provided a guidance for the subsequent translation of the research results into parameters for the design of walkable built environment. However, they do not represent the precise perimeter or the design of building blocks with which a walkable city can be assembled, but rather need to be understood as the foundation on which a creative design process can subsequently unfold.

The findings clearly unveil the qualities of a walkable city. Since the needs of pedestrians include structural, functional and qualitative design parameters and relate to all design benchmarks, walkability can only effectively be established when it is considered at all planning steps. Generally, structures must be designed to be functional and comfortable and offer a high quality of stay to encourage walking, but because walkability as a concept is highly adaptive, given deficiencies in some aspects can be compensated for by providing other qualities. The urban parterre plays a special role in regards to the walkable city since the street space and the ground floor of the adjacent buildings are most directly perceived while walking. Its functioning is highly dependent on the legal situation; therefore, the planning of a walkable city can only be successful if the appropriate policy changes are made.

[22] The shortcomings of the D-variables as found in this study have been addressed before. (Handy 2018)

[23] This deficit stems from the origin of the D-variables in transportation research, where parameters like quality of stay are not paramount.

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🏆 *reviewed paper*

Climate Proofing Spatial Planning Policies in Austria – Case Studies and Findings

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1 ABSTRACT

The Austrian Panel on Climate Change (APCC, 2014), as well as the next report version (2021) emphasise that spatial planning policies have to be empowered to combat climate change. While the 2014 version contained a rather modest presentation of spatial planning and mobility approaches, the future version will have a full chapter on “spatial planning and climate change”. Usually, APCC reports tend to trust sources that are highly validated and highly agreed upon by many experts. “Climate proofing” should be a process to measure the mitigation and adaptation impact of spatial strategies and programmes, but so far there is only poor evidence that this exists: we believe that spatial planning is powerful, but it is hard to prove this in qualitative and/or quantitative terms and numbers.

Keywords: criteria, policy, strategy, climate proofing, spatial planning

2 INTRODUCTION

The Institute of Spatial Planning at TU Wien has already organised two courses under the branding “Planners for Future” to fill this knowledge gap, and to improve learning about climate proofing for spatial planning policies, one of the successes of these lectures was the founding of the "build for future" group, an association of architecture and spatial planning students (Build for Future 2021), organised as subunit of “Friday for Future”. This paper reports on three selected spatial strategies, comparing their status on environmental impact today with a clearly improved future “version” to show our results.

One case study dealt with the expansion of ski areas in Tyrol. The Spatial Planning Act, the Nature Conservation Act and the cableway programme of the federal state were examined for indicators on climate-friendly developments. The results showed that there were no clear parameters in all three instruments. As a consequence, we developed an evaluation tool for such extensions. This is a two-phase-system, which provides for a point system in combination with “K.O. criteria” (i.e., snow reliability, glacier protection and protected areas).

Whereas Austria is still the European champion in terms of land use, the German concept of the “Eco Account”, which prescribes compensation measures for construction projects, was examined for effectiveness. Again, a lack of proportionality was found and an adapted climate proof version, based on qualitative and quantitative indicators, was developed for Austria.

Another topic introduced in this paper is the problematic amount of secondary residencies in several touristic regions e.g., Wörthersee, which lead to increasing vacancy, land use and rental fees. In order to establish a climate friendly and sustainable development in that region, two international vacancy taxations (France and City of Vancouver) were compared and adapted to the spatial requirements of the Wörthersee region. If applied, the vacancy rate in this region would be reduced by 25 percent and up to 50 percent within five years.

So far, a few findings around the climate proofing of spatial strategies and policies are possible: there are a lot of reports and analyses criticising the lack of “evaluation culture” around climate proofing of spatial strategies and policies, but still very few attempts to really try exactly that. Also, many experts emphasise the necessity of “adaptive resilience” (Jesse et al. 2019) instead of former mitigation approaches, but they don’t show workarounds on how to improve this „climate proofing toolkit“ for spatial strategies and policies. At the TU Wien, we will go on to work on that toolkit, improving the given methods and developing new ones that will definitely use more criteria than the CO2 balance.

3 STATE OF RESEARCH AND METHODOLOGY

The connection between spatial planning and the climate crisis has entered the scientific discourse. We, as spatial planners, presume to create resilient cities and regions through sustainable and foresighted spatial development (e.g. city/region of short distances, mixing, provision of public services). Yet in the past and probably the future, certain development trends (e.g. individual traffic, urban sprawl, soil sealing) did and will not correspond to this goal. Responsibility for this is generally assigned to policy makers. Yet even as spatial planners ourselves, we only have a very limited knowledge of the impact that spatial planning policies, instruments and programmes actually have on the climate crisis.

As part of the Climate Proofing course, students analysed selected strategies, instruments, and programmes for their ACTUAL impact and outlined TARGET proposals. The basis for this analysis was a jointly developed criteria grid, which shows in which areas there is a lack of information and data to support statements quantitatively and qualitatively. The course proceeded as follows using a concrete spatial context (regional or neighbourhood/settlement) as a basis:

- Jointly develop indicators (for impact strength) and criteria (for the transformative transition between ACTUAL and TARGET)
- Analysis of selected plan documents, programmes and instruments (to what extent these are aligned with adaptation strategies of the climate crisis and what the impact strength is in the ACTUAL and TARGET to be assessed)
- Recommendations for action and suggestions for improvement (increase of effectiveness, repeatability).

In the instruments of spatial planning, there is a shortfall in liability between the smallest unit (individual buildings) and an entire federal state. This is true regardless of whether they are directly spatially effective instruments (e.g. settlement expansions, developer inside competitions) or the "classic" indirectly spatially effective instruments (e.g. subsidies). Regions are one such spatial category for which often no one is explicitly "responsible". For subspaces, e.g., neighbourhoods, relevant data is often not available. Within the framework of the course, a conscious attempt was made to model such " understeered intermediate spaces" in their climate balance. The three selected case studies (ski area assessment, landscape account, mobilisation of unused dwellings) identify missing information and missed potential and give an insight into what they could achieve.

4 CASE STUDIES

4.1 Ski area expansions in Tyrol

A screening of the Regional Planning Act, the Nature Conservation Act and the cableway programme of the Federal Province of Tyrol for climate-relevant factors was carried out. Included were those that are also of particular relevance for the sensitive alpine ecosystem. Initial results showed the following:

First and foremost, purely economic factors, such as profitability or competitiveness, are used in the instruments for assessment. Although soil and nature conservation are addressed, concrete measures or demands for climate protection are not mentioned. In practice, the nature of the existing indicators allow even climate and environmentally damaging location decisions for ski resorts to be presented as "environmentally sound" (Hahn et al. 2020).

The student group developed a simple but effective two-phase ski area assessment tool to address this. The first phase of the assessment includes three crucial criteria (snow reliability[1], glacier protection[2] and protected areas[3]), which determine whether the project should be considered at all. Only if all three criteria are met (1. the area has snow guarantee; 2. glacier areas are not affected; 3. protected areas remain

[1] Snow thickness from 30 to 50 cm; presence of snow in 7 out of 10 winters; snow cover from the end of December to the end of March (Schickhofer 2017).

[2] Rapid glacier retreat is the most obvious feature of climate change in the Alps. If the project affects a pristine glacier, it will fall through the review.

[3] The area apportionment of protected areas should no longer be valid. If an area is protected in any form, it must be absolutely unassailable.

untouched) can phase two be applied. For this purpose, seven additional criteria were defined (Table 1), which have been assigned a rating from -1 to 3. The higher the score, the more sustainable is a realisation of a ski area project in terms of climate protection, but a total of 2/3 of the points must be achieved to pass the Climate Proofing.

Using this list of criteria, two expansion plans in Tyrol were evaluated by the group. The St. Anton Kappl extension as well as the Ötztal-Pitztal link do not fulfil the prescribed criteria of the first phase. Even if this was the case, it had not been possible to carry out a climate proofing under the specified factors for both projects due to lack of accessibility to the required data.

Criteria	Scale: -1 (very poor) to 3 (very good)
Elevation	Up to 2000m = 3 points; 2000-2250m = 2 points; 2250-2500m = 1 point; above 2500m = 0 points.
Ecological footprint	Ringler (2017) derived a value system for the ecological footprint of ski resorts. The range is from 5 (Oberschwende) to 120 (Sölden). 0-30 = 3 points; 30-50 = 2 points; Over 70 = 0 points
Positive displacement effects	In rare cases, ski area connections lead to positive relief effects (e.g. traffic load, utilisation pressure). If this is to be expected, it should be rewarded.
Land consumption of new slopes	The more area is used, the less points should be given for this. 0-10 ha= 3 points; 10-20 ha = 2 points; 20-30 ha = 1 point; 30 ha + = 0 points.
Compensatory measures	If compensatory measures are provided beyond the environmental impact assessment (UVP) in the case of an extension, this is to be positively rewarded with points.
Maximum CO2 value	Every expansion is accompanied by CO2 emissions during construction and later during operation of the plant. Maximum permitted limit values would have to be introduced here.
Maximum water consumption	In view of the fact that less water will be available in the Alpine region in the future, the water consumption of existing snowmaking systems must be determined in advance in the event of an expansion. If this exceeds the maximum value to be defined, an expansion would have to be prohibited.

Table 1: Criteria catalogue for climate proofing of ski area expansions in Tyrol by Hahn et al. 2020

4.2 Eco account for Austria

In order to minimise the ecological consequences of construction projects, the so-called prohibition of deterioration was established in the 1970s in Germanys Federal Nature Conservation Act. It is based on the following consideration. For a construction project (regardless of its size and the initiator(s)), an ecological compensation action (for example, unsealing, renaturation, woody planting or measures to protect biodiversity and species diversity) must be taken, because in principle, no deterioration for nature and landscape may result from this construction project (Wende et al. 2005; Froger et al. 2015).

The compiled criticisms of the student group (Doden et al. 2020b) are as follows:

There is a disproportionality between intervention and compensation. The compensation areas are too small to be seen as compensation

The compensation areas are not site-specific, i.e., for example, an affected community does not have to benefit from a compensation measure even though a construction project is being carried out there.

Instead of implementing a compensatory measure, it is also possible to make compensatory payments to an "eco-account". This can subsequently be used to carry out measures. However, these compensation payments are disproportionate to the actual costs of the compensation area, as they are much cheaper.

The most important thing for a possible implementation in Austria is therefore a plausible specification of the proportionality between intervention and compensation, in order to reduce the negative impact on the environment and to compensate it on a high level. The abstraction of interventions in nature should be avoided by a clear intervention-compensation key, with a focus on areas.

Transferring the concept to Austria, this instrument could look like this. In the case of an intervention of size x, another area of size x must be qualitatively upgraded and another (also of size x) must be de-paved. This results in an impact-compensation ratio of 1:2. However, there is the possibility to reduce the compensation measure through adaptation or mitigation, i.e. compensation within the impact area. Since the German model has no specifications as to where these compensation measures should take place, the idea was expressed here to include an additional factor with regard to the distance radius.[4] This should ensure that the immediate surroundings also benefit (Doden et al. 2020a).

The previous specifications for the "eco-account" in Germany still have few criteria for climate protection, which is why the student group created three qualitative and three quantitative indicators for the evaluation of the construction projects (Table 2), in order to be able to carry out climate proofing for the accruing projects here as well. Together with a sensible measure of site-specific and obligatory compensation measures, it is possible to estimate the impact on climate change.

QUANTITATIVE		QUALITATIVE	
Land consumption	Area ration between replacement area and intervention area	Interdisciplinarity & Diversity	Gender distribution during procedure implementation
Area equity	Building/green space ratio and accessibility	Environmental Justice	Arrangement of the areas to the settlement area/impact on the quality of life, popularity of the city.
Climate Change Adaptation	Expansion/maintenance of critical infrastructure (e.g. flood protection)	Climate Change Adaptation	Quality of nature conservation/ecological & temporal sustainability of measures/environmental education.

Table 2: Indicators of a Climate Proofing by means of a Landscape Account in Austria by Doden et al. 2020a

4.3 Housing activation contribution

At the intersection of protecting key soil functions and reducing greenhouse gas emissions is the examination of sustainable settlement development on the basis of a vacancy tax (David et al. 2020). The taxation of vacant housing serves policy makers as a market-activating instrument to limit speculation (voluntary vacancy) and the associated problems of housing availability (Segú 2020). Existing analyses are extended here by the aspects of "climate impact". For this purpose, international examples of vacancy taxations were analysed and possible applications in Austria were discussed. The models were not created with the aim of being exact forecasts, but rather to visualise the potential of a housing activation contribution or vacancy tax as climate mitigation policy (David et al. 2020).

The Empty Home Tax (EHT) was introduced in Vancouver in 2016. Homes that are declared, designated, or deemed vacant are subject to an annual tax of 1% of the assessed taxable value. In other words, a constant tax rate based on property value. Vacancy rates have already been noticeably reduced in four years and more housing units have been added to the market (City of Vancouver 2020). The "Taxe sur les Logements Vacants" (TLV) was passed in 1998 with the aim to bring more apartments onto the market. Apartments that have been vacant for at least two years were taxed at 10% of the rental price. If vacancies persist, the tax rate also increases. Relevant effects on vacancy rates have been demonstrated (Segú 2020).

	0 SCENARIO Development without intervention in the Wörthersee region	SCENARIO 1 Taxation based on Vancouver model Consistent tax rate based on property value	SCENARIO 2 Taxation based on the French model Increasing tax rate based on presumed rent charged
Change in vacancy rate	0%	-51,5%	-24%
Effect on CO2 emissions from new buildings	+120.400t	-142.900t	-66.700t
Change in sealed surfaces	+10,71ha	-18,56ha	-8,56ha

Table 3: Comparison of the scenarios up until the year 2026

Potentials of the application in the Wörthersee region are modelled by the students in three scenarios until the year 2026: A zero scenario, an implementation of a vacancy tax modelled after Vancouver's EHT, and a scenario developed after France's TLV. The zero scenario is intended to represent the development of vacancy without planning or political intervention, with a constant percentage of vacant residential buildings and an extrapolation of the average new buildings 2011-2018. For the applications of the respective vacancy levies, the empirical percentage changes on the units added to the housing market were adopted for the Wörthersee region. This was based on an idealised model in which the activation of vacancy leads to a

[4] Within the 5 km radius, the general provisions apply. However, if this distance is exceeded, the area already determined for compensation is calculated with a factor of 1.1. For each additional 25 km of distance, the factor is increased by 0.2.

termination of construction activities. The achievable positive effects for the housing market and the climate balance can be seen in Table 3. The CO2 savings effects were calculated using a primary energy approach: what amount of CO2 would be saved if additional new housing units did not have to be built in the first place while mobilising existing housing.

5 DISCUSSION

Before conclusions can be drawn about how future climate proofing work should be done, it is important to establish the conceptual framework within which any climate proofing can and should operate. While there has been (Birkmann und Fleischhauer 2009) a strong awareness for over 10 years that spatial development is appropriate for climate change mitigation, a serially proven and versatile "toolkit" for doing so is still lacking. This is a very unsatisfactory state of affairs, especially for future planning practice, because in the context of resilience, we have long had to assume transformative resilience, rather than adaptive resilience (Hat und Stöglehner 2019). Transformative resilience entails using the climate crisis as a lever to achieve a new target state, because the "old" state would merely lead to the time before the crisis. The students' analyses presented show how any spatial developments can be subjected to climate proofing using the "toolkit" of simple sets of criteria. These were able to coherently integrate both mitigation and adaptation measures.

An example of how the assessment toolkit of site planning has not yet arrived at climate proofing is, for example, that while the environmental impact assessment tool is capable of modelling the effects of a siting decision in great detail, it is not suitable for arguing this in a much larger system boundary of climate adaptation, or the principle question of the "necessity" of the project is not asked. In short, this tool is designed to do something it was not designed to do in the first place. In future designs of climate proofing, it will therefore be important to define and test both process- and subject- and object-related measurement criteria (Birkmann und Fleischhauer 2009). The reflection between the statement of quantitative and qualitative measurement criteria must lead into a "double loop learning", which means that phenomena are not only understood and measured, but new spaces of interaction are created through participation and education processes (theLivingCore 2019).

6 CONCLUSION

The course Climate Proofing of spatial planning instruments in Austria has fulfilled the claim of not only trying out climate proofing, but also opening up new spaces of interaction in the process, through an impressive and versatile set of criteria. In this set, the much-vaunted CO2 is merely a supporting actor (albeit an important one!). The four most important categories and findings were:

Area criteria (including saved sealing in m², ratio between intervention and replacement areas).

Processual and behavioural criteria (e.g. footprints of mobility and consumption behaviour between ACTUAL and TARGET, change in quality of life, but also fairness and diversity in the mapping of actors in the decision-making processes)

Primary energy criteria (CO2 savings through mobilisation of existing buildings instead of additional primary energy expenditures through new buildings)

Future criteria (respecting FUTURE environmental conditions including appropriate back-casting of current strategies, e.g. evaluation of future snow reliability and the amount of heat days).

A general challenge in climate proofing is the lack of data basis or access to data sets. Another weakness of already existing climate proofing is the lack of or inaccessible method documentation. This makes the comparison of findings and benchmarks impossible and precludes further development and discourse. However, the fact that there is “no data” (or just poor data) is not an excuse for neglecting climate proofing research nor investing creativity. Herein, creativity means to develop alternative research patterns. This means to collect data oneself, or (if not possible due to resource shortage) to use not obviously meaningful, but related data as proxies and to interpret them with regard on their value in climate proofing statements. The case studies presented in this article show exactly this way of working in an outstandingly successful and convincing way.

With further case studies or a creative extension of such criteria, the climate change impact of spatial planning instruments could at least be made more comprehensible in the future and, after these learning effects, it could be better ensured that these instruments could develop a considerably increased binding force and seriality, especially in the "under-controlled intermediate spaces" (Department für Raumplanung 2014). Future research on climate change and climate proofing should follow the “polluter pays principle”, in addition to the aspects of an increased seriality and liability of the policies (as mentioned before). The examples shown in this paper have their spatial focus in rural areas, this orientation might fit well for Austria (with about 35% of the people living in cities), but not at all for the future elsewhere: Globally, the proportion of people living in cities is currently 55%, in only a few years it may be 65% or more. This means that dense urban structures should be given more attention in climate proofing in the future. Here, the experiences from climate proofing experiences in rural areas could be adapted and promoted.

Finally, the question arises who will coordinate the international research with the goal of the "best possible" climate proofing methods. The authors of this paper believe, that this role should be filled by the IPCC (International Panel on Climate Change), and also by a much stronger policy prescriptive character of the climate change assessment reports.

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Construction Automation: Post-Pandemic Integrated Robotized Construction Sites

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1 ABSTRACT

The interest in automation and robotics in the construction field has grown significantly in the last decade. Smart cities and smart construction depend mainly on applying the concepts of industry 3.0 and 4.0 which adopt the smart construction concepts. They include automation, 3D printing and robotics. Virtual and augmented reality along with the internet of things (IoT) can be useful tools for applying automation and coordination between the operators, engineers and autonomous machines. Construction faces problems after the pandemic due to large on-site crew and machines being used by workers side by side; thus automation is an efficient solution for construction after the pandemic providing a safe environment for working.

This paper is an analytical research work focusing on using robotics and autonomous machines on-site in different construction tasks to mitigate the pandemic effect. It analyses the impact of on-site automation and the challenges facing it. The case study presents a methodology for using integrated on-site robotics and machines and analyses their impact on tasks planning and execution. It ends up with a concept for applying integrated robotised construction on-site depending on smart construction concepts; thus reducing problems that arise when using single tasks robots as site planning and interference of robotics. Also this allows reducing on-site workers and applying social distancing responding to WHO measures as well as solving congestion on site which is necessary for the pandemic constraints.

Keywords: Automation, Robotics, On-site factories, Pandemic, Prefabrication, Construction 4.0.

2 INTRODUCTION

The pandemic affected the construction sector and led to delays and pausing of projects (Alenezi, 2020). This is due to the complicated nature of construction sites where several tasks are executed in parallel. The construction industry lags behind the manufacturing industry in applying advanced technologies. While Japan has been developing and applying automated construction and robotics more than twenty years ago, the construction industry in Egypt still relies on large on-site crew and hazardous working methods (Bock, 2008; El Safty et al., 2012).

Automated construction involves using single task robots for performing specific finishing tasks, material handling and assisting human workers on-site. It developed from working indoor and in factory settings to working outdoor in facade finishing tasks and up to building components assembly (Melenbrink et al., 2020). It also involves general purpose robots as drones, exoskeletons, 3D printers and cable driven robots. Automation levels ranges from operator assistance and up to full automation depending on the nature of tasks performed and site conditions (Bock & Linner, 2016a) However Harari (2016) stated that automated construction differs from automated automobiles industry.

This research objective is to prove that shifting to automated construction and coping with industry 4.0 concepts will be essential to mitigate the pandemic's effect. And to discuss the automation effect on the site's safety and human workers on-site, showing whether automation replaces or cooperates with workers.

In order to achieve these objectives, a literature review of the potentials of automation for the construction sector and the challenges facing construction due to the pandemic was carried out. Then a case study is performed for construction after the pandemic from pre-construction phases to full execution based on the precautionary measures requirements and the autonomous solutions selected for an educational building. The research ends with a discussion of the effect of automation on the construction industry, the challenges facing automation application and a concept for applying construction after the pandemic according to construction 4.0 principles.

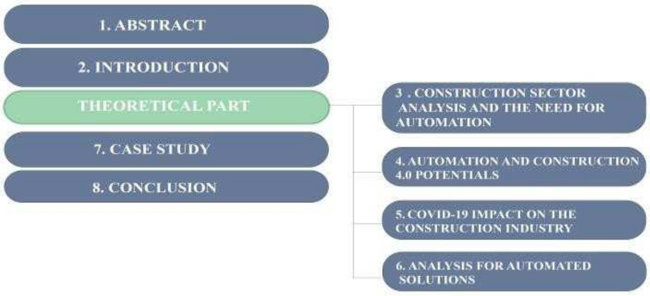


Fig. 1: Research parts (Researchers, 2021)

The research is divided into parts (fig. 1) including a literature review for the construction sector status, the need for automation and its potentials along with construction 4.0 concepts. Then a case study is performed for the automation of an educational building, ending with a concept for applying automation after the pandemic.

3 CONSTRUCTION SECTOR ANALYSIS AND THE NEED FOR AUTOMATION

The construction industry represents about 10-15% of the annual GDP (gross domestic product) of Egypt and enrols almost 15% of the Egyptian manpower (American Chamber of Commerce in Egypt (AmCham), 2020). However, workers are subjected to significant hazards that can result in fatal injuries or death in construction sites. Statistics show that the construction industry critical injuries are about 55,000 yearly (El Safty et al., 2012).

According to Manzo et al., (2018), it is possible to automate about 49% of all construction tasks. The automation potential is approximately 35% for labourers; it is 50 % for carpenters, 42%t for electricians, 50% for plumbers, and 88 % for operating engineers. Whereas in the next few decades, crane operators and bulldozer drivers could be displaced by AI-controlled machines.

4 AUTOMATION AND CONSTRUCTION 4.0 POTENTIALS

According to Lee et al., (2018), the fourth industrial revolution emphasises that the base for revolutionary changes in the construction industry is shifting towards digital and information technologies. This in turn enhances the creativity of organisations and leads to better quality assurance. Munirathinam (2020) stated that interconnectivity, automation, machine learning and real-time data are the key concepts of industry 4.0. This enables proper planning and information circulation throughout the project phases. BIM (building information modelling) plays an important role in design and coordination as well as 3D printing; it also enables programming of single-task robots motion and paths. Prefabrication, off-site 3D printing and modular construction market are expected to increase after the pandemic as it allows fabrication of building components in factory settings; thus reducing on-site congestion and decreasing on-site tasks to assembly work. For efficient structure assembly of components, the robot-oriented design concept (ROD) must be applied in the design phase as the assembly is performed by single-task robots or on-site factories. Unmanned aerial systems as drones can be aerial or terrestrial and it is used for inspection and surveying. Work assist as exoskeletons and robots help workers lift heavy loads and decrease injuries (Davila Delgado et al., 2019).

5 COVID-19 IMPACT ON THE CONSTRUCTION INDUSTRY

According to Breisinger et al., (2020) the construction sector employs a large share of Egyptian labour. The government managed to run the projects during the pandemic while monitoring the application of precautionary measures in the construction site; as decreasing the number of workers and social distancing. The construction activities witnessed a decrease of 5% during the pandemic. The pandemic affected the construction sector as a result of the travel ban and lockdown. The material supply is also affected by the lockdown. Social distancing and precautionary measures led to decreasing the number of workers on-site and shifting work and meetings from the conventional work methods to working virtually.

The travel ban affected the material supply and international specialists' presence. The lockdown reduced the working hours and productivity leading to contractual problems. Companies started reducing staff which led to unemployment (Al Amri & Marey-Pérez, 2020). The construction projects' delay was determined as a critical delay. This occurs when contractors do not finalise the project in the contract period (Alenezi, 2020).

According to the (MAP, 2020), the construction sector income witnessed a decrease due to several factors including the materials shortage. The steel production had significantly decreased whereas the cement production slightly increased. This is obvious in the GDP which declined to 8.1% in the second quarter of the fiscal year 2020.

Construction projects were paused due to the lack of demand by the customers, supply chain problems or difficult working conditions during the lockdown with safety measures and government restrictions. This has affected the economy negatively and workers became jobless (Wallace-Stephens & Morgante, 2020).

The labour cost is estimated to increase compared to machines that can still work in close proximity. This is due to the fact of labour shortage due to social distancing and partial lockdown, while machines do not require social distancing or hygienic measures (Wallace-Stephens & Morgante, 2020). Therefore the pandemic accelerated the shift to automation in several industries. The use of robotics in construction reduces communication between humans and could be a good choice instead of them. Robotics are more reliable and efficient and less costly. Also they can be controlled remotely so there is no need to be on- site (Chen et al., 2020).

(Wallace-Stephens & Morgante, 2020) described the construction industry as high Covid-19, high automation risk. It employs mostly men with high levels of young workers (under 30) who are expected to have low levels of education and are lower paid.

In the design phase, engineers and planners worked from home which saved much time and cost. However, working from home cannot displace the site visits and real meetings. Virtual site visits can be a choice for foreign specialists and external visitors; hence virtual reality will play an important role in construction sites (Jones et al., 2020).

Online meetings decrease cost and time and facilitate coordination between the project's teams and stakeholders. This enabled the stakeholders and client to monitor the project progress on site. Videos and digital aids are used to track work progress, safety measures and absent workers on site (Jones et al., 2020).

6 ANALYSIS FOR AUTOMATED SOLUTIONS

This section presents an analysis for automated solutions which can be applied on-site throughout the different phases of construction. Starting from the site preparation phases, substructure work, superstructure work and ending with finishing work. Material handling and storage can also be automated to store and deliver material in time to specific locations. Several systems have been developed by different companies, some examples have been used on-site while others are still in the conceptual phase. The examples presented in this section are the most convenient ones according to the project requirements and degree of automation. However, automated systems are not limited to the mentioned examples.

6.1 Site preparation phase

Excavation and site levelling work is considered a mature technology. A number of autonomous machines have been developed for construction in contrast to the mining industry (fig.2). Research in automation of those tasks is still in progress and only concepts are available as Volvo's autonomous solutions (fig.3). However, add-ons for upgrading conventional construction equipment are being used to achieve different levels of automation; including hardware add-ons (fig.4) or software for programming machines (Bock & Linner, 2016a).

Fig. 2 (left): Automatic Digging and Soil Removing robot (Tokyu, 2016) Fig. 3 (middle): Volvo compact excavator (Volvo, 2021)
Fig. 4 (right): Add-ons for conventional equipment (ASI, 2016)

6.2 Substructure work

The Pile driving process can be automated based on a 3D model for the soil and piling plan (fig.5). It cuts piles to the desired length after the driving process and allows real-time calculation of the soil parameters during the process (Hovila, 2012).



Fig. 5 (left): Pile driving machine (Hovila, 2012). Fig. 6 (middle): Reinforcement placing robot (Kajima, 2016). Fig. 7 (right): concrete distributor (Kajima, 2016).

For reinforcement positioning, Kajima's reinforcement positioning mobile robot is used (fig.6). While concrete casting is done using Kajima's rail-guided concrete distributor (fig.7). Concrete levelling and compaction are executed using Fujita's Concrete Floor Levelling Robot (fig.8) (Bock & Linner, 2016a).

3D printing using concrete is performed using the gantry system COBOD (fig.9) developed by Peri. Kajima developed positioning and joining of vertical reinforcement robot (fig.10) (Bock & Linner, 2016a).

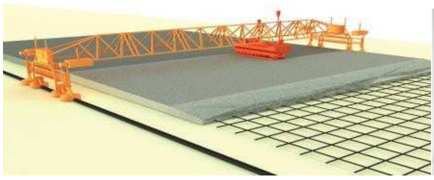
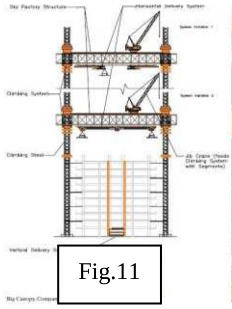


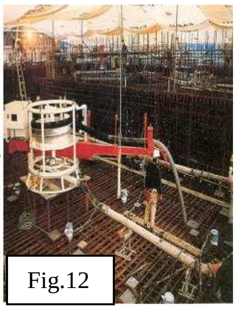
Fig. 8 (left): concrete levelling robot (Kajima, 2016). Fig. 9 (middle): CBOD 3D printer (Peri, 2021). Fig. 10 (right): Vertical reinforcement robot (Fujita, 2016).

6.3 Superstructure work

For handling, assembly and repeated positioning tasks, the big canopy on-site factory is used (fig.11) (Bock & Linner, 2016b). Concrete casting work is done by the compact concrete distribution robot (fig.12) by Kajima which can be programmed or manually guided by a worker. Reinforcement is positioned using the Automated Crane developed by Takenaka (fig.13). The reinforced concrete cores are 3D printed using the COBOD printer (Fig.9).

Bricklaying is performed using fastbrick Hadrian system (fig.14) which is mounted to a truck on which bricks are stored. Another example is SAM100 (fig.15) bricklaying robot which has high productivity and is compact enough to be used on upper floors (Bock & Linner, 2016a).





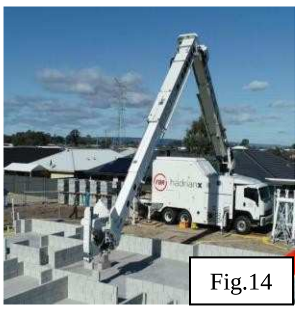


Fig. 11: Obayashi on-site factory (Bock, 2016). Fig. 12: Concrete casting robot (Kajima, 2016). Fig. 13: Reinforcement positioning crane (Takenaka, 2016). Fig. 14: Hadrian system (fastbrick, 2021). Fig. 15: SAM100 (construction robotics, 2021).

6.4 On-site material handling and storage systems

Obayashi developed an automated on-site delivery system consisting of automatic transfer equipment, automated forklift and automated storage rack (fig.16); hence enhancing autonomous operation. Other material handling systems include the Kajima rail-guided system (fig.17). It is more efficient by being programmed after standardising the routes and allows coordinating with the arrival of the materials on-site. Takenaka developed a mini-logistic unit for material transfer (fig.18) (Bock & Linner, 2016a).



Fig. 16 (left): Material handling system (Obayashi, 2016). Fig. 17 (middle): Rail-guided system (Kajima, 2016). Fig. 18 (right): Automated mini- logistics unit (Takenaka, 2016).

6.5 Finishing Tasks

Finishing tasks include exterior finishing for façade work, as well as interior finishing. Interior finishing includes tile work for floors and walls, wall painting, partitions' and ceiling panels installation.

6.5.1 Exterior façade components installation

Exterior finishing involves the installation of façade glass panels, painting work. Façade panels are installed using two robots depending on the panels' size. Kajima developed two systems for this purpose. A system installed on the roof (fig.19) to assist in lifting large panels while the final fixation is done by workers from inside the building. It operates from the roof by an operator. Another system is the compact lightweight system (fig.20) which assists in panels' installation while operating from inside the building; this in turn limits the panels' height installed and can be used for small windows and façade beams (Bock & Linner, 2016a).



Fig. 19 (left): Panels' installation system mounted to the roof (Kajima, 2016). Fig. 20 (middle): Panels' installation on-floor system (Kajima,2016). Fig. 21 (right): Façade painting system (Kajima, 2016).

6.5.2 Facade painting

Facade coatings, spraying and full painting stages are performed by Kajima's painting robot suspended from the roof (fig.21). The material supply system is located on the ground floor and supplies material via a hose. It has a sensor designed to detect wall irregularities and facade elements and openings to avoid them. It has a productivity of up to 290 m2/hour (Bock & Linner, 2016a).

6.5.3 Interior finishing tasks

For tile setting, FCL developed a robot that can be programmed, fully or partially automated. It consists of a mobile platform that can move on tiles and has a storage area on board, a control and power supply unit and a suction end-effector for holding tiles (fig.22). It requires a worker to assist in corners and critical areas by cutting and placing tiles and can work with other similar robots 24/7; thus increasing productivity (Bock & Linner, 2016a).

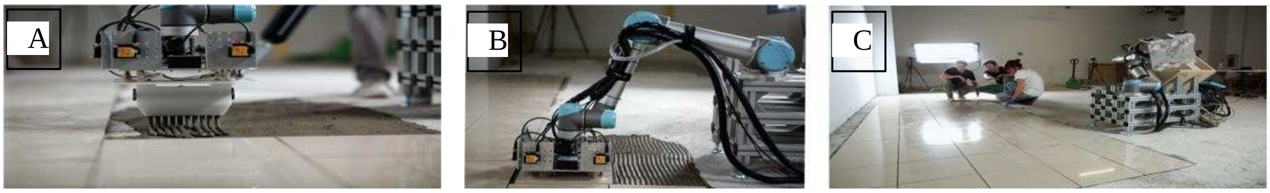


Fig. 22: tiles setting system A) mortar placement, B) tile placement; C) overview of the machine showing tiles placed (FCL, 2016).

The tile setting robot by Hazama and Komatsu consists of a tile setting unit, mortar storage and a gantry system for moving the tiles setting unit along the wall. The tile placement is done in vertical strips (fig.23), strip by strip and only an operator and worker are needed to set the system and prepare the wall for the process. However, the size of the tile is fixed (Bock & Linner, 2016a). Tokyu introduced a fully automated mobile platform system (fig.24) for installing ceiling panels with storage on board. Interior wall finishing can be performed using robots; wall plastering is done by semi-autonomous or assisting robot Anex (fig. 25) which only needs to be positioned by a worker. For fixing light fixtures and fittings, a mobile drilling robot by nlink (fig.26) is used which measures, marks and autonomously drills holes in the ceiling. The robot path

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can be programmed using a BIM file with only manual positioning of the robot by the operator (Bock & Linner, 2016a). MIT developed an automated robot for the partition framing installation (fig.27). It has a storage area for the channels and an efficient manipulator. It consists of two systems; the trackbot for installing C-channels on ground and ceiling, and the studbot for installing studs (Bock & Linner, 2016a).

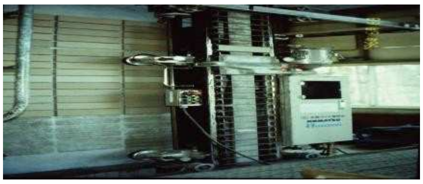

Fig. 23 (left): wall Tiling (Bock, 2016). Fig. 24 (middle): ceiling panel robot (Tokyu, 2016). Fig. 25 (right): wall plastering Robot (Anex, 2016)

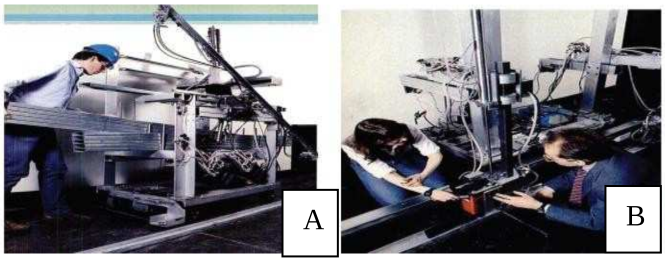

Fig. 26 (left): drilling robot (nLink, 2016). Fig. 27 (right): A) studbot system B) trackbot systems (Bock, 2016)

7 CASE STUDY: FACULTY OF FINE ARTS BUILDING AT PHAROS UNIVERSITY CAMPUS, ALEXANDRIA, EGYPT

The case study illustrates the automation for the faculty of fine arts building at Pharos University in Alexandria. It is a horizontal building divided into three blocks, consisting of a basement, ground floor and seven levels (fig.28). The structural material is concrete and the building footprint area is 3,660 square meters. This case study provides a concept for automating the construction tasks of the building clarifying the changes that would take place in the construction materials to meet the robots' specifications. The facade (fig.29) includes glass panels, windows and a large mashrabiya which will be 3D printed offsite and assembled on-site.

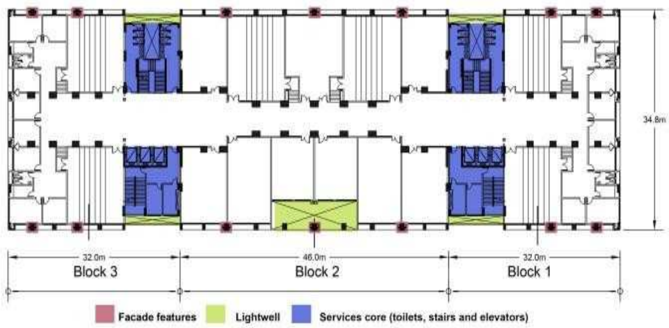

Fig. 28 (left): Building repeated floor plan showing zones (Researchers, 2021). Fig. 29 (right): Building main façade visualization (Youssri Azzam, 2019).

8 METHODOLOGY

This section presents the methodology applied to the case study of the educational building. It starts with the planning tasks and workers' shifts according to the pandemic's constraints and preparing a covid-19 work resume plan. Then performing a survey for tasks that require automation; to decrease on-site crew and time. And finally the development of a concept to apply automation on-site according to the pandemic's measures; starting from pre-construction phases and throughout the on-site tasks. Then a discussion is made to analyse the outcomes of the case study, the requirements to enhance automation application, and the challenges facing automated construction on-site.

8.1 Covid-19 work resume plan

The pandemic imposes changing the way construction projects are implemented starting from pre-construction phases. Social distancing and precautionary measures are a must to mitigate the pandemic effect. Working from home and coordinating through different platforms is one of the solutions to decrease congestion in offices and on-site. It saves time and improves coordination by synchronization of work and data. Virtual reality can be used for training on-site workers remotely. Planning of tasks and workforce would enhance the work sequence and avoid on-site congestion. Also, tasks should be ranked according to the degree of risk of each task and choosing a suitable solution. Some countries imposed preparing a site safety plan by the contractor identifying the necessary measures and precautions on-site, the site access, protective equipment provided, screening, facilities as well as isolation wards in case of infection. Relying on new construction techniques and off-site manufacturing is another solution to decrease time and replace the shortage of on-site workers. A summary for work resume solutions is shown in (fig.30).

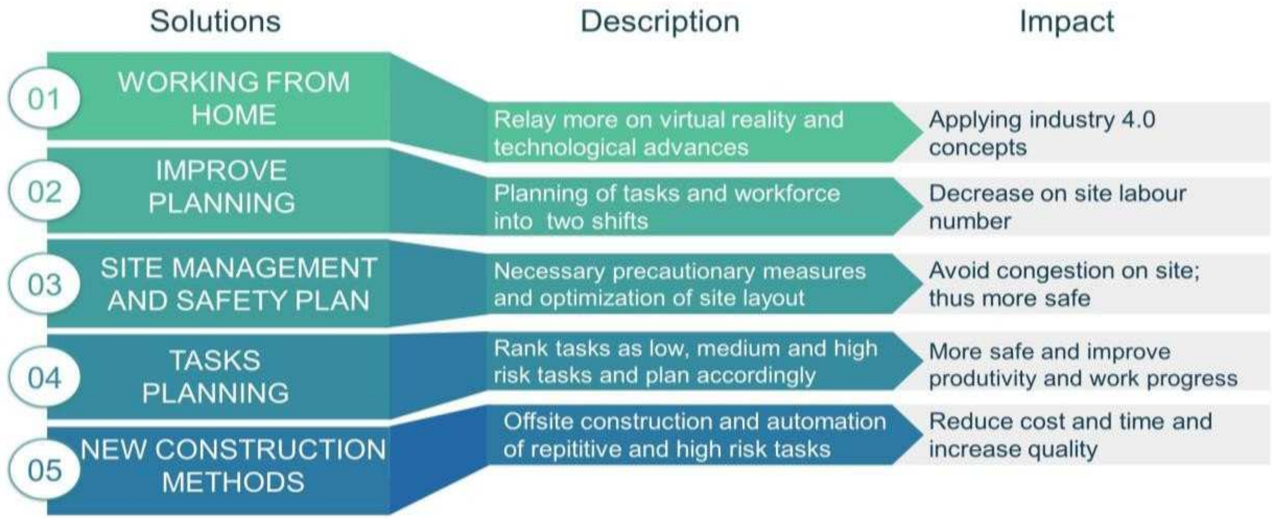

Fig. 30: Solutions for work resume on site and their impact (Researchers, 2021)

8.2 Survey for tasks which require automation

Construction tasks that have a priority for automation are tasks that require a large crew; hence it is a must to reduce on-site workers. Concrete work is an example as it involves several tasks from formwork preparation, reinforcement placement and concrete casting and finishing. Solutions for concrete work include prefabrication of concrete components off-site autonomously and only assembling them on site. Another solution is automation by using robots for each task of the conventional concrete tasks. Automation also involves 3D concrete printing which can be performed using fibre reinforced concrete; hence reducing the need for reinforcement or by placing reinforcement autonomously using robots. Façade finishing work is a high-risk task and accounts for several injuries; thus automation would be safer. Interior finishing tasks require automation as well since it is executed indoor which exposes the workers to the risk of infection.

8.3 Concept development

Applying automated construction during and after the pandemic involves several aspects (fig.31). It starts from the data gathering and work monitoring during construction. This involves construction methods and design requirements to apply automation efficiently. Robot oriented design is a must to adapt to working with robots and manipulators. The major problem during construction is to reduce on-site congestion. This can be achieved by reducing site visits and instead use drones to monitor work on-site. On working with prefabricated components, coordination between on-site construction and components delivery and storage on-site must be planned. BIM links all the phases from data gathering, designing, planning, scheduling to components fabrication and 3D printing industry. In case of limited storage area, the construction consolidation centres are used as it allows storing components in centres or warehouses and acts as a distribution facility and delivers them to the site on time for use without being stored on site.

Fig. 31: Automated construction 4.0 concepts (Researchers, 2021)

8.3.1 Site preparation phase

Excavation and site preparation tasks are executed using mature technologies with add-ons for autonomous operation (fig.4). Digging is done with Tokyu digging robot (fig.2) and excavation using Volvo excavation robot (fig.3).

8.3.2 Substructure work

The building's foundations are composed of piles and a raft foundation on top of the piles. The pile-driving process is performed using the pile driving machine fig. (5). The raft foundation is executed using Kajima's reinforcement positioning mobile robot (fig.6). While concrete casting is done using Kajima's rail-guided concrete distributor (fig.7). Concrete finishing work is executed using Fujita's (CALM) (fig.8).

Foundations walls are 3D concrete printed using Peri COBOD machine (fig.9). Reinforcement work is done by Kajima's reinforcement robot (fig.10).

8.3.3 Superstructure work

For decreasing on-site tasks, columns, beams, slabs and stairs are prefabricated and brought on-site for assembly after being stored in CCC due to the limited site area. The building structure is constructed in three phases, since it consists of three blocks. This in turn prevents congestion on-site. The slab type is precast hollow core slab. The Big canopy on-site factory (fig.11) is used for precast components handling and assembly. Then concrete grouting is done using the compact concrete distribution robot by Kajima (fig.12). The reinforced concrete cores are 3D printed using the COBOD printer (fig.9). The reinforcement is positioned using Takenaka's crane robot (fig.13). Brickwork is performed using SAM100 (fig.15) and fastbrick Hadrian system (fig.14).

8.3.4 Material handling

Obayashi's automated on-site delivery systems as well as Takenaka's unit are used on floors (fig.17 and 18). While Kajima's system is used for materials handling on the ground floor upon arrival on-site (fig.16).

8.3.5 Finishing work

Exterior finishing involves the installation of façade glass panels, painting work. Façade panels are installed using two robots depending on the panels' size. Kajima's system installed on the roof is used to assist workers in lifting large panels (fig.19). For small windows, Kajima's robot (fig.20) is used operating from inside the building. Façade painting is executed using Kajima's painting robot suspended from the roof (fig.21). Interior finishing involves tiles setting by FCL robot (fig.22), ceiling panels' installation by Tokyu mobile platform (fig.24) and installing partitions by studbot and trackbot (fig.27).

Wall plastering is done by Annex system (fig.25) and interior wall tiling by Hazama and Komatsu (fig.23). nLink robot is used for drilling holes in the ceiling for fixtures (fig.26).

8.4 Results and Discussion

The case study presented the application of single-task robots along with on-site factory to automate the construction of the educational building. This involves the use of construction 4.0 concepts to make work and coordination easier throughout the project's phases. The objective of the case study was to prove that automation is a safe solution for the pandemic restrictions without affecting work progress. This will be discussed in the following subsections.

8.4.1 Compliance with covid-19 restrictions

By applying automation, the reliance on on-site crew decreases significantly as almost every system requires a few workers; including the operator and one or two helpers in some operator assistance systems. Touchless equipment is an important requirement after the pandemic; thus autonomous systems are a good choice as they are remotely controlled or automated.

8.4.2 Productivity

Automation increases work productivity and decreases the overall schedule. It allows working continuously in two shifts and some systems can work for a full day. Some systems are used for various tasks by integrating different end-effectors; thus reducing the number of equipment used on-site and avoiding congestion. Automated systems allow performing tasks in parallel which cannot be achieved by traditional working methods due to the need to reduce on-site workers.

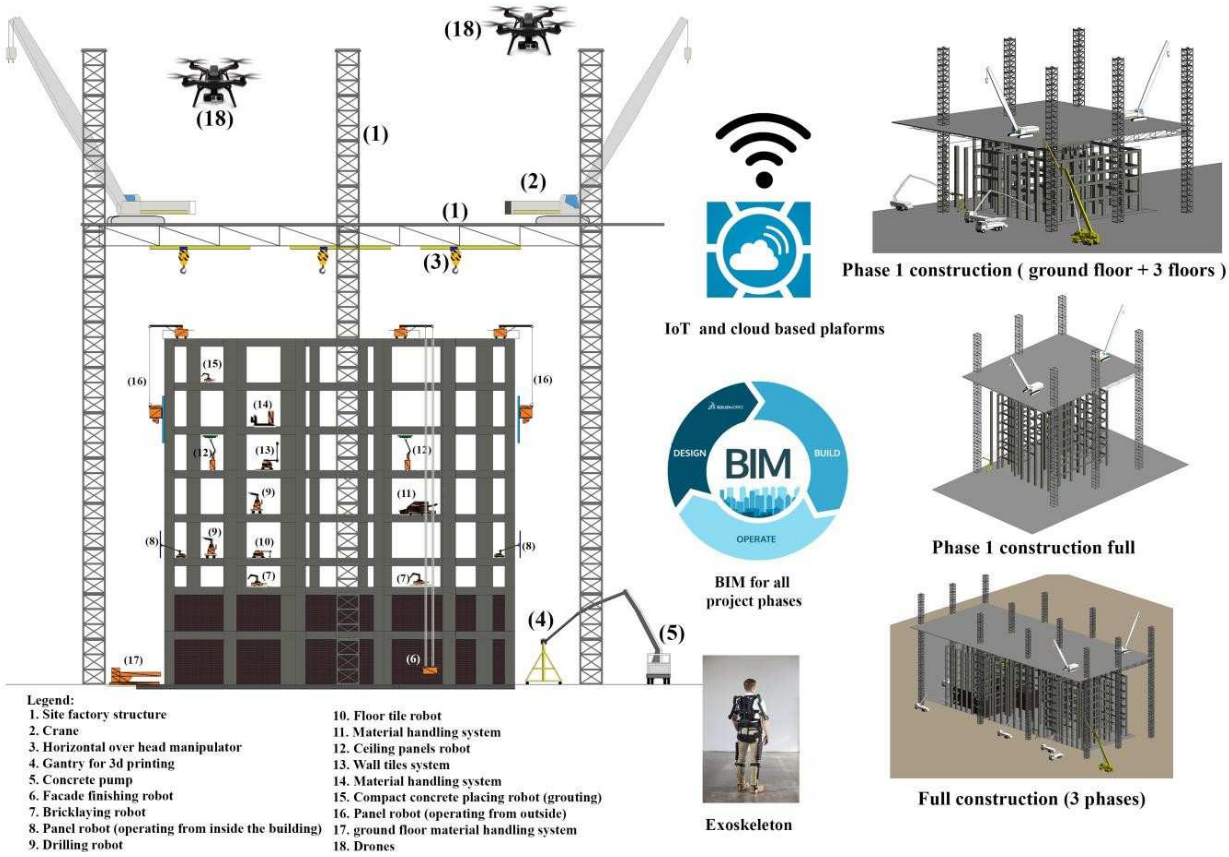

Fig. 32: Building construction progress, robots, systems and technologies used for automation (Researchers, 2021)

8.4.3 New technologies and design considerations

The potential of off-site manufacturing for high-order components as full detailed façade components, or full bathroom modules is expected to increase. Prefabrication of structural components is also gaining attention after the pandemic. This decreases the dependency on professionals to assemble them and allows automated assembly by on-site factories. 3D printing on-site saves time and allows customised designs without using scaffolding, also off-site 3D printing is efficient as it provides a variety of materials and prevents on-site congestion. IoT, connected devices and drones are essential for monitoring work, on-site workers and ensuring social distancing. A summary of the systems used in the case study are shown in (fig. 32)

With increasing automation levels, the design stages become more detailed and complex. The level of detailing increases to avoid errors during execution. To ensure good quality of the produced components, architecture design must cope with robot-oriented design to allow robotic assembly and integration of different systems in on-site factories. Design for assembly and disassembly are new emerging terms that decrease time and waste on-site during construction and deconstruction of buildings. Though the whole system seems more complex than the traditional construction methods, it can be divided into more simple sub-systems and components must be designed accordingly. On-site logistics and robots work cells must be well planned by an expert to avoid conflict between systems operating on-site floor by floor and phase by phase. Due to the lack of on-site storage and the nature of the site, CCC (construction consolidation centres) are used to supply components upon assembly; thus avoiding components damage or improper storage and congestion on-site.

8.4.4 Degrees of automation and construction workers condition

Automation levels vary from operator assistant to highly automated systems, however, full automation is still in the conceptual stage. Although automation decreases the reliance on on-site workers, it does not displace workers completely as automation starts gradually. This allows shifting workers to operators and supervisors on and off-site as well as helping in robotic assembly operations after proper training, so it does not cause unemployment. Due to the high cost of automated systems and shifting to automation, shifting is done gradually and for specific tasks depending on the project’s scale and location. In large scale projects, automation saves money for the contractor and provides high quality and decreases materials waste as well as labor insurance cost. However, in remote and uneven terrain sites, some automated solutions would be difficult to use and to set up routes required for their operation or even to ensure systems and workers safety.

8.4.5 Challenges facing automation application

The high initial cost of robotics and automated systems is among the major challenges facing its application. The lack of trained, educated workers who can deal with advanced technologies is another challenge. Laws and regulations are an obstacle for importing, implementing or manufacturing of advanced machines. The time required for setting up equipment must be considered to avoid delays in the project’s overall schedule. Drones operation must comply with the country’s regulations. The flight zone must be defined for the crew operating the drone showing potential hazards as power lines, high-traffic areas, or high structures and machines on-site which are higher than the drone potential. Coordination with filed crew and work scheduling and planning is necessary to avoid accidents on-site. The complexity of automated systems and their interference in small sites due to improper planning must also be considered.

9 CONCLUSION

Shifting to automated construction and coping with new technologies became essential. The pandemic affected the construction sector by delaying projects and causing financial problems; thus, it is considered a catalyst for automation. Automation of construction tasks and applying construction 4.0 concepts throughout all the project phases is a must to mitigate the pandemic’s effect. It helps decreasing on-site crew and replacing them with operators and helpers assisted by robots. However; in order to apply automation efficiently, planning of tasks and systems used must be considered. Proper planning for tasks, workers, and equipment plays a huge role in resource allocation, decreasing time and costs. Also, a robotics specialist must be involved in the planning of automated systems along with site logistics to ensure the integration of systems during operation. Prefabrication of structural components is expected to accelerate construction progress. 3D printing applications are expected to increase on-site for customized designs, and off-site for components in the facade. This in turn saves time, as only on-site assembly is required. Single task robots planning with on-site factory prevents congestion on-site or interference of systems. Robot-oriented design concepts allow components design for assembly and ensure components payloads according to the robots‘ specifications. However, automated systems and 3D printers’ costs would hinder using advanced technologies. Regulations and codes must be updated to allow using new technologies and importing them.

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CRISALIDE decision support system for urban development: from idea to implementation. Rostov-on-Don, Russia

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1 ABSTRACT

This paper aims to synthesize the results of the two-year experience in implementation of the decision support system for urban development. CRISALIDE project (City Replicable and Integrated Smart Actions Leading Innovation to Develop Urban Economies) started in October 2018 and was one of the very few projects financed between E.U. and Russian Federation through the ERA NET RUS PLUS (ENRP) program. It was also the only financed project in ENRP dealing with urban planning topics in this current E.U. programming period (2013-2020).

The project became possible due to the rising requests for innovations in urban life resulted in a noticeable shift in a political discourse towards the innovative ICT led economy, the new digital technologies, and the smart city policy in Russia. Though new initiatives seem too focused on technological solutions and lack a comprehensive understanding of smart development, they provoke the appearance of public discussions of the mentioned issues in cities, which themselves are the ecosystems for developing innovation. The missing components might be provided from the bottom level by using the place-based approach and implementing smart planning tools responding to the wicked local problems. This assumption lies in the basis of the CRISALIDE project aiming at bringing together technological, social, and organizational innovations.

CRISALIDE was experimenting in the Russian city Rostov-on-Don through a collaborative approach involving E.U. and Russian researchers, creating an innovative digital platform to facilitate the renewal and regeneration of brownfields. The first selected experimental field was the area of the old airport relocated outside of the city. Attracting notable attention of different local and regional actors due to its size, location, marketing potential, and regional significance, the selected brownfield helped involve local experts, activists, and policy-makers to develop an innovation tool and raise a public discussion on urban development. A series of consortium events, new collaborations, and discussions became essential for designing future development scenarios.

CRISALIDE system has an open, flexible structure based on urban ontology. It is a variant of artificial intelligence and will serve diverse issues in different cities. Oriented towards support in three main activities in urban development – new construction, reconstruction, and services provision – the system functions in three different modes. Three modes allow implementing required levels of public participation: from the internal communication within city administration to the public discussion involving all citizens.

Keywords: smart cities, planning for sustainable development, urban innovative inititiatives, urban policy design, DSS, Russia

2 INTRODUCTION: CONTEXT FOR INNOVATIONS

Recent numerous innovations introduced in urban planning are reflections on the fast development of GIS technologies, Big Data technologies, and smart city concept popularisation worldwide. Most of the countries are affected by these transformations, and the cities in different parts of the world become a testing ground for experimentations in applying new technologies in solving a variety of urban issues. Different tools and modeling approaches are being developed to support decision-making in urban planning (Leeuwen & Timmermans, 2006) based on land-use or movement simulation, virtual environment, or augmented reality.

In Russia, in recent years, a shift in a political discourse towards the innovative economy, new technologies, and smart cities solutions is noticeable (Batunova & Trukhachev, 2019) even though the interpretations of a smart city concept by different players depend very much on the field where they operate and focus mainly on the utilities' modernization and energy efficiency (Boykova, Ilina & Salazkin, 2016). This shift is happening on the transition from the administrative command economy to the neoliberal market, accompanied by the changing perception of urban planning.

After the long soviet period of the highly centralized planned economy, the socialist system collapsed, and the following 'no planning period, the state came back to the idea of the planning's necessity, and now it reopens urban planning in new conditions. The 'no planning period on the background of fast economic growth provoked many urban issues existing in the contemporary Russian cities, such as unplanned urban sprawl, chaotic land use, insufficient or ineffective transport, and engineering infrastructure. Urban planning legislation in new Russian history was created from zero (Golubchikov, 2004); it is still in the process of transition and is characterized by many shortcomings. At the same time, several new state initiatives influencing urban development are presented, among which a new housing strategy and two national priority projects – on the comfortable urban environment and smart cities. The smart city concept became an important political slogan in Russia, and the government announced the construction of 50 smart cities to 2025 (Batunova, e. & Trukhachev, 2019).

Innovations appear in many areas, including the integration of new information and communication technologies in the Russian administrative system and the evolution of the e-Government concept performed through three consecutive federal programs (Gritsenko & Zherebtsov, 2021). However, innovations in spatial planning during the same period can be likely associated with the new technologies and information systems implementation. Much less attention is paid to the managerial and policy innovations needed for a city to become smart (Taewoo&Pardo, 2011). Geoinformation systems in spatial planning, land use, or urban infrastructure are considered features of innovations, but in most cases, using new technological tools in urban planning and management does not necessarily lead to the changing approaches towards more progressive ones. Information systems serving to support decision-making processes in the creation of urban strategies and spatial development plans, the formulation of urban policies, the promotion of e-government, the management of urban infrastructures and housing stock or land use management in urban areas emerge as scattered fragments, which integration becomes even more difficult than in the 'pre-digital period'. Supporting decision-making is useless when decision-making lacks wisdom (Batunova, e. & Trukhachev, 2019).

The urban planning system and practices in Russia still have many attributes borrowed from the soviet past, such as centralization, bureaucratization and technocracy (Iyer, 2003), and institutional and social transformations are slow. It is especially evident in the low participation of non-government actors in urban planning decision-making and its weak impact. The new Urban Planning Code enacted in 2004 formally introduced such tools as public hearings that should serve as a tool for the people's involvement in the urban planning process, but in practice, this tool has minimal impact on the final decisions (Batunova et al., 2020). That also depends on the immaturity of the Russian civic society and little experience in public participation in urban development that has still been implementing through a top-down approach.

In such critical for introducing social and organizational innovations conditions, the CRISALIDE project aimed to build innovative solutions through a dialogue between local and international experts, different stakeholders, and actors. At the same time, it also had a practical goal: to develop a digital open and flexible platform as a tool to support the decision-making process in urban planning that would involve a wider range of actors in the decision-making process.

This paper represents the synthesis of the implementation of the decision support system for urban development in the Russian city Rostov-on-Don. It shortly describes the content of three main phases of the project: 1) inception phase: the evolution of the CRISALIDE's concept; 2) planning process activating period and boosting collaboration towards R&D in the involved Russian city; 3) final phase of the delivery of the innovative decision-making tool.

3 CRISALIDE: CONCEPT

The CRISALIDE project started with the idea to enhance the long-term collaboration in research and innovation among researchers, companies (technology providers), and the public sector through the design and implementation of a decision-making tool. The results and the impacts were organized in three innovation domains: 1) organizational innovation(such as new niches for the local, city-based private sector to boost R&D and innovation activities, policy impact to reinforce local and national related policies about collaboration in the field of R&D and innovation); 2) technological innovation and 3) social innovation (enhanced Local Identity to improve social capital, increased climate and environmental awareness to favor communities preparedness, increased ICT development awareness to enhance local economics).

The partnership constellation consists of 6 partners from 4 Era.Net Rus Plus call countries: Russia, Romania, Austria, Greece. CRISALIDE partnership comprised partners possessing relevant competencies to implement project activities and deliver valuable results:

(1) Private organizations skilled in territorial planning (at both local and regional level), as well as policy design - to provide expertise in integrated and sustainable urban and regional development, participatory planning processes and tools: Southern Urban Planning Center (Rostov-on-Don, Russia), URBASOFIA (Romania), CORP (Austria);

(2) Organisations with specific technical knowledge towards ICT systems and IGIS applications – to provide modern and updated technological solutions and digital services in the archaeological environment and ensure a homogeneous approach at consortium level: SPIIRAS (Russia), CORP (Austria);

(3) Organisations with specific knowledge in research and development – to support and coordinate research activities as well as territorial partners in implementing their activities at the local level: NIRD URBANINCEC (Romania) EMaTTech Forestry Department (Greece).

The inception phase was characterized by different analytical and cognitive activities and was realized through context research and innovative development schemes design. In this first step, different analysis methods applied research and knowledge transfer are pursued in the involved city to understand in deeper levelthe city context and achieve the set CRISLAIDE'S objectives.

From the beginning, a strategy of using a place-based approach and implementing solutions to specific planning tasks in the city was chosen, which allowed testing the product during the entire development and implementation process. This approach made it possible to apply the results of theoretical research in practice, to receive feedback from users, and, in turn, enrich theoretical work with empirical experience. When choosing a city for the project's implementation, the essential condition was such case characteristics that would allow further use of the results obtained in other cities. At the same time, the peculiarities of the city development had to form a set of conditions, on the basis of which a wide range of various planning tasks could be formulated, in support of solutions for which the decision-making support system could be tested.

For the realization, the city of Rostov-on-Don, with a population of 1,130,305 people, was selected. Rostov-on-Don is the capital of the Rostov region in Southern Russia and the administrative center of the Southern Federal District. The city is in 10th place out of 1,113 cities of the Russian Federation in terms of population, and its metropolitan area has a population of about 2.16 million people. Rostov actively participates in all national programs and projects. In 2018 the city became one of 36 pilot cities defined in the priority project ‚Smart city 'as municipalities, where Smart City technologies will be introduced.

4 CRISALIDE: PARTICIPATION PROCESS

The planning process and activating – IUP (Innovative Urban Projection) – phase designed and structured the IDSs (innovative development schemes) through participatory workshops. The innovative development schemes were developed together with the key local actors and experts in the selected city Rostov-on-Don. The Innovative Urban Projection stage methods used:

- the local planning process, co-design of IDS through organized events (the organization of workshops in order to assess local urban issues and their solutions through application of ground-breaking planning tools and/or innovative technologies, held by experts);

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- co-design process for the collaborative platform (technical partner together with experts developed the innovative decision-making tool based on the developed IDSs);
- Assessment of the achievements of the workshops prioritization of selected projects promoting innovation and definition of the roadmap for implementation and sustainable maintenance.

The experimental site selected for the CRISALIDE project implementation was the area of the former airport 'Rostov-on-Don' located in the eastern part of the city in nine kilometers from the city center Pervomaysky administrative district. It was defined after the detailed analysis of the existing brownfields within the city borders, the approved city strategy and general plan, and negotiations with the local authority (Fig.1). The airport stopped its operation in December 2017, when the new international airport opened - Platov International Airport. The local planning documents consider the old airport's territory as an internal spatial resource for development years before the actual realization. Thus, the city's General plan approved in 2015 proposed the construction of 1,596 thousand square meters of housing within the plot of 267 ha until 2035. After the new airport construction, the local authority started to promote the area for redevelopment, and several projects have been done, one of which was presented at the Russian Investment Forum in Sochi in 2018.

Fig. 1: Location of potential sites for redevelopment on the territory of Rostov-on-Don.

In the local planning documents, the old airport's territory was considered an internal spatial resource for development also long before the actual implementation of the airport relocation. Thus, the city's General Plan approved in 2015 provided the old airport area to construct 1,596 thousand square meters of housing until 2035. The draft Strategy of Social and Economic Development of Rostov-on-Don defined this area to form a new sizeable multifunctional district: multi- and mid-rise residential buildings, public and business zones, infrastructure development.

The CRISALIDE project was aimed at enhancing bottom-up participation in the urban development process. Research on participation design processes distinguishes four levels of influential participation: communication, consultation, collaboration, and empowerment (Stelzle & Noenning, 2019), and the CRISALIDE focused primarily on the second and third levels of influencer engagement - consultation and collaboration – with the goal of achieving long-term research and innovation collaborations between developers, researchers, technology providers, and the public sector. Through the selection of an experimental area that is an essential site for different types of local stakeholders – authorities, business, or public representatives – CRISALIDE created conditions for the collaborations and public discussions of the area's future (Batunova et al., 2020). It was reached through the organization of the design workshop that is, according to Müller (2003), a kind of "third space" in which different parties communicate with each other in an unfamiliar environment and must create shared knowledge and even the processes of developing this common knowledge. Exploring this "third space" through collaborative design helps build the capacity of both users and developers. Capacity building is the various aspects of the will, knowledge, skills, partnerships, resources, infrastructure, and leadership needed to enhance the ability to plan, implement, evaluate and sustain efforts

From 14 to 18 June 2019, four partners of the CRISALIDE consortium - Southern Urban Planning Center (Rostov-on-Don, Russia), Urbasofia (Bucharest, Romania), NIRD UBANINCERC (Bucharest, Romania), CORP (Vienna, Austria), as well as participants of the project SPIIRAN-Scientific and Technical Bureau of High Technologies (St. Petersburg, Russia) and the Southern Federal University (Rostov-on-Don, Russia) held a one-week workshop on the topic "Redevelopment of urban areas" with the participation of representatives of the State Duma of the Russian Federation, Rostov-on-Don City Duma, Administration of the Rostov Region and Rostov-on-Don municipality, the Chamber of Commerce and Industry of the Rostov Region, developers, public organizations, architects, urbanists and ecologists of Rostov-on-Don. The event was held in the main building of the Southern Federal University in Rostov-on-Don. The workshop consisted of six thematic three-hour sessions with the participation of local experts and the final seventh session with the participation of the consortium partners. More than 30 experts and specialists of various profiles took part in the event (Driedger et al., 2007).

The participatory workshop was organized with a dual purpose: 1) to lay the foundation for the design of a decision support system by mapping existing knowledge and collecting justifications and 2) to develop technical and local requirements for an innovative decision-making tool. Thus, based on a set of key performance indicators (KPIs) that have been discussed and agreed upon with a multi-stakeholder group, the system will provide decision-makers with a set of values based on smart decisions and a comprehensive quality of life formed in the process of urban redevelopment.

The workshop methodology was developed by partner Urbasofia (Bucharest, Romania) and was clearly linked to the collaborative design cycle, which includes the following steps:

- identification of (local) problems and needs in relation to (global) problems;
- mapping of relevant stakeholders;
- collection of evidence (collection of relevant data);
- identification/mapping of resources (opportunities and threats);
- determination of expected results;
- idea generation (collective brainstorming);
- definition of actions (prioritization of actions);
- appraisal.

The workshop "Redevelopment of Urban Areas" held in Rostov-on-Don confirmed the correct choice of the approach to the joint design of the decision support system and made a significant contribution to the formation of the substantive part of the decision support system in the field of urban planning. The CRISALIDE project created an opportunity to enhance dialogue between public and local authorities and integrate bottom-up initiatives into the local decision-making system. The practice of public involvement at the pre-design stage is uncommon in Russian cities. It, therefore, is an innovation that allowed consolidating public opinion, taking into account the various interests of the present and future periods, including most effective local development resources in the use and launch processes at the local level that activates socio-economic development (Batunova et al., 2020).

5 CRISALIDE: IMPLEMENTATION

The third implementation phase focused on increasing the capacity of local actors through the implementation of the innovative decision-making tool.

The system of intelligent decision-making support for urban environment management is primarily intended for the integration of decision-making processes in the field of creating urban strategies and spatial development plans, formulating urban policy, promoting e-government, managing urban infrastructures and housing stock, retraining production areas and their development (science parks, incubators, a network of clusters of small and medium-sized enterprises). CRISALIDE's innovative decision-making tool is a software and hardware complex based on intelligent GIS (IGIS). IGIS provides the ability to integrate maps of various formats, implement a scenario approach in urban development modeling, 3D modeling, support for 2D modeling, support decision-making based on expert knowledge, monitor changes and assess the possible impact of decisions on the development of the urban environment.

CRISALIDE system designed as an open, flexible structure based on urban ontology. It is a variant of artificial intelligence that will be able to serve diverse issues in different cities. The system is based on a digital model of the city, created by the project team on the basis of the urban ontology developed during the first stage of the project. Ontology in information technology is understood as a description of the subject area using a conceptual scheme (Fig.2). A conceptual schemy is a data structure containing all relevant classes of objects, their relationships, and rules (axioms, restrictions) adopted in the area under consideration (Sowa, 1995).

Among the advantages of using ontologies to represent a model of the urban environment, the following should be noted:

- consistency: ontology presents a holistic view of the urban environment as a subject area;
- uniformity: the material presented in a single form is much better perceived and reproduced;
- scientific nature: the construction of an ontology allows you to restore the missing logical connections in their entirety.

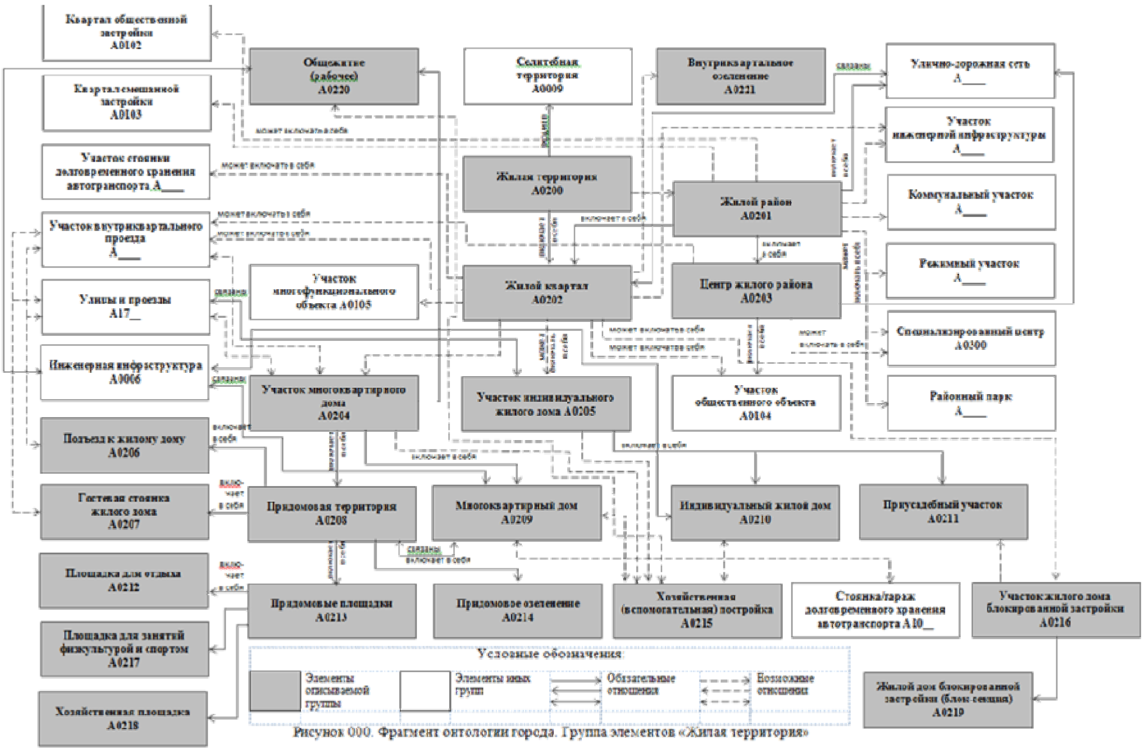

Fig. 2: The fragment of city ontology. The group of the elements' Residential area'.

The developed for the CRISALIDE system ontology proceeds from the division of the city into four main subsystems: spatial, economic, ecological, and social. The urban ontology is a description of the main entities of the subject area with which an expert (knowledge specialist) works in urban development. The ontology consists of classes describing basic concepts (for example, School, Kindergarten, Shopping Center, etc.) and ontology objects related to specific schools or kindergartens (for example, kindergarten № 5). Each ontology object has properties that allow it to be used for solving computational problems; the ontology object takes the set of properties itself from the class, and each object has its own values. Also, ontology objects have connections with other objects, which allows applying various methods of logical inference. The system allows supplementing and editing the ontology based on expert opinion, adapting it to specific tasks. Editing of ontology objects occurs centrally from the ontology editor without using inconvenient and often complex tools for working with databases (or files) directly

Oriented towards support in three main activities in urban development – new construction, reconstruction, and services provision – the CRISALIDE system functions in three different modes. Three modes allow implementing required levels of public participation: from the internal communication within city administration to the public discussion involving all citizens (see Fig.3). Those three modes were defined during the participatory design process described in the previous chapter.

The first mode of functioning that had been implemented during the development period is the PROFESSIONAL MODE. This mode is oriented to the internal use of the tool within the city administration and involves the participation of a decision-maker and a professional analyst working in the structure of the Administration. In this simple scheme, a decision-maker gives the task to a professional analyst who works within the system requesting, if necessary, additional data from different departments of the Administration and information systems if the CRISALIDE database does not contain the necessary information.

The second mode of functioning is the EXPERT MODE which is planned to be developed at the next stage of the system's implementation. This mode implies the involvement of the expert community in the decision-making process. The experts in this mode can formulate the issues themselves; they can detail the requirements for the issues' solutions to change the calculated coefficients. They are provided with a private chat for communication.

In the final version of the system, the third, PUBLIC MODE, will be implemented. It should be realized based on a web portal, where everyone can have access. Citizens can express their proposals on the issues solving, and they can model the parameters of the urban planning solutions. The best (from the point of view of the system) solutions can be displayed on the portal

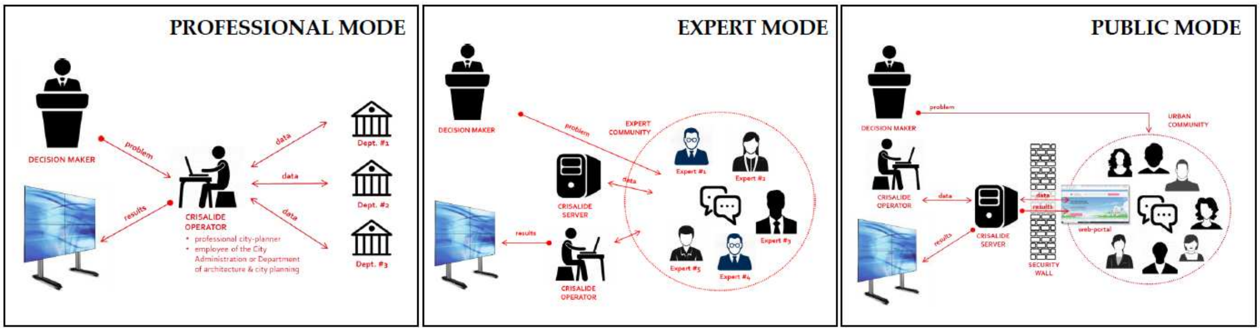

Fig. 3: Three modes of the CRISALIDE system operation.

The operation within the system differs according to three main processes in urban development in which the decision-making support should be realized: new construction, reconstruction, and services provision. Fig.4 demonstrates an operational model for the 'new construction' task.

Depending on the task, the CRISALIDE system proposes different algorithms in new construction, redevelopment, or assessment of services provision. All algorithms include three main phases: data imput, modeling, and results presentation.

Unfortunately, the pandemic situation created obstacles and slowed down the process of the implementation: the final steps, including system testing and assessment, should still be realized. However, the system has been registered in the Russian Federal service for intellectual property and received a patent.

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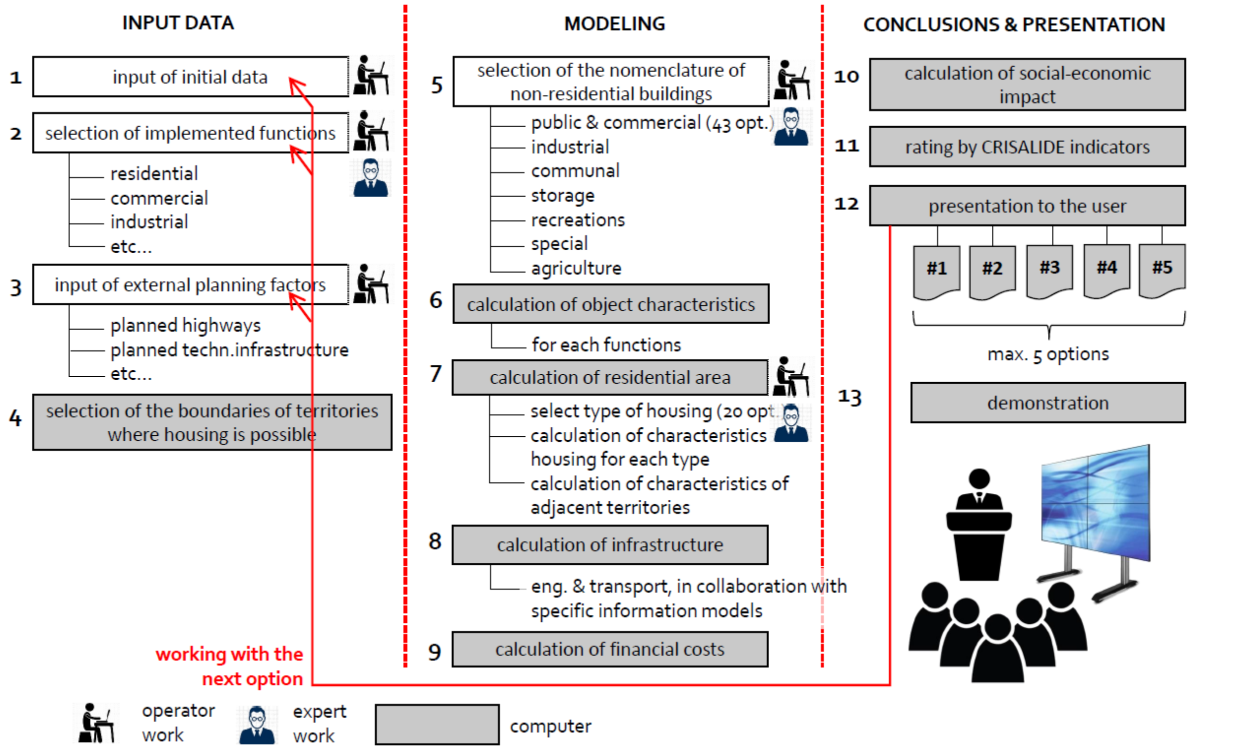

Fig. 4: Example of the operational model for the new construction.

6 CONCLUSION

The contemporary transformations of the Russian national policy brought to life the development of a smart city concept in Russian cities, which is still in a very initial stage but became a driver for the numerous initiatives in this field. CRISALIDE project (City Replicable and Integrated Smart Actions Leading Innovation to Develop Urban Economies), being of such initiatives, became one of the very few projects financed between E.U. and Russian Federation through the ERA-NET RUS PLUS (ENRP) program and the only financed project in ENRP dealing with topics related to urban planning in this current E.U. programming period (2013-2020).

The CRISALIDE project used a way of working on the cities that is very distant from the ordinary practices operated in Russia, building the solutions from the bottom, working with the stakeholders in identifying the problems to be faced, and defining the figure of the planner as that of a mediator and facilitator of complex processes. The CRISALIDE project, being oriented to developing an innovative digital platform, created an opportunity to introduce social and organizational innovations in urban planning through a participatory bottom-up approach. The digital dimension is an arrival point of an actual participatory planning process (Elisei, Batunova & Draghia, 2019).

Experimenting with the first selected experimental field – the area of the old airport relocated outside of the city – the project involved local experts, activists, and policy-makers in developing an innovation tool and raising a public discussion on urban development. A series of consortium events, new collaborations, and discussions became essential for designing future development scenarios.

The central part of the CRISALIDE innovative decision-making tool is a knowledge base that includes a set of ontologies describing objects of the urban environment and the relationship between them (such as transport infrastructure, engineering communications, residential areas ore public areas). Another component of the knowledge base used is a set of objects - elements of the urban environment.

Designed as an open, flexible structure based on urban ontology, the CRISALIDE innovative decision-making tool is oriented to integrate decision-making processes in the field of creating urban strategies and spatial development plans, formulating urban policy, promoting e-government, managing urban infrastructures and housing stock (facilities and utilities, regenerating residential areas), re-qualifying productive areas (renovation former industrial zones, temporary use of vacant buildings) and their development (science parks, incubators, a network of clusters of small and medium enterprises), as well as land use management in urban development areas.

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Cycle4Value: a Token-based Incentive System to Promote Cycling

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1 ABSTRACT

Despite various measures to promote cycling, the overall proportion of journeys taken by bike in Austria has improved only slightly in recent years. As part of its mobility strategy, the Austrian Federal Government has set itself the target of doubling the proportion of journeys taken by bike in in 7 years. To this end, motivational or behavioural approaches should be preferred to costly infrastructural measures. In this context mobile apps for tracking but also for monetising users' own data – as a technological manifestation of the "quantified self" – are developing rapidly. Sweepstakes and even performance-related rewards are booming in many areas. At the same time, however, there is increasing awareness of data protection in Europe. In this respect, blockchain technology has great potential for handling user data due to its decentralisation, transparency and security (Buhl et al., 2017). Applications on the blockchain are disruptive innovators for a wide range of applications, from transaction processing to land register entries to logistics chains. In all these, data can be stored using decentralised, unforgeable blockchain records (Hopf & Picot, 2017). Applying such innovative measures can also support cycling promotion with all its associated benefits in reduced emissions, positive health effects and reduced infrastructural costs.

The solution envisaged in the project reward cyclists for regular cycling with so-called "Cycle Tokens". The key technologies – machine learning and blockchain – present an innovative solution for the validation of routing data and transaction processing. As proof of concept, it is tested whether and how a safe and transparent process of value generation for regular cycling can be created via a utility token, to translate the macroeconomic effects of cycling into value units.

Keywords: Machine Learning, Blockchain, Cycling, Gamification, Nice Rides

2 INTRODUCTION

Ten years ago at the peak of the gamification hype, the research project "Nice Rides" targeted the promotion of bike commuting in the (sub-) urban area. While the primary goal was to implement a new routing algorithm allowing the choice between safe, time efficient and attractive routes, Nice Rides integrated a motivational framework with gamified elements to achieve a change in long established behavioural patterns (i.e. not choosing the car for commuting). The target group was directly involved in the design of the gamification framework as well as in the optimisation of the routing algorithm regarding the safety and attractiveness of bike routes. Users were encouraged to rate junction points and cycling pathways on an interactive map running on mobile and desktop clients. The gamification framework implemented mechanics like points, achievements and challenges such as "Cycle2Free" – thus enabling users to unlock premium features of the Bike Citizens app. Ten years on from Nice Rides we are working on the next iteration of a tokenised incentive model for sustainable mobility. In Cycle4Value, a transparent and low-threshold reward model for promoting cycling based on blockchain technologies is currently being tested in practice. The economic, health and ecological benefits/effects of cycling are presented simply and, after a plausibility check using machine learning, converted into a real value (Cycle Tokens). These value units are stored in a digital wallet and can be remunerated in a test marketplace. The research project surpasses conventional incentive systems because, on the one hand, both the storage of the value units and the redemption process are decentralised, tamper-proof and transparent and, on the other hand, the real economic benefit of active cycling is fairly monetised.

2.1 Practical Background

Despite various measures to promote cycling, the overall share of journeys made by bicycle in Austria has changed only slightly in recent years (Tomschy and Steinacher, 2017; Illek and Mayer, 2013). In line with its mobility strategy, the Austrian federal government aims to double the share of journeys made by bicycle in seven years. In addition to infrastructure, motivational and behavioural approaches in combination with technological innovations play a central role in achieving this ambitious goal. The positive effects of cycling on a collective and individual level (e.g. reduction of air and noise pollution, reduced land use, health-promotion, improved and socially just mobility), especially when substituting car journeys, have been proven in numerous studies (Bracher et al., 2002; Macdonald, 2007; Schäfer and Walther, 2008; Litman, 2003). Cost-benefit analyses, among others, proved to be a promising approach to quantify the ecological, economic, health and traffic benefits of cycling. While there are various incentive approaches to promote cycling, which primarily pursue an event character and are based on the distribution of prizes, Bike Citizens has already taken the first step towards a performance-based bike currency (Finneros) in the course of the research project Nice Rides. However, a transparent and tamper-proof solution for validation, storage and redemption has not yet been implemented. This is where the Cycle4Value framework comes into play, by utilising machine learning and blockchain technologies.

2.2 Motivational Framework

Cycle4Value develops and evaluates a blockchain-based incentive system, based on complementary integration of the transtheoretical model (Prochaska et al., 2009). In order to change human behaviour, it is necessary to understand the underlying behavioural processes. Many theories of motivational psychology and behavioural science have attempted to describe and explain mobility behaviour, including the theory of planned behaviour (Fishbein and Ajzen, 1975), the norm-activation theory (De Groot and Steg, 2009) and the self-regulation theory (Bamberg et al., 2011). In line with (Prochaska et al., 2009), the self-regulation model (Bamberg et al., 2011) claims that behaviour changes through a time-ordered sequence of stages, each stage involving various cognitive and motivational difficulties.

Within our motivational framework monetarised incentives will be triggered using smart contracts powered by the Blockchain as a Service (BaaS) platform Ardor. By providing information and action-related knowledge (Staats et al., 2004), setting goals (Locke and Latham, 2002), comparison and competition with other users, and rewards and feedback (Fujii and Mackey, 2009; Froehlich, 2011), mobility behavior is influenced in a targeted, playful manner. In addition, incentives enhance behavioural control and support positive aspects of eco-mobility (Ajzen and Manstead, 2007). The major advantage of this token-based incentive system is that the individual interventions are fed directly to individual users, increasing motivation and the likelihood of voluntary and longer-term behavior change. The main goal is to achieve a change in established behavioural patterns by encouraging positive attitudes and awareness regarding the economic, ecological and health-related effects of cycling. Through the integration of modern ICT technologies such as a token-based incentive system and plausibility algorithms supported by artificial intelligence and machine learning, target groups will be rewarded with Euro pegged utility tokens for participating in field tests in Vienna, Graz and Krems (Austria) as well as Berlin (Germany). Based on a meta-analysis, the value for each token is defined as 1.37 Euro per kilometre (more details can be found on https://www.cycle4value.at and in our previous paper (Seewald et al., 2021).

2.3 Blockchain Technology

(Pfeiffer et al., 2020) show that blockchain technologies are a valid way to secure gamification frameworks and their ecosystems. The authors also provide insights into innovative consensus algorithms and their vital ability to monitor multi-chain processes. In this context (Komiya and Nakajima, 2019) examine consensus algorithms as a reward system. They introduce their Proof-of-Achievement (PoA) approach, an algorithm optimized for blockchain games which focusses on the number of tasks achieved in the game. Similarly, (Yuen et al., 2019) perceive consensus algorithms like Proof-of-Work (PoW) as a bottleneck for games. Their proposal is called Proof-of-Play with a focus on peer-to-peer solutions. Along with Proof of Stake (PoS) as the consensus algorithm featured by Ardor, an environmentally friendly consensus method is used within Cycle4Value to verify all transactions, while at the same time ensuring connectivity to ERC20 protocols. When using PoS a mixture of volume (stake), online time and random components determines whether a node validates transactions. This makes it possible to operate the blockchain in a more energy-efficient way. In fact, a Raspberry Pi Zero is enough to operate a node in the network.

2.4 Cryptoeconomics

Cryptoeconomics is an emerging field of economic coordination games in cryptographically secured peer-to peer networks (Voshmgir and Zargham, 2020). This field was bootstrapped following the appearance and popularisation of the Bitcoin network, which runs a protocol for a Peer-to-Peer Electronic Cash System (Nakamoto, 2019). Transactions in the Bitcoin network are based on a newly created unit of account inherent to the protocol and governed by a set of simple and deterministic rules. The detachment of this unit account from anything outside of the system and its rigid issuance policy led to the creation of a digital token, the value of which – when denominated in a commonly used unit of account like the e – is very volatile, with swings of sometimes more than 10% per day. The volatility of Bitcoin and many digital assets which followed led to a widespread belief that this characteristic is inherent to digital assets based on cryptoeconomic protocols. This is however not the case, as the emergence of stable coins such as Bank (2019) showed. The Ethereum protocol, first described in a 2014 whitepaper (Buterin et al., 2014), popularised the idea of cryptoeconomic systems with support for fully programmable smart contracts. This led to a plethora of innovations in the digital assets space and inspired the idea of mapping the economic benefits of cycling to such a digital asset.

One important consideration for such a token-based incentive system which rewards cyclists with theoretically cash-equivalent tokens is, of course, fraud. Especially for large stakeholders like cities, it is very important that incentives not be misallocated as otherwise the expected benefits may not materialise. In fact, one of the main obstacles to wide distribution of such incentive systems is exactly this capacity for fraud, and large stakeholders have taken this issue as an argument against the wide deployment of such systems. We will describe our approaches to deal with this issue in section 3.4.

3 METHOD

3.1 Research Questions

The primary aim of the Cycle4Value research project is to increase the awareness of the positive effects of cycling, the acceptance of cycling as a means of mobility and the implementation of cycling as a habit, which will primarily support the subsequent ambitious transport and health policy strategies.

The research questions are as follows:

(1) Is a tokenised incentive framework able to alter attitudes towards cycling and improve awareness of the positive effects, as well as alter behaviour (cycling as a habit)?

(2) Do users and stakeholders see the monetised value of cycling as a fair reward?

(3) Can the legacy ad-hoc plausibility model of the Bike Citizens Beta App be replaced by a machine learning system trained on similar data?

(4) Can the legacy ad-hoc plausibility model of the Bike Citizens Beta App be replaced by a pre-trained transport-mode-detection model?

(5) Can such a system be made and kept cheat-proof indefinitely by leveraging artificial intelligence and machine learning techniques, as well as continuous retraining?

(6) Can such a system be made and kept cheat-proof more simply (using captchas or similar techniques), by preventing automated generation of large numbers of accounts by bots?

(7) How can cheating detection techniques be improved "on the ground", when it is unlikely that ground truth data on cheating techniques is available in a timely manner (excepting deliberate challenges to the user base)?

Research questions (1) and (2) are addressed within this paper (e.g. in Section 3.1); (3) and (4) were already addressed in (Seewald et al., 2021) and will be summarized and slightly extended in Sections 2.4 and 3.2; (5), (6), (7) will be only partially addressed here and are to some extent left open for future work as a definitive evaluation is not yet possible within our project.

3.2 Research Material

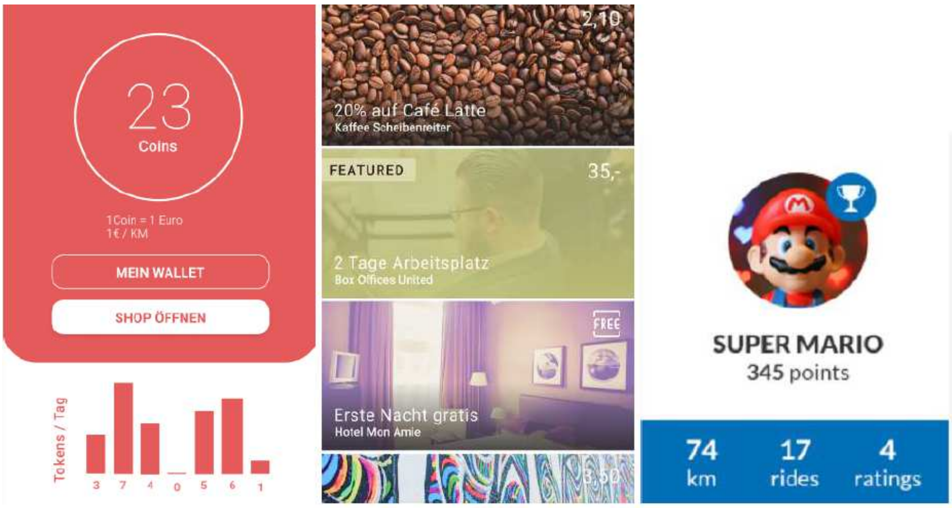

Fig. 1: Left, Centre: Cycle4Value dashboard and marketplace; Right: Nice Rides dashboard.

The Bike Citizens Beta App, which has been extended by new features in relation to the token-based reward system, serves as the object of investigation. During the beta test, aspects of usability and acceptance by users and stakeholders were surveyed by means of an online questionnaire. In addition, users were recruited from the Bike Citizens network to actively try to outsmart the existing routing algorithm. After a previous marking, recorded tracks are marked as fake tracks. Figure 1 show the Cycle4Value dashboard as well as the marketplace, and on the right the dashboard that was implemented in Nice Rides. While we are currently pursuing the token-based reward approach, the previous project relied heavily on established gamification elements such as points – the so-called “bike impact score”, badges and challenges.

3.3 Framework

Figure 2 shows the incentivisation approach followed in Cycle4Value. Where Nice Rides used an abstract point system including digital badges, in Cycle4Value every kilometre cycled is converted into a cycle token, based on a formula that considers individual and collective benefits of cycling. Before being transferred to a digital wallet, the registered route data is checked for plausibility using machine learning. The wallet serves as a frontend, where the user can view the current status at any time. The Cycle Tokens earned in this way serve as vouchers for a marketplace supplied with incentives from various partners such as shops, public transport providers and cultural institutions.

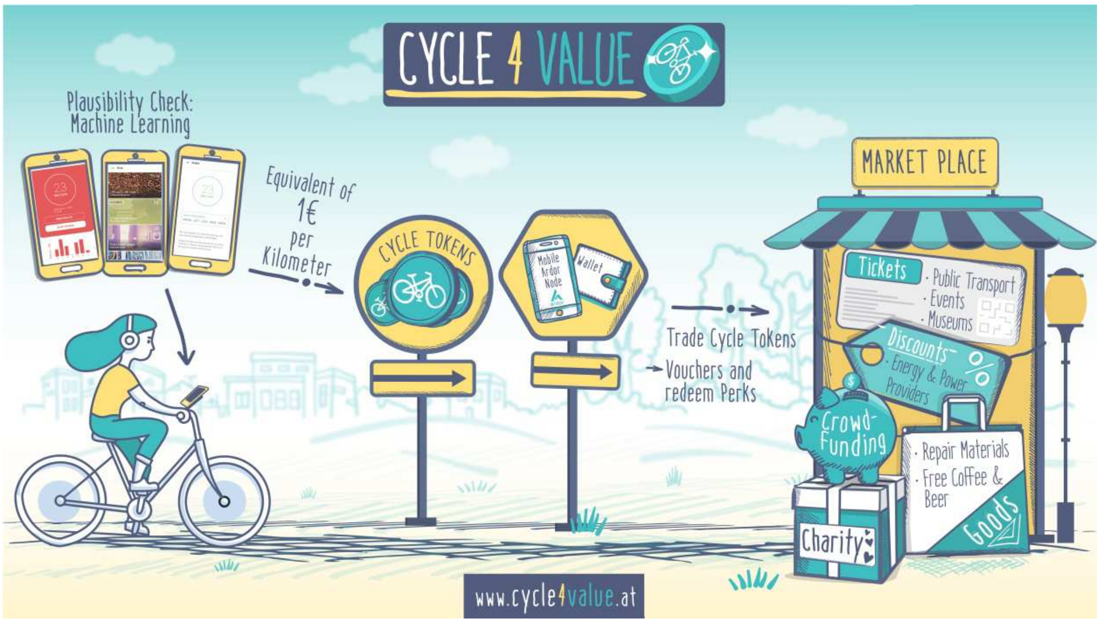

Fig. 2: Incentivisation approach followed in Cycle4Value

3.4 Cheat Proofing

To investigate cheating and fraud detection – and thus cheat-proof the system – we previously analysed an existing ad-hoc legacy system which tests for the related concept of track-based cycling plausibility – created mainly to prevent people uploading noncycling tracks. In (Seewald et al., 2021), we have shown that the results of a legacy model for plausibility detection of cycling tracks can to a moderate extent be reconstructed by a classically trained rule-learning model with handcrafted features, as well as to a somewhat lesser extent by a pretrained transport mode detection (TMD) model, even though the latter was trained on a completely different dataset.

To better compare both measures, we split the original plausibility values of 0-100 into five (almost) equally large intervals: [0;20); [20;40); [40;60); [60;80); [80;100] and computed arithmetic mean and standard deviation of the new plausibility measure over each interval. Fig 3 shows the results, and the same values averaged for each possible legacy model plausibility as a Raw Mean. The latter roughly corresponds to a ROC curve. The mean TMD-derived plausibility measure increases strictly monotonically from the lowest to the highest interval. Although standard deviation is initially high, it shrinks for higher intervals. A recalibration of the TMD model or an adaptation of the threshold for plausibility could improve the match considerably. The Pearson’s correlation coefficient between legacy and TMD measure is 0.31, indicating a weak to moderate correlation. Note again that the TMD model has not been trained on any part of our datasets, so these results are quite surprising and indicate that TMD models are a good starting point for a trainable plausibility – and possibly also cheating – detection system. Note also that the legacy model was not explicitly designed to detect cheating and fraud, but rather to increase the quality of uploaded data by ensuring that only bicycle tracks were accepted. We are currently improving on this work to build the final track-level fraud detection system.

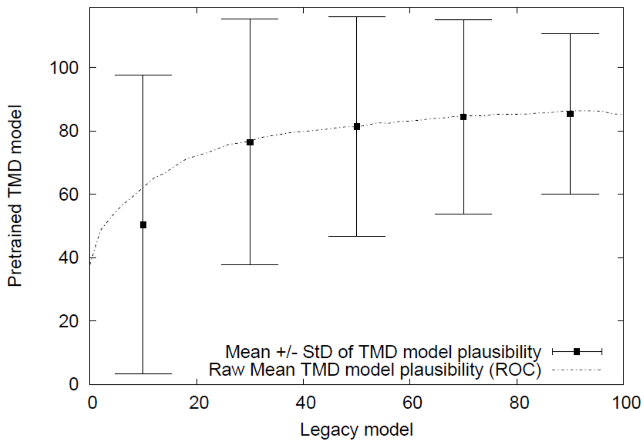

Fig. 3: Comparison of the ad-hoc plausibility (legacy) model with transport-mode detection (TMD) model.

However, as will be seen later in section 4.2 not all types of fraud are detectable at track-level. We also have to consider attacks involving multiple tracks, such as using multiple phones on a single bike, which can only be detected at multiple-track level. It is necessary to build a multiple-track-level fraud detection system as well.

4 RESULTS

4.1 Expert Survey

14 experts from the city administration, technical universities and transport planning took part in an online survey. 37% of the participants considered gamification to be “over”, and alternative incentivisation approaches as preferable when promoting cycling. Vouchers, giveaways and initiatives such as “Cycle2Work” were given as examples. None of the stakeholders currently use a blockchain-based incentive system. Regarding the value of a cycled kilometre as basis for a cycle token, values between 0.26 and 0.5 Euro were seen as most appropriate (57%) followed by 0.51-0.75 Euro (29%). Considering that the sum of 1.37 Euro as derived in Cycle4Value includes both individual and collective benefits, there is a good match with this expert view, if 50% of the value is granted to the user and eligible for collecting rewards (= 0.68

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Euro which take into account the collective benefit). In terms of the positive impact of cycling, the greatest relevance was attributed to environmental benefits (67%). However, the meta-analysis carried out showed that the greatest benefit actually comes from health-related effects, although the ratio can shift flexibly depending on the CO2 price per ton. 83% see the incentive system as valid means to promote cycling.

4.2 Cheating and Attack Modes

The semi-monetary compensation in form of tokens which are potentially convertible to cash makes cheating the system (respectively fraud) much more likely. While the number of false negatives (Type II errors, undetected cheaters) should be small, the number of false positives (Type I errors, i.e. people wrongly classified as cheaters) should also be small to prevent disillusionment and reduced trust in the reward system. To some extent this can be optimised by using learning algorithms that output confidence values and by choosing appropriate thresholds. In our latest model, the number of tokens generated corresponds to the square root of cycling kilometres per track and is cut-off at two levels: at most 4 tokens per track, and at most 8 tokens per day, yielding some buffer against attacks by limiting payoff for a single user. However as this is probably not sufficient, we have collected six types of possible attacks on the system. This list may be of course be incomplete and is intended only as a starting point.

(1) Uploading tracks from sports events (e.g. cycle racing)

(2) Uploading tracks from delivery services

(3) Uploading tracks made with other vehicles (may include e-bikes)

(4) Using more than one phone on a bicycle

(5) Uploading automatically generated fake tracks

(6) Uploading modified real-life tracks

Attacks (1), (2) and (3) are not a large problem. In (1), the restriction of the maximum number of tokens per track and day – mentioned above – severely restricts the possible gain per user. (2) should not yield any payoff as these bike rides would happen anyway even without incentives. However if only a single person profits, it remains a minor problem. We could address it by either filtering out common bike routes which

could be applied to attack (1), should too many similar tracks be uploaded. Attack (3) should be easily detectable by the fraud detection system although the differentiation of e-bikes is still an open problem.

The more interesting cases are attacks (4) to (6): (4) should be detectable – especially once we have gyroscope and accelerometer sensors – by aligning multiple tracks and determining their similarity. The local sensor movements on these tracks will be extremely similar, but this can only be detected on the level of multiple tracks, and not from a single track. We will address this in future work as such data has just become available.

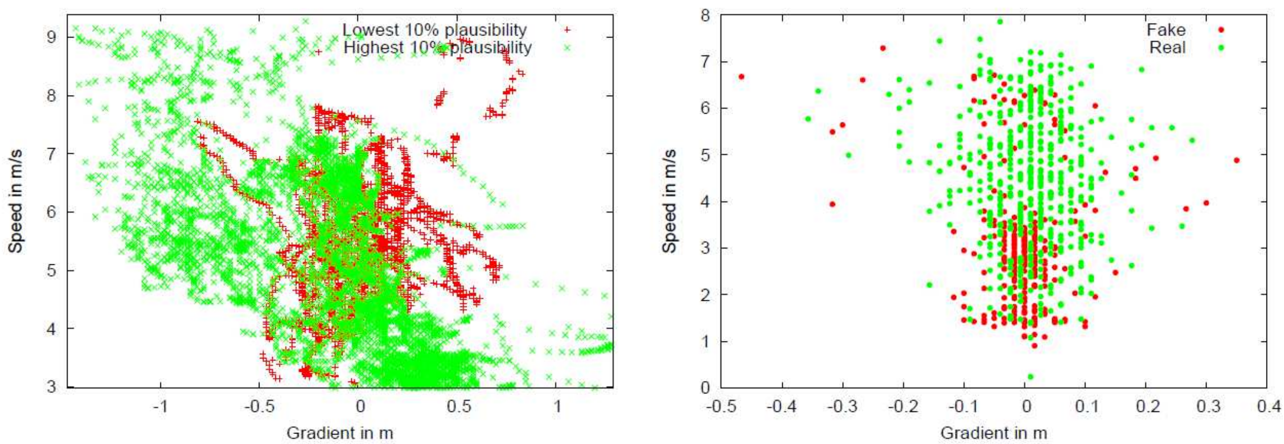

Fig. 4: Left: Scatterplot of gradient vs. speed, coloured by 10% lowest and highest plausibility, on historical data; Right: Same scatterplot on first batch of competition data with by-track user-defined classification Real and Fake.

For attack (5), it is important that not all details of the system are known, otherwise engineering a reverse system is made correspondingly easier. However, since we focus on machine learning techniques throughout, it is likely that creating realistic fake tracks will be very hard, and people will mainly resort to replaying modified existing tracks (6), which should again be detectable by their similarity. Also, only (4) to (6) – and (3) when combined with (4) – ensure potentially unlimited payoff, which is surely the most tempting fraud scenario. It should also be noted that only attacks (3) and (5) can be addressed at single track level with models described here. The other four attacks must be addressed at the level of multiple tracks and will need a completely different approach, although likely one also partially based on artificial intelligence and machine learning techniques. As the most tempting attacks call for many users to be automatically created, another option may be to simply make user registration non-scriptable, e.g. by using captchas or requiring a short cycling sequence with pulse rate (for example, by using the front smartphone camera and pulse-by-face). As this list may be incomplete, we are currently running a competition for cheating with appropriate incentives before deploying the system widely. This should give us sufficient data on other scenarios not considered here. As first result, we obtained two fake tracks which the legacy plausibility system classifies with maximum plausibility.

Fig. 4 shows the results. It seems that for the competition tracks, the distribution of gradient vs. speed is much more similar than for historical data which indicates that new unique attack modes may possibly be found in the newer data.

5 DISCUSSION

New technologies (e.g. navigation and routing apps) in combination with incentive systems (e.g. gamification) are becoming increasingly popular within the cycling community. However, there are still many open questions – for example, how to leave the level of abstract and often gamified rewards and deliver real rewards; and what their underlying value could be. This is mainly related to the problem of quantifying the costs and benefits of cycling in monetary terms and ensuring the quality of tracking data. Privacy concerns also play a significant role here, as sprawling, unrestricted tracking & exploitation methods generate sceptical criticism.

Cycle4Value therefore explores the use of blockchain technologies based on digital tokens to translate track data into value units. In this way, the entire process of distribution, storage and redemption of Cycle Tokens can be mapped and automated. Thanks to blockchain technology, all accounts can also be secured against fraud and hacks. Since each “cycled” token appears once and uniquely as a public entry on the blockchain, it also has a unique, ideal value. This leaves behind the purely digital incentive level of common gamification approaches and gives cycling a real value.

Another innovation in the project is the use of machine learning for plausibility checks of registered cycling trips or cycling routes (“tracks”). In contrast to ad-hoc code, which typically uses highly predictive features (e.g. maximum acceleration and speed) and is thus relatively easy to circumvent by suitable countermeasures (e.g. driving slowly, controlled acceleration), in machine learning the learned model will typically use a large number of slightly predictive features, making it significantly more difficult to intentionally cheat the system. Another advantage of a machine learning system is that it can be retrained if new attack types are found and thus can remain useful much longer. However, as we mentioned a single-track prediction is not sufficient. It is also necessary to compare multiple movement patterns using appropriate distance metrics to prevent “multiplication” of “genuine” bike rides (e.g. using multiple smartphones in the backpack or on the bike). Cheating by using alternative means of transport with similar movement patterns is thus effectively prevented as far as possible. Care is taken here to ensure that “real” journeys continue to be recorded correctly (as small a false positive rate as possible). Towards this goal, we are currently running a competition for cheating with appropriate incentives and are researching fast algorithms for multiple track alignment. The solution presented in this paper is currently being implemented and piloted using the Bike Citizens Beta App. First reviews received by stakeholders suggest this approach has potential to shift mobility behaviour in the right direction.

6 ACKNOWLEDGEMENTS

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reviewed paper

Densification of the Existing Urban Pattern: the Case Salzburg

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1 ABSTRACT

Most European cities are facing the challenge of a continuous demand to enlarge their housing stock. Based on the common sustainable development goals, this demand should be created in the range of the existing urban pattern, which means that transformation of areas or the increase of density on underused plots. A town like Salzburg, which is characterized by a high amount of valuable historic buildings and neighborhoods, has also to deal with this question. The strategy of the past years was not to extend the urban pattern in the green surrounding, because of the proximity to the mountains and protected landscape. This paper will give an overview of the chosen strategy and development of the past 25 years by studying 22 different projects. The reason for these projects was, that there are arguments that the densification of recent projects in Salzburg is too high and delivers unsatisfied urban projects. This study is based on an overview of the development of different densities and approach of the projects. The conclusion will discuss the different opinions and will give recommendations about an improved approach to a sustainable future planning.

Keywords: urban pattern, Salzburg, densification, strategies, case study

2 INTRODUCTION

2.1 Densification as a method to reduce land use

In the latest Land-Report of the WWF in 2021 Austria is approved for falling the national sustainability and climate goals. One reason for this development can be followed up by the land consumption, which amounts recently to 13 hectares per day (WWF 2021). The target is 2,5 ha per day, which seems uncertain when and how this can be reached. (Bundeskanzleramt 2020) More than half of the land consumption can be attributed to the building development, which leads in the planning projects and policies to an intensification of densification strategies. These recommend avoiding further greenfield developments, instead they promote the densification of the existing urban structures. Which means that the future development should be focussed within the limits of the city by using different approaches, which are in general similar and have all in common to increase the density (Nagel 2018). There are different methods ranging from adaptation and extending existing building structures to a total reconsideration of the land usage. By increasing the density also another benefit is that more people are living in the city which helps to maintain and sustain other functions, like shopping or retail, which is in general moving to the outskirts of the centers. (Nagel 2018) One consequence of intensive land use is the need to build new roads, which are economically problematic, especially due to the effect of urban sprawl. (Fitz, A. et al. 2020)

Figure 1: Development of shopping and retail services at the outskirts of the cities (Source: Stefan Netsch)

There are two different definitions used in the same way: densification and inner-city development. The aim which both imply is similar, but the difference is that densification is an instrument, which tries to create a higher density by using existing building structures, while the inner-city development on the usage of not or underused plots is directed. (Spitzer et al. 2017) Using the existing building structure is mostly done by extending the roof structures or adding a new floor. Both methods are depending on the existing building structure, while the method where the building is demolished is based on the development of a new building. (Wong 2017)

Figure 2: Extending the housing units by roof-stacking (Source: Stefan Netsch)

The usage of vacant or not properly used plots, like stacking grounds or former commercial areas or football grounds are seen as very suitable spaces to develop in an already developed situation as potential densification cases. Another case of densification can especially be seen in single family house estates, where usually the plot is quite large, and the building is very small in comparison. This is also a potential whereby adding a building the density will be extended.

Figure 3: Densification of a plot by adding a second single family house (Source: Stefan Netsch)

To measure density there are different methods, which are often based on the density created by the building on the plot. This is expressed in the form of the ground space index (GSI) and floor space index (FSI). (Roskamm 2016) Other possibilities the measurement by dwellings per hectare or by the population density per hectare. In opposite to the rational facts of the building, these both measurements give more an impression about the human acitity and the usage. (Sim 2019) In general density is related with the factor of developing more floor space, which indicates a greater value for the real estate development (Berghauser, Pont 2009). Next to the discuss of density the discussion of inenr city development is very much linked to the mix of uses. During the post war times most cities in Europe followed the concept of the functional separation, while in recent developments the concepts where influenced by the idea of the compact city (Richter et al. 2018). One of the major topics of the compact city is the implementation of mixed uses within the building or the neighboorhood. The purpose of this approach is to fullfill the basic needs, like smaller shops or social services like kindergardens or doctors, of the inhabitants of the neighboorhood. The challenge of the densificatication of the inner city is besides the physical implementation of new buildings and urban structures, also the challenge to provide sufficient infrastructure, such as social facilities or public services. These infrastructures are in demand by residents, especially at the neighbourhood level.(Böhm et al. 2016) The danger is that the densification will lead to an undersupply of this type of infrastructure as the population increases. This contribution will give an overview how this practice is implemented in the urban pattern of the city of Salzburg and indicates some of the advantages and disadvantages, which go hand in hand with the densification.

2.2 Situation of Salzburg

The city of Salzburg is also the capital of the Federal Province of Salzburg (Austria) with about 157.160 inhabitants (Stadt Salzburg 2020). It has with of 2395 inhabitants per km2 about 50% of the density of Vienna, which has 1,9 million inhabitants (It is not a fast growing city and has a moderate growth with around 5-10% (Stadt Salzburg 2020).

Figure 4: Historical inner city of Salzburg (Source: Stefan Netsch)

Between 500 and 1000 new flats were developed annually during the study period from 1994 to 2020. In total 6400 new flats were newly developed. (Stadt Salzburg 2020) Even if Salzburg is not really growing rapidly and the scenic location suggests great land potential, demand for land is great and availability is very limited. The overview of the examined examples show that the focus of the project development is directed to densifying the city and to reuse former used plots for the inner city development. Greenfield development on former not sealed or intended for other uses occurs very rarely and if then on a small scale. Another necessity for inner development in Salzburg is the high protection status by UNESCO. Including the buffer zone, the city has almost 500 ha protected urban structure, which can be developed further, but the conditions are very specific in order to preserve the baroque character of the city. (UNESCO 2017) Most of the first restrictions relate to the design of the façade or the height development of buildings, as various visual axes are to be preserved in the urban area. If projects are implemented in this inner-city area, they will be reviewed by a design advisory board and, if necessary, adapted according to the specifications. (UNESCO 2017)

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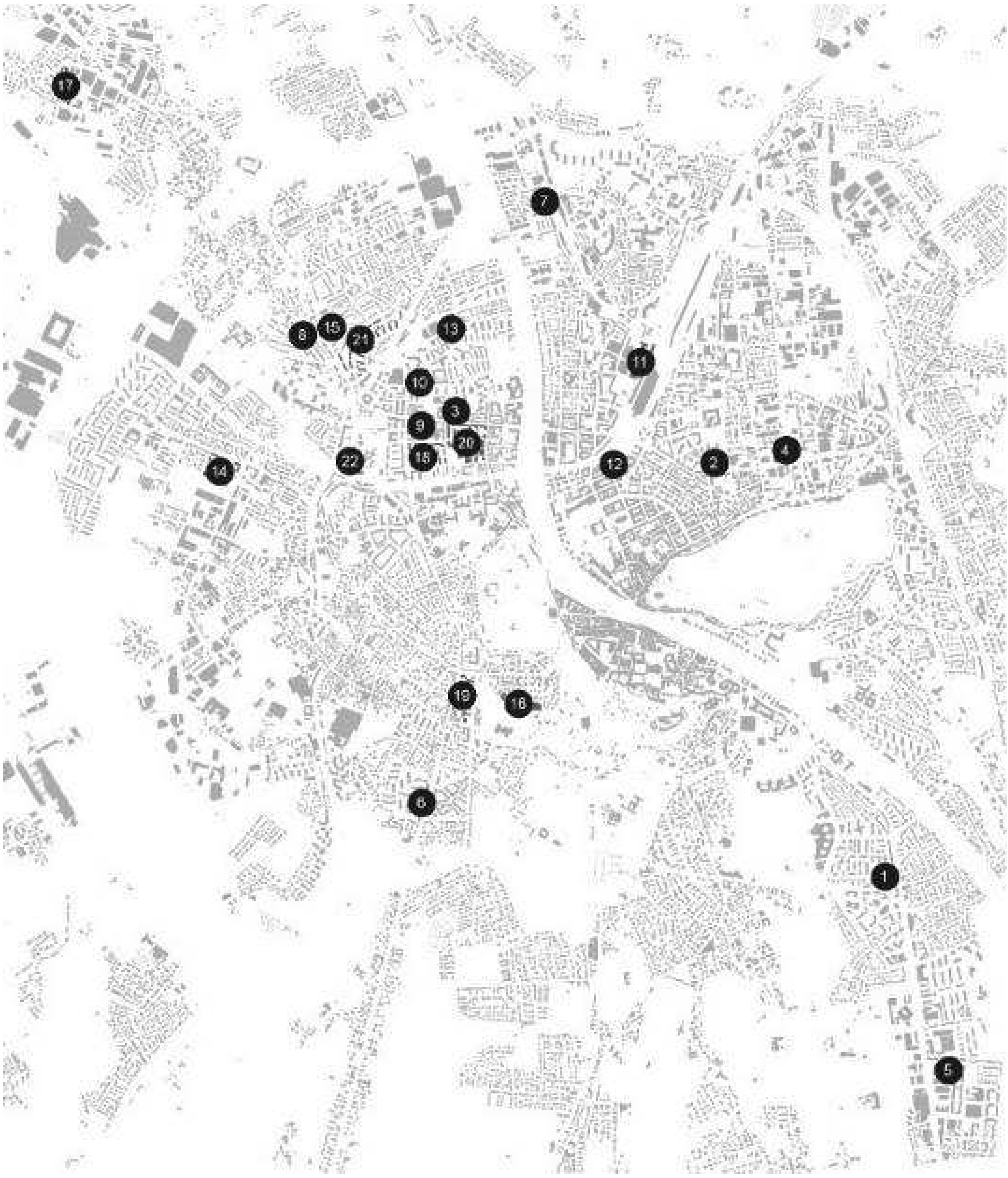

Figure 5: The distribution of the densification cases are concentrated in the northern part of the city of Salzburg. In this area of the city, dense housing is concentrated, whereas in the south there is a transition to the open landscape by means of detached houses. (open access map data retrieved from SaGis; editing by the author)

2.3 Methods

This research in Salzburg was done in 2020 by a descriptive case study approach that pursues a structured comparison of different densification projects. Within the research, 22 examples have been studied, which illustrate the variety and possibilities of densification projects in the past 26 years. The year 1994 was chosen because then one of the first significant projects "Hernau" was realized. The project was carried out in three stages. Within the first stage a desk research was done to map the project and to analyze the basic data (e.g. size, housing units, additional functions, e.g.). The stage of the field work was necessary to conduct an onsite mapping to collect further aspects and data, which was necessary to compare and frame the projects in a bigger picture of the city. In the last step, data which was provided by the City of Salzburg was used to add further data that contribute to the complete presentation of the projects. In some cases, the provided data was checked with local architects, housing companies or the planning departmenet of the city.

3 DIFFERENT CASES OF DENSIFICATION

In total there were 22 cases collected, with the first project finalized in 1994 and the last one in 2020. During this time period there was a continuous development of densification projects, but the realization period is depending on the complexity of the project.

The range of size of the individual projects is wide. It ranges from small interventions with 0.11 ha to new urban blocks with 7.5 ha. The distribution of the individual projects shows that they are mostly smaller projects with less than two hectares total area. In total, more than 46 ha of already developed urban land could be used again. The number of newly created residential units also depends on the respective area size of the projects. In the smallest case this is 12 flats and in the largest case more than 600. This is due to whether only a single building was realized or a new neighborhood. An exception is project no. 4, which was implemented as an office and commercial project. This is remarkable, as these types of projects tend to be located on the outskirts of the city.

	Projectname	**Construction Time**	**Mixed Use**	**Areasize (ha)**	**Dwellings**	**Dwellings/ha**	**Ground Space Index (GSI)**	**Floor Space Index (FSI)**
1	Zentrum Herrnau	1992-1994	Yes (Retail, Offices, Gastronomy, Bank)	1,8314	86	47	0,27	1,33
2	City 11	2002-2004	Yes (Offices, Surgeries, Bank)	0,9401	84	89	0,35	1,73
3	@fallnhauser	2004-2006	No	0,3439	47	137	0,48	2,40
4	Business Boulevard	1998-2006	No (only commercial)	1,3458	No	No (only commercial)	0,6	2,38
5	Alpensiedlung	1996-2006	No	0,4892	65	133	0,3	1,12
6	Lanserhofwiese	2005-2007	No	7,4993	83 +320	54	0,23	0,69
7	Franz Ofnerstr	2006-2007	No	0,9402	92	98	0,17	1,04
8	Kapellenweg	2007-2008	No	0,3310	24	73	0,23	0,68
9	Esshaverstraße	2008	No	0,1128	12	106	0,24	0,94
10	Neue Mitte Lehen	2007-2009	Yes (Retail, Surgeries, Library, Bank)	2,0876	48	23	0,34	1,68
11	Postareal	2006-2009	Yes (Offices, Retail)	1,6224	104	64	0,56	4,51
12	Humboldtstraße	2008-2010	No	0,2298	60	261	0,53	3,19
13	Parklife	2010-2012	No	1,488	88	59	0,33	1,64
14	Freiraum Maxglan	2011-2013	No	4,9496	356	72	0,15	0,93
15	Kirschgarten	2012-2013	No	0,2458	23	94	0,28	1,11
16	Sternbrauerei	2011-2014	No	1,4107	100	71	0,45	1,81
17	Saalachstraße	2015-2016	No	1,6674	139	83	0,26	0,79
18	Strubergassensiedlung	1950-1962 /2017-18	No	3,3243	636	191	0,23	1,04
19	Riedenburg	2016-2019	Yes (Surgeries, Gastronomy, Kindergarten)	2,8295	316	112	0,25	1,24
20	Stadtwerke	2009-2019	Yes (Surgeries, Laboratory, Retail, Gastronomy)	4,96	581	117	0,50	2,49
21	Glanbogen	1950-1951 /2017-2020	No	5,5326	550	99	0,25	1,00
22	Rauchmühle	2018-2020	No	1,79	220	123	0,26	1,80

Table 1: Overview cases

In summary, conclusions can be drawn from the individual projects for the four following thematic areas, which on the one hand show approaches to solutions, but also point to the issue of inner development, which must be analyzed and solved individually in each project:

3.1 Typology of project

Looking at the size of the potentials to be developed shows the challenge that cities like Salzburg have to face. The size of the respective inner development projects is getting smaller and increasingly concentrated on the level of a single plot of land. Larger brownfield developments are becoming increasingly difficult, as much of this space has already been activated in the past. This challenge “finding new spaces” for inner city development a lot of cities are facing. At present, the availability of land is also becoming increasingly difficult due to rising property prices.

If it is not a single plot, which can be used as a kind of infill development, the tendency is to great projects, which do not only serve the inhabitants of the neighborhood, but also on a wider scale. In larger projects such as Maxglan (No. 14), it becomes clear that the offer in addition to housing like kindergarten or the generous open space is not only intended for the residents of the project, but also for those who live in the urban neighborhood.

Figure 6: Development of social infrastructure tp provide services for the neighboorhood (Example 14)

Figure 7: Addition of the existing urban structure (Example 12).

The possibilities offered by inner development go far beyond the mere production of living space. They offer the chance to solve the deficits that exist at the level of the urban district. In most cases, it is a question of creating infrastructures that serve the public, such as public spaces or social infrastructures (e.g. kindergartens, playgrounds, etc.).

Density

The density values of the projects show a broad range of different GSIs and FSIs. However, the statement of the values is limited to purely factual statements and less about the perception of the current density in the context of the project. It is difficult to make a statement about the quality of the project purely on the basis of density values. Rather, the actual project must be perceived in the context of its surroundings. This becomes clear in the case of project no. 11, for example, which on the one hand has a high density due to its central urban location, but on the other hand is also due to the urban planning situation. Because of its size, this project contributes to the continuation of the urban structure. The totality of the case studies shows the great diversity of the density values achieved, even if the project areas are comparable

The real differentiation takes place through the production of the number of housing units. However, a high number of dwellings does not necessarily mean a high density of use by residents. Much more remarkable as a result is that most projects achieve a density of 80 to 120 dwellings per hectare. It can be concluded from this that the normative information from development plans does not necessarily contribute to the perception of density, but that other parameters are also important.

3.2 Open Space

The challenge of free spaces in the projects is manifold. They have the fundamental task of providing internal access, but on the other hand they are also an indicator of the quality of stay. In addition to seating and bicycle stands, many projects also have the option of play areas.The differences in the type and design of the public spaces vary in the sample collection greatly in the projects and depend on the type of spatial context. The spectrum ranges from large park-like areas (No.14), to small-scale green and play areas, to urban outdoor spaces like No.20.

Figure 8: Public Spaces in the Riedenburg (Example 19)

The diversity in terms of project size and type also has an impact on the type of publicly accessible space available. In the development of a single plot of land, residential open spaces are particularly developed at ground level, leaving little space for the public. However, in projects where an almost park-like green space has been developed, it can be assumed that this is also useful for the neighborhood.

3.3 Mixed Use

One of the key factors of the compact city is the variation and combination of different usages. Particularly in the first-floor zone, it is evident that in the urban area a use that attracts the public often contributes to the

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revitalization of the neighborhoods. In addition to retail, this can also be everyday services, such as laundries, post offices, etc. In many cases, the floors above are occupied not only by residential units but also by other facilities such as offices (e.g. architects, lawyers, etc.) or doctors' surgeries. This direct combination of uses with housing means that many routes can be eliminated.

Within the implemented projects, different uses are brought together. It is obvious that the majority of the projects were implemented with usage on housing (n=15). Only a small number, such as project no. 1, show a mixed use with residential and mostly commercial use. Project No. 4 is an exception with purely commercial use, which was implemented in the urban area.

Figure 9: Different uses of the basement zones (Example 20)

The example of the Stadtwerkareal shows the positive mix of uses. Since this part of town has a very high population density, uses in the first floors that contribute to the support of the residents are particularly important in addition to the public spaces. Therefore, many community facilities are located there, ranging from the district office to homework supervision to rooms that can be rented temporarily It is undisputed that one of the central problems of mixed use is that the spaces in the first floor zone are usually difficult to market and are only suitable for living to a limited extent. For this reason, many projects also forgo mixed use, which is also challenging in terms of floor plan development.

4 CONCLUSION

The densification ofneighboorhoods in the incner city pattern has a lot od adavantages, like the reduction of land comsumption, the addition of new housing units or the extension of usages, which are needed on a wider scale. But espacially the existing infrastructure needs a special attention, because it is succesfull to use the technical infrastructure like roads, sewage installation, etc. or the social infrastructure like kindergartens, schools, playgrounds, etc. more efficiently. But it needs a careful planning because there is the threat that by an too intensive densification of an overloading of the the existing structures. It is therefore necessary to look at inner development on a larger scale.

Density in particular is viewed critically in many projects and also leads to their rejection. However, in many cases it is not the density itself that is the problem, but rather the increased burden it places on public space or streets. This leads to a negative perception, which could, however, be taken into account in planning.

The problem, however, often lies in the fact that it is a matter of individual projects that only appear to be problematic in their entirety because they are embedded in the neighbourhood.

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Designing Waste Management Systems in the City of The Future

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1 ABSTRACT

Each year people on the planet produce tons of waste. The more urbanised a country is, the more residues it produces. Its management is one of the most expensive services to municipalities and in many countries, it is still one of the main concerns. Many environmental and health problems are associated with poor waste management practices and the absence of circular economy approaches. Moreover, traditional waste management systems are designed from a waste production perspective. The process is focused on the collection of the produced waste, system coverage of it across the urban territory and its expansion. The prevalent way of thinking is still: out of sight, out of thought. Fewer efforts are put into transforming solid waste management in the direction of having a material or resource flow. Often municipalities work in silos and for this reason, solid waste is regarded as an independent process, acting on its own, designed and operated individually. Although there are many overlaps that the operation can have if it is planned in an integrated manner.

The paper presents solid waste management (SWM) regarding this integrated perspective, highlighting the synergies that could be achieved with other sectors such as mobility and logistics. It describes what can be understood under material circularity from an SWM perspective and how the principles and ideas described in the paper can be integrated into the urban planning of future cities ensuring that the waste is handled as a valuable resource.

Keywords: Solid waste management, Circular economy, Zero waste, Reuse model

2 NEED FOR CHANGING THE TRADITIONAL WAY TO DO IT

2.1 Urban Waste Crisis

Rapid urbanisation and exponential population growth are undeniably significant phenomenon since the past century. The world population is expected to increase from 7.9 billion in 2021 to 9.9 billion by 2050 (IISD's SDG Knowledge Hub, 2020) and more than two-thirds of the world population is predicted to live in cities. The World Bank (2020) indicates that nearly 7 out of 10 people will live in cities. Similarly, another alarming trend that is in direct proportion to urbanisation is global waste production. Currently, total solid waste annually generated in the world is estimated to be around 7 to 10 billion tonnes and as of 2016, 2.01 billion tonnes of municipal solid waste is generated (Kaza et al., 2018). Here, according to Kaza et al (2018), municipal solid waste refers to waste generated by residences, commercial enterprises and institutions. Other wastes such as industrial, medical, electronic, and construction and demolition waste are not considered to be municipal solid waste.

Kaza et al's (2018) What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050 report indicates that global waste is estimated to increase by 70% by 2050 and it is also expected to surpass the population growth. According to this World Bank report, the global average of waste generation was 0.74 kilograms per person per day in 2016 and the United States has the highest average of waste generated with a per capita of 2.21 kilograms a day. Furthermore, COVID-19 has caused serious disruptions in the way waste is generated and healthcare waste is said to have monumentally increased due to the pandemic (Das et al., 2021). The pandemic has further instigated an unprecedented increase in the consumption of single-use products mainly plastics and experts call for a zero-waste approach and stress on the need to shift from a linear to a circular economy (Sarkodie and Owusu, 2020).

These alarming trends in waste generation in urban areas is a universal issue. Urbanisation coupled with population growth in cities is the driving force behind the increase in the amount of waste generated. Moreover, solid waste challenges concern people, municipalities, and cities alike, affecting them and the environment in multiple ways. SWM is especially a major challenge for municipalities of fast-growing cities and is also undoubtedly one of the most expensive services offered. The way waste is collected, treated and disposed of in cities requires utmost attention and the problems related to this pose a great challenge to cities

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and municipalities worldwide. Poor and improper solid waste management not only can cause various health, environmental, and social challenges but also influences pollution levels in cities. Greenhouse gas such as carbon dioxide and its equivalent generated from the way solid waste is treated and disposed of, are expected to rise from 1.6 billion tonnes in 2016 to 2.6 billion tonnes by 2050 annually (Kaza et al., 2018).

Waste management practices, quantities and quality of solid waste generated vary significantly due to demographics and socio-economic variables (Boateng et al., 2016) and in rural and urban areas, developed and developing countries. More developed and industrialised countries tend to have a better waste management system in place but at the same time, high-income countries produce more waste per capita and consume more goods. According to the World Bank estimate, in 2016, developed nations such as the United States, Canada, Australia and Germany's annual waste generation per capita per day is greater than 1.5 kilograms. Whereas, in several developing countries of Africa, Asia, and South America this number ranges from 0 to 0.99 kilograms.

In 2016, countries of East Asia (mainly China) and the Pacific region collectively generated the highest amount of waste globally. However, according to the 2018 World Bank report, there will be a shift in this trend. Waste generation in especially low-income countries is projected to be incremental. The fast-growing nations of Sub-Saharan Africa, South Asia, and the Middle East and North Africa are estimated to at least double the amount of waste generated by 2050 (Kaza et al., 2018). Furthermore, urban waste generation and its composition are closely linked with changing incomes of rapidly urbanising and industrialising cities. The composition of municipal solid waste ranges from organic and metal to paper and plastic waste. This composition differs among low-income and high-income countries. While most of the waste generated in low-income countries is organic waste, packaging waste forms the bulk of waste generated in high-income countries since people in cities rely on packaged and industrialised products. Overall, these statistics indicate that the urban waste crisis is a universal challenge.

Further, it is essential to take political issues into account, as urban waste is mainly exported to other local authorities with which agreements need to be reached. On a macro level, developed countries generally export waste to developing countries. To tackle the movement of hazardous waste among nations, nearly 180 countries worldwide and the European Union joined the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal that entered into force in the year 1992. On a micro level, urban waste may be collected from one authority that oversees the waste collection and exported to other local authorities that provides services for processing. The World Bank report indicates that there are different administrative and operational models across municipalities. An issue arises when the municipalities have different viewpoints and priorities in managing waste. To address this issue of differences among municipalities and other agencies, a common platform is required to efficiently coordinate decisions and regulate the management.

2.2 Traditional Waste Management Systems

In most countries, the principal aim of local administrations is to get rid of waste to not disturb the cities' landscapes. If its management works "well" it is not given much attention or resources. Hence, systems are traditionally designed from a waste production perspective. Efforts are put especially on the collection to keep the waste out of sight and consequently out of mind. This applies particularly to developing but also emerging countries, which grow at a very fast rate making it hard for them to keep the pace in the expansion of the system on par with the waste increase. Often the waste is informally deposited on the street and arbitrary dumpsites appear in cities. When cities have a problem in managing their waste, it becomes immediately visible and gets worse day by day. Uncontrolled waste management can easily become dangerous as it gets mixed with hazardous or/and medical waste not only for people involved in collecting disposing of waste such as waste pickers but also for the environment as it causes air pollution and soil contamination. In this sense, what tends to become a priority is to get it out of the way by collecting it, but sustainability is usually not considered.

The administration is usually one of the reasons for the deficiencies in waste management systems as it is not handled as such a relevant matter. In many cases, the planning and operation take place in an isolated form and not necessarily in coordination with other sectors such as energy, agriculture or mobility. In addition to this, the systems vary among high-income and low-income countries. Waste management in cities is generally supervised by local entities such as municipalities. Globally, 216 cities reported a dedicated solid waste management department, whereas 21 cities do not have a dedicated department and this information is unknown in 131 cities (Kaza et al., 2018). Since solid waste management requires an inter and transdisciplinary approach, most often cities struggle to coordinate comprehensively to address any issues that might occur. The World Bank studies indicate that municipalities mainly take a decentralised approach in managing their waste. Furthermore, a recent trend in cities suggests that municipalities are increasingly collaborating with the private sector and public-private partnerships to efficiently manage their waste. For example, many municipalities in Indian cities have employed private contractors for the transportation of municipal waste (Sharholy et al., 2008). In addition, inter-municipal cooperation, as a partnership between two or more municipalities established for waste management is a notable example that has gained acceptance in Europe. This cooperation between municipalities is beneficial because it may increase efficiency, reduce costs, and aid in reaching economies of scale. Coordination is the key to successful partnerships. Few European countries such as France, Spain, Italy, and the Netherlands have inter-municipal cooperation to manage waste (Kolsut, 2016) that has resulted in productive waste management systems.

Forms of the so-called Smart Waste Management can be found today in many developed cities. The term is applied to a type of management that uses technology to increase efficiency. This is allowed through intelligent routes for the trash collectors, the avoidance of both unnecessary trips and congested streets but also the use of mobile applications to better inform the citizens about the service provided. The implementation of this type of management uses different types of devices such as Global Positioning System sensors and ultrasonic level sensors, machine-to-machine connectivity and have the potential to reduce time in the collection processes and the costs.

Recycling systems are widely applied worldwide but the global recycling rate reflects how poorly the systems are implemented in general. The recycling rate is used as an indicator to measure progress in many countries. Firstly, the recycling rate is measured as the percentage of waste recycled from total generated waste. However, Hotta et al (2015) highlight that this indicator is defined and calculated differently among different nations especially in Asian countries due to the existence of the informal recycling sector. Due to these varying methods to measure recycling rates, it is harder to draw parallels. In 2019, the EU generated 502 kg of municipal waste per capita and recycled only 48% of its waste (Municipal waste statistics - Statistics Explained, 2021). In addition, compared to its European counterparts, Germany performs the best in the world, topping the list with the highest municipal waste recycling rate of 66.7% (Eurostat data 2019). Whereas, according to the OECD report (2015), among the 34 OECD nations, Chile and Turkey are the worst performing countries when it comes to municipal waste management with a recycling rate of merely 1%. Another significant result stated in the report is that New Zealand comes at the bottom of the list that disposes of all its municipal waste in landfills. This suggests that be it a high-income or low-income country, recycling rates are not uniform across continents. A different approach and smart innovative solutions are required, and much work needs to be done to address challenges that affect recycling rates.

2.3 Next level Circularity

Circularity or also notably known as the circular economy is an emerging concept that refers to a sustainable model of production and consumption of products and services across multiple industries. Based on several definitions of circular economy, Geissdoerfer et al (2017, p.759) comprehensively define the circular economy as a “regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops.”

Globally, the current and conventional model in consumption of goods follows a linear model of ‘take-make-dispose’ (MacArthur 2013). This linear approach causes depletion of non-renewable resources and is a threat to the environment. In contrast to this, the circularity model consists of a closed-loop approach. That is to say, the model is sustainability-driven which reduces the consumption of resources and generates less waste. In this case, waste is considered a valuable resource rather than an issue. It can be said that this is the best method to manage waste. Furthermore, the circularity model could result in the reduction of carbon emissions, greenhouse gas emissions and waste streams. The MacArthur Foundation’s report ‘Towards the Circular Economy’ (2013) presents that implementation of the circularity model could lower materials consumption by 53% by 2050. Considering the trends in waste production and management systems, it is evident that a well-informed integrated change is urgent and crucial.

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The process of using resources to make materials and materials to make products requires high amounts of energy. Worrell et al. (2016) highlight that nearly 25% of global CO2 emissions is produced due to materials production. Consequently, waste generation and greenhouse gas emissions are inevitable by-products of material production. Although on a global scale, greenhouse gas emissions from waste management are less than 5%, it is still crucial for a system change since materials consumption and production patterns are influenced by the growth of cities. Cities in the future with serious intentions of reducing their negative impact on the environment and consciously using resources and pursuing sustainable operation and ways of doing should aim for what we call here a “Next Level Circularity”. The concept of next level circularity demonstrates the change in a systems perspective. It highlights that to avoid and minimize waste production to the furthest extent, the systems should be looked at through the lens of materials perspective. Recyclable material systems should be designed to achieve material circularity. Nevertheless, to practice this type of circularity, cities must implement measures and specific frameworks such as Ecological public procurement policies, Local production, repair, reuse and recycle initiatives, Eco-design principles in the built environment, Bio-intensive urban agriculture, Energy generation from biomass, Innovation in water and waste management systems, Infrastructure solutions for e-mobility and low-energy districts.

2.3.1 Material Pact

Packaging materials are an important contributor to municipal solid waste. Concerns about packaging waste, particularly plastic packaging, and its negative and long-term environmental effects are growing. Despite increased concern over plastic pollution, plastic manufacturing and consumption are expected to continue to increase in the next decades (MacArthur 2013). Numerous variables, including governmental and legal changes, there is a growing concern about food and packaging waste, environmental pollution, and global demand for food and energy resources. All these influences the development of sustainable packaging that is made from renewable and environmentally friendly materials, as well as sustainable waste management options at the end of product life.

The Material Pact can be defined as a network of initiatives that brings together all relevant parties on a national or regional level to create solutions for a circular economy for packaging materials. Each initiative is directed by a local organisation and brings together governments, corporations, and residents around a shared vision and a set of ambitious local goals. Redesign and innovation may help to eliminate redundant and problematic plastic packaging. Before plastic was invented many products such as vegetables, soaps and other items were sold without any packaging and this was a norm in selling products. Today packaging is predominant and overused not only for practical reasons but also used for special design purposes and other unnecessary motivations. A shift in behavioural change can be achieved by awareness-raising campaigns and encouraging more conscious consumers.

For instance, packaging and the use of plastic, in general, should be regulated by the local administration. In this sense, the usage of plastics can be clearly defined, and only certain plastics must be allowed in the fabrication of packaging. The material pact regulations and guidelines are designed aiming that every plastic packaging is reusable, recyclable, or compostable and only used when and if needed; reuse is promoted instead of single use. According to its characteristics, especially its recyclability, the following materials can be recommended:

NYLON 6 - A potential inspiration source as a material with infinite closed loops Nylon 6, the most popular nylon grade, is a polymer built up by synthesising caprolactam, its monomer building block. Polyethylene Terephthalate (PET) - is one of the most important commercially consumed polymers; it is an increasingly conventional material like paper, wood, metal and glass in a variety of applications.

Polylactic Acid - Polylactic Acid commonly known as PLA, is a polymer made from renewable resources. Contrary to other thermoplastics which are petroleum-based, some of the raw materials used for PLA’s production include corn starch, tapioca roots, sugarcane. Its properties, however, are comparable to other plastics in the industry. These characteristics and consumers’ desire to use a less impactful material have triggered its rapid entrance into the plastic market as a competitive commodity.

Compostable Packaging - Fully compostable packaging should be prioritised. Companies can be incentivised to its design and its local production. Examples of materials for this are mycelium (roots of mushrooms) that can be then composted at home or in the local facilities.

Edible Packaging - Edible food packaging is a sustainable type of packaging that is designed to be eaten or can biodegrade efficiently like the food it contains. Edible packaging comes in many forms and is constantly being improved and innovated to be made from many different types of substances. Already different types of edible packaging are available for different types of food e.g., edible coffee cups in the market.

2.3.2 The Reuse Model

Innovative reuse models, enabled by digital technology and altering consumer preferences, can unleash significant benefits. Reuse is defined in the British Standard and International Organisation for Standardisation, as well as in EU regulations, as shown in Table 1.

Table 1. Definitions of reuse and reusable packaging in standards and directives.

Standards and Directives	Definitions
BS EN 13429: 2004 Packaging reuse [11]	**Reuse**: operation by which packaging, which has been conceived and designed to accomplish within its life cycle a minimum number of trips or rotations, is refilled or used for the same purpose for which it was conceived, with or without the support of auxiliary products present on the market enabling the packaging to be refilled: such reused packaging will become packaging waste when no longer subject to reuse **Reusable packaging**: packaging or packaging component that has been conceived and designed to accomplish within its life cycle a minimum number of trips or rotations in a system for reuse
Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives [12]	**Reuse**: any operation by which products or components that are not waste are used again for the same purpose for which they were conceived
Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 Establishing a framework for the setting of ecodesign requirements for energy-related products [13]	**Reuse**: any operation by which a product or its components, having reached the end of their first use, are used for the same purpose for which they were conceived, including the continued use of a product that is returned to a collection point, distributor, recycler, or manufacturer, as well as the reuse of a product following refurbishment
ISO 18603: 2013 Packaging and the environment—Reuse [16]	**Reuse**: operation by which packaging is refilled or used for the same purpose for which it was conceived, with or without the support of auxiliary products present on the market enabling the packaging to be refilled **Reusable packaging**: packaging or packaging component that has been designed to accomplish or proves its ability to accomplish a minimum number of trips or rotations in a system for reuse
BS 8001: 2017 Framework for implementing the principles of the CE in organisations [23]	**Reuse**: operation by which a product, component, or material can be used again without requiring any reprocessing or treatment

Table 1: Definitions of reuse and reusable packaging in standards and directives (Muranko et al., 2021).

These definitions emphasize a systemic and performance-driven approach to reuse, as they refer to the presence of a reuse system, auxiliary products that facilitate reuse, a minimum number of reuse rotations or trips, and the fact that reusable packaging eventually becomes waste and must be recycled. Reuse is not new to the consumer and was certainly there before as common practice before plastic in packaging was invented, but it is an emerging practice. For example, Bronze Age archaeological discoveries have shown repair activity on broken or abandoned pottery in Greece and the reconditioning of bronze and iron razors for reuse across Europe. Records of public actions in late 18th-century European countries, e.g., the Netherlands, show that various second-hand household products, such as kitchen utensils, were commonly bought for reuse (Muranko et al., 2021). With the increased interest in reuse, reuse model frameworks have gradually appeared in the literature. Just like the circular economy approach, reuse can mitigate negative environmental consequences induced by the intense mining, manufacturing, distribution, use, and disposal of packaging, including waste accumulation and contamination of the air, water, and land (Pardini et al., 2020).

Shifting consumer preferences have in some countries enabled a new paradigm of creative reuse that can yield major benefits, such as digital technology and changes in user preferences. Such models can aid in delivering a superior user experience, tailor products to each user's unique demands, gain insights about users, solidify a brand's identity, streamline operations, and save money.

Also reusing materials created by a refurbishing process is an operations technique that involves slowing the flow of materials by extending the product utility. In the waste pyramid, reuse is followed by recycling, which has become a very popular and very common practice. Reuse however should be prioritised and preferred as it allows for lower ecological and carbon footprint. The reuse system has three main elements, namely the re-user behaviour, reusable product and finally the reuse-enabling infrastructure.

The models can be sequential and/or exclusive reuse models (Muranko et al., 2021). Exclusive reuse involves a product that is repeatedly used by a single user throughout the product's lifetime for the same purpose for which it was intended, as well as using and enhancing reuse-enabling infrastructure (Muranko et al., 2021). In this model, the user owns the reusable items, retains ownership of the product, and is accountable for recovery, continued use, and recycling after the product has been retrieved for re-introduction into the consumption phase. For an item to be considered as recovered, its functionality must be re-established, and a person or organisation must be prepared to use it. The item can then be reintroduced into the cycle of ‘utilisation-recovery-preparation’. An example is durable cloth sanitary towels (e.g., Bloom and Nora), which are composed of a consumable (an absorption layer) and a facilitator (structural layer), both of which are reusable. The consumables of products belonging to this model are typically made of non-perishable materials (e.g., fabrics) that are durable enough to withstand multiple uses. Various examples of the reuse model can be seen in Fig. 1.

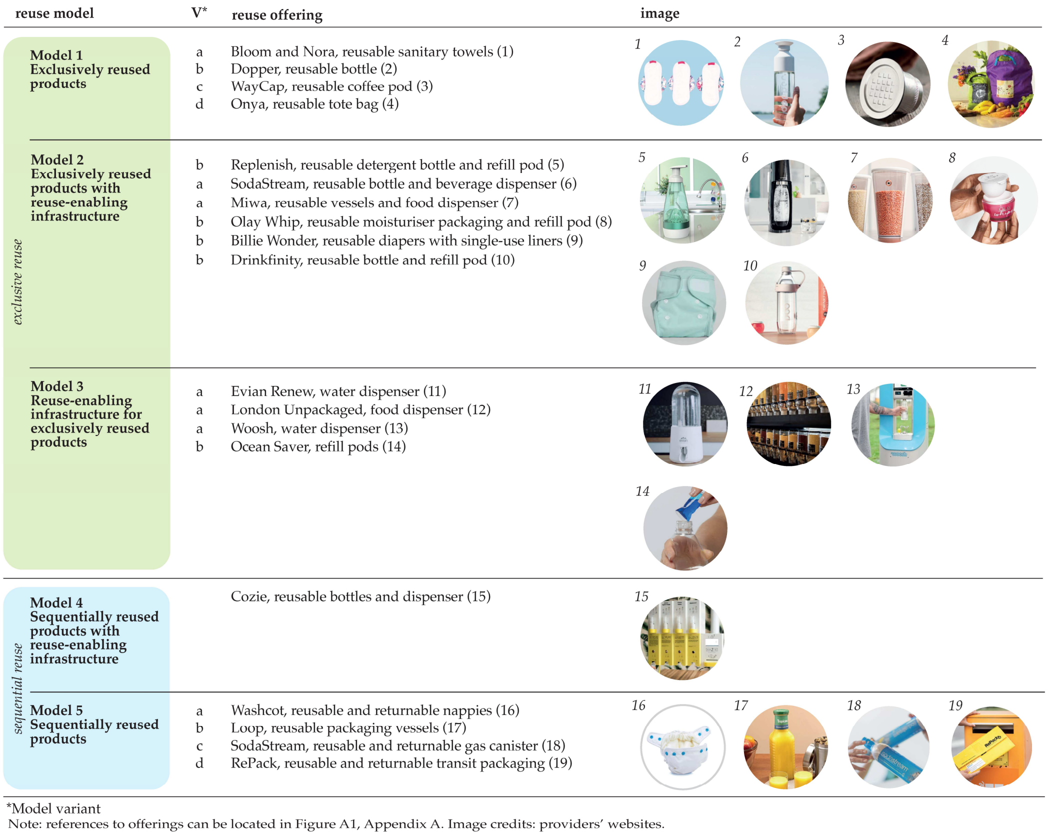

Fig. 1: Various examples of the Reuse model (Muranko et al., 2021).

Sequential reuse is a product use behaviour in which a reusable product is used consecutively by multiple users throughout the product lifecycle for the same purpose for which it was created and with the help of reuse-enabling infrastructure (Muranko et al., 2021). When sequential reuse models are implemented, the user has access to a reusable product. The user is responsible for returning the reusable product to the provider, who is then responsible for returning it for reuse and recovery, and on return to the consumer. The ‘Utilisation-Recovery-Preparation’ is a cycle of steps the manufacturer uses until the consumer does not return the product, when the reusable product is no longer fit for use, or when the provider decides to discontinue making the product. Reuse models can provide a database with the information needed to determine if a reuse offering suits the needs of the target audience and their technological, infrastructural, and financial capacities. This model is commonly used in-store dispensers used to refill skincare products into parent reusable, returnable vessels and refill pods such as SodaStream.

2.3.3 Sustainable Packaging

In addition to proper packaging design, sustainable packaging involves the creation and usage of packaging that is more sustainable. To meet the changing consumer demands, manufacturers must also adopt newer life cycle inventory (LCI) and life cycle assessment (LCA) methods, which will assist them to employ packaging that has a lower environmental impact and ecological footprint (Lee et al., 2005). To see all the design, choice of materials, processing, and life cycle, the package needs additional in-depth study and documentation. Sustainable packaging must meet the functional and economic needs of the present without jeopardizing the ability of future generations to satisfy their requirements. Instead, considering sustainability to be an end state, it should be regarded as a continual process of improvement. There are several regulations on both business and consumer levels when it comes to sustainable packaging. Some requirements must be put in place by law while others are up to the discretion of packagers. Investors, employees, management, and customers can have a direct impact on corporate choices and help create environmentally friendly company policies.

The main goals of sustainable packaging are:

(a) Convenient and functional product protections, safety, and regulatory compliance.

(b) Low-cost packaging: The less expensive, the better, because the lesser it is, the more one is willing to use it.

(c) Foster a long-term commitment to both human and environmental health.

In addition to the goals, the factors for designing sustainable packaging that must be taken into consideration are reusability, recycling rate, water and energy usage, use of renewable resources, and atmospheric factors. Sustainable packaging describes a range of approaches that meet multiple sustainability criteria, with little or no impact on the environment and its resources (PWC Plus 2019).

3 MATERIAL CIRCULARITY IN THE CITY OF THE FUTURE

Many infrastructural and management factors are involved in transforming the urban environment into smart communities. Technology or infrastructure is only one component of this transition; the collection of suitable data to define smart solutions, as well as the changes in consumer behaviour driven by smart solutions, are two other pillars of future smart cities (Esmaeilian et al., 2018). To address the problem of waste management, a new approach to waste collecting and treatment is required but most important for its overall planning and the general concept people have about waste needs to change. In future planning, the talk should not be anymore about waste management but rather material circularity systems. The system should from the very beginning consider the whole product life cycle and the vision of the entire process should be clear. This means that once a product is designed, its end and the process behind needs to be clear. Conscious and responsible planning should aim for a waste-free city in which waste is avoided at all times and if any, it is then minimized and converted into resources for other systems. In general, to become a zero-waste smart city, three approaches are required: waste avoidance, effective waste collection, and ultimately, effective value recovery from collected waste.

Fig. 2: Smart Waste Management System ("Solid waste clipart 5 » Clipart Station," n.d.)

3.1 Cross-sectorial planning to ensure synergies and cost-efficiency in the city of the future

This approach is something that cannot be achieved through isolated planning. Synergies within municipality departments but also with producers and the industry, in general, must be established. Material circularity can only be implemented in coordination and alignment with many other urban planning sectors and in many cases also demand regional coordination. From the production perspective, this should be implemented in alignment with the economic department, or authorities responsible for regulating the products available in the market and its local production. Aiming to make sure that the defined policies as the producer responsibility principle are respected and that products are designed in the best possible way by following the circularity approach. For this reason, strong coordination with the commercial and industrial sectors is crucial. From another perspective, aiming more to a full recovery of nutrients, the alignment with the

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wastewater sector to combine solid waste treatment with sludge treatment is relevant. Further the process of food waste into compost is the most effective when coordinated with local food production and agricultural activities that demand it.

Besides in a city that allows for new planning or some restructuring, the coordination with mobility and logistics offers great potential for adding efficiency in the process and reducing costs. For instance, in new planned cities, the waste collection should be done using the most efficient and less contaminating technologies. Whenever possible underground systems shall be chosen, and the infrastructure used for waste collection should be carefully planned together with the infrastructure needed for the city mobility and logistics. Future cities will ideally be planned to envision and prioritise shared mobility systems as well as mobility as service approaches. Ideas for this type of mobility include the use of Automated Guided Vehicles that run on magnetic surfaces, the same that can be used for multiple purposes. In this scenario, the car as we know it does not have a place nor the streets as we are used to. The infrastructure created is then planned for being used for a variety of services and purposes, so it would be the tunnels built for the transport of the waste to the collection and treatment facilities, which at the same time can be used for package deliveries and others. The selection of the exact system will depend on the location and density of the community; in higher density areas preference will be given to the pneumatic system for waste collection for reduced carbon footprint and better efficiency. In general, the integration of the different systems, urban services and its infrastructure must be the norm and always prioritised. This applies also to the type of vehicles used, the software, and the hardware employed in the implementation. The coordination guarantees efficiency and reduction of costs at all levels. Regarding the treatment, the proximity principle should be applied to facilitate the local reuse as well as unnecessary transport.

The aim in future cities should be to create a holistic, economic industrial and social framework that seeks to have a city that is not only efficient but also and essentially waste-free. For this, apart from creating the appropriate regulations, creativity, and tech-savviness are necessary as they can encourage people to incorporate more environmentally friendly measures. In this sense, technology can be a great help when facilitating people, the correct handle of their residues. Blockchain has proven to be an ideal player in initialising digital tokens. Blockchain solutions can also help to reduce the ecological ruin prompted by waste in general. Well-designed applications also help in delivering relevant information, such as collections hours, the right use of containers, containers locations, among others. Depending on the needs, this can be complemented with advanced solutions such as smart bins that not only do compacting to increase the capacity of the container but also help with the sorting. They can be especially helpful in tourist places, where the local administration does not have the opportunity and enough time to train the “temporary user” of the services. Finally, gamification and different forms of incentives can bring the right push and motivate the users in the right way to make them part of the solution. Incentives offered can be a great motivation for people to dispose of their waste in the right manner. The incentives can be in the form of monetary rewards that can be exchanged for kilometres of public transport or entrance tickets to certain amenities, discounts for local shops, and other services. Also, the possibility to see people’s progress along the time can be motivating and even more if there is a competition component added, for example among different users, blocks of houses, companies or schools. Many options could be chosen for each specific context, but the combination of the right tools is what can make the difference.

4 CONCLUSION

Since waste is mostly looked at as waste nowadays, meaning, waste is looked at as a valueless and useless entity, cities must realise the potential waste has and must tap into this resource just like any other. The amount of waste generation will only continue to rise with rapid urbanisation and population growth. With waste generation on the rise, poor waste management practices can be dangerous to health, environment, and the costs will be higher to repair the damage than prevent. The consequences can have long negative effects as continuing polluting land, air and water. The existent pressure on the availability of resources and the environmental consequences of linear consumption systems are pushing models of the circular economy. The global landscape and crisis warrant urgent, smart, and sustainable actions.

Ideally, the challenges require a shift in the way waste is treated and generated right from its nascent stage. Materials and products must be designed to last longer and in such a way that they can be utilised in the circularity loop, before even having to refurbish them or recycle; products and material lifecycle must be prolonged, and materials seen as nutrients circulating in safe and healthy metabolisms. Cities and municipalities need to take a holistic approach to evaluate urban waste and synergies among responsible stakeholders are essential to implement sustainable waste management systems. This can only be achieved through an integrated solution with the help of laws, regulations and a good mix of incentives and the help of adequate technology. Socio-environmental-technical understanding of urban solid waste is necessary (Gutberlet, 2017) but more importantly, the synergies it has with other sectors is key in delivering smart and innovative solutions that are closely linked with environmental and economic outcomes. Therefore, there is a clear need for a paradigm shift in the way urban waste is managed globally.

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Developing and Implementing the Design-led Nexus Approach for Sustainable Urbanisation

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1 ABSTRACT

The design-led nexus approach aims to integrate design thinking and nexus thinking for urban food-energy-water (FEW) management. The approach was originally proposed in the M-NEX project with a grant by the Sustainable Urbanisation Global Initiative (SUGI) and has been developed through a series of participatory design workshops since 2018 in six consortium cities, including Amsterdam, Belfast, Detroit, Doha, Sydney and Tokyo. This article describes theprocess to develop the methodologies and applications about this unique approach, for SUGI peers to share and learn from each other. The M-NEX design-led approach is developed reflectively in a series ofdesign workshops in six target cities. Through the iterative practices in different contexts, we found that (1)the food-as-entry approach serves as a trigger to attract stakeholders' attention, and the FEW nexus provides a common ground for stakeholders to rethink the sustainability of cities by breaking down the barriers of siloed thinking, (2) the design-led method works by combining design thinking and systematic nexus thinking iteratively in visual and scientific languages, (3) the iterative application of a scientific evaluation tool, FEWprint, makes the performance of design solutions visible and comparable through communication, and (4) living labs play a key role in networking actors, practicing ideas, and scaling up to the policy landscape. We also learned that (1) FEW issues and solutions are sensitive to contexts, (2) redundant resources and the potential for improving self-sufficiency can be discovered even in developed cities by creatively integrating knowledge, technology and policy, and (3) the nexus approach is beneficialfor all actors, including governments, companies, and community leaders who are looking for collective ways of working towards policy goals such as zero carbon emissions and the Sustainable Development Goals (SDGs).

Keywords: urban living lab, FEWprint, design workshop, moveable nexus, supporting platform

2 INTRODUCTION

Human civilization faces many threats and is on the brink of several planetary boundaries (PBs) (Steffen et al., 2015). Accelerating rates of urbanization are increasing the global demand for food, energy and water (FEW); climate change is amplifying the rate and extent over which resource degradation is occurring (Hoff 2011). As consumption levels increase, the couplings between FEW resources tighten, making theirmanagement complex and difficult. Increased productivity or efficiency in one sector often impacts the economic, political and environmental security of the whole FEW system (Bazilian et al. 2011). On the other hand, the Paris Agreement not only urges all to reduce global warming, but also points to the need to design a comprehensive transformation of urban systems and the way societies will be organized. The United Nations initiated the SDGs in whichFEW-related goals sit at the center of the vision (Liu et al, 2018). Implicitly, this calls for (a further) integration of FEW sectors to overcome siloedthinking and encourages innovative actions.

Typically, the relationships between food, water, and energy are not yet mutually beneficial. Our cities, and the systems that support them, have not been designed to address the FEW nexuses. Consumers in cities are not very much aware of the complex interrelations of food, water, and energy, and therefore will not change their behavior easily. Meanwhile, farmers in rural areas of the world produce food under increasing stresses of water and energy. Gaps exist in awareness of the roles and impacts of climate change. To date, most FEW research has resulted in assessment tools and policy proposals. The integration of food, energy and water in practical urban environments is problematic, and can be detailed in terms of three main aspects: spatial design is often lacking in FEW projects and programs; assessment tools are mostly used at the end or long after a plan or project is realized; and the involvement of stakeholders and citizens is limited to approving or declining a proposition.

Due to the connectedness of FEW in social and ecological systems, the nexus approach has been attracting attention since the first Nexus Conferencein Bonn, Germany (Hoff, 2011). The European Union implemented the Urban Nexus Project in 7FP(http://www.eurocities.eu/) from 2011 to 2014 and released a series of reports on the urban nexus, including climate change resilience, health and quality of life, and competition for urban land (Urban Nexus, 2013). The National Science Foundation (NSF) of the United States allocated a large research budget for the food-water-energy nexus and launched priority research activities in 2017. Correspondingly, Belmont Forum openeda call for the Sustainable Urban Global Initiative: Food-Water-Energy Nexus (SUGI-NEXUS, https://jpi-urbaneurope.eu/calls/sugi) with the Joint Programming Initiative Urban Europe,and consequentlyprovided grants for 15 projects at the end of 2017,among diverseapplicationsfrom around the world.

The Moveable Nexus, in short M-NEX, is one of the SUGI granted projects. It is unique in that it formalizes management tools, policy proposals, and assessment methods, both qualitative and quantitative, into physical design solutions through explicit design principles and procedures for understanding the complexity of FEW cross disciplines, fields and sectors.Since the commencement of the project, the M-NEX methodology has evolved incrementally through a series of design workshop held bi-annually at six consortium cities, including Amsterdam, Belfast, Detroit, Doha, Sydney and Tokyo (see http://m-nex.net). As a result, M-NEX has become not only the project acronym for the key concept of the movable nexus, but also the name of the output of the project, the design support platform that integrates nexus thinking into design, evaluation and engagement.This article describes the development process and the results of the project. It provides rich experience on how to incorporate the FEWnexus perspectives into urban design at the building, neighborhood, city, and regional level, to conduct collaborative urban FEW design with stakeholders and inhabitants.

3 NEXUS CHALLENGES AND RESPONSES

3.1 Complexity of FEW Nexus in Cities

FEW is a wicked problem in consideration of the complexity of cities and related to many urban problems. Food, energy, and water are highly intertwined, and even parametrically related. There are trade-offs and synergistic effects (Haase, Haase& Rink, 2014; Vogt et al., 2010). Due to the inter-connectedness of FEW in social and ecological systems, it is assumed that a nexus approach could improve sustainability in general terms, and as a result has attracted attention as a way to challenge the complex urban issues related to the status quo.However, “the application and implementation of a nexus approach is still in its infancy” (Liu et al., 2018). This is particularly true in urban contexts. Most research is focused on the supply side of the equation, namely on how to secure FEW resources in response to growing global demand. In academic research there was a tendency to view food, energy, and water separately, whether it was for resource management, production and supply, or product distribution. Thus, awareness of the nexus concept was often weak. Governmental sectors or utility agencies typically treat the problems as independent issues (Bettencourt & West, 2010). Each sector generally has its own system, making it difficult to act in a broad and integrated way. When it comes to the environment, someone would argue that considerable efforts have already been made and that efficient resource use has been achieved, so there is little room for further improvement. Citizens take thecity as a given service, as long as they pay their bills, regardless of the fact that, in reality, maintaining food, energy, and water services involves enormous costs, and this leads to severe constraints for urban sustainability.

Substantial research has been conducted on food, energy, and water (F, E and W) separately, as well as the nexus-pairs FE, EW and FW (Varbanov, 2014), and for the nexus of all three (Endo et al., 2014; Endo & Oh, 2018). Most of the research highlights scientific mechanisms of nexuses and the increase of F, E, W-related risks associated with population growth and development. Examples of typical approaches are surveys of ecological resource availability (Daher & Mohtar, 2015), urban metabolism modeling of production, consumption and disposal (Bazilian et al., 2011), shifting to a low-carbon circular economy (Bhaduri et al., 2015), and reducing external inputs from outside the region while and encouraging local production for local consumption (Siddiqi and Anandon, 2011). Limited studies have been conducted that delve deeply into the urban space and design solutions (Romero-lankao, McPhearson& Davidson, 2017).

3.2 Response from the Moveable Nexus

The goal of the M-NEX project is to develop an integrated design methodology that links complex and location-specific FEW problems at the architectural, urban, and regional scales. Instead of defining the nexus as risks, we consider that the FEWnexuses should integrate their components and by doing so, turn problems into opportunities to create a supportive environment and sustainable services. Actually, every city is unique in terms of its land, people, and relationship to the bioregion. Similarly, resource flows are different in every city around the world, too. Solutions for sustainability will be also unique in different contexts, scales, and timing. FEW provides a common playing field in the forms of buildings, transportation, green space, etc. (urban design, spatial design, architecture) for stakeholders to overcome the complexity. The moveable nexus combines the physical world in situ and cybernetic knowledge in human brains or computers into design solutions that are adapted to local contexts. To respond to the challenges and achieve the purpose, this project uses the term moveable nexus philosophically (Yan and Roggema, 2019). The multiple facets of the moveablenexus have been highlighted by the project publication (Roggemam, 2021). The following three are vitalin particular for understanding and implementation.

3.2.1 Moveable nexus thinking

The FEW nexus should be seen as a moveable nexus, which is capable of transforming its parts, its shape, and its capabilities. “The urban environment is changing all the time and, under influence of climate change, pandemics, migrationtowards the city and many more mechanisms, seems to be transforming at an ever faster pace” (Roggema, 2021). The traditional way these processes are approached is often by reducing them to simple problems for which a straightforward solution is sought. This is a misconception. For static problems a simple solution suffices, and is even needed to let society function properly. But at the same time when problems are unstructured, or wicked, a simple solution often proves to make problems worse. Thinking about the future city in terms of the ways food-energy-water generation, distribution and supply are organized may well make a difference for urban dwellers’ quality of life. The urban context is unprecedented and cannot be predicted very well. When uncertainties increase, the demand for simple responses seems to be the preferred way of treatment. This is, however, an implicit flaw, because when the complexity of the problems rises, the responses can no longer be simple. Responding as if the city is stable while in reality it is increasingly dynamic would only bring fake solutions that last for a short time. The opposite approach must be the way forward: when problems are wicked, self-organizing processes and responses that do not bring definite solutions are preferable, as they can adjust themselves as the problems change along the way. For FEWnexuses this implies that a moveable approach, in which the solutions are flexible, and benefit from all other components in the system, will decrease uncertainty, in the longer term in particular(Roggema, 2021). The moveable nexus will be presented as a way of thinking that brings this alternative within reach, with examples from around the world, in different contexts and at different spatial and temporal scales. As befitsa moveable philosophy, all perspectives can be used elsewhere, and the knowledge is meant to move around. This inspires alternative way to collect the knowledge and create solutions that adapt to changing conditions.

3.2.2 Design-led nexus approach

The integration of food, energy and water is not yet mainstream, and there is no established methodology to practice the nexus approach (Yan and Roggema, 2019). It was not common in urban planning and design because of the complexity of the problems per se, the uncertainty of outcomes, and the difficulty of communication between scientific research and design practice. On the other hand, design is by nature a trans-disciplinary approach to problem-solving, which draws upon logic, imagination, intuition, and systemic reasoning in order to explore potential innovative solutions to problems (Kimbell, 2011). Designers explore concrete integrations of knowledge that will combine theory with practice for new productive purposes (Buchanan, 2010), integrating the opinions and needs of multiple stakeholders. In spite of the romantic image that design is a highly personal process, in most cases design proposals are in fact the culmination of shared knowledge and consensus on a specific issue (Kimbell, 2012).

These advantages make a design-led approach particularly appropriate to address wicked problemson the philosophy of moveable nexus thinking. It is extremely useful, as it is able to create something out of nothing that existed before, presenting opportunities to be continuously and collaboratively adaptive, as a city, as a landscape, and as a society(Roggema, 2021). This is particularly true in participatory design where design proposals are the result of professional design activities and communications with a variety of stakeholders.

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With this concept, the M-NEX project developed a design-led nexus approach for urban FEW designs. This approach organizes the sophisticated design process into a series of charrette workshops, an intensive form of design activity often adopted in design practice (Yan and Roggema, 2019). It offers a demanding process with expectations about delivering innovative solutions within a tight time schedule. The need to present the outcomes visually creates pressure to deliver content that is aspirational. The step-by-step design process gives a clear guide for performance and turning inspiration and creativity into regional-to-local design propositions that belong together. Participation and communication provide opportunities for stakeholders to envision and create a new perspective on the future of a geographical area from diverse perspectives.

3.2.3 Moveable nexus platform

Making the workshops workable requires the support of data, informationand communication tools. The M-NEX project planned the moveable nexus platform with three modules: design method, evaluation tools, and participatory mechanisms. Each module consists of the following functions (Yan and Roggema, 2019).

Design method

The design method provides guiding procedures to explore solutions with stakeholders. The procedures are composed of the following steps.

(1) Inventorying FEW-related existing or potential resources and availability of space for urban agriculture, including rooftops, vacant houses, and abandoned, inadequately used or vacant lands

(2) Designing solutions to improve the efficiency of land and space use for food production and ecosystem services with less energy and water consumption by integration of FEW technologies and knowledge

(3) Composing the nexus matrices that mobilize the material and flows of resources cross sectors and disciplines in the social-ecological context

(4) Evaluating the environmental costs and added benefits of solutions through the enhancement of spatial, temporal and service connections among specific social-ecological systems

(5) Delivering the alternatives of solutions and reiterating the design process with stakeholders

This is an iterative and learning process with stakeholders working together. The inventory includes social, financial, and industrial aspects. The mobilization of resources implies the activation and connection of existing and potential capital across industrial, administrative and academic boundaries, with more flows and services.

Evaluation tools

The evaluation of design solutions is a tricky issue. There exists a long list of indicators to assess the impact of human activities on the environment, such as the most typical ones, which include food mileage, CO2 emissions, virtual water use,and the ecological footprint (EF) (Wackernagel & Rees, 1998),etc. Inspired by EF, we developed an indicator we call FEWprint which expressesin terms of land area asthe sum of (1) the land area needed to meet with the demand for food, energy, and water, and (2) the forest area to absorb the corresponding CO2emissions related to FEW resources and services. FEWprintwill be applied iterativelythrough the design process. The output can expressthe existing environmental loadof the FEW demand as a baseline, or the effects ofFEW production and creative design for FEW supply at local level within a household, a street block, a neighborhood, or a city.Such a simplified indicator is extremely useful to assess the performance of design work under different scenarios and alternatives. Stakeholders can understand the environmental costs, the trade-offs and the synergies of different solutions, and eventually rethink the inter-relationships of their behaviors.

Participatory mechanisms

The engagement of multiple stakeholders is conducted through a series of design workshops in the moveable nexus approach. There could be four types of partners: intermediate support organizations, the local community, experts in spatial planning, and public or private sectors.Each partner potentially brings specific resources and advantages, such as physical space, skills, knowledge, financial or regulatory options. During the workshops, design experts visualize resources and produce solutions. The local community can gain an awareness of the issues and co-create the shared values. Private or public sectors might be inspired and then turn the plan and design into policy and business actions. Our experience has told us that intermediate support organizations such as an urban living lab driven by local actorscan play a key role to connect stakeholders together (Yan and Roggema, 2017).

In summary, the moveable nexus platform is a technical support for moveable nexus thinking. The design-led moveable nexus approach is a process to develop the platform through informed design workshops. Urban living labs are the physical places to accommodate the activities for engagement. Consequently, the moveable nexus thinking, the design-led nexus approach, and the moveable nexus platform in cooperation with an urban living lab commonly form the framework and methodology of the M-NEX project.

4 IMPLEMENTING THE MOVEABLE NEXUS

4.1 Establishing Living Labs

The M-NEX project has unfolded at six living labs, including Amsterdam,Belfast, Doha, Detroit, Sydney, and Tokyo-Yokohama. The six cities differ in terms of geographical features, bioregions and societal conditions, but all of the cities are mature and share several concerns in terms of sustainability in their urban areas. Yan and Roggema (2019) reported on the geographical features, bioregional differences, and social themes of every study area. Each city has developed the urban living labin flexible ways. It can be initiated by the research team originally or be a joint facility with stakeholders such as the WISE Living Lab in Tokyo-Yokohama (http://sankaku-base.style).

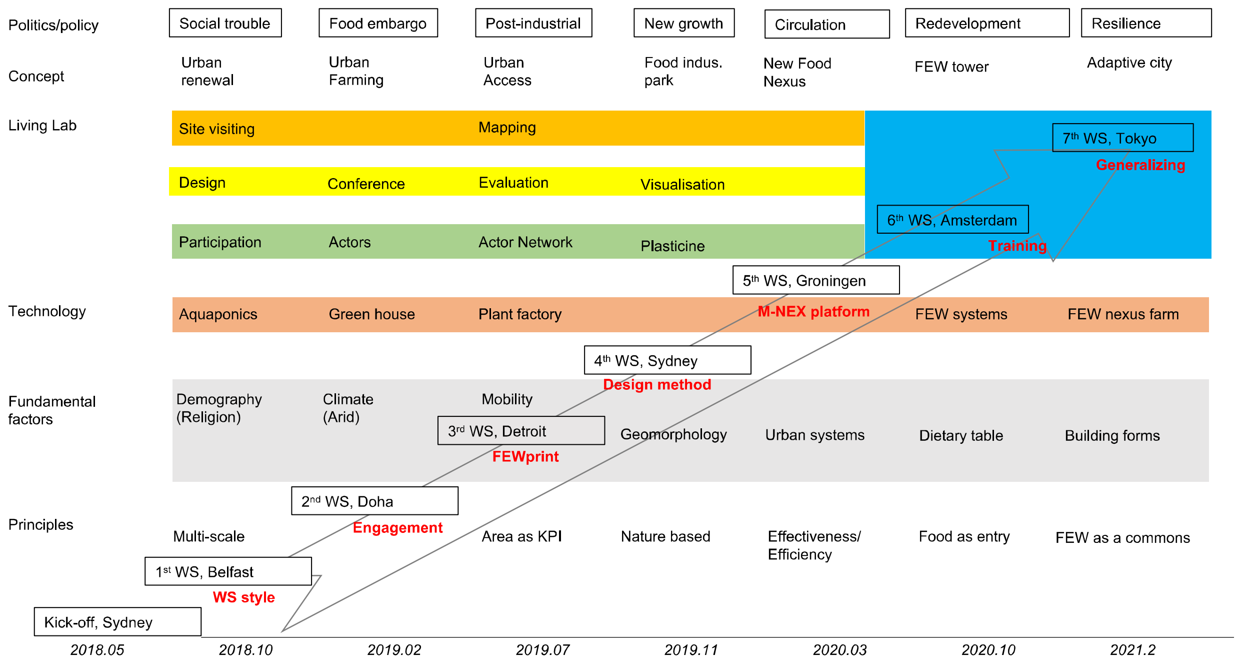

Fig. 1. Incremental project workshop (WS) and results

4.2 Managing the design workshops

The key characteristic of the M-NEX project wasto develop expertise as we harvested knowledge through a series of international design workshops organized at the respective living lab by the individual partner in each of the consortium cities. Every partner country was scheduled to organize aone week-long design workshop with local stakeholders and communities once through the project period. The aim of those workshopswas to co-design a solution for the project site and develop additional knowledge for a specific theme, which then feeds back into the methodology and builds up the evaluation tool (FEWprint). After the first international workshop, the shared knowledge was applied in local workshops in the partner countries for local partners, without international participation. The enriched methodologyat the local level and the advanced evaluation tool was then used as input to the next international workshop in the next partner country. The same process occurredevery six months, following a rotation schedule.Before and after each international workshop, each team held local workshops, practice the learnt method and tools at the local level, and provide feedback to the next international design workshop.By the end of the research project (36 months in total) the design-led meetings and workshops hadsuccessfully been held to harvest the ways of approaching and appraising the applicability. The process and results of the workshops are illustrated in Figure 1, which depicts the understanding of how the design-led approach works overtime. The advantage of this management style is the rotation of method development through practice along with partners and participants.

4.3 Results

As shown in Figure 1, following the kick-off event in Sydney, the first workshop was held in Belfast and focused on creating an initial vision for technical food systems in a post-industrial city. The workshop established the participatory style for running the design workshop. The second workshop, in Doha, organized a comprehensive conference with various stakeholders in food and urban farming to look at how to secure the food supply of a city under a food embargo. The workshop highlighted the importance of networking and engagement of stakeholders with a living lab. The third workshop took place on food access and security in Detroit, a post-industrial city with large amounts of vacant land in the urban center. The research conducted by the Detroit team on FEW material flows and actors on urban food issues initiated the development of FEWprint and the visualization of actors. The fourth workshop, in Sydney, worked on the design of a food industrial park near the planned new airport. The design workshop emphasized the development of the emerging area in harmony with natural ecological systems through the iterative design process. The fifth workshop, originally scheduled for Tokyo, was relocated to Groningen because of the nascent outbreak of COVID-19 in the Asian region. The design work and trial of FEWprint tools at three scales (farmland, campus, and region) inspired discussions on urban FEW circular systems. The sixth workshop, hosted by the Amsterdam team online, proposed a redevelopment plan ofthe harbor district based on a pig firm. A technical training session was also organized by younger researchers to apply FEWprint in six cities. The final design workshop was organized virtually by the Tokyo team. The workshop integrated the expertise developed so far and summarized the nexus approachfor designing adaptive cities in response to climate change. This process was repeated bi-annually, with seven international workshops held (after the kickoff workshop) over the course of three years. Each team had the obligation to host one international workshop over the period. Other organizations participated and cooperated. Consequently, the knowledge obtained at each workshop was integrated and provided as expertise and solutions from the M-NEX Project at each level, from building to neighborhood, city, and region.

5 FINDINGS AND DISCUSSION

5.1 Moveable nexus as a learning process

The project took the complex sustainability challenges of the participating cities, and communicated FEW design solutions in concrete, visual, and physical ways to stakeholders and residents through a series of design workshops. The knowledge developed in each workshop was added to the M-NEX platform and used to gradually enhance the tools. It was then applied to other cities. Each team brought its most urgent topics to the international design workshops, and the teams worked together to refine and build common design methods, evaluation tools, and cooperation platforms. For example, the UK team (Belfast) worked on the design of food factories, while the Dutch team (TUD) focused on energy planning in the FEWnexus.Ultimately, we delivered the research findings, policy recommendations and technical innovations, such as implementation of FEW at the University campus (Doha), revitalization of a post-industrial city (Detroit), and future FEW strategies for consumption-oriented cities (Tokyo-Yokohama, Sydney). The knowledge and solutions developed in these themed workshops were then subsequently integrated finally at three different scales: building, neighborhood and city. The teams also brought what they learned back to their cities, applied them in practice locally and undertook actions toward the next international workshop. This process deepened the understanding of FEW issues and promoted consensus on actions and plans for each city. All of the teams learned from each other and studied the potential to incorporate FEWmanagement into their own cities. The living labs have worked jointly in the six urban areas, and shared design methods to build co-creative platforms, as well as evaluation tools and participation frameworks. Hence, the moveable nexus was a learning process. The series of design workshops provided input on design, evaluation and participation through the generated and distinctive platforms to the case study projects managed in each partner city. The entire project travelled iteratively along the project partner projects, while developing new knowledge and delivering designs at different scales in each partner city, and then integrated the methodologies, tools and participation at the end.

5.2 Principles forthe Moveable Nexus approach

Common factors and principles were observed by obtaining new knowledge and creating solutions for problem solving through the process as shown in Figure1. Some of the key points are highlighted below.

5.2.1 Food as entry point

The food-energy-water nexus is a wicked problem in cities. To simplify the problem, we used food as an entry point in organizing workshops and eliciting solutions. This was considered from both the demand and supply sides. From the perspective of demand, (1) food is essential to survive, (2) food is coupled with energy and water, (3) the availability of food is an issue of personal mobility as well as a deliverable urban service, (4) the quality of food is a barometer of the quality of life for a family or a community, (5) food is meaningful as a way to enjoy life and look for new opportunities, and an important consideration with regards to health, environment, and mobility, and (6) food culture varies by nation, context, and personal preference (i.e., vegan, vegetarian, meat-eating, etc.) and each results in a different environmental footprint. From the perspective of supply, (1) food is part of a complex supply and demand network within cities, (2) food systems are sensitive and change over time through processes such as urbanization, (3) food services are one of the largest and most complex businesses in cities, (4) food is a hot topic in the environmental realm, taking many forms such as organic food, slow food, food loss, and food waste, etc.The choice to use food as an entry point helped to facilitateour approaches to stakeholders.

5.2.2 FEW as a commons

Generally, the supply of and demand for food, energy and water are managed separately by each sector. While industry and government work hard to secure the life supporting services, FEW is often ignored in urban management. Architectural and urban designers tend to think that FEW is a given output of the market or from public services, and reserve little room for alternative ways to supply the systems in place. Only recently, the movement toward SDGs has been changing the atmosphere in academic and management realms as the food-energy-water synthesis is emerging as a key leverage tool for urban sustainability and social equity. Research indicates that FEW access and consumption emit almost 70 percent of CO_2 emissions at the level of individual livelihoods (Dhakal, 2020). Food can be used as a lens to consider social, economic and environmental relationships between the demand and supply in cities. It can be a catalyst to rebuild the relationship between production and consumption of FEW in social-ecological systems. We found that FEW has the potential to be a commons for silo-based stakeholders to sit together at the living lab and think about services and infrastructure collaboratively. This significantly supports the initiative of the SUGI call (https://jpi-urbaneurope.eu/), catalyzing stakeholders to take actions on sustainability issues.

5.2.3 FEWprint as KPI

FEWprint is a tool developed by the M-NEX team for interactive design. It can be considered as a subset of the ecological footprint (EF). As mentioned above, as with EF, FEWprint is calculated as the land area to produce food, energy and water services for a specific social or physical unit and the equivalent forest area required to absorb the correspondent CO_2 emissions through the production, transportation and consumption of FEW services. A social unit consists of an individual, a household or any group of people, while a physical unit is defined either as a detached house, a single unit in an apartment, a building, a neighborhood, or a city. This practice enables FEWprintto be scaled upfrom the building or street block level to the urban or regional level forpolicymakers.

How to deal with changes in FEW was the key issue ofthe moveable nexus thinking. FEWprint can be used as a key performance indicators (KPI) to evaluate the effectiveness of design propositions under various scenarios: for instance, business as usual (BAU), incremental change, and transformational change, adapting to climatic and demographic changes in comparison with the currentcondition as a baseline. Typically, the space reserved for producing or managing FEW components locally within densely built-up urban environments is very limited while more opportunities are available in suburban or extra-urban zones. The situation is changing as a result of a revolution in the production of renewable energy such as photovoltaic panels. Self-produced, or locally-produced and harvested food, energy and water could shorten the distance between demand and supply, eventually reducing the intensity of FEWprint where that gap is shortened. Therefore, FEWprint is useful to evaluate not only the consumption intensity of FEW but also the effects of efforts to reduce the intensity. By using FEWprint, the M-NEX method can (1) redesign the relationship between demand and supply, (2) reassess the costs and benefits of FEW resources and services, and (3) rediscover the opportunities in cities for innovative FEW management in the future.

5.2.4 Technological innovations

Technology playsa key role in solving problems toward sustainable urbanization by improving productivity, reducing carbon emissions and creating jobs. One of the missions forthe M-NEX project was to integrate the fragmented knowledge and technology into the spatial arrangement of design works. The propositions ofdesign workshops and the activities at the six living labs have intensively reflected this mission. The choice of technology is a selective decision based on local natural and social-economic conditions. For instance, the Belfast team proposed urban vertical farming by aquaponics to revitalize unused industrial buildings; the Doha team invented a semi-underground greenhouse to prevent overconsumption of fossil energy; the Detroit team designed urban agriculture parks with ventures that are developing plant factories underground and on the ground; the Sydney team proposed a food industrial park near a new airport to serve an Asian market; the Amsterdam team designed a food tower that produces diverse food products with a significantly reduced FEWprint; the Tokyo team proposed a renewable energy and hydrogen-based home FEW nexus firm for a large number of detached houses in the suburbs of Tokyo.No one solution fits to all ofthe cities. Adoption ofthe technologies should be based on the understanding of the political visions and the fundamental factors of each study city.

5.2.5 Context dependency

Regarding the urban FEW design, we should always think about how we can input contexts into the design process. As shown on the top of Figure1, each city had distinct concerns and the priority of problems to discuss and the solutions were totally dependent on the socialeconomic and natural conditions of cities.Thosecontexts are absolutely crucial to understand, because they will directly impact the ability to design in any given situation. There is a kind of demographic dimension of contexts to this too. It may beeasier in the Netherlands to propose an all-vegan diet in conversation with stakeholders than in the United States, for example, and practices will differ at the individual and cultural level in Qatar versus in Japan. It is then a challenge to implement the policy goal at a community level. Although the acceptance of this kind of global policy may be distinct from countries and cities, a common indicator like FEWprint or a common language likethe SDGs does help localizethe moveable nexus approach properly into the distinct context.

5.3 M-NEX, the Developed Moveable Nexus Platform

Throughthe processandabovefindings, theprojectteamdevelopedthe designsupportplatform, M-NEX,asshown inFigure2. This diagram illustratestheessenceofthedesign-lednexusapproach. The key concept of the platform, as indicated at the top of the diagram, is land area to be expressed as FEWprint, the key performance indicator to measure the resource-use efficiency and design solution effectiveness. It first accountsfor the land area required to meet the demand for FEW and the forest area to absorb CO2 emissions in FEW resources and FEW services asFEWprint baseline. Then, the area existing and to be created to supply FEW resources and services, as well as to absorb CO2 emissions, are accounted for again. By increasing FEWprint NEW and reducing FEWprint NOW, we can shrink the range needed to meet the FEWdemand and supply.

The design method under the area concept is composed of three phases, with nine steps as a whole, and each phase is supported with sophisticated intelligence and ICT tools. The first phase with three steps is to explore the site at different scales, understand the policy context and define the design concept. FEWprint is calculated as a baseline here. The secondphase iterates design and evaluation with FEWprint under different scenarios and adaptive strategies. Basically, all situations and technologies have the same basic elements that can come into this process, such as new energies, vertical agriculture, or green infrastructure, etc. The third phase is participation and co-creation with players at a living lab. The FEW nexus provides a commons to bring the stakeholders—from the upper stream such as utility companies to the lower stream such as grocery shops and inhabitants—to the living lab.

This platform is moveable and flexible for teams to modify for each of their specific contexts and policy issues, ranging diversely from aspects such as carbon neutrality and SDGs to the circular economy. The comparisons can be most meaningful between different adaptive strategies. By applying the platform, we can compare the outputs in the cities, or compare and contrast different approaches in different cities; for example, a business-as-usual strategy versus an alternative proposal within a given city. We can identify the role of an individual household, or an individual stakeholder. We can examine a type of housing, versus a neighborhood organization, or the precinct organization that allows for the institutionalized dimension of the system to be spatialized in the city, or a more general comparison that we would see different patterns across these cities. The comparisons across cities will be more about context differentiation, and the focus could be on how the approach and the tool can be utilized in different contexts around particular technologies and scalar differences.

6 CONCLUSION

M-NEX was designed to have an impact across a variety of scales, stakeholders and locations. The decision-making tool and platform weredeveloped through intense community-based workshops in six locations around the world. The research team visited each location to collaborate with local stakeholders from various sectors in urban living labs to address and formulate a strategy to tackle local FEWproblems. This approach ensured an applicable strategy that provided value for the local academic community, citizens, end users, and commercial parties. The outcomes of each location were analyzed and combined to refine the moveable nexus approach. This process of refinement has helped the output of the moveable nexus platform M-NEX to gradually mature. The iterative design process developed within the project integrated FEW systems, participatory design, FEWprint evaluation and communication formats, and presented a new direction for urban design processes. As the work is disseminated, we expect these methods and processes will help to shape future urban design practices, both academic and professional.

7 ACKNOWLEDGEMENTS

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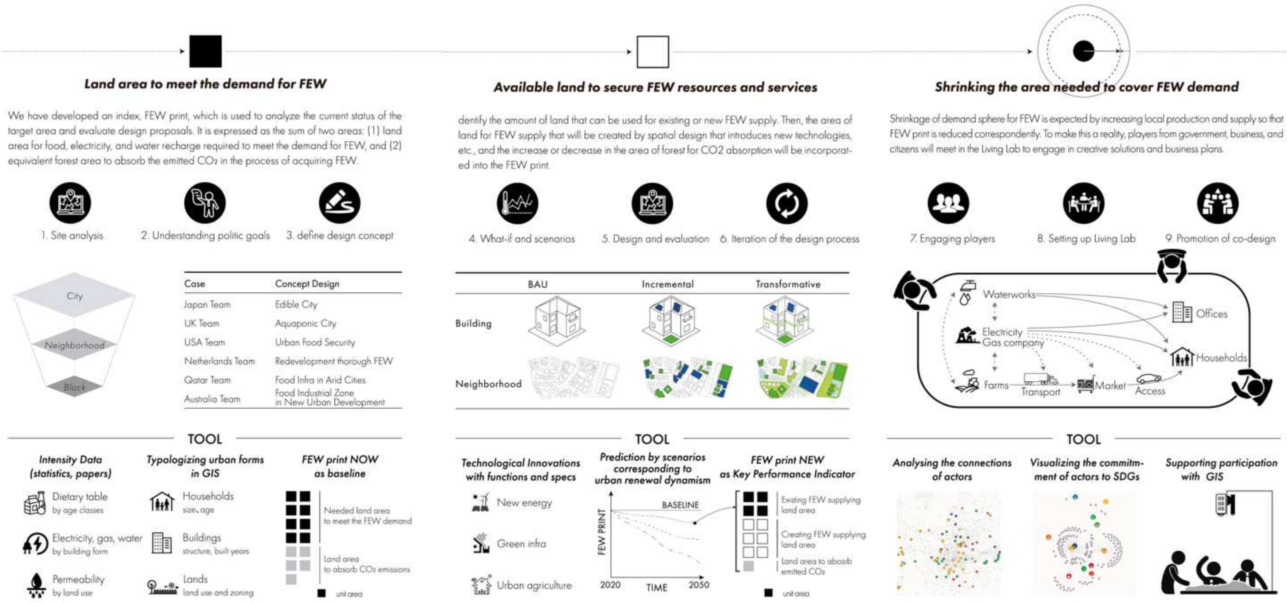

Figure 2. The structure of the design support platform M-NEX

Developing Cultural Heritage Plan in Response to Future Challenges: Case of Lamu-Town World Heritage Site, Kenya

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1 ABSTRACT

Spatial justice is a term that advocates for the equal distribution of resources and privileges that are not easily accessible by the commoners due to various reasons such as financial constraints, poor education among others (UN-Habitat, 2018). Choosing Lamu Town as a case study, one of the best preserved Swahili settlement would best bring out how spatial justice would play a significant role in the preservation of cultural heritage. The term commoners in this research refers to the indigenous people. With the promising future of Lamu since its initiation of Lamu Port – South Sudan – Ethiopia Transport (LAPSSET) among many other development projects that are neighboring the town, the threat to the heritage site due to uncontrolled developments expedites. The role of urban planning in spatial justice applying in Lamu Town would be to provide a sense of acceptability, support, compliance and suitability for the commoners in Lamu. Putting in mind the boundaries of sustainability in cultural preservation for future generation. The research employed qualitative study methods, such as; conducting primary dataset that includes online survey questionnaires with 40 participants and 10 physical survey questionnaires, interviews with 5 local experts, photo observation and on desk survey. According to the data collected so far, there is a larger concern for the declination of cultural heritage due to urban developments. Secondly, all aspects such as land, housing, water, electricity and waste system are inadequate for the rapid growth of population.To conclude, the contribution of this research is to highlight on the importance of spatial justice and its role in safeguarding cultural heritage that not only plays a significant role in economy but as well as protecting a far greater value which is identity.

Keywords: Cultural heritage, spatial justice, urban planning, sustainability

2 INTRODUCTION

Lamu Old Town is located on a small island off the north coast of Kenya, as seen in figure 1. Its neighboring towns such as Shella, Pate, Siyu and Faza are as well among the best preserved swahili settlements, each with a distinctive aura along the East African coast (Marguerite Y. 1979) whose cultural practices relate to the teachings of the Islamic religion. Lamu Town has the largest populations among the neighboring towns hence choice of the case study. The Old Town was enlisted as a World Heritage Site in 2001 by United Nations Educational, Scientific and Cultural Organization (UNESCO) due to its realization of its unique cultural heritage and its characterization of indigenous building technology that was borrowed from different traders and colonists such as the Indians, Arabs and Portuguese. The Old Town is a historical site with a good number of still surviving 17th and 18th century stone houses that are about 700years of age or more and which had been screened from modern development pressures (National Museum Heritage Act, 2006. Cap 216).

However, as a result of Lamu Port – South Sudan – Ethiopia Transport (LAPSSET) near Lamu town that consists of several other infrastructural components such as: a new modern port of 32 berths, planned new transport infrastructure containing an airport, railway line, an oil pipeline and a good number of highways. Among other developments such as metropolis city with the capacity to take in 1.1 million people see figure 2. All the developments mentioned above happening at the node of Lamu World Heritage Site. Where regardless of its protection by a number of organizational bodies would be impacted. Its effect already being felt. Therefore increasing the urban challenges facing Lamu Town and the efforts of conservation of the historical site.

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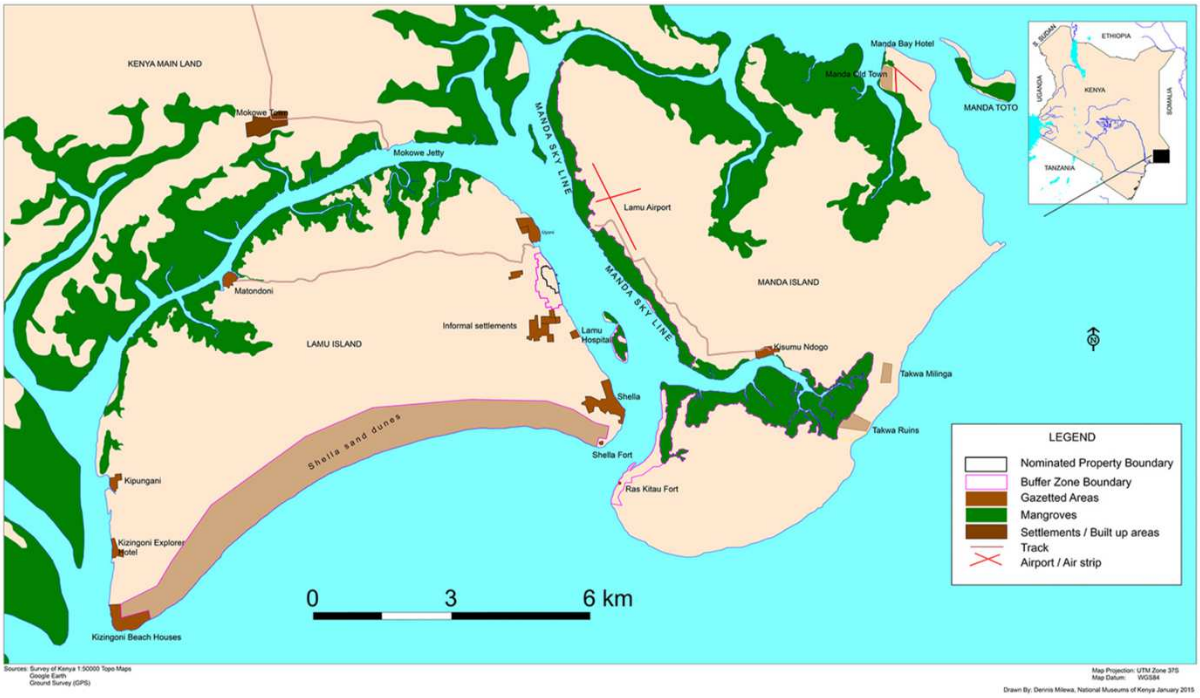


Fig. 1: Location of Lamu (Source: National Museum of Kenya)

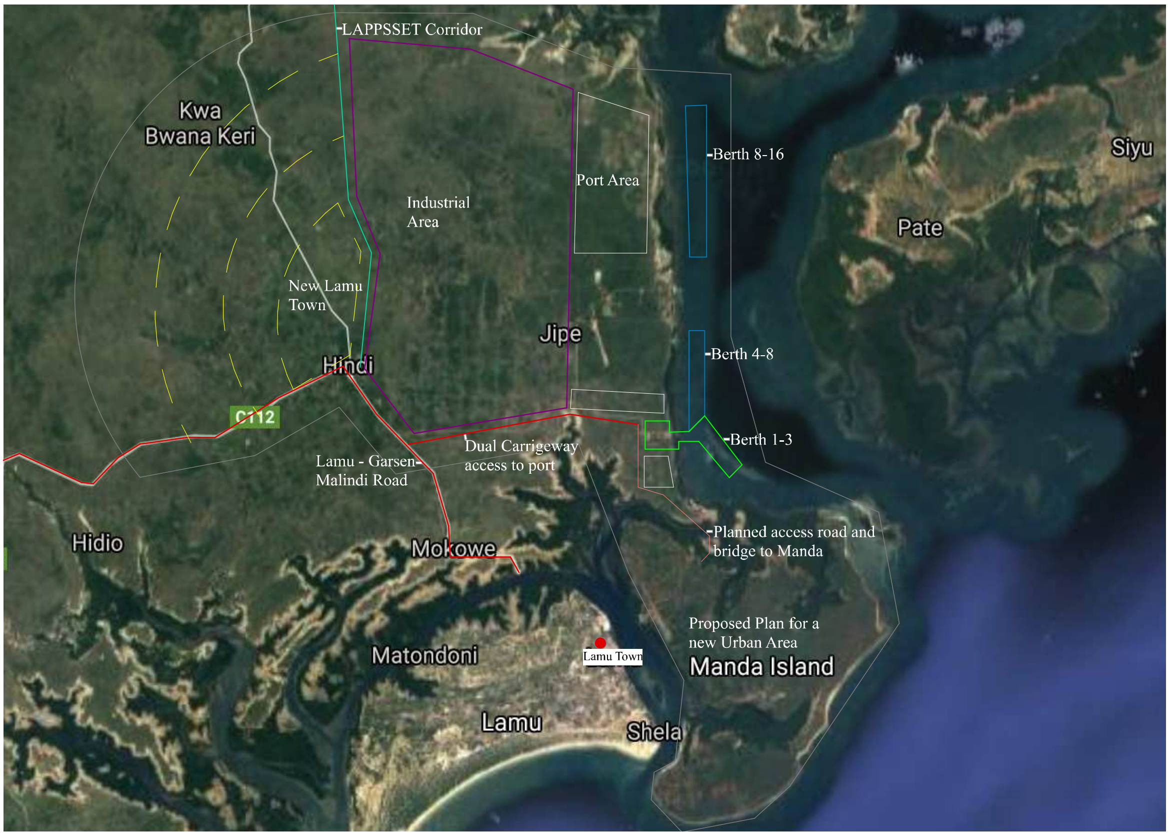


Fig. 2: Upcoming developments neighbouring Lamu Island (Source: Edited from Google maps)

Experts say that regardless of efforts to prevent any kind of development relating to the port, the town will undergo development whether intentional or not (World Heritage Committee, 2015). Through projection of population estimation between the year 2009 - 2025, it was computed that by 2025, Lamu Town population would be at 12,242 (Lamu County Spatial Plan, 2017). A census was conducted in 2019 and the population was at 25,385 surpursing the computed population of 2025 by twice the estimated figure. Thus proving that Lamu Town is at a greater risk than anticipated. The emergence of such pressures will have a profound effect on the Old town. With an increase in urban pressure imposing on the commoners, resources such as land, housing, water, electricity and sanitation does not meet the demand of the rapidly increasing population.

Moreover, most commoners finding the living conditions becoming harder especially after being affected by the decline in tourism and the fishing industry as a result of the port development.

2.1 Physical Context

Lamu Old Town is the oldest and best preserved Swahili settlement on the East African coast. According to (Lamu County Spatial Plan, 2017: pg.11), about 65% of the physical structures are in good condition with only 20% being in need for minor changes and that of the remaining 15% may need total restoration. The majority use of the buildings being commercial, public purpose or residential. The town is characterized by narrow intertwining streets where most are less than an arms stretch allowing for pedestrial movement and donkeys in most streets, in some the pedestrians have to pave way for the donkeys to pass.In 2013, through the new County Government Act, Lamu was urged to prepare a spatial plan showing the Land use zones for its future vision and figure 3 shows the proposed Land-Use-Zones of Lamu Island by the County Government in 2013 that is yet to be implemented.

The vernacular architecture of the town depicts a two-storey building with a terrace constructed from local resources and with local traditions, often with wooden facades, and overhanging eaves. The carvings in the wooden doors are highly decorated, reflecting floral patterns. With the modern material and technology most upcoming buildings use this technology as it is cost and time efficient.

Moreover, Lamu town having been known of a place that offers tranquilty due to its minimal motorized vehicles that only served as a garbage collector, ambulance and policing that was only used on the seafront. Major transport used was donkeys and carts where goods are moved through the narrow twisted alleyways of the town. Until of recent times, motorbikes are now mostly used as a means of transport for people from one place to another. This has brought debates on whether they should be banned, but as of now, thereis no control on the motorcycles. Moreover, the streets not only serve as a space for movement but rather as a socializing space where youth and elders engage in talks and even play board games thus integrating both tangible and intangible attributes that bring out its outstanding universal value as a Heritage Site. On the other hand, the shore line of the sea is used a space to conduct businesses as well as a space that allows people to enjoy the view of the ocean. Over time, the seafront has been used for cultural festival activities that happen each year attracting visitors from different parts of Africa, Gulf and other parts of the world. In addition to this, the Town has a common square that acts as the center of the town, where auctions, political and social functions take place. Neighboring the square is a market which plays a significant role in the community’s identity.

2.2 Economical Context

Over the century, the main economical source of income of Lamu is tourism and fishing. Other sources being furniture making and farming. The two major source of economy has proven to not being reliable due to security threats by terrorists, change in climatic conditions and the new port development affecting the nearby fishing grounds where local fishermen with insufficient fishing equipment greatly suffer. The town has continuously been undergoing economical decline threatening the cultural heritage due to displacements of its commoners in search of jobs, better education and living conditions.

2.3 Culture and Lifestyle

The culture and lifestyle of the commoners in the Old Town remains conservative and responds to the Islamic teachings as majority of the people are Muslims. Lamu, has ever since been a center for Islamic knowledge from 19th century by the arrival of the Jamil al Layl Sharif, Habib Saleh from Comoro Islands, who is said to be a direct descendant of prophet Muhammad (Paul G. 2018). Each year Lamu holds three festivals one celebrating the birth of prophet Muhammad known as ‘Maulid’ and the second one the cultural festival showcasing the culture of the people of Lamu and sport games from donkey racing to boat racing and dhow racing on every new year’s day. According to Sheriff, Islam played a role in the Town’s evolution in their planning. He further states that Islam provided administrative, legal, educational and spiritual structures that allowed for the expansion of the Swahili city states (Sheriff, 2010: 239). The lifestyle of its people is mostly simple and as result of the climatic conditions, the working clock starts off early in the morning and stops slightly after noon then resuming in the evening after their evening prayer ‘asr’.

3 RESEARCH METHODOLOGY

In line with the research goals that aim at expounding on challenges facing the commoners in relation to the unmanaged urban development on the heritage site, the research strategy used is based on qualitative research methods.A variety of sources were used to obtain data for triangulation purposes. Thus allowing for proper assessment of different sources of information to investigate concepts on the fact that a consensus of the findings will producebetter results. The figure belowshows the outline of the dataset.

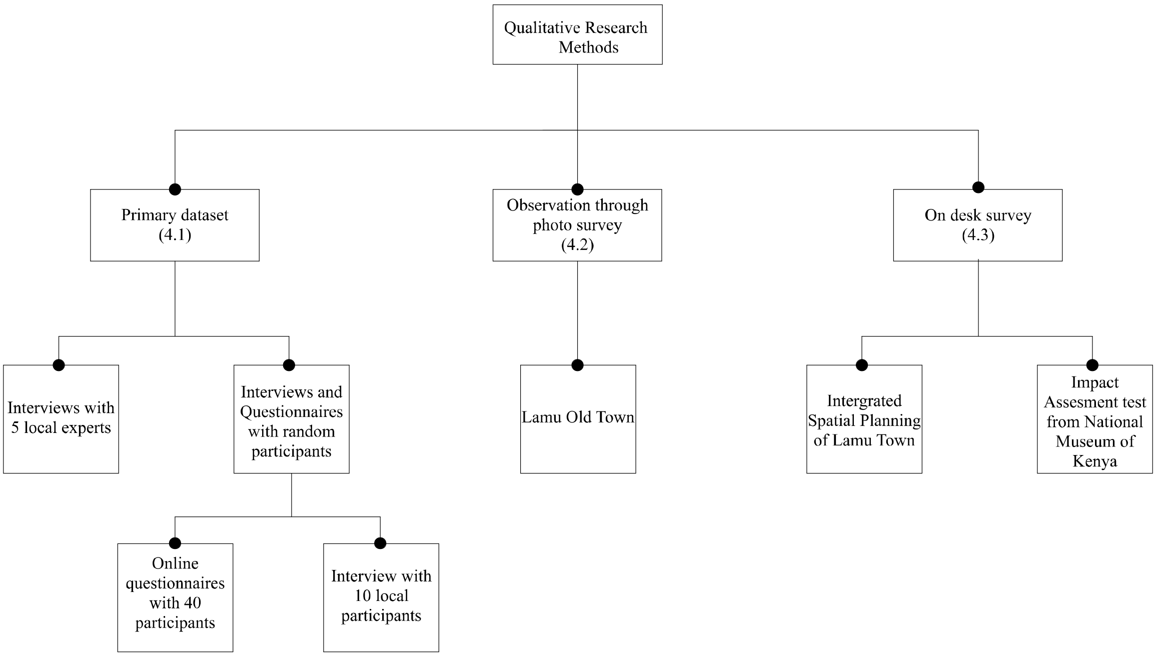


Fig. 3: Diagram showing qualitative research methods

Structured question	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5
What are the positive and negative effects of development in Lamu town	**Positive:** -The money harnessed if properly managed could help the heritage site -Improvement in all sectors; health care, security and infrastructure **Negative:** -Spontaneous, poor management -Inadequate sewer system -Modernisation -Issue of purchasing power affecting the locals	**Positive:** -Employment -Improvement in socio-economic development **Negative:** -Depletion of natural resources -Food insecurity -Displacement of indigenous people -Heavy impact on fishing industry -Rapid demographic change	**Positive:** -Improvement in building technology **Negative:** -Traffic -Sporadic development -Loss in heritage -Insufficiency of land -Land conversion	**Positive:** -Employment **Negative:** -Decline in tourism -Change in ecosystem -Loss in heritage -Land conversion -Pollution	**Positive:** -Employment -Improvement in infrastructure such as the expansion of market building, paved road on seafront **Negative:** -Insecurity -Effect on torism -Pollution
Which aspects (water, electricity, land, housing & transport) meets demand of rapidly increase in population of Lamu Town	-Non meets the demands	-Non meets the demands	-Non meets the demands	-Non meets the demands	-Non meets the demands
If funds were made available for future development, which area should it be focused on	-Disaster risk management to be implemented -Diffusing pressure by buying land and creating space -Improvement in services	-Environmental friendly technology -Fishing industry -Alternative livelihood projects -Improving solid-waste infrastructure	-Water to be looked at as a necessity -Public utilities -Constructing a different path for motorist -Designing of the seafront	-Landscaping -Improvement of facilities -Improvement of street lights -Designing of the seafront to represent culture	-Fishing industry -Improvement of facilities -Improvement in tthe education sector
How can funds be raised	-County government of Lamu -Donors	-Donors, UNICEF -National Museum of Kenya -Bilateral organisation	-Donors -UNESCO -Lamu County Government -Mosques	-Donors -UNESCO -World Heritage Bank	-Donors -UNESCO -NGO's
What roles should residents play in helping to plan for a viable development	-Community led initiative centre -Learned community member to give back	-Request support ffrom donors	-Sensitization of community	-Creating awareness -For the learned to give back to community	-Community led initiative centre -Creating awareness

Table 1: Response from local experts

4 RESEARCH FINDINGS

4.1 Primary dataset

An empirical data was conducted with 5 semi-structured interviews with local experts on heritage conservation and urban planning (Fig. 3)sampled by selecting them from public sector (Table 1). This assisted in providing an in-depth exploration of emerging issues, observation and documentary evidence. Interviews was sought through the respondents perspectives on issues concerning the heritage and urban planning. The interview schedule consited of five main questions that aimed at effects of development on a heritage site.

Respondent 1: Mr. Mohammed Mwenje, Curator of the Lamu Museum, National Museum of Kenya

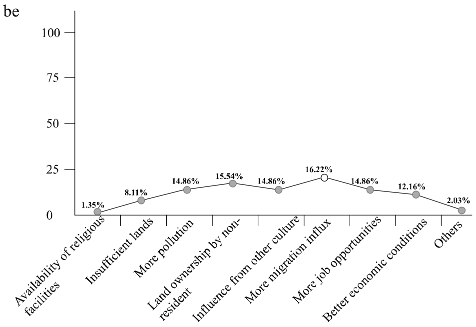
Respondent 2: Mr. Mohamed Baishe, Director of Environment and Natural resources, Lamu County

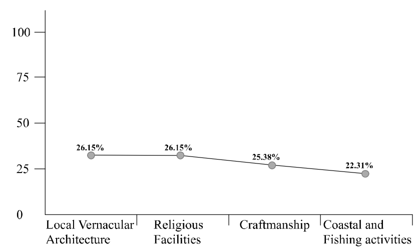
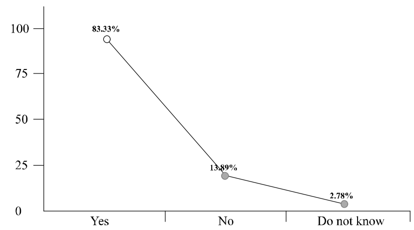
Respondent 3: Arch. Omar Saggaf, County Architect and Head of Public Works

Respondent 4: Mrs. Husna, Lamu Museum

Respondent 5: Mr. Maawya Farid, Commisioner of Lamu County Service Public Board

An online questionnaire with 40 participants at random was conducted, majority of the count 23 being of the age 25-40, 18 being of the age 40-60, 4 above 60 and 4 between 18-25 years. 73% of which are residents of lamu and 90% being indigenous people of Lamu. On the level of education, 88% had an educational achievement of college/university, 6% of secondary certificate, 2% each of primary certificate, technical school and 2% responded non of the above. Under empolyment, 42% of respondents were working in pubilc, 35% in private, 2% industrial and 21% in other forms of jobs. This type of online questionnaire had an advantage of getting the response from educated people yet a disadvantage of getting response from participants who found the choice of language challenging. I therefore conducted 10 interviews with the locals by using the local language and their response was included in the illustrations below.

QUESTION	RESPONSE
What aspects will be affected by development	
Positive and negative aspects that will be affected by development	Migration influx affecting the cultural heritage Competition of job opportunities with non-locals Concerns that the locals will not be able to cope with the socio-economic change Positive aspect that it would improve the activities and the economic growth Decline in the fishing industry Fear of increase in marginalization, exploitation of locals and tribalism Insufficient lands and land conversion Religious and cultural animosity Increase in pollution

QUESTION	RESPONSE
What aspects of culture should be preserved	
Other important aspects	Traditional mode of transport which is the use of donkeys, walking and use of carts for heavy goods Fishing industry as a key role in the heritage of lamu Protection of intangible cultural heritage Protection of historical buildings and sites Protection of mangrove forests
Do you believe in integrating culture and development as a way of providing quality of life and fulfill future needs of the town	

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4.2 Observation through photo survey

Fig. 4a : Seafront during the day, Fig. 4b : Seafront at night


Fig. 5a: Open storm drainage system, Fig. 5b: Building materials scattered along the seafront neighbouring the temporary market


Fig. 6a: Vernercular architecture, Fig. 6b: Modern architecture


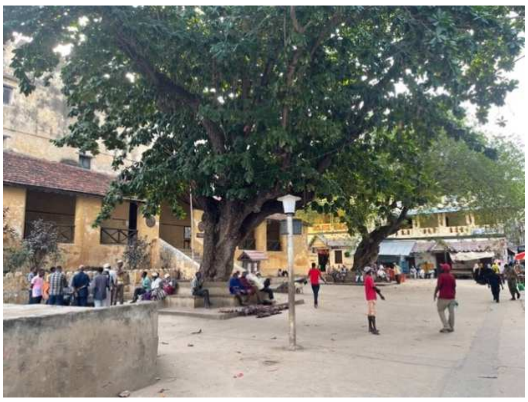

Fig. 7a: Open space around the main hospital, Fig. 7b: Open space (mkunguni)

Fig. 8a: Traditional mode of, Fig. 8b: Traffic on the sea front, Fig. 8c: Tractors loading building transport materials

4.3 On desk survey

4.3.1 <u>Proposed spatial plan of Lamu Island</u>

As Lamu is heading towards a new era of large-scale development and infrastructure investment, mostly as a result of the multi-million dollar LAPPSET project. Just as these developments could generate substantial economic and social benefits, they as well could pose a threat when not managed properly. Responding to the facts, Lamu County Government developed a county spatial plan in 2017 to guide the development, use, demacating the conservation zone among other resources in the next county that was meant to last for 10 years. The spatial plan is yet to be implemented. Figure 9shows a proposed Land Use Zones in Lamu Island by the County Government. The Old Town has no direct connection with the mainland and through studies it has been noticed it would improve the economy by just providing the access as seen in fig. 4 hence it was proposed in the spatial plan.

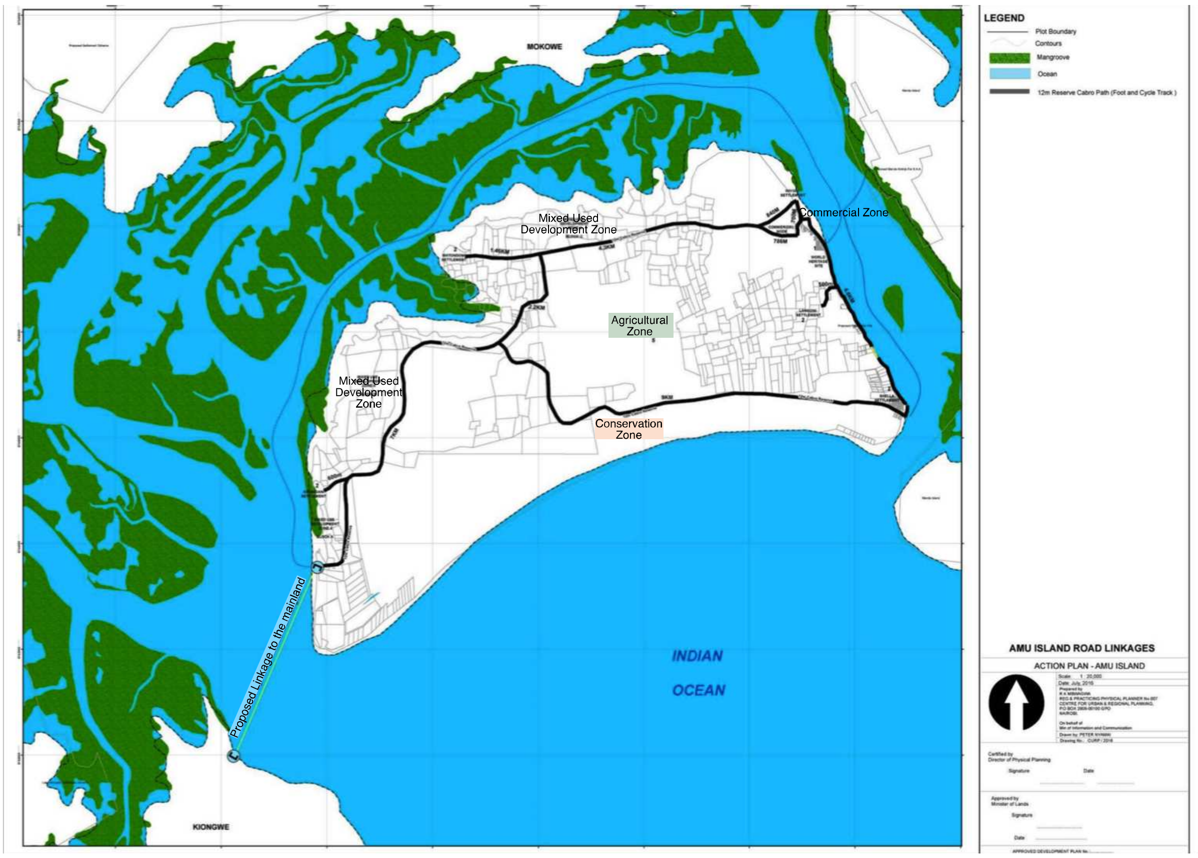

Fig. 9: Proposed Spatial Plan, 2013 (Source: Lamu County Spatial plan)

4.3.2 <u>Impact Assesment Test on The Heritage Site</u>

The National Museum of Kenya (NMK) on behalf of the state-party to the World Heritage Committee (WHC) by conducting a Strategic Environmental Assessment (SEA) which was used as a tool for

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safeguarding and building sustainable policies, plans and programs and the strategic initiatives of LAPSSET corridor Infrastructure Development Project, that there was a changing in the order of land use (NMK 2017). Lamu's landscapes are seen to undergo drastic changes. Such as; increase in land-use change in favor of settlement and urbanization, communities becoming more sedentary more or so around permanent water sources, increased in the commotion for individual land ownership, constricted livestock grazing leading to overstocking and localised overgrazing, increased adoption of both rain-fed and irrigated agriculture, increased human/wildlife conflicts, increasing land degradation and reduced carrying capacity, pastoral livelihoods under great threat and last but not least, increase of severity and impact of droughts (NMK 2017).

Moreover, on the question of escalating poverty; Lamu's livelihoods are under threat from:reduced carrying capacity, increased severity and impact of cyclic droughts. Increased in unemployment especially for young adults, dwindling water resource base and cases of Lamu dropouts on the increase. Overall poverty levels in Lamu remain high (NMK 2017).

In addition to the pre-existing concerns on community land management, the following was stated: Lamu lands are undergoing drastic and accelerated change due to: intensified clamor for individual ownership of formerly communally owned land, accelerated and contentious allocation of communally owned land, official and unofficial encroachment on community land, lack of appropriate legal mechanism to govern community land and increasing conflict over access and control of land (NMK 2017).

In the Strategic Enivornmental Assessment (SEA) for Lamu County Infrastucture Development Project the following were given as the priority concerns; the question of water demand management,inorder to support urbanization, industrialization, port functions, etc. Modalities for co-existence between LAPSSET investments and wildlife. Wildlife dispersal areas and corridors. Impacts on biodiversity and ecosystem services. Endemic and rare species. Loss of forest cover, mangrove ecosystemwhich also acted as the breeding areas for fish. Potential impacts on land, land ownership and associated benefits. Rush to alienate community land to private individuals and firms. Impacts on pre-existing livelihoods and production systems. Indigenous forest-dependent communities such as pastoral systems andfishermen. Modalities for sustainably managing change; Immigration, cultural dilution, political implications; Urbanization and industrialization –social services. Management of the environmental balance; Environmental flows, waste management and pollution (NMK 2017).

5 DISCUSSION

This section discusses the findings from evidence gathered through the on desk survey, interviews, and photo-survey discussed above. Data analysis has been conducted through questionnares, interviewing officials, and direct observation notes. Photos shown in this section are taken as part of the direct observation and photo-survey of Lamu Old Town. Furthermore, the representation of cultural heritage from the document analysis is included in this data discussion. Two thematic areas of discussion emerged from the findings.They include: effect of uncontrolled development on the heritage site (5.1) and valuing heritage on an intangible dimension (5.2)

5.1 Effect of Uncontrolled Development on the Heritage Site

Through the inadequately planned and managed heritage site Lamufaces immense challenges in its urban context. For instance, as a result of unsafe housing with poor provison for clean water, sanitation, inadequate infrastructure and services that currently Lamu is facing, can turn natural hazard into a disaster. By way of illustration as seen in figure 5a, with an open storm water drainage near the market area which tends to block oftenly due to the unsanitary conditions, could result to an outbreak of harzadious diseases such as cholera.

Lamu Town experiences a drastic change in its physical context from several issues that are as a result of sporadic increase in population. This being a small island with a limited carrying capacity posses a major issue in land efficiency. Through the census that was conducted in 2019, the population surpursed the computed number by twice the estimate. As a result, it caused the encroachment of conserved areas, land conversion by building on agricultural land and land demand sky rocketing as people with purchasing power out buy the locals creating a major threat towards the intangible heritage.

From the traditional mode of transport being donkeys and carts to how buildings interact with one another and with the streets, to how open spaces function as a socialising space gives this town a unique urban heritage that generates tranquility and ambience. However, due to poor management, the town is experiencing a sporadic change, from uncontrolled motorcycles, pollution and servicing as seen in figure 5a, 5b and 8b, 8c.

Despite having a magnitudinal project neighboring the area, the essential aspects such as: water which is rationed by each house-hold getting access to water twice in a week for an hour each, surge in electricity in the evenings, sometimes blackouts and waste management are far from reach. An issue that will continue to worsen as population increases if not handled instantaneously. The issue in proposing a different waste management that includes the sewer system is critical, as negligence in it could cause an epidemic.

Moreover, as the town expands, the denser it becomes and so do the conditions of the environment change. Due to the uncontrolled development and poor spatial planning there are no play areas for children or adequate open spaces which are currently only found at the sea front see figure 7a and 7b. In additon, there are no policies implaced that manage or reduce existing and future disaster risks, which can prove to be catastrophic were there to be an outbreak or a disaster such as fire and other natural causes.

5.2 Valuing Heritage: Intangible Dimension

In its landscape, urban planning plays a significant role in reinforcing a town’s identity through the integration of heritage and historic urban area conservation, management, and planning strategies into local development processes and urban planning aids (Girad L. 2013). An ideology that lacks in the preservation of Lamu’s cultural heritage. Moreover it fails to acknowledge the interconnectedness of economic, social, cultural, and environmental systems that could play as a key resource in urban sustainable development.

Through local expert interviewees, they pointed out that the local politicians are not concerned with the value assigned to Lamu’s cultural heritage as they should and without political buy-in and commitment, heritage is then being left at the margins of urban development.

Furthermore, the developments have affected the major economical activity of Lamu Town, the artisinal fishing industry. Where traditional methods of fishing is still used and their main fishing grounds affected by the port development. Regardless that some fishermen were compensated, it was not a sustainable solution as the money was inadequate and for them not being exposed and learned, their lives becoming difficult. And there is still no measures that have been placed to enable the fishermen to go deep sea fishing

Without the acknowledgment and appreciation of Lamu’s culture and values, opportunities for establishing social cohesion and connectivity are missed. Lamu’s urban fabric is under consistent pressure to “modernize”, leading to the continuous disappearance of traditional skills and crafts that are part of the intangible cultural heritage (Jigyasu R. 2014). Expert interviewees commented on the depreciation of a sense of place and belonging in the commoners of Lamu due to the various physical environmental challenges mentioned above and the increase in population.

In addition, the social connectivity and cohesion are becoming weak and therefore there is lack of interest in engaging with Lamu’s heritage. This challenge will worsen when considering migrant populations who have settled in Lamu primarily for industrial activities and have no inherited sense of responsibility to conserve and value Lamu’s heritage.

6 CONCLUSION

This paper has examined the challenges the commoners face in Lamu’s Heritage Site as a result of poor spatial planning. The discussion is based on the grounds of a growing population in a poorly managed urban setting and how its negligence affects the identity of the commoners. The town of Lamu is explored as an exemplar study through qualitative fieldwork. Although Lamu is yet to make effective steps in addressing its spatial planning issues and the existing challenges on commoners. The findings from this study highlight the following:

The need for decision-makers with the involvment of the commoners to enforce new policies that protects the already diminishing heritage by acknowledging the spatial injustice the commoners face.By providing better living conditions through adequate infrastructure, good management and cooperating both formal and informal sectors.

As a result of the sporadic increase in population in a limited land carrying capacity, the future generation of the commoners is faced by a threat as people with purchasing power outbuy the commoners from their ancestral lands. Inorder to sustainably preserve the heritage of Lamu by valuing the intangible dimension, policies that protects the commoners from being replaced should be considered.

Of great significance should be, that the commoners are able to live in a condusive environment that they could reflect as their identity. Proper spatial planning policiesthat reflect the commoners identity by borrowing from the past should be adopted. Inthat it will allow them to have a sense of belonging.

To maintain its land use allocation pattern of Lamu, there is a need to asses, monitor and oversee the trend and the pattern of development as they happen. For instance the uncontrolled motorized traffic that threatens to destroy the unique ambience of the island. For the unchecked development damages the beauty of Lamu and the sustainability of the heritage site.

Assembly points should be designated as part of the disaster risk management strategy. As it is, Lamu town is densly populated and measures of prevention of disaster is highly significant.

An initiative should be taken in developing an alternate waste management strategy which may include installation of risk-reducing infrastructure such as closed storm water drainage and slope stabilization as the current is not environment friendly and with the increase in population, the situation will worsen.

Future research can be focused on urban cultural representation. Lamu is not a unique case, the narrative on this case study reflects current challenges on conservation of heritage assets in rapidly-growing urban areas and also portrays how much the commoners are affected by such pressures.

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Developing Design Baseline to Reduce Urban Environmental Load in Food-Energy-Water Demand

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1 ABSTRACT

Cities reflect diverse spatial patterns as a result of their composition in population density, building forms, and household types. These differences, to a large extent, reflect the quality of life of an area's inhabitants and the correspondent environmental load their lifestyles impose. Environmental load is related to the supply and demand for food, energy and water. As a result, identifying gaps between supply and demand is a common starting point for urban planning and design aimed at zero-carbon emissions and other forms of sustainable urbanism. In this regard there is substantial research and tools that can be applied to these issues. One typical example is the Ecological Footprint which uses an equivalent land area to express the demand for the production of goods and CO2 absorption. This indicator is powerful at the macro level with regards to the conceptualization of the problem, but difficult to use at the small scale when considering the benefits of particular design options. Against this background, this study aims to develops an indicator to express a design baseline that enables the quantitative evaluation and comparison of the demand and supply of FEW as well as their contribution to environmental load with regards to food, energy, and water at the city block level.

Many environmental indicators were developed in recent years to clarify the interaction of the so-called FEW Nexus, or the confluence between the otherwise separate realms of food, energy, and water. However, these indicators are also difficult to apply at a small scale. This study develops an index that enables the quantitative evaluation and comparison of the relationship between food, energy and water at the city block level. The demand and consumption for food, energy, and water associated with residences are strongly influenced by the type of households under consideration. Meanwhile, the potential production and supply of food, energy, and water for a given household is mostly determined by the capacity to install solar panels and home gardens, which are themselves strongly determined by building forms and land use. Therefore, the baseline of a city block for FEW demand and supply can be assessed by identifying the type of households and the form of buildings within it. With this in mind, we categorized "household types" in terms of the number of family members, the age group and gender; "building form" is defined either as a detached house or an apartment. The demand for food, energy, and water associated with a given "household type" (per household or per capita) is defined as social intensity. The unit associated with "building form" is defined as physical intensity. The social and physical intensity were carefully identified through statistical data and previous studies. Based on these preparations, the demand for FEW, as well as the amount of production, can be estimated at a household level and aggregated to the city block level. Physical estimation of the demand and supply are then converted to an environmental footprint by applying the concept of the Ecological Footprint to FEW.

This indicator was applied to the Tokyo-Yokohama metropolitan area as a case study. In order to improve the comparability at the regional level, the metropolitan area was categorized by three forms, namely the inner city, near urban and suburban. Typical areas were selected to represent the social and spatial characteristics of each. Finally, the method was applied at the metropolitan scale using GIS data in sample areas.

The result clearly shows the spatial differences in demand and supply of food-water-energy as well as the correspondent environmental print. While the environmental print per unit area is greater in the inner city, the per capita number is greater in suburban areas. This indicates that suburban areas have a larger responsibility to reduce their environmental footprint through food-water-energy consumption. This knowledge is helpful to move environmental issues from being a matter of concern for the government to being a problem for communities and individuals.

Keywords: Ecological footprint, GIS, Building form, Environmental load, Food-Water-Energy Nexus

2 BACKGROUND

While food, energy, and water (FEW) play a central role in the system that supports the demands of human life, the CO_2 emitted in the process reaches nearly 70% of the global CO_2 emissions (Ramaswami et al., 2016). In addition, the majority of the world's population was officially urban from 2007, and the number is only increasing. By 2050 two-thirds of the world's population is expected to live in urban areas, and FEW consumption is subsequently concentrating in urban area(Kammen & Sunter, 2016). As a result, urban areas face increased sustainability challenges and are faced with the need to pursue ever higher resource efficiencies. However, the demand and supply of FEW have traditionally been managed separately in each sector, and efforts to reduce carbon outputs are reaching their limits. Therefore, in recent years, attention has been focused on the complex demand and supply networks that exist between FEW sectors, and resource efficiency is expected to be improved using these interactions.

It is known that there are large local differences in FEW consumption in cities, and that the potential of the FEW nexus is regionally dependent(Jones & Kammen, 2011). This is connected to the fact that 50% of a city's CO_2 emissions are attributed to its urban structure, including population density, land use, and building types(Christen et al., 2011). Given the extraordinary diversity of urban systems (climate, geography, morphology, demographics, culture, and economy), effective CO_2 emission reductions are necessarily context dependent(Kellett et al., 2013). Without that simple understanding, cities cannot make decisions on how and where to direct the application of policies and regulatory measures. However, with regard to the FEW nexus at the city level, previous efforts by researchers have concentrated on quantifying the flow of the FEW nexus, with little assessment of qualitative factors such as the geographic, historical, and political context of the cities that house them(Newell et al., 2019). Cities are beginning to implement the FEW nexus, and accumulating qualitative knowledge in implementing the nexus approach is an urgent (Artioli et al., 2017; Simpson & Jewitt, 2019).

Against this backdrop, the design-led implementation of the FEW Nexus is gaining attention as an interdisciplinary design-led approach.(Yan & Roggema, 2019). Such a design-led approach is characterized by its ability to comprehensively handle complex systems, such as supply chains or those involving multiple stakeholders(Fleischmann, 2019). This shows how a design-led approach is suitable for dealing with the complex supply and demand that exists between the various sectors of the FEW, but the tools to support this approach are not yet well developed. For example, there is no FEW Nexus indicator designed to accommodate the multi-scale approach often seen in urban design.

In order to develop an indicator tool to support a design-led approach, this study visualized the relationship between FEWs at the urban, neighborhood, and city scales, and developed an environmental load indicator that can be used as a design baseline for the FEW Nexus. This environmental load is limited to that associated with FEW demand, and in this study, it is limited to carbon dioxide (CO_2) emissions, the largest GHG. We applied this indicator to a case study of the Tokyo metropolitan area to verify the validity and operability of the indicator.

3 CONCEPT OF FEWPRINT

Although many indicators have been developed to assess the environmental impacts of people's daily activities, there is still little consensus on how to apply them(Ramaswami et al., 2021), and the same is true for FEW-related indicators(Newell et al., 2019). However, in the context of linking urban design and environmental impact indicators, the Ecological footprint has gained some recognition(Moos et al., 2006). The Ecological footprint can be converted into a unified unit of area even for different sectors, is convenient for visualization, and is easy to set as a Key Performance Indicator(Moos et al., 2006). The greatest advantage is that there is a common language of "area" between Ecological Footprint and urban design. In general, the space that can be reserved for local production or management of FEW in a dense urban environment is very limited, and clarifying this area is an important first step in urban design. The Ecological Footprint, on the other hand, is calculated as the sum of the land area required to produce and manage various services and the forest area required to absorb the CO_2 emissions generated through the production, transportation, and consumption of these services. In other words, it makes it possible to integrate land use and environmental impact into one study.

On the other hand, there are some challenges in calculating the Ecological Footprint, such as the need to collect data from various sources and the difficulty in applying the method at relatively micro scales due to the problem of data sources(Moos et al., 2006). The main reason for this issue is that most previous ecological footprint studies have focused on entire cities and used a top-down approach of spatially disaggregating energy consumption(Kellett et al., 2013). This top-down approach not only poses the challenge that it is not suitable for application at micro scales, but also that it does not require an understanding of the processes that lead to CO2 emissions and is therefore not suitable for design-driven approaches or scenario-based predictions(Kellett et al., 2013). To address this challenge, recent research has presented an extension of bottom-up models based on consumption processes to enable environmental impact assessment at the micro-scale(Christen et al., 2011; Kellett et al., 2013). This approach not only facilitates the calculation of design baselines at the neighborhood or city block scale, but also facilitates the assessment of the environmental impact reduction potential of new urban forms as indicated by design scenarios. However, this concept has not yet been introduced into the Ecological Footprint.

In this study, the FEWprint will be developed as a subset of the Ecological Footprint, a general indicator that evaluates the impact of human life on nature in terms of equivalent land area, and will be maintained as a support tool for urban design in order to develop the FEW Nexus. As with the Ecological Footprint, the FEWprint is calculated as the sum of the land area required to produce and manage FEW services and the forest area required to absorb the corresponding CO2 emissions through the production, transport, and consumption of FEW services. To estimate the corresponding CO2 emissions through production, transport and consumption of FEW services, a bottom-up approach using social and physical intensities is adopted. Social intensities consist of any group of individuals, households, or age groups, while physical intensities are defined as single-family homes, apartment units, buildings, neighborhoods, or cities. Thus, FEW demand can be assessed at the household or building scale, and further extended to the neighborhood, city, or regional scale. The current FEW demand is used as a baseline from which to begin the FEWprint analysis.

4 METHOD

4.1 Typological analysis

Cities develop diverse spatial patterns as a result of their composition in population density, building forms, and household types. In order to closely represent the impact of these spatial differences on the demand and supply of food, energy, and water, two typologies need to be considered. Firstly, the demand and consumption for food, energy, and water associated with residential life is strongly influenced by the type of households. Secondly, the potential of production and supply of food, energy, and water for a household to alleviate the demand is mostly determined by the capability to install solar panels and home gardens, which is in turn strongly determined by building forms. Therefore, the baseline of a city block for FEW demand and supply can be assessed by identifying the type of households and the form of buildings. We categorized the "household type" in terms of the number of family members, and the groupings of age and gender, and the "building form" in terms of detached houses and apartments. The basis for this classification depends on the available FEW consumption intensity data.

4.2 Baseline calculation

4.2.1 Amount of demand and supply

Food Demand

Regarding food, its demand is largely dependent on age and sex. In other words, the demand for foodstuff (k) in the target area (FD_k) can be calculated by multiplying the food demand intensity by age and sex ($FD_{k,\ age,\ sex}$) by the population by age and sex ($P_{age,\ sex}$), as shown in Equation 1.

$$FD_k = FD_{k,age,sex} \times P_{k,age,sex}$$

In urban areas, the decline in labor force due to the aging of agricultural workers has led to the conversion of ordinary farmlands into allotment gardens. Home vegetable gardens are also gaining popularity because they can be easily managed at home. While it is important to understand the actual situation of such small-scale vegetable production, it is difficult to identify the products in home and allotment gardens without careful fieldwork. However, when estimating for a large area, the work becomes an unmanageable amount.

Therefore, by using the cultivated area of home vegetable gardens by building type (SKGbldg) and the rate of home vegetable garden implementation by building type (RKGbldg), we can simply obtain the production area.

$$L_{FP,farm} = \sum_{bldg} SKG_{bldg} \cdot RKG_{bldg}$$

Energy Demand

In terms of energy, the demand depends largely on the household size. In other words, the energy demand (ED) of the target area can be calculated by multiplying the energy demand intensity ($ED_{household}$) by the number of households per household size ($H_{household}$), as shown in Equation 3.

$$ED = ED_{household} \times H_{household}$$

On the other hand, it is necessary to consider the existence of existing autonomous decentralized energy supply systems. Solar panels are a decentralized power generation system possible at the household level. The amount of electricity generated by solar panels can be estimated from the size and number of panels. The annual electricity production (EP) from solar panels in the target area can be expressed as Equation 4 using the system capacity intensity of solar panels by building type (P_{bldg}) and the solar panel installation rate by building type (RPV_{bldg}). (H), (P), and (K) refer to the average solar radiation, the system capacity of the solar panels, and the loss factor, respectively.

$$EP = H \cdot K \cdot 365 \cdot \sum_{bldg} P_{bldg} \cdot RPV_{bldg}$$

Therefore, the exact energy demand (ED) needs to be expressed as in Equation 5, taking into account the amount of electricity generated by solar panels (EP).

$$ED = ED_{household} \times H_{household} - EP$$

Water Demand

In the water sector, the demand depends largely on the number of household members. In other words, the water demand (WD) in the target area can be calculated by multiplying the water demand intensity ($WD_{household}$) by the number of households per household size ($H_{household}$), as shown in Equation 6.

$$WD = WD_{household} \times H_{household}$$

On the other hand, the construction of a water supply environment in residential areas is being promoted with the installation of water tanks. This is a system in which the rain that falls on the roof is channeled into a water tank to store rainwater. In other words, if we can determine the area of the roof of a house where a water tank is installed, we can calculate the annual water supply by multiplying it by the annual rainfall. The amount of water available for self-sufficiency (WP) of the target area can be expressed as Equation 7, using the positive radiant area of the roof of each building (RA_x), the water storage tank installation rate by building type (RWS_{bldg}), and the annual precipitation (RW).

$$WP = RW \cdot \sum_{bldg} \sum_{x} RWS_{bldg} \cdot RA_x$$

Therefore, the exact water demand (WD) needs to be expressed as in Equation 8, taking into account the amount of water available for self-sufficiency (WP).

$$WD = WD_{household} \times H_{household} - WP$$

Conversion to footprint

Food Demand

Food is linked to energy, water, and land in the process of its supply. For example, land is indispensable during food production. Therefore, the land ($L_{k,farm}$) needed to meet the demand (FD_k) for foodstuff (k) in the target area can be expressed as in Equation 9 using the land ($L_{k,base}$) needed to produce 1 kg of foodstuff (k).

$$L_{k,farm} = L_{k,base} \times FD_k$$

In other words, the total land for the production of food demand (FD) in the target area ($L_{FD,farm}$) is shown in Equation 10.

$$L_{FD,farm} = \sum_k L_{k,farm}$$

Next, we evaluate the energy associated with the supply of foodstuff (k). The CO_2 emissions (CE_k) associated with meeting the demand (FD_k) for foodstuff (k) in the target area can be expressed as in Equation 11 using the CO_2 emission factor ($CE_{k,base}$) of foodstuff (k).

$$CE_k = CE_{k,base} \times FD_k$$

Furthermore, this CO_2 emission amount (CE_k) can be converted into land by replacing it with the forest area required to absorb that CO_2 emission amount. In other words, the forest area ($L_{k,CO2}$) for absorption of CO2 emissions associated with the demand (FD_k) for foodstuff (k) in the target area can be expressed as shown in Equation 12 using the forest area ($L_{CO2,base}$) required to absorb 1 kg of CO_2.

$$L_{k,CO2} = \frac{CE_k}{L_{CO2,base}}$$

In other words, the total land area ($L_{FD,CO2}$) required to absorb CO_2 emissions associated with food demand (FD) in the target area can be expressed as in Equation 13.

$$L_{FD,CO2} = \sum_k L_{k,CO2}$$

And the water associated with the supply of food (k) is usually referred to as virtual water. This virtual water (VW_k) associated with food demand (FD) in the target area can be converted into land area by replacing it with the area required to absorb equivalent water as rainwater. Introducing this idea, the area ($L_{k,VW}$) required to acquire the virtual water (VW_k) associated with the demand (FD_k) for foodstuff (k)in the target area from rainwater can be expressed as in Equation 14 using the annual rainfall (RW) in the target area.

$$L_{k,VW} = \frac{VW_k}{RW}$$

In other words, the area ($L_{FD,rain}$) required to obtain the virtual water associated with the food demand (FD) of the target area from rainwater can be expressed as in Equation 15.

$$L_{FD,rain} = \sum_k L_{k,VW}$$

Energy Demand

Energy is supplied from a variety of energy sources, and each energy source generates different CO_2 emissions. In other words, the CO_2 emissions (CE_{ED}) associated with the energy demand (ED) in the target area can be expressed as in Equation 16 using the sharing ratio (ERR_l) of a certain energy source and its CO_2 emission coefficient ($CE_{l,base}$).

$$CE_{ED} = ED \sum_l (ERR_l \cdot CE_{l,base})$$

This CO2 emission (CE_{ED}) can be converted to land by replacing it with the forest area required to absorb the CO2 emission. In other words, the forest area ($L_{ED,CO2}$) required to absorb CO2 emissions associated with energy demand (ED) in the target area can be expressed as in Equation 17 using the forest area ($L_{CO2,base}$) required to absorb 1 kg of CO_2.

$$L_{ED,CO2} = \frac{CE_{ED}}{L_{CO2,base}}$$

By the way, hydroelectric power generation is one of the energy sources. The area ($L_{ED,rain}$) required to obtain the amount of water ($W_{ED,hydro}$) used in hydropower generation from rainwater can be expressed as in Equation 18 using the annual precipitation (RW) of the target area.

$$L_{ED,rain} = \frac{W_{ED,Hydro}}{RW}$$

Water Demand

A lot of energy is required for water supply. This energy is supplied from various energy sources, and each energy source has different CO_2 emissions. In other words, the amount of CO_2 emissions (CE_{WD}) associated with the water demand (WD) in the target area can be expressed as Equation 19 using the amount (ER_m) shared by a certain energy source (m) in water supply and its CO_2 emission coefficient ($CE_{m,base}$).

$$CE_{WD} = \sum_m (ER_m \cdot CE_{m,base})$$

This CO_2 emission (CE_{WD}) can be converted to land by replacing it with the forest area required to absorb the CO_2 emission. In other words, the forest area ($L_{WD,CO2}$) required to absorb CO_2 emissions associated with water demand (WD) in the target area can be expressed as in Equation 20 using the forest area ($L_{CO2,base}$) required to absorb 1 kg of CO_2.

$$L_{WD,CO2} = \frac{CE_{WD}}{L_{CO2,base}}$$

The area required to obtain the water demand (WD) from rainwater ($L_{WD,rain}$) in the target area can be expressed as Equation 16 using the annual rainfall (RW) in the target area.

$$L_{WD,rain} = \frac{WD}{RW}$$

Environmental loads of FEW demands

The total environmental impact in terms of land, is calculated in 4.2.2. However, it should be noted that the water used for hydropower generation is subsequently used for domestic and agricultural purposes. To reflect this, the environmental impact (EI) can be expressed by the following equations.

When $L_{ED,rain} \geq L_{FD,rain} + L_{WD,rain}$

$$EI = L_{FD,farm} + \sum_n L_{n,CO2} + L_{ED,rain}$$

When $L_{ED,rain} < L_{FD,rain} + L_{WD,rain}$

$$EI = L_{FD,farm} + \sum_n L_{n,CO2} + L_{FD,rain} + L_{WD,rain}$$

$$(n = FD, ED, WD)$$

5 CASE STUDY

5.1 Features of study area

The target areas are Tokyo prefecture and Kanagawa Prefecture, the latter being located in the southwest part of the Tokyo metropolitan area, which has the world's largest population. In these two prefectures, more than 23 million people live in an area of about 4,600 square kilometers. Many of the urbanized, built-up areas were developed during the high economic growth period after WW II and widely spread in suburban and extra-urban along radially distributed railways. Similar with all of Japanese cities, this region is facing declining birthrates and an aging population. Therefore, the governmens are trying to remake the cities in a more compact form by attracting services and residents to the walkable area near railway stations. In addition to, the built-up areas are approaching a time when infrastructure and other upgrades will be needed, as the vulnerability witnessed by the devastating disasters like the Great East Japan Earthquake in 2011, the heat wave in 2018, and the super typhoon Hagibis in 2019. Adding to that existential fear is a political and moral issue. In consideration of its size, the metropolis has a responsibility to act urgently to reduce CO2 production. It is similarly useful to recognize that the production and consumption of food-energy-water is responsible for more than 60 percent of total CO2 emissions. In responce the Japanese government initiated an action plan on climate change adaptation in 2015. It also lunched the SDGs Future City Program in 2018 to accelerate the transition and transformation towards a carbon neutral and sustainable society.

5.2 Data management

The respective data on age and number of households by household size required to determine the social typology was obtained from the 2015 census. Other data required in the process of analysis were maintained as shown in Table 1.

Variable	Description	Data Source
$CE_{k,base}$	CO2 emission coefficient of food (k)	Ministerial Order Concerning Calculation of Greenhouse Gas Emissions from Business Activities of Specific Emitters (2016)
$CE_{l,base}$	CO2 emission coefficient of energy source (l)	
$CE_{m,base}$	CO2 emission coefficient of energy source (m) required for water supply	
$ED_{household}$	Energy demand intensity by household size	(Inoue et al., 2006)
ER_m	Share of energy sources (m) in water supply	Energy Consumption Statistics by Prefecture (2017)
ERR_l	Share of energy source (l)	
$FD_{k, age, sex}$	Food demand intensity by gender by age	National Health and Nutrition Survey (2019)
$H_{household}$	Number of households by household size	National Censes (2015)
$L_{CO2,base}$	Forest area required to absorb 1 kg of CO2	Forestry Agency
$L_{k,base}$	Land required to produce 1 kg of food (k)	(Yan & Nakayama, 2021)
$P_{age, sex}$	Population by age and sex	National Censes (2015)
RW	Annual precipitation	Japan Meteorological Agency
VW_k	Virtual water for food (k)	(Oki & Kanae, 2004)
$WD_{household}$	Water demand intensity by household size	Bureau of Waterworks Tokyo Metropolitan Government

Table 1: “List of sources of data needed for calculating FEWprint”

5.3 Result

Using the methods in Chapter 4 and the data collected in 5.2, we visualized the FEWprint in GIS in Figure 1 and Figure 2. Figure 1 shows how many times the FEWprint is the area of the city by the census truck. In Figure 2, we visualize the value of FEWprint per capita. The result clearly shows the spatial differences in demand and supply of food-water-energy as well as the correspondent environmental footprint. While the environmental footprint per unit area is greater in the inner city, the amount per capita is greater in suburban areas. This indicates that suburban areas bear a larger responsibility to reduce their environmental load through food-water-energy consumption.

6 DISCUSSION

A study that analyzed CO2 emissions in Chicago showed similar results to our analysis, with per capita CO2 emissions being higher in the suburbs(Farr, 2007). However, compared to Figure 1, the difference between urban centers and suburban areas in Figure 2 is not as clear. This is a feature that was not seen in the previous report(Farr, 2007). This suggests the characteristics and issues of the FEWprint presented here. In this calculation of the FEWprint, we considered differences in demand due to household size and age, and supply capacity due to building structure, but there were no variables that directly represented differences between urban centers and suburbs, such as building size. Furthermore, we did not take into account the mobility associated with food procurement, which is expected to be very different between urban centers and suburbs. However, it has been pointed out that the environmental burden associated with food access is significant(Coveney & O’Dwyer, 2009). In order to bring environmental issues down to the level of the general public and to make concrete designs, the urban structure needs to be reflected in more detail in the FEWprint.

The key point of the design-led approach for FEW Nexus is the use of area. How much productive area already exists, how much is potentially available, and how much can be created through design. The potential of an area can be calculated with the use of the FEWprint tool in an iterative manner, a familiar process for those who work professionally in any design field. This means that each time a design is considered and re-evaluated in the normal design process, it can also be modified and evolved depending on how much productive area can be developed. In this way, the FEWprint serves as a baseline for design.

The FEWprint is useful not only for evaluating the baseline of FEW demand, but also for evaluating efforts to reduce CO2 emissions in the process. Implementing the FEW Nexus as a policy or policy vision also requires assessments and approaches at different spatial levels, such as buildings, city blocks, neighborhoods,

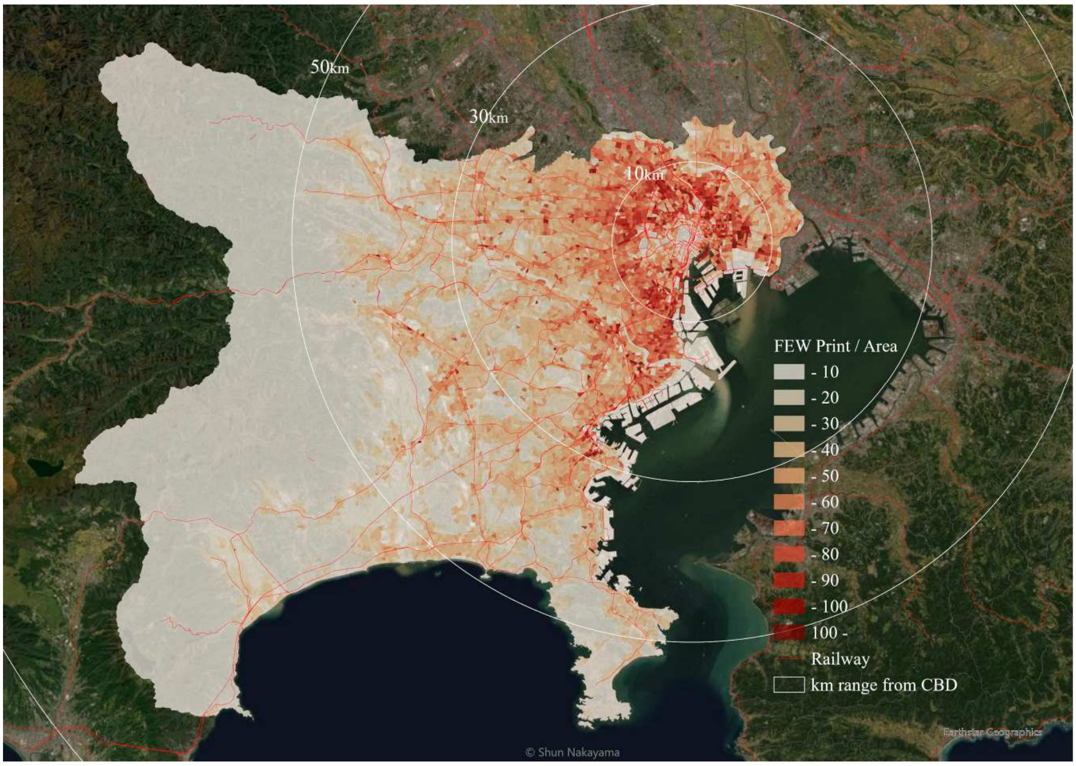

Fig. 1: How many times the FEWprint is the area of the city by the census truck.

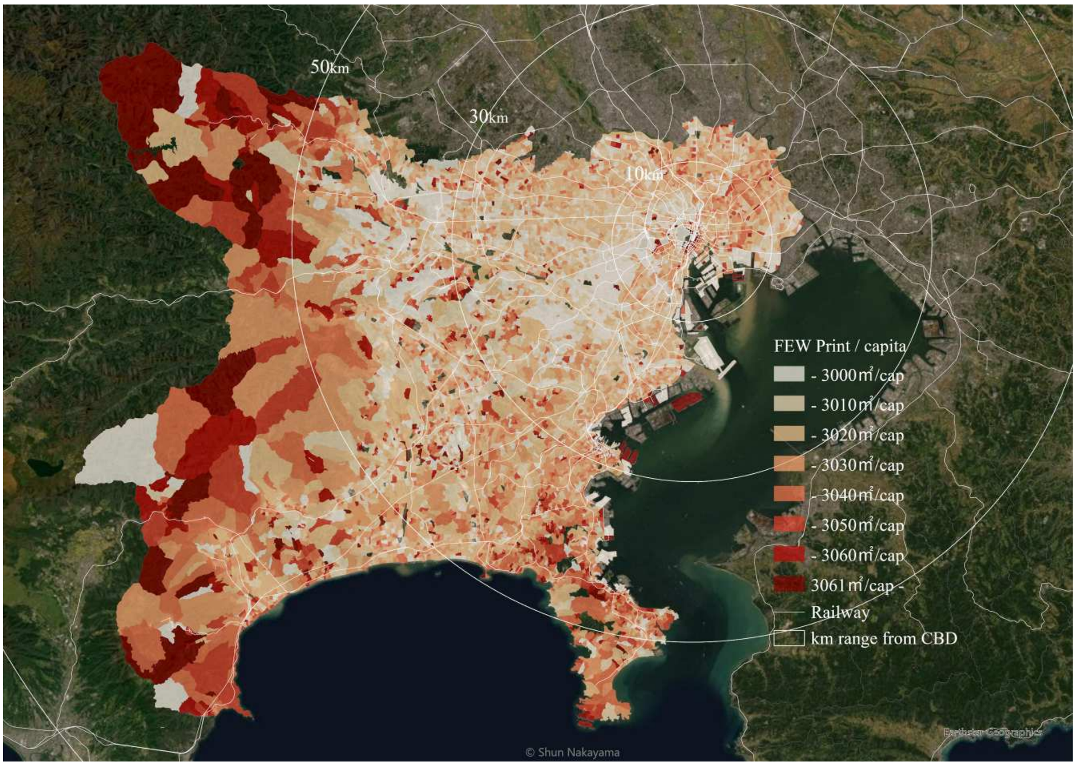

Fig. 2: The value of FEWprint per capita

and cities. This can be done by applying the FEWprint to future scenarios. If this results in a reduction of FEWprint, it means a more efficient use of FEW resources. GIS is a suitable way to represent FEWprints at multiple scales.

7 CONCLUSION

In this study, we noted that the essence of the design-led approach for FEW Nexus is the area available to meet the demand-supply for FEW physically and the area required to absorb the environmental costs both in the present and the future. These two apects are evaluated quantitatively by introducing the FEWprint as a key performance indicator.

Armed with this instrument, we could quickly evaluate the FEW baseline in any specific conditions by identifying a set of dietary tables, household and building types. This baseline can be used as reference to examine the performance of new designs, the nexus effects that will be achieved by specific solutions, the performance of a stakeholder, or the effect of relevant urban policy. By giving the available area in a house, a building, a block or a neighborhood as well as the social and physical intensity for food, energy, water, the M-NEX method is applicable to any scale with the support of GIS.

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Different or Alike? Motivation to Participate and Social Influence in Online Discussions by Age and Gender

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1 ABSTRACT

While the use of incentive mechanismsto stimulate efficient communication and collaboration among individuals in online platforms, groups and communities has been widely documented and discussed, comparatively little is known about the influence of age and gender on the motives for participation in these platforms and how responses may vary based on these personal attributes in less developed countries like Afghanistan. In this paper, we examined if the age and gender of the respondents affect the kinds of incentivesthat stimulatetheir effective participation in online discussions andifsuch online discussions have a social influence on participantspresented with such incentives. To this end, we firstrun an idea contest project, using a real word online discussion forumcalled D-Agree in collaboration with Kabul Municipality (KM). Weincorporateddifferent incentive schemes which yielded 3,892 respondents/participants whocumulatively exchanged14,587 opinions and responses on the platform. This enabled us to conduct a post discussion survey, usingSurveyMonkey where 201 respondents participated. We demonstrate that financial (e.g. monetary reward) and social (e.g. fulfilling the desire to learn and improve one's abilities, knowledge and experience)motives consistently outperform all other incentivesas motivators of participation in Afghanistan. The results of this work demonstrate that males and females are influenced by similar incentives to participate in online discussions. As for the social influence of participating in online discussions, the results show that respondents were affected from a moderate level to a great deal, butwith no significant differences based on age and gender. The output of this research might open a new direction in the study of social influence based on incentive mechanisms. This could be used as a planning tool to stimulate participation in forums/platforms for crowdsourcing.

Keywords: Idea contest, Civic engagement, Extrinsic motivation, Online discussion, Online participation

2 INTRODUCTION

The emergence of computer mediated communications over the past few decades has dramatically changed many people's social lives (Sun et al. 2011). In particular, online forums have become a major medium for facilitating large-scale discussions on various issues ranging from personal, family, societal to governance. Online communities, which are usually divided into smaller groups within these forums, might act collectively in ways that seem intelligent (Malone et al. 2009). Thus, online forumshave attracted research attention as an approach to discourse-centric collective intelligence to offer innovative solutions for improving critical social problems (Haqbeen et al. 2021). Online forums provide efficient tools for eliciting participation in crowdsourcing projects and policy-making. While some discussions in online forums may be very specific(e.g. discussions of climate change issues in Climate CoLab platform or urban-related SDGs in D-Agree platform), some othersmay be general social platforms with unrestricted focus (e.g. discussing travelexperiences in TripAdvisor or sharing social experiences about one's self, family, career or pressing social problems such as insecurity, public health issue like the global CoronaVirus pandemic, unemployment and inequality on Facebook). Unlike the discussions in conventional forums where people just share their experiences and communicate with one anotherthrough citizen-initiative interactivities,participants in specific purpose discussion forums focus on solving particular thematic social problem, such as climate change (Introne et al. 2011; Klein 2007), challenges of urban planning and enforcement(Haqbeen et al. 2020a; Haqbeen et al. 2020b) orthe CoronaVirus pandemic (COVID-19)(Haqbeen et al. 2020c; Haqbeen et al. 2020d). These forums foster democratic deliberations aimed at generating innovative solutions to improve the society in line with the United Nations' sustainable development goals (SDGs)by focusing on solving specific social problems.

Users in online discussion forums may be autonomous individuals, but they often participate in discussions as collectives. The insights and intelligence from these collectives cannot be explained by aggregation of individual intelligence(Woolley et al. 2010) and being part of these collectives seems intelligent (Malone et al. 2009).However, in online forums, the level of interactivitymay be low due to the distributed and asynchronous nature of online discussions[Tavanapour et al. 2019]. As a result, peoplemay not actively take part in discussions as collectives. Therefore, in order to encourage people to actively discuss in an online environment, incentive mechanismssuch as discussion gamification (Dai et al. 2016), virtual incentive(Takahashi et al. 2016), scoring systems and automated facilitationhave been developed (Ito et al. 2020).

In view of the foregoing, different type of artificial intelligent (AI)-enabled facilitation such as argumentative facilitation (Hadfi et al. 2021); discussion visualisation and incentive mechanisms (ranking system, gamification) have been introduced as extrinsic motivation solutions for online discussions with a view to stimulating interactivity and boosting users' intrinsic motivation. Specifically, AI-enabled facilitators and discussion scoring systems can spur interest in the discussions and help individuals to interact with one another.The online discussions which utilizesa scoring system is proposed to enhance the various intrinsic and extrinsic motivational factors that are directly proportional to participants'engagement(Ito et al. 2014; Takahashi et al. 2016). Gamification, which includes point-based systems and virtual rewards, acts as a strategy toincrease the contributions of members involved in online communitiesand discussions (Takahashi et al. 2016).

Studies show that both intrinsic and extrinsic motives affect individuals' decision to participate in these online platforms and communities and their level of interactivity with other individuals. In online discussion forums, users are motivated to take part in discussions when observing other users' participation (Sun et al. 2011). This influence may be strengthened by incentive mechanisms such as gamification, ranking system facilitation or other factors. However, little is known about what types of extrinsic incentivesinfluencepeople to participate in online asynchronous discussions in lessdeveloped countries like Afghanistan and if the effect of these motivators is dependent on the ages and gender of participants. Therefore, this study contributes towards filling this knowledge gap by highlighting the factors that facilitate the collaboration and interactivity of individuals in online environments.In this paper, we explored how extrinsic motivators influence participation and level of interactivity in online discussions and if these motivators differ for different ages and genderof respondents.The findings of this study may be useful for the providers of crowd discussion support platforms and "crowd-sourcers" in selecting appropriate incentives for crowdsourcing in Afghanistan and elsewhere.

2.1 Problem statement

A fundamental concern when implementing crowdsourcing is how to meaningfully engage participants. Crowdsourcing involves engaging anonline community or multiple communitiesthrough online forums in order to harness the knowledge of citizens into the process of policy-makingby an interested party, individual or organization (Brabham 2008).However,crowdsourcing initiatives may be marred by lack of interest, asynchronous discussions, and low participation rate if adequate or best-fit incentives are not incorporated. Therefore, crowdsourcers must not only introduce extrinsic motivators in their crowdsourcing initiatives, but also, such incentives must resonate with the personal and social attributes of targetsin order to increase their chances of participating in discussion forums and policy dialogues. In reality, however, identifying the right mix of incentives that could spur participation in online discussion forums remains a daunting challenge.

On the other hand, not much attention has beenpaid to the social influence of active participation in online discussions on people and if the social influence of such participation variesbased on the ages and gender of participants. Social influencerefers to the process through which people change their minds, modify their views, or change their behaviour as a result of their social interactions with others(Moussaïd et al. 2013). Thus, there is a need to identify various motivational beliefs, as well as gender and age-related behavioural attitudes toward online discussions.

2.2 Motivation and incentives

Motivation arises through interaction among different motives and incentives in a particular situation (Atkinson 1958). Motivation is mainly classified into two: intrinsic and extrinsic (Hossain 2012a). Intrinsic motivation refers to the motivation that isdriven by the tasks, so that individuals do not require external pressure(extrinsic motivation) to activate it. According to Lepper et al. (1973)people are intrinsically motivated if the task itself is enough for satisfaction and there is no further reward apart from the activity.

However, extrinsic motivation is driven by external incentives. Factors such as curiosity or interest are examples of intrinsic motivators while extrinsic motivators could be financial, social and organisational. Low motivational levels presented by participants in discussions degrade the discourse's collective intelligence and result in a lack of interest to collaborate with one another.When the motives differfrom the actual activity, external factors such as money, fame, prize etc. prompt motivation (Hossain 2012b).

In online discussions, both intrinsic and extrinsic motivators areneeded to influence participants' engagement (Haqbeen et al. 2021).Sincemotivation is considered a process to release, control, and maintain discussion activities,it is imperative to know the factors that motivate people to participate. Having insights about different incentives helps to boost the motivationof participants to engage in and contribute meaningfully to online discussions, even though participation in such discussions mayimpose some constraints on their time and other resources.

To do this, we adoptedthe concept of discussion scoring and ranking system as virtual gamification and linked it with financial and social rewards in the online discussions. D-Agree ranksthe participants based on their virtual points which are in turn assessed through postings, replies, and likes, or received likes and replies from other participants. We proposeda monetary reward of 30k, 20k and 15k Afs (≈ 385, 257 and 192 USD) for top three and certificates to top ten participants, respectively at the end of the contest project.The cash prizes and certificates to the top threeand ten discussants, respectively (female = 1 and male = 9) were given by the Mayor of Kabul City at an official ceremony (see link to the award ceremony at https://www.youtube.com/watch?v=xdhZYJo_8nQ.

3 METHODOLOGY

We used an onlinediscussion forum based on facilitation. This was followed by an online survey, which sought information from respondents on what motivated themto participate inonline discussions in order to assess the effects of the proposed incentiveson their participation. We focused only on respondents'datagenerated from survey forum in this study.

3.1 Study area

The current study used an open call idea (Brabham 2008) to shed light on motivation factors in online communities in Afghanistan. The open online call was chosen due to itsaccessibility given the representation of Afghan citizens in online communities both in Afghanistan and other parts of the world. Respondentswere asked to join specific discussion spaces based on their residential areas and preferred time.We created 24 virtual spaces, 22 for Kabul city, comprising 22 urban districts, 1 for the 34 provinces of Afghanistan and one for Afghans in the diaspora.

3.2 Sample and sampling method

We used D-Agree as the discussion forum and SurveyMonkey as our survey instrument for this study.First, we used D-Agree, a text-based online discussion platform,which is anchored on support and facilitation means like artificial facilitation, incentive mechanism, ranking system and content visualisation developed by our team for hosting large-scale discussions or deliberations (Ito et al. 2020). The users in online communities were asked to join specific discussion spaces based on their residential areas and preferred time. The call for participation was made using open idea call techniques of convenience sampling.The call to participate was posted on Kabul Municipality's Facebook Page. KM's official Facebook page has 382,000 followers as of July 6, 2021. Thus, the link was available worldwide and could beviewed by anybody with an internet connection. The online discussion social experimenttook place from August 13 to October 02, 2020 and generated 14,587 opinions from 3,892 registered participants.

Following the online discussions, using D-Agree, we used SurveyMonkey as a post-discussion survey instrument to assess if the incentives introduced within the online discussions had any effect on their interest to engage in the discussion activities as well as their opinions and behaviourin the course of the discussion and after. SurveyMonkeyis a cloud-based software used by researchers to collect data on various issues of interest to them. Itspecialises in online surveysand rapid productionof results (Halim et al. 2018).We used a licensed version of the software to design our questionnaire survey and sent the link to all who participated in the online discussions, using D-Agree. 201 participants (female = 49; 24.3% and male = 152; 75.6%) participated in the survey.

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3.3 Discussions and survey instrument

A divergence discussion phase was selected for online discussion of this study. Discussion at D-Agree is divided into the following three phases: divergence, convergence, and evaluation. Divergence phase was chosen because we can collect a wide variety of opinions on the discussion themes. (Haqbeen et al. 2021). We selected seven discussion topics or raisedquestions and discussed possible solutionsto the challenge ofsolid waste management (SWM) inKabul city.Each of the seven themes covering different aspects of SWM lasted for one week. Based on participants' engagement with these themes, they were scored and ranked by the system in real-time within their related groups. They all discussed the same topics within the same time while using different spaces.

A closed-ended questionnaire was used to elicit responses during post online discussions.The questionnaire was divided into different sections, comprising questions on: (i) personal and demographic information; (ii) motivations for participating in online discussions; and (iii) effect of social influence from online discussions on knowledge and behavioural change. The two main questions related to the dependent variables were presented, using multiple-choice and Likert-scale. These questions were phrased thus:“What motivated you to participate in online discussions?” and“Didparticipation in online discussions affect your thoughts and result in behaviour change?” The first question contained 7 items related to preferred motives (multiple-choice), while the second was a five-point Likert-scale-type question.

3.4 Datasets

The survey data was digitised and analysed with the help of STATA/SE 16.1. There was no missing data, whether user and system-based. Indeed, the response rate from the 201 respondents was 100 percent. A reliability test was conducted to ensure that the data had internal consistency.Regarding the validity of the analyses of the data generated throughLikert-scale-type questions, we used mean values and t-tests. In addition,descriptive analysis enabled us to disentangle the demographic characteristics of the respondents and their means of preferred motives.

4 RESULTS AND DISCUSSION

4.1 Demographics of the sample

Table 1 shows the characteristics of respondents who responded to the SurveyMonkey questionnaireused for this study. There were 49 (24.38%) females compared to males which accounted for 76 percent of total respondents in this study. Many factors could explain the low representation of women in the survey. First, literacy rate among Afghan women is abysmally low at 29.8 percent compared to that of men, which stands at 55.48 percent(World Bank 2018). Second, reports from the Afghanistan Communication and InformationTechnology Ministry (MCIT) statistics indicate that access to internet and smartphones is lower among women (smartphone users = 32%; access to internet = 39%) compared to men (smartphone users = 68%; access to internet = 61%). Note that this comparison is based on all internet users which only constitute 11.4% of Afghanistan's population to the physical space.Finally, social and cultural barriers such as the pressure of care and domestic work may adversely affect the time that women could devote to online networking and discussions (Sahab et al. 2016). These factors cumulatively exclude women from meaningful engagement in economic, social, and political spheres of life compared to men (Breath, 2012).

The highest number of respondents (n = 90; 44.78%) out of all the six age groups were 25-34 years old. This finding may be explained by the demographic composition of the Afghan population, with a large representation of young people (NSIA, 2021). It may also be due to the stylised fact that young people (millennials) tend to be more technologically curious and savvy than older generations (Volkom et al. 2013). Most respondents (n =78; 38.815) held a bachelor degree. This may have been informed by our use of an online survey forum which tends to be biased in favour of educated individuals, compared to the use of conventional survey tools during field visitations (Sahab et al., 2015, 2016). Most respondents were employed (65.98%) while a considerable number of them were still in school (20.10%).

4.2 Respondent's motives for participating in online discussions

The analysed results on respondents' motivations for participating in online discussions are shown in Fig. 1.The results showing the age-specific motivations of the respondents are shown in Fig. 2. Finally, the results on the gender-specific motivationsfor participating in online discussionsare shown in Fig. 3.

		Participant	Percentage
Valid		201	100.0
Excluded		0	0.0
Age	18 to 24	27	13.43
	25 to 34	90	44.78
	35 to 44	65	32.34
	45 to 54	13	6.47
	55 to 64	5	2.49
	≥65	1	0.50
Gender	Female	49	24.38
	Male	152	75.62
Education	Less than High School	2	1.00
	High School	28	13.93
	College	53	26.37
	Bachelor	78	38.81
	Master's	34	16.92
	PhD or Higher	6	2.99
Employment	Government Employed	18	9.28
	Private Sector Employed	48	24.74
	Self Employed	62	31.96
	Retired	4	2.06
	Not Employed	23	11.86
	Student	39	20.10

Table 1. Characteristics of the respondents for the current study (n = 201).

The analysis of the motivation to participate was predicated on multiple response questions, as mentioned in Section 2.2. Cash prize for winners (66.67%) and certificate for winners (50.75%) were the first and second preferred motivators, respectively,for participating in online discussions among the respondents from a list of seven motivators suggested in the questionnaire (Fig. 1). However, the motivationsfor participating in online discussions do not significantly differ based onrespondents'age groups or gender (Figs 2-3).

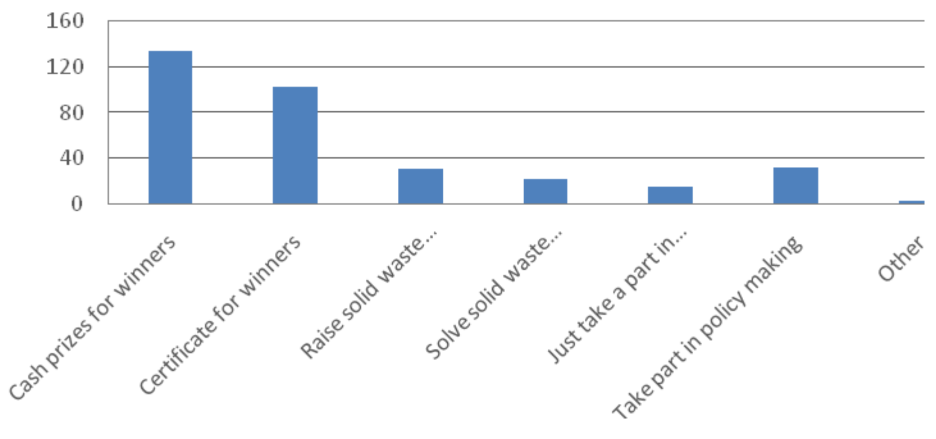

Fig. 1: Number of respondents motivated by each motivator

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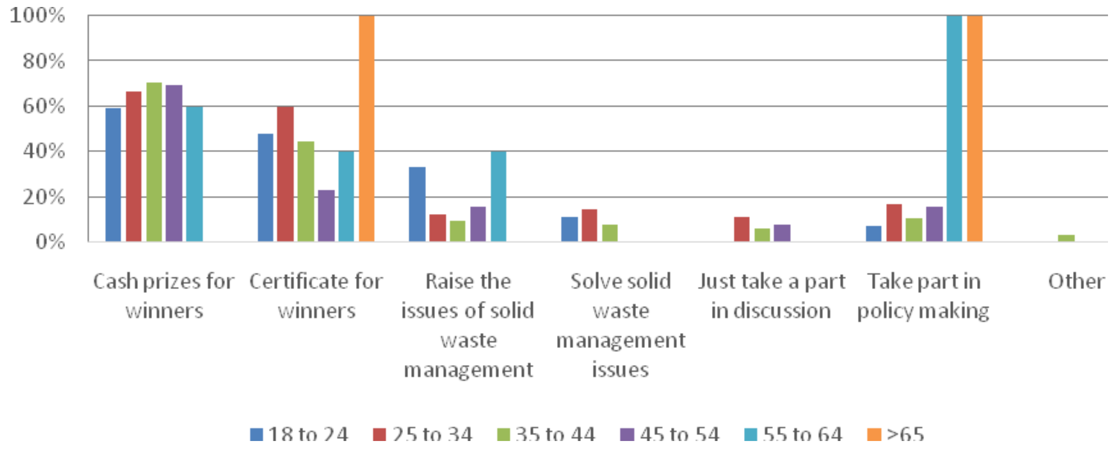

Fig. 2: Motivational factors to participate by age groups

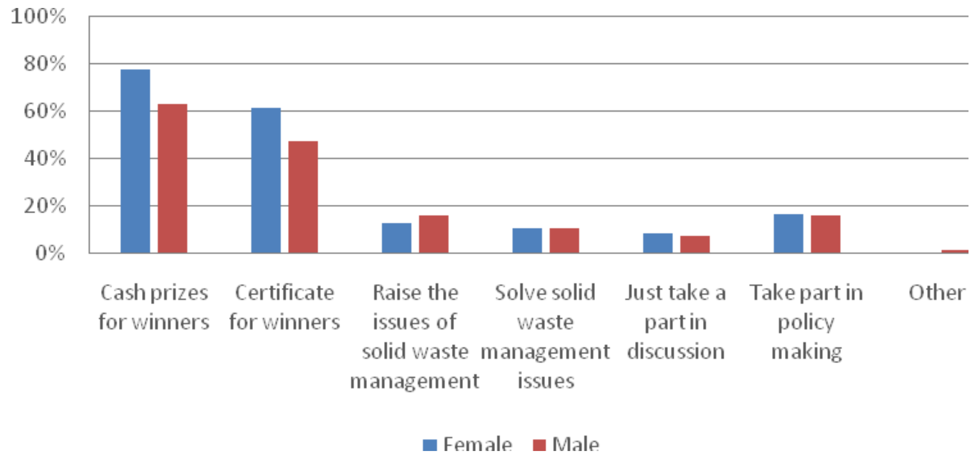

Fig. 3: Motivational factors to participate by Gender

4.3 Social influence of participants and overall discussion

The analysed results on the influence of other participants in online discussions are shown in Fig. 4, while those related to the prospect of attitudinal and behavioural change in relation to SWM due to participation in online discussions are shown in Fig. 5.

To understand the influence, we used two single choice questions. We asked participants if they were influenced by other participants' opinions and if the discussions brought any changes in their behaviour regarding waste management. We demonstrate that the opinions of other participants expressed in online discussions had a significant influence on the participants, as alluded to by 51.24 percentof the respondents who reported a great deal or a lotof influence. Another 46.27 percentof them claimed to be moderately influenced by other participants' opinions, while only 2.49 percent reported little or no influence of online discussions on their opinionstoward SWM (Fig. 4). However, there was no evidence that the age or gender of respondents affected their perception of the influence of online discussions on their opinions. The results of the question about the behaviour change (Fig.5) was similar to that of influence of online discussions on participants (Fig. 4). Specifically, most participants (51.74 percent) reported that the discussions had changed their behaviours a great deal or a lot, while 43. 28 percentopined that their behaviourshad moderately changed. However, 4.98 percent of the respondents believed that their behaviour had changedonly a little or remained unchanged. Like the reciprocal influence of the opinions of other participants in the online discussions, we did not find any significant difference in behavioural change towards SWM based on respondents'ages and gender.

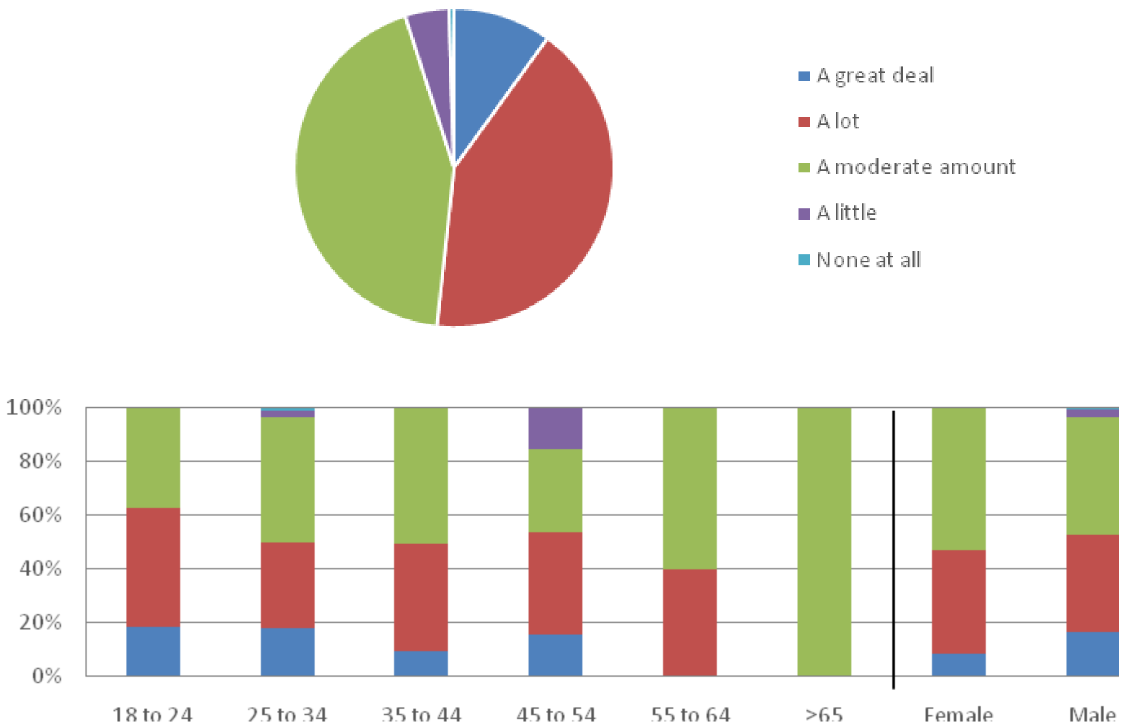

Fig. 4: (top) Overall influenceof other participants' opinions in the online discussion, (bottom) Influence of other participants opinions by age and gender

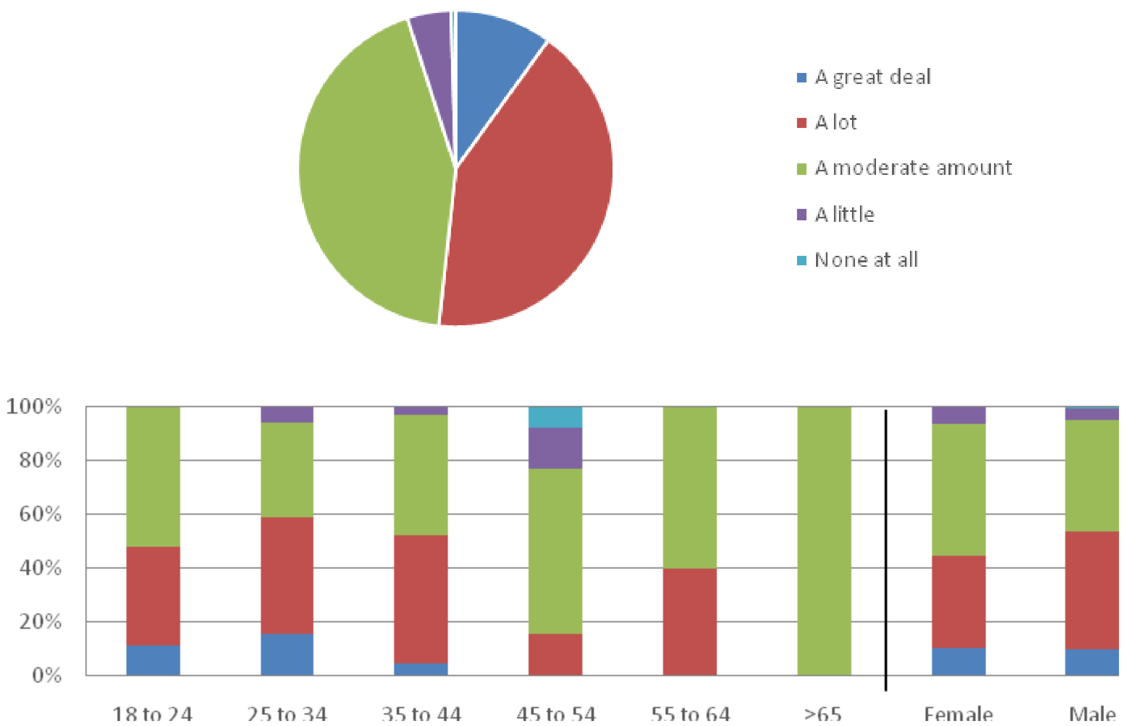

Fig. 5: (Top) Overall behaviour change toward solid waste management due to participation in the discussions, (bottom) behaviour change on solid waste management caused by age and gender.

5 CONCLUSION

This paper proposesa municipal idea contest project,to discuss a real urban issue of Kabul City, solid waste management (SWM), using our proposed online forum in an incentivized setting. Our research project's main approach was not only harnessing the wisdom of crowd for offering SWM innovative solutions to KM, but

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also, we aimed at identifying the factors as motives that are most likely to stimulate user's participation, and their engagement in activities in online discussions. In particular, we designed a questionnaire as a post-discussion survey instrument and called all subjects who had taken part in the municipal idea contest project online discussion to take part.

According to online survey (201 respondents who had taken part in both online discussion and post discussion survey), the financial (66.67%) and social (50.75%) incentives were the two primary motivators of respondents' decision to participate in online discussions of all the seven suggested motivators in the study. This demonstrates that the use of incentives (monetary and social rewards) in asynchronous online discussions could facilitate interactivity and mutual exchange of opinionsamong users. We also showed that these motivators do not significantly differ based on respondents' age groups or gender.Finally,our study shows that the social influence of online discussions on participants ranges from moderate to a great deal, but this effect does not vary significantly based on participants' age groups or gender. These findings offer promising prospects for scholars, researchers and policy makerson how best to engage people in mutually beneficial online discussion platforms. Moreover, like the KM's initiative to improve SWM which has been the focus of this study,efforts to track and change citizens'knowledge, attitudes and behaviours towards progressive dimensions through advocacy could benefit from the findings of this study.

After all, this is the first study of its kind conducted to offer an innovative solution for Kabul city SWM which was established through crowd and the medium of online discussion support platform. Considering the cross-sectoral aspect of harnessing the wisdom of crowd, the finding of this study will contribute to conducting crowdsourcing projects to many other areas of Kabul City such as water, transportation and the environmental issues.

5.1 Limitations and future perspectives

The main limitation of our study is perhaps the use of open and convenience call for post-discussion survey. Although it may have become popular asa formal method of accessingrespondents (female and males) and collecting data on various issues, the fact that Afghans tend to participate in incentivized tasks in online communities made the sample collection a bit difficult for post-discussion survey.The post-discussion survey could also benefit from incentives. In addition, Afghan males tend to predominate in online communities made the sample a bit biased in their favour compared to females due to sociocultural constraints on women's use of time and networking. Therefore, we hope to consider including two equal sample strata (splits) to female and male respondents, using a stratified random sampling technique in our future work. Furthermore, we believe that the skewed sample in favour of highly educated respondents constitute a limitation to the representativeness of our sample. Therefore, we shall also endeavour to boost our samples to incorporate respondents with different levels of education, especially as waste management issues, the focus of our online discussions in this study is generally presumed to be more pressing among poorer and less educated population. Finally, we plan to conduct further experiments, using two groups of respondents: a controlled group without the prospect of benefiting from any incentive mechanism for participating in online discussions and a treatment group with the prospects of benefiting from incentive mechanisms for participating in the discussions. This will enable us to provide a more robust statistical evidence on the actual determinants of participation in online discussions based on the data generated from the post-discussions survey.

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reviewed paper

Is the New Silk Road Enhancing Urban Expansion? Spatio-Temporal Analysis with Remote Sensing Data

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1 ABSTRACT

The world population is growing, and a majority of the population is and will be living in urban areas. Nearly 90 percent of this growth takes place in Asia and Africa. However, urbanisation processes are not distributed evenly. Mostly they are concentrated in prosperous regions, at infrastructural nodes, or along trade routes. The so-called New Silk Roads are new trade routes where massive investments are currently made to connect China with the world. The aim of this study is to analyse the dynamics of spatial urbanisation in spatial proximity to the New Silk Roads. In detail, we want to test the hypothesis whether higher spatial growth rates are recorded for cities along these routes than for cities in the same region but away from the New Silk Roads.

For this task, we apply remotely sensed data. In this study, we extracted urban areas from multitemporal Landsat data for the time period of 1990 to 2019. We classify settlements using a Random Forest (RF) supervised classification technique. We used Gray-Level Co-Occurrence Matrix (GLCM) texture features together with spectral indices as feature set. We derive training data for our classifier by a stratified sampling method using geoinformation from the Global Human Settlement Layer (GHSL) and the ESA annual Land-cover data. The resulting consistent classifications of urban areas have temporal intervals of 5 years, i.e. 1990,1995, 2000, 2005,2010,2014, 2019 and feature high accuracies.

We selected cities with over 300,000 inhabitants. We define cities in proximity to the New Silk Roads (NSR cities) within a 100 km distance vs. cities with at least 100 km distance from the NSR (non-NSR cities); these cities are located in China, central Asian countries such as Kazakhstan, including Iran, Turkey, and Russia. We quantitively analyse spatio-temporal urban expansion trends for both groups, NSR, and non-NSR cities, for testing our hypothesis. To do so, we applied various urbanisation indices such as Overall Built-up Changed Area (OBAC), Annual Expansion Area (AEA), and urban Expansion Rate (ER).

Generally, our results reveal that spatial urbanisation is increasing over the last almost 30 years in all cities among our sample. The spatial comparison of our two groups of cities reveals that our hypothesis can be confirmed: from 2014 to 2019, urban expansion in cities along the New Silk Road was significantly faster with an annual expansion rate of 339 km2 compared to 113 km2 in cities spatially distanced from the New Silk Roads. This trend did not exist before the year 2010.

Keywords: Landsat, Remote Sensing, New Silk Road, Urbanization, GHSL

2 INTRODUCTION

Urban areas have been expanding over the past decades, and it is predicted that the world population will further increase in the coming decades. According to the latest UN report on World Population Prospects (United Nations, 2019), the world population reached 7.7 billion in 2019, indicating that the global population has grown by over one billion people over the past 14 years. Sixty-one percent of the global population lives in Asia (4.7 billion), and 1.44 billion in China alone. With it, China is the world's largest country in terms of total population. In recent decades China has experienced the highest growth rates both in population and urban areas (Taubenböck et al., 2014; Shi et al., 2019) .

The Sustainable Development Goals (SDGs), particularly Goal 11 and the UN New Urban Agenda, call countries to develop National Urban Policies and strategies as an essential part of achieving economic, social, and environmental goals. Therefore, public authorities are in need of information about urban dynamics, dimensions, and forms to understand current processes and its impacts. This knowledge must be the basis to develop policy strategies for urbanisation challenges (SDGs, 2020). The most obvious change is the physical expansion of urban areas. Traditional field data collection is not viable, and conventional urban data sources are often outdated and hard to obtain (Taubenböck et al., 2009). In order to be able to map and describe this urban expansion, current, large-scale data sets are needed. Remote sensing data have become a valuable source for large-area, multi-temporal and consistent classification of settlement areas. Many studies investigated the extraction of built-up areas from medium resolution data (e.g. Doustfatemeh and Baleghi, 2016; MacLachlan et al., 2017; Verma et al., 2018). The detection of urban areas at a global scale is evolving from coarse to medium resolution open-source Earth Observation (EO) data, taking advantage of methodological and technological advances. For example, the Global Human Settlement Layer (GHSL) generated at 30m resolution (Pesaresi et al., 2016), the artificial surfaces mask of the GLOBELAND30 – GLC309 (available at 30m resolution and referring to the year 2010), (Chen et al., 2015) or at 12-meter resolution the Global Urban Footprint (GUF) (Esch et al., 2012).

Cities often developed in favorable locations. For a long time, locations on rivers or by the sea were decisive locational advantages (e.g. Kostof, 1991). The existing or future planned infrastructure is also a key locational advantage. Infrastructure nodes are one central attraction point. In general, urban areas are expected to grow further by more infrastructure development (Aljoufie et al., 2011). In 2013 the Belt and Road Initiative (BRI) was announced by the Chinese Government (Suprabha Baniya et al., 2019); this initiative is aiming at the revival of the old Silk Road, which is now referred as the New Silk Road (NSR). The planned NSR is developed based on the ancient land-based routes (Ni et al., 2017). The rise and fall of cities along the historical Silk Road are closely linked to the trade's rise and fall (Ni et al., 2017). Some studies predict that cities located along the NSR are expected to have higher growth rates due to the advancement of infrastructure connection and an expected thriving economic future (Jakóbowski et al., 2018).

Since the New Silk Road initiative's inauguration, several scientific studies related to this project have been published. However, the majority of studies explored non-urban aspects; these topics include international political economy and geopolitical economics (e.g. Lee et al., 2018; Summers, 2016; Suprabha Baniya et al., 2019), Chinese foreign policy implications (e.g. Ferdinand, 2016; Wang, 2016), the framework and assessment of the Belt and Road initiative in general (e.g. Chan, 2018; Cheng, 2016; Huang, 2016). Few studies explored aspects of urbanisation: Chen et al. (Chen et al., 2019) studied urbanisation patterns and poverty reduction on the country level for nations along the Belt and Road initiative from 1996 to 2016. Feng et al. (2017) studied spatial patterns of the urban system along the NSR using DMSP-OLS night-time light data; they analysed 273 main cities in 1992, 2003, 2014 and found that the number of relatively small cities is decreasing, and the number of large and medium-sized cities is increasing. To date, geopolitical and geo-economic aspects of the NSR have been investigated, the urbanisation aspect, however, remains mostly unexplored. In this study, we intended to investigate if spatial urban expansion along the NSR outgrows these cities far off the NSR.

2.1 Background

The ancient Silk Road was a network that connected East to West (130 B.C.- 1453 A.D.). The transportation means were camels or horses. Stops were needed for transit and food supplies. For these reasons, settlements along the Silk Road gradually became central to the trades where people and goods gather, the merchants exchanged their goods and made their transactions. These activities led to the formation of a significant number of large ancient cities along the NSR (Ni et al., 2017). The rise and fall of these ancient cities along the ancient Silk Road were closely linked to the success and fall of the trades. Thus, it is expected that the revival of the Silk Road may accelerate the expansion of the NSR cities, even the emergence of new cities. Farkhod et al. (2019) showed most of the NSR connectivity projects that are implemented and planned in the frame of the NSR projects located in central Asian countries (Table 1). These projects have been initiated to improve existing and build new infrastructure between these cities and countries, which are today only poorly linked with each other. It has been shown that transportation and economic development strongly correlate with population growth and spatial expansion of cities (Aljoufie et al., 2011). Therefore, it is expected that the NSR and its connectivity projects trigger urbanisation in the cities connected to it.

Study area

We selected all cities with over 300,000 inhabitants along the New Silk Roads (NSR cities). We defined cities within a 100 km corridor along the NSR (NSR cities) as connected to the new infrastructure development. At the same time, we selected the same number of cities per country that are further than 100km from the NSR (non-NSR cities). We understand them as too far away for direct impact by the NSR; these cities are located in China, Kazakhstan, Kyrgyzstan, Tajikstan, Turkmenistan, Iran, Turkey, and Russia (Figure 1). We use these two groups of cities to compare urbanization rates.

Country	Projects	Total funding(mln USD)
Tajikistan	16	4515.9
Kazakhstan	14	14539.3
Kyrgyzstan	11	1773.04
Turkmenistan	5	1402.5
Uzbekistan	5	1269

Table 1. NSR projects by country (Farkhod et al., 2019)

Figure 1. Geographical location of NSR and non-NSR cities

2.2 Data

For spatiotemporal analysis of urbanisation in a large study area, earth observation data proved to be an independent and cost-effective data source allowing for sufficient accuracy (e.g. Taubenböck et al., 2012). In this study, we selected – due to the need for wide area and for a 30-year temporal coverage from 1990 until today – data from the Landsat program. Data from the TM (Thematic Mapper), ETM+ (Enhanced Thematic Mapper plus), and OLI (Operational land Imager) sensors are available for our monitoring period with a comparatively high spatial resolution of 30m.

The settlement classification is performed in combination with the existing GHSL layer (Pesaresi et al., 2016), which contains a built-up area extent for 1990, 2000, 2014. We used the cloud-based platform Google Earth Engine (GEE) to process the available Landsat data. The GEE public data catalog contains an archive of multi-Petabyte of historical and present satellite imageries, especially the entire Landsat archive from Landsat-1 to Landsat-8. The GEE archive is updated every day with around 6000 new scenes from active earth observation satellite missions (Gorelick et al., 2017).

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3 METHODOLOGY

The developed workflow for mapping settlement areas from remote sensing data and the analysis of their spatial expansion over time included four methodological steps (Figure 2): Image-preprocessing, classification, validation and analysis of urban expansion.

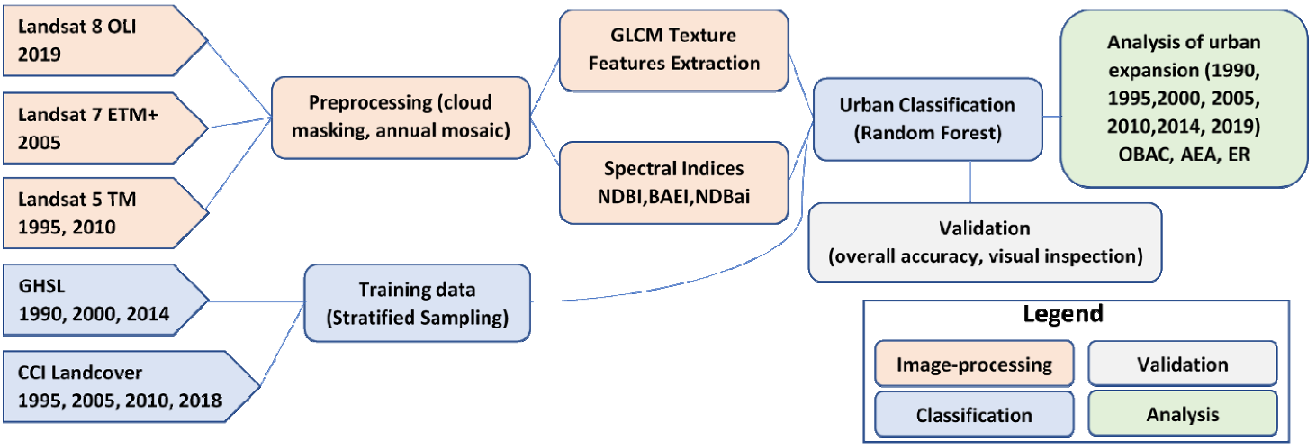

Figure 2. Overview of the methodological steps

The first step was image pre-processing, which included cleaning from cloud contamination. Surface reflectance data has been combined with a cloud mask to mask out the cloud-contaminated areas. Subsequently, annual mosaics using the median, i.e. the median value of the correspondent pixel from all available scences for the entire year have been constructed. For processing, we applied a circle buffer with 70 km diameter (equivalent to the diameter of the biggest city in the study area) around the cities' point location. In order to have a comparable spatial baseline for the cities, we applied the 'morphological urban areas' as introduced by Taubenböck et al. (2019). The morphological urban areas delineate the city from the countryside in a consistent manner along a density gradient. As this is done in a consistent manner for all cities, the spatial units are comparable, unlike historically created administrative boundaries of cities.

In a second step, we developed a feature space consisting of three GLCM texture features: variance, contrast, dissimilarity of each of the seven bands of the Landsat data. In addition, three spectral indices NDBI, BAEI, NDBai were used. These are introduced in the next section in detail. Overall, we produced a feature space with a total of 24 input variables.

The third step was classification; we generated the training data using stratified sampling from the GHSL and the ESA land-cover data as the base layer. This method takes previously produced land-cover information and returns the specified number of training points per class, considering the spatial distribution and other parameters like disproportional sample number per class area for better training data. A random forest supervised classification approach was carried out to classify the urban areas.

The fourth step was validation of the classification results; one-third of the training data were used to evaluate the overall accuracy of the RF classifier. In addition, we also investigated the results visually.

3.1 Multi-temporal land-cover classification

A land-cover classification extracting ten thematic classes (rainfed agriculture, irrigated agriculture, vegetation, forest/tree, shrubland, grassland/rangeland, bare land, water, snow, and built-up area) was performed on an individual basis, for each time step, and for each study sub-region. The main purpose of this classification was to identify urban built-up areas for the spatio-temporal measurement of urban expansion. In this study, we adopted the definition 'urban areas' as introduced by Schneider et al. (2010). This definition relates to places that are dominated by the built-up environment. The built-up environment includes all non-vegetative, human-constructed elements, such as buildings, roads, runways, etc. (a mix of human-made surfaces and materials). 'Dominated' implies coverage greater than or equal to 50% of a given landscape unit (here, the pixel). Pixels that are entirely covered by vegetation (e.g., a park) are not considered urban, even though they may function as urban space in terms of land use.

We applied the supervised random forest (Breiman, 2001) algorithm to classify urban areas. The classifier relies on the combination of texture features and spectral indices (Bramhe et al., 2018; Lu et al., 2005).

Satellite images not only contain spectral information encoded in different wavelength channels but they also feature rich information in terms of context or spatial information. To extract the urban areas effectively, the inclusion of the contextual and neighborhood information has been shown beneficial. Given that, each class or object pixels shows prominent characteristics in line with neighboring pixels. Therefore, textural image information such as the Gray-Level Co-Occurrence Matrix (GLCM) (Haralick et al., 1973) has proven meaningful for higher classification accuracy. The calculation is based on tonal (DN) differences between pairs of pixels in a spatially defined relationship with consideration of all pixel pairs within the neighborhood. Bramhe et al. (2018) reported the advantage of using Grey-Level-Co-occurrence-Matrix (GLCM) texture features together with spectral indices the extraction of built-up areas with higher accuracy. In line with this, we applied the Normalized Difference Built-up Index (NDBI), the Built-up Area Extraction Index (BAEI), and the Normalized Difference Bareness Index (NDBai). We applied the variable importance (VI) measure to optimise input variables. Based on the empirical results achieved, a total of 24 input features have been identified that contributed the most to the final result: The GLCM texture features variance, contrast, dissimilarity of each of the seven bands of the Landsat data as well as the three spectral indices NDBI, BAEI, NDBai.

We selected training data for training the classifier using a stratified sampling method (Millard and Richardson, 2015). The ESA Climate Change Initiative (CCI) (ESA, 2017) annual land-cover data were used as spatial reference for non-built-up classes. The GHLS was used for training data selection within built-up areas. The training data have been extracted separately, and the classification was run to ensure higher classification accuracy. Based on the empirical result, 2,000 training points per non-built-up land-cover class and 4,000 training points for the built-up class yielded a good result. The built-up areas' training points are further filtered with an NDVI threshold to exclude all points that have a higher value of the specified NDVI threshold to improve built-up area detection accuracy. The NDVI threshold was achieved through empirical results observing the classification accuracy.

The final classification result was then re-classified into three thematic classes: 'water', 'land', 'built-up area'. The following classes have been merged to the 'land' class; forest/tree, shrubland, grassland/rangeland, bare land, and snow. For accuracy assessment, one-third of the generated point data being independent from the trainnig data were used to evaluate the overall accuracy of the RF classifier. The accuracy assessment has been utilised for each run per study subregion.

A post-processing filter has been performed to exclude outlier pixels that were misclassified for the year 1995, 2005, 2010. The mask was taken from the GHLS layer that contains a permanent land thematic built-up class which remained stable from 1975 to 2015; this thematic class has been used to mask out few misclassified pixels to increase the classification accuracy.

3.2 Spatial units for comparison of cities

For a consistent analysis and comparison of urban spatial growth across cities, it is essential to select a suitable Urban Boundary (UB) that can correctly divide urban and rural areas (Xue et al., 2018). However, administrative units do not provide consistent units. Therefore, this unit has been shown to be inadmissible or distortions occur in comparative urban analysis (Wang et al., 2018). One suggested solution is using an UB that is generated using a harmonised and data-driven method applied for all cities. In this study, the Morphological Urban Areas (MUAs) developed by Taubenböck et al. (2019) were used as UB for further analysis. The MUAs delineate urban from rural along a decreasing built-up density from the centre to the periphery. The advantage of the MUAs are that they consistently delineate cities. Further information on the MUAs methodology can be acquired from Taubenböck et al. (2019). We calculated the extent of built-up areas in square kilometer and area-related indices for all cities based on the respective UB.

3.3 Measuring physical expansion of cities

The higher-ranking goal of this study was to test whether spatio-temporal expansion of NSR cities is higher than in non-NSR cities. To do so, we applied urbanisation indices. Urbanisation indices are used to measure the extent and speed of urbanisation over time. We used three indices: The Overall Built-up Changed Area (OBAC) measures the amount of changed built-up area between two-time steps, the Annual Expansion Area (AEA) measures the amount of annual urban expansion, and the urban Expansion Rate (ER) index is used as

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an indicator of urbanisation speed (Qian and Wu, 2019; Haas, 2016). The formulas of the three indices are introduced below.

Overall Built-up changed Area OBCA = BA (t2) - BA (t1) (1)

Annual Expansion Area AEA = [BA (t2) - BA (t1)]/(t2 - t1) (2)

Expansion Rate ER = ([BA (t2) - BA (t1)]/ BA(t1))*100 (3)

BA stands for the built-up area, BA(t) refers to the amount of settlement areas in particular time steps. The letter (t) refers to the time, and t1 is the prior time of t2.

3.4 Results: Spatio-Temporal Analysis of Urbanization along and off the New Silk Road

In general, we measured cities along the New Silk Road with higher urban growth rates than cities spatially off the route. This result confirms our central hypothesis.

Figure 3 illustrates the spatio-temporal evolution of settlement patterns from 1990 until 2019 for the examples of Almaty (Kazakhstan) and Kermanshah (Iran). Almaty is a city along the NSR, and Kermanshah is a sample city off the NSR by our definition. In addition, the morphological urban areas are shown in the figure to encompass the main settlement. The figure shows urban growth in general, but it is particularly interesting to see how growth in Kermanshah occurs along linear structures.

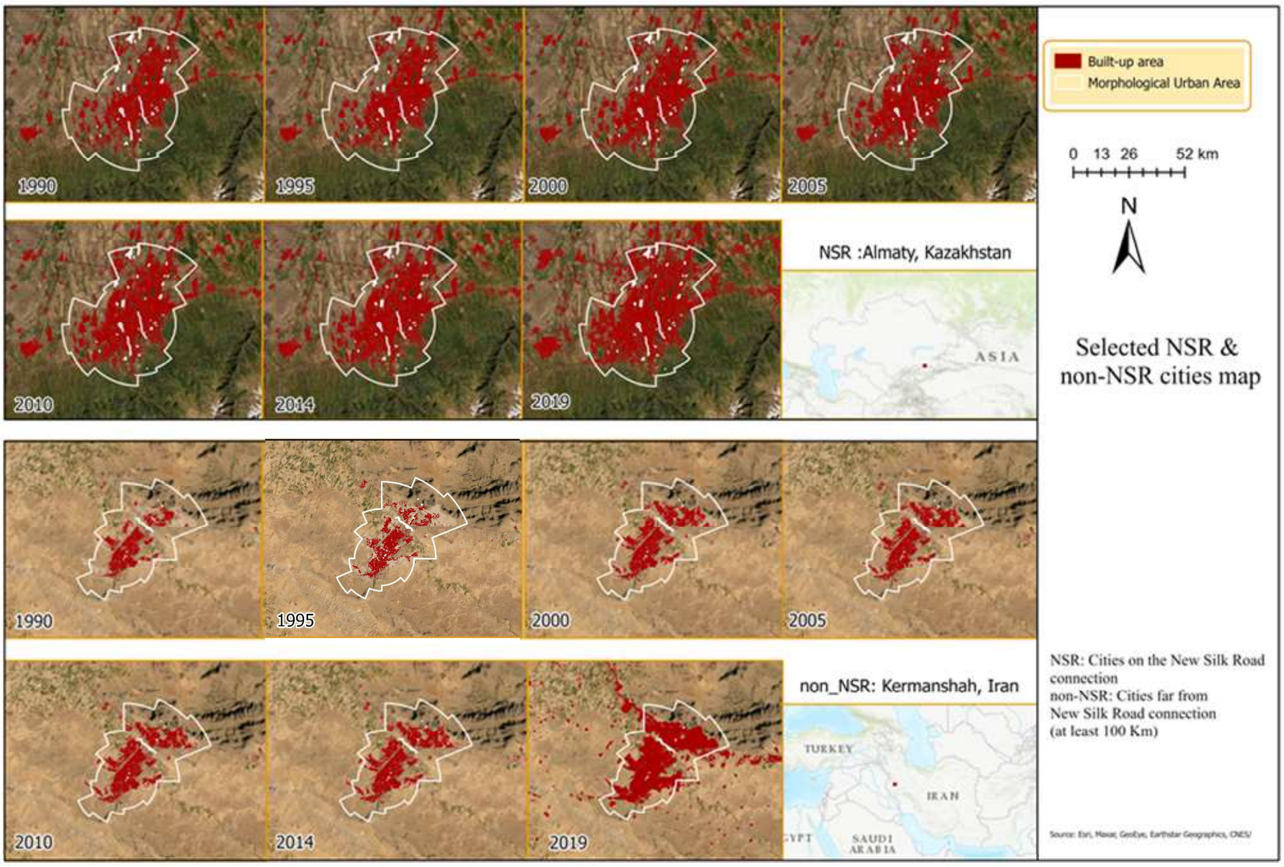

Figure 3. Classification result for NSR and non-NSR studies

We have evaluated the classification accuracy during the classification process; we used one-third of the training sample to evaluate the classifier's performance, while the remaining two-thirds were used to train the classifier. We measured the overall accuracies range from 75% to over 90 % dependeding on the particular city.

We have calculated the total urban area in square kilometers of all cities for each period, and we have calculated the area-related urban indices (OBAC, AEA, ER) to measure and quantify the magnitude of urban expansion in NSR and non-NSR cities. The total built-up area for the NSR cities detected in the initial year of our study 1990 was 4230.93 km2. We measured an increase to a total built-up area of 7926.06 km2 in 2019. In contrast, the total built-up area for the non-NSR cities was 1154.77 km2 in 1990 and then increased to 2919.52 km2 in 2019.

To investigate further the degree of change in both groups of cities, the three utilised urbanisation indices are calculated and they are as follows: The OBCA index, which shows the changed built-up area at two-time steps, and the AEA, which shows the annual expansion area, reveal that there has been generally fluctuating urban growth rates over the five year or yearly time periods. However, what is particularly interesting here is that from 2014 onwards, i.e. after the New Silk Road was launched as a project, the absolute area growth of the cities has been measured highest by far (Table 1).

year	1990-1995	1995-2000	2000-2005	2005-2010	2010-2014	2014-2019
NSR cities	1026 (205)	223 (45)	333 (67)	232 (46)	185 (46)	1696 (339)
Non-NSR cities	654 (131)	80 (16)	253 (51)	155 (31)	60 (15)	563 (113)

Table 2: Overall Built-up Changed Area (OBCA) and Annual Expansion Area (AEA) in km² (rounded)

For a relative analysis, we calculated the ER, which is used to capture the speed of urbanisation for the study periods. The ER compares the amount of urban land of two-time steps as a relative measure of urbanisation speed. The results of the ER index show that NSR cities expanded compared to non-NSR cities at a relatively slower speed from 1990 to 2010. However, we measured from 2010 onwards that the expansion speed of NSR cities overtakes the non-NSR cities (Table 3).

year	1990-1995	1995-2000	2000-2005	2005-2010	2010-2014	2014-2019
NSR	24.25	4.25	6.08	3.99	3.06	27.22
Non-NSR	56.64	4.40	13.40	7.24	2.61	23.90

Table 3: Expansion Rate (ER) in percent

Overall, we found that spatial urbanisation significantly increased from the years 2010 and onwards, independent whether cities are along the New Silk Road or not. At the same time, the analysis showed that urban expansion along the New Silk Road accelerated in the last decade. While until 2010 growth rates were actually slightly higher in non-NSR cities, we see that from 2010 NSR cities have higher growth rates.

4 DISCUSSION

It is interesting to see, that our main finding, that urban expansion is from 2010 onwards higher in NSR cities than far off the New Silk Roads, coincides with the inauguration of the NSR. However, we must clarify that our analysis is only descriptive and shows an effect that demonstrates a possible consequence of investments along the trade route. But, we cannot establish a clear causal relationship here due to the data situation as well as due to the manifold possible influencing factors.

This increase of urbanisation rates in the last decade coincides with the inauguration of the NSR. After the announcement of the BRI initiative, many projects were implemented to build as well as to reinforce the necessary transportation infrastructure to connect NSR cities and to ultimately connect China and the participating countries to Europe. It is well accepted that new economic opportunities in the cities attract more urban dwellers and consequently result in the expansion of cities. Based on the result achieved in this study, the result indicates an increased growth of built-up areas in NSR cities. Thus, there appears to be a link to increased urban growth rates.

With respect to our input data, we have measured an overall high accuracy of classification results. However, the effects of misclassifications to our results must remain unclear here. In addition, we measured for the period from 1990-1995 very high growth rates for all three urban indices. These are related to methodological differences, where higher settlement detection rates were performed in 1995 compared to 1990 due to an improved data situation. Thus, we assume growth rates from 1990 to 1995 overestimated in our analysis. From 1995 onwards, however, results are consistent and plausible. Beyond, by the applied method in this study some challenges in mountainous regions were observed; the geological structures and terraces similar in spectral reflectance to settlements were also included as built-up areas. Their effect, however, was low as these misclassified pixels were mostly excluded using the morphological urban areas in the final analysis.

5 CONCLUSION

In this paper, we have investigated the spatial urbanisation trend in cities along the NSR in comparison to cities off the NSR. We found that, indeed, NSR cities feature increased urbanisation rates since 2010 and

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higher urbanisation rates than cities spatially not directly connected to the NSR. Beyond, the results of the analysis confirm the accelerated growth cities in the study region in the recent decade in general. Although we cannot establish a causal relationship here, the NSR initative with its developed projects seems to trigger these expansion rates.

Remote sensing proved to be a reliable tool for large-scale analysis of urbanisation trends. The proposed method of extracting urban areas using medium resolution multitemporal Landsat data resulted in acceptable classification accuracies. In linking these spatial data with other data on economic, demographic, social or environmental issues, we see a high potential for new scientific insights along such a megaproject. Beyond, from a remote sensing point of view, we encourage further research with higher resolved satellite data to investigate this topic more in-depth. As the New Silk Roads will expand beyond our study areas, further studies are encouraged systematise and confirm the identified trends.

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Effectiveness of In Situ Upgrading in Improving the Quality of Life of Beneficiaries Living in Informal Settlements in South Africa

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1 ABSTRACT

Informal settlements have been a recurring problem in South Africa and it is undeniable that eradication of informal settlements is a goal difficult to achieve. However, the fundamental problem is not the mere existence of informal settlements but, the poor quality of life the residents are subjected to. Since 2004, South Africa has embarked on a journey to improve the quality of life of informal settlement dwellers through the implementation of Upgrading of Informal Settlement Programme (UISP). Not only did the state recognise that upgrading informal settlements can be a viable solution to the housing backlog but also acknowledged that housing strategies that relocate the poor have a significant impact on the livelihoods of the urban poor. Thus, UISP is set to achieve effective informal settlement upgrading through ensuring minimal disruption to livelihoods, encourage community empowerment and community participation. The paper presents results of a study conducted on the implemented UISP in Slovo Park informal settlement. The study is conducted using a qualitative approach which entails in-depth interviews with ten residents of Slovo Park and two City of Johannesburg officials on the possible impact UISP has on improving quality of life. This paper reveals how effective is UISP in ensuring land tenure security for the urban poor. Furthermore, the paper highlight factors that hinders the effectiveness of UISP. Results from this paper can be used to monitor and review the outcomes of in situ upgrading by highlighting the shortcomings in the planning and implementation process. In addition, findings from this study could assist the National Department of Human Settlements in achieving successful in situ upgrading by improving the UISP process using recommendations provided.

Keywords: Community empowerment, informal settlement, in situ upgrading, livelihoods, quality of life

2 INTRODUCTION AND CONTEXTUALISATION

South Africa has experienced influx of migrates to major cities over the past two decades (Ziblim et al., 2013). Socio-economic inequalities have left many poor households unable to provide for their needs including accessing shelter and or adequate housing. Despite the over 1 million new houses built since 1994, the South African new democracy has since been battling with meeting the growing housing and infrastructure demand. Particularly in metropolitan cities such as Cape Town, Johannesburg and Ekurhuleni, leaving many families resorting to seeking affordable accommodation in informal settlements or backyards of formal residence units in the townships (Møller, 2007). Nonetheless, formation and expansion of informal settlements has been a challenge faced by most developing countries. Many among them initially pursed forced eviction and demolition of existing informal settlements as an 'easy' way to eradicate informal settlements. This practice has made the residents of informal settlements poorer as the vacant land created through eradication of informal settlements is later, amongst other things, commonly used for development of luxury housing units, and shopping centres, benefiting the upper class (Arimah & Branch, 2011). The third UN Conference in Istanbul in June 1996, launched the Istanbul Declaration on Human Settlements, which brought change in the global policy dialogue on the need to ensure adequate shelter for all. This policy agenda was later renewed within the framework of the UN Millennium Development Goals MDGs, which indicate under Goal 7 Target 10, to expressively enhance the lives of more than 100 million informal settlement dwellers by the year 2020. Developing countries had to oblige by this target, thus instituted various programmes aiming at improving informal settlements (Ziblim et al., 2013). Although the upgrading programmes do not provide a lasting solution to the development and expansion of informal settlements, some governments have been implementing this approach since the 1980's using funds from the World Bank. The UN-HABITAT and the World Bank established the Slum Upgrading Facilities (SUF) in 2004 with the core objective of summoning domestic capital for informal settlement upgrading undertakings through facilitating links among numerous local actors that possess resources such as financial, technical and political elements of development projects. The UN-HABITAT and the World Bank have also been driving foreign investment from global capital markets to enable funding of upgrading programmes initiated by municipal authorities, nongovernmental organisations, private property developers and utility companies (Arimah & Branch, 2011).

Cities Without Slums (CWS) recognises that informal settlements are characterised by urban poverty, it therefore intends to reduce urban poverty which exists within informal settlements through the SUF programmes that will empower citizens, improve economic opportunities, create jobs and improve governance capacity to manage future urban growth (Arimah & Branch, 2011). Informal settlement upgrading programmes are focussed on improving the environment within which informal settlements exists, also known as in situ upgrading. It is notable that this was a radical change in attitude towards the existance of informal settlements especially in urban areas. Upgrading programmes provided a locality-based enhancement strategies intended to replace the various degrees of undesirability and deterioration in informal settlement through the initial provision of basic social services and physical infrastructure such as water reticulation, sanitation, waste collection, storm drainage system, street lighting, paved footpaths and streets (Abbott, 2002). Huchzermeyer (2011) indicated that compared to previous informal settlement intervention strategies, implementation of informal settlement upgrading programmes is relatively cheap and ensures that livelihoods and social support system are uninterrupted. Given the creative manner in which housing is commonly constructed in informal settlements, the upgrading programme acknowledges that if government provide the bulk infrastructure, formalise the settlements, provide tenure security and improve access to social services, the community is capable of gradually improving their housing structures.

National Department of Human Settlements introduced UISP designed under National Upgrading Settlement Programme as a progressive intervention to eradicate informality in human settlements. One of the main UISP objectives is to upgrade the existing informal settlements incorporating community participation to achieve effective upgrading (Huchzermeyer, 2009). There is much literature focusing on UISP as a strategy to eliminate informality in human settlements (Abbott, 2002; Charlton & Kihato, 2006; Gardener, 2003 and Huchzermeyer & Karam, 2006), however, current studies do not indicate the effectiveness of UISP in improving the quality of life of beneficiaries. The primary outcome of the paper is to inform future human settlement policy by indicating the successes and failures of UISP in improving the quality of life of informal settlement residents. Findings from this paper can also be used to monitor and review the outcomes of in situ upgrading in providing quality of life and improving the socio-economic circumstances of residents of informal settlements by highlighting the shortcomings in the planning and implementation process.

2.1 Conceptual framework: Informal settlements and in situ upgrading

Defining informal settlements requires specific context as its definition varies from culture to culture, social class and often changes with time. Subsequently, the term informal settlements does not apply to all countries. Some countries call them slums, while some call them squatter settlements. Corburn & Karanja (2014) describes informal settlement as a representation of human deprivation to adequate access to safe water, adequate access to sanitation and other infrastructure, poor structural quality of housing, overcrowding, and insecure residential status. According to Amao (2012), an informal settlement can be defined as a residential area which was established without legal claims to the land or permission from the relevant authorities to occupy. These are unplanned settlements and are built in areas that are sometimes unsuitable and environmentally hazardous and using noncompliant building plans. Despite the varied names, informal settlements have similar characteristics. People living in informal settlements have similar circumstances that suggest their informality. These include unauthorised use of vacant public or private land, illegal subdivision and/or rental of land, unauthorised construction of structures and buildings, reliance on low cost and locally available scrap construction materials, absence of restrictive standards and regulations, reliance on family labour and artisanal techniques for construction, non-availability of mortgage or any other subsidised finance. Talukdar (2018) observed that it is becoming commonly acknowledged that in most developing countries, informal settlement is a representation of the poverty trap. People living in informal settlements often exist in conditions that expose them to risk for their health, prosperity, safety and undignified way of life. It is argued that due to their illegal occupation status, informal settlement dwellers have generally limited access to basic social services if at all. Lack of regulation within the settlement have resulted to the overcrowding which contributes to stress where sharing of communal resources such as water stand taps, drainage and toilet facilities is concerned as well as prevelance of crime and violence (Amao, 2012). The South African Department of Human Settlement identifies a settlement as an informal settlement with the following characteristics, which forms the basis of the definition; a settlement in an inappropriate location, a settlement that was formed illegally, an area with restricted public and private sector investment, a settlement overwhelmed with poverty, vulnerability and social stress (Ziblim et al., 2013).

In situ upgrading is a relatively new idea of tackling urban informality challenges instead of eradicating informal settlements. In situ upgrading is an approach focusing on promoting land tenure security by firstly regulating informal settlements. It is also an approach that recognises and promotes maintenance of existing social relationships and community cohesion in informal settlements. Through land tenure legalisation and infrastructure improvements, in situ upgrading aims to gradually improve living conditions of residents living in informal settlements (Khalifa, 2015). Braathen et al. (2014) indicated that in situ upgrading of informal settlements is the state's acknowledgement that informal settlements can form part of a housing solution. It is also the state's recognition that the traditional housing strategies that allocate housing in the periphery of the city have a negative impact on the livelihoods of the urban poor.

3 IN SITU UPGRADING IN SOUTH AFRICA

The Housing White Paper 1994 obligates municipalities to ensure that all residents live in socially and economically integrated communities that sustain livelihoods and provide reasonable access to healthcare, education and social amenities. The policy further states that housing delivery should occur by means of various possible mechanisms because it is government's first and foremost priority to deal with the problem of housing for the poor. The Comprehensive Plan for Sustainable Human Settlements of 2004 brought about various housing strategies to address issues of adequate housing in South Africa. This includes initiations of sites and services, Breaking New Ground (BNG) launched in 2004 (Wekesa et al., 2011). According to Marais & Ntema (2013), the first large scale sites and services project was implemented at the Freedom Square informal settlement and benefited over 100,000 households. BNG projects under the National Housing Subsidy Scheme would provide land, housing and basic services using the project-linked capital subsidy programme also known as the 'Reconstruction and Development Programme' (RDP) housing subsidy. According to Huchzermeyer (2014), BNG also came along as informal settlement eradication strategy in which households qualifying for the one-off capital subsidy were offered the subsidy to later be relocated to an identified area where completed units were allocated. Although this programme provided many poor communities with low-cost housing, residents were disadvantaged because they were commonly relocated to the periphery of the city where economic opportunities are scarce. Providing housing for the poor in the periphery of the city does not address challenges of urbanisation and urban poverty, instead it undermines the social networks created by residents of informal settlements as their survival strategies, causes higher transportation costs and perpetuates social exclusion (Tshikotshi, 2009).

It was recognised that this housing subsidy strategy was only dedicated for developments on vacant land, which presented a policy gap in terms of the availability of subsidy system designed to facilitate in situ upgrading of informal settlements. To fill this policy gap, during the same year as BNG was launched; the Upgrading of Informal Settlements Programme (UISP) was introduced as Chapter 13 of the National Housing Code. Five years later, UISP was incorporated into Part 3 of the new Housing Code (Huchzermeyer et al, 2014). Not only was this move viewed as closing the policy gap, it was an act of acknowledgement that informal settlements are a part of cities and have the potential to solve the housing backlog for the urban poor, while preserving livelihoods (Wekesa et al., 2011). However, implementation of UISP was delayed at the provincial and local government level until 2008 when the NDH established a National Upgrading Support Programme (NUSP) which was incorporated in the UISP. NUSP's main task is to promote and support the implementation of the UISP in terms of co-ordination with sectors and partners involved as means to ensure that government's capacity and professional practitioners are strengthened to implement community-based incremental upgrading, mainly in the metropolitan cities (NUSP, 2015). NUSP was established to largely assist UISP in achieving Outcome 8 'Human Settlements' - upgrading of 400,000 households in informal settlements by 2014 (Huchzermeyer, 2014). UISP had a pilot project in all nine provinces, many of which intend to implement in situ upgrading throughout the province (Ziblim, 2013). Upgrading Informal Settlement Programme consists of four fundamental phases, namely; (1) application, (2) project initiation, (3) project implementation and (4) housing consolidation (Huchzermeyer, 2006). UISP recognises that the poor are attracted to particular locations due to the economic opportunities such locations

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have to offer. Therefore, living in informal settlements is a survival strategy. Within these informal settlements, residents develop strong social networks which are considered their coping strategies. These include access to credit from community groups and the ability to create self-employment opportunities that have a strong customer-seller network and community-based mutual help and support (Braathen et al., 2014). UISP is set out to achieve effective informal settlement upgrading through ensuring minimal disruption to livelihoods, encourage community empowerment and community participation in decision-making (Huchzermeyer, 2006 and 2009). Informal settlement interventions that are not accessible to beneficiaries will result in their displacement to housing options that offer affordability and, in many cases, these are new or existing informal settlements, irrespective of the inclusiveness of the initial allocation procedure. Therefore, if skills development was not possible during the UISP implementation phases, then community-based or area-based subsidy mechanisms must be considered.

Like any other state housing programme, UISP is funded by government subsidy which caters for land rehabilitation, incremental provision of basic services, infrastructure provision and the last phase of the UISP process which is the housing project and sometimes health and educational facilities, recreational centres and shopping centres. While national government is liable for establishment of a funding framework for housing development, negotiating and securing funding allocation from the state budget for housing. Provincial government is there to support and strengthen the capacity of municipalities to facilitate housing provision including assessing funding applications received from municipalities, administer national housing programmes and monitor the performance of accredited municipalities. This leaves the local municipality with the responsibility to facilitate the development and management of housing stock as per their Integrated Development Plan (IDP) as well as identifying suitable vacant land for relocation (NUSP, 2015). The first step towards upgrading an informal settlement through UISP process requires feasibility investigation by the local municipality. When the location is proclaimed suitable for re-development and assumed that relocation is inevitable for community members in some cases, application for funding must consider both in situ upgrading and the relocation site (Huchzermeyer, 2009).

UISP principles and approaches apply also to relocation site and this is done to minimise the additional stress that comes with relocation. Nikuze et al. (2019) observed that there are worse socio-economic impacts associated with awaiting relocation, which is beyond the physical relocation, yet these are not given enough attention. Securing of livelihoods before relocation takes place helps concerned individuals to become more resilient and enable them to cope with post- relocation. Huchzermeyer (2009) highligted that UISP in situ upgrading is a positive response to many court cases of housing rights violation and forceful evictions that have been reported since 2000.

4 RESEARCH METHODOLOGY

The study is set out to explore the effectiveness of in situ upgrading in improving the quality of life of beneficiaries, studying Slovo Park informal settlement. The study area was chosen because it is one of the oldest informal settlements in Johannesburg and recently received a favourable court ruling to have the settlement upgraded through the UISP. Although there are no recent statistics on the total population of Slovo Park and the number of migrants in and out of the settlement, in 2011 the area was indicated to constitute of a total of more than 5 000 individuals, about 1 600 shacks amongst the 1 050 stands. The informal settlement was formed in 1994 and has since been expanding. The study applied a qualitative method, in which in-depth interviews and field observation were conducted. The combination of the two different data collection styles was proven to increase the standards of validity or to strengthen the credibility of research findings as compared to the use of a single data collection style (Salkind ed., 2010). The target population is the residents of Slovo Park informal settlement, particularly individuals older than 20 years preferably the elders within the families. The sample consist of participants who have lived experience of the subject matter, as such, are more likely to provide reliable and valid information. The sample was representative of the entire inhabitants of Slovo Park as it also included participants who are renting a shack and those who were allocated a stand in all genders. In order to understand the phenomena under investigation in the perspective of the participants, the researcher employed a semi-structured interview approach.

Interviews were conducted with ten (10) residents of Slovo Park. Although the sample size it relatively small, the selection was purposive and saturation was reached. Interview questions were written in English but the interviewees were interviewed in the participants‘ preferred language, which was mostly Southern Sesotho and IsiZulu. This is because the researcher avoided compromising the quality of the response. Thus, in order to preserve high quality in the answers provided by participants, the researcher allowed the participants to answer in their home language. Within 24 hours of the interview sessions, the recorded interviews were translated into English by the researcher and a written text of each interview was created. Through the transcribed interviews, the researcher established several themes that emerged consistently. Interviews were also conducted with two (2) of the City of Johannesburg (CoJ) municipal officials as facilitators (the Project Officer and Deputy Director for Housing Department) of UISP in the study area. For anonymity, participants’ names are disguised in the write up. The following themes guide data collection and analysis:

(a) Regulation of informal settlement

(b) Community Empowerment

(c) Safety within the community

(d) Improved livelihoods

(e) Improved food security

(f) Ineffective community participation in planning UISP

(g) Overcrowding

(h) UISP, a prolonged programme

5 A PERSPECTIVE ON THE UPGRADING INFORMAL SETTLEMENT PROGRAMME

This paper is providing details of views emerging from interviews and the literature, with an emphasis on the impact of UISP in improving the quality of life of informal settlements. This section is organised into two sub-sections, namely; success factors and limitations of UISP.

5.1 Success factors of UISP

5.1.1 Regulating of informal settlement

For the purpose of this paper, a stand can be described as a plot of land occupied by a household for residential purposes. During the interviews with residents of Slovo Park, the stand owners indicated that the high court’s verdict to have Slovo Park upgraded meant that the informal settlement is finally being regularised. Therefore, they will no longer live in constant fear of being evicted. Although stand numbers are changed every ten years, these numbers are reallocated to the existing owners and this has been providing the confidence in property ownership. This was indicated by the respondents in the interviews who said that “government will never evict us after investing so much money into electricity installations. Although stand numbers change every 10 years, I am not threatened because all these numbers are allocated to the same ID number…" Respondent 1. “I have a stand number that reassures me that I will not be relocated. Even if they change these numbers every 10 years, no one can claim my stand. In the yard, I have an electricity cable connected only to my house, as such, rentals are not a threat because it is clear to them too that the stand belongs to me. If I had financial resources, I would build a formal housing structure just like some of the community members who have already started”. Respondent 2.

From these views, it appears that residents of Slovo Park informal settlement are certain that regularisation of the settlement was achieved through the UISP process and that has reassured the residents that they will not be forcefully evicted from the area. As such, the in situ upgrading process was effective in instilling the confidence that residents have a secure place to live and this was achieved by installing electricity cables into each shack with a stand number. According to Amos (2011), the definition of informal settlements has been realised mainly based on their illegal or unpermitted occupation of land. The fear of illegal eviction and demolition has contributed to the likeliness of residents of informal settlements to build their shelters using building materials that are easy to remove, such as corrugated iron. Thus, regulating the settlement has impacted the residents positively because it implies that the settlement forms part of a planned area and it unblocks assets accumulation for the residents as they will be able to invest in their properties in compliance with the city’s acceptable building standard and norms. Tenure regularisation also promotes provision of urban services which were previously absent (Arimah & Branch, 2011). This also forms part of what Wekesa et al. (2011) indicated as the state's acknowledgement that informal settlements are not only a part of the cities but a potential solution to the existing state housing backlog.

5.1.2 Community Empowerment

Interviews revealed that some of community members were empowered during the electrification project, through the offering of temporary employment. It was highlighted that there were no initial intentions to employ community members on the project, which also delayed implementation processes. The decision to employ unemployed members of the community, accompanied by a fair selection process coordinated by the councillor ensured a successful implementation. These were views expressed by Respondent 3, who explained that "the Councilor facilitated the employment of unemployed community members. He applied a process called "fuduwa" meaning that individuals would put their names into a container which is shaken, and names are randomly picked. Even people living with disabilities were employed in the project".

From the above, residents from informal settlement expected upgrading projects not only to facilitate provision of services but also to provide employment, even if it is temporary. El Menshawy et al. (2011) indicated that an informal settlement intervention strategy must empower its beneficiaries through transforming their livelihoods. Therefore, community participation should go beyond decision-making and involve the community during the implementation stage. Simone et al. (2005) observed how this translate to public ownership and accountability necessary for the success of the project implemented for the beneficiaries. Furthermore, community capacity building (both leadership skills and technical knowledge) is realised. By achieving this, the UISP process achieved a successful community participation. According to Wekesa et al. (2011), UISP is one of the few progressive approaches that seeks to contribute towards social inclusion and economic empowerment of the urban poor.

5.1.3 Safety within the community

Residents indicated that, since the decision to upgrade Slovo Park in 2016 by the high court, the community got electrification in 2018. Electricity cables and metres were installed into the stand owner's shack and those who rent share with the stand owners. It was also observed that there are streetlights installed on each street. Residents expressed that this has contributed to the safety of the community. It was revealed during interviews with the residents of Slovo Park that quality of life has improved since the electrification project. Firstly, shack fires have reduced immensely. Secondly, health related issues contributed by paraffin gas have ceased. Thirdly, people no longer wake up too early to prepare for work, therefore, have extended resting period since they walk to work. Fourthly, food security has improved because households are able to buy food in bulk and store in refrigerators, which saves money in a long run. Lastly, the degree of crime has declined because streetlights have brought safety within the community. These were views expressed by the following participants, who indicated that"the quality of life has improved intensively between the time we were relying on illegal connections and now. I have changed from using a paraffin stove and a wooden stove to cook and heat water to bath in the morning, preparing for work" Respondent 3. "Access to electricity has simplified my life and I no longer fear for the safety of my children. When I leave my children for work in the morning or for a night shift, I am comfortable even if I were to forget the lights on" Respondent 2."Having access to electricity has eliminated the health issues I previously had when using a paraffin stove, which released gas that affected my lungs and eyes. With electricity, I can simply use an electric kettle and a 2-plate stove to prepare meals and heating bathing water. This saves me a lot of time. Through the light provided by the streetlights, we can monitor and ensure safety within the community" Respondent 4. "…I can buy food in bulk and store in the fridge. I have a monthly budget. In the morning, I can work up a little later than I used to to prepare for work. I no longer rely on 'mbaula' to warm up water, so, it saves me plenty of time. The streetlights installed have provided safety within the community as we are able to see everything that is happening on our streets at night. So, this has reduced the crime rate. I am also safe walking on the street in the early hours going to work" Respondent 5.

Individuals in the study have a view about their quality of life and their interpretation of the concept is accepted. Based on the above views, it is evident that residents are satisfied with the social infrastructure improvements meant to improve their quality of life. According to Amao (2012), there are three main philosophical approaches to determine the quality of life. The first philosophical approach is the normative ideals and belief systems that individuals live by. This describes the personal experience of people. The second philosophical approach describes the satisfaction citizens attain from obtaining the things they desire.

The third philosophical approach encompasses the first and second approach, therefore description of quality of life, factors such as feelings of joy, pleasure, contentment, and life satisfaction based on personal experience. According to Tonon (2015), when qualitative methodology is applied in a quality of life study, it becomes imperative to consider people´s perceptions, opinions, feelings, ideas and interpretations. This approach is important to help the researcher understand people's experiences of wellbeing and issues related to quality of life. This is because the study of the quality of life has a direct link to the material conditions such as the social welfare and to the psycho-social conditions such as the personal welfare.

5.1.4 Improved food security

It was also indicated during interviews that since the electrification, residents not only are able to save money on monthly groceries but also have improved food security. These were comments made by respondents, who said "…having access to electricity has reduced the amount of money I spent on basic food. I can buy food in bulk and store in the fridge" Respondent 6."Access to electricity improved food security in the household and helps me stick to the monthly grocery budget. Having to constantly buy meat, at times rotten because vendors also used ice to keep the meat fresh and this made it very hard for me to save money towards other needs. When I go to work, I know that my children have access to good food during the day because, as you may know a shack is very hot, so when we leave cooked meals in the pots, the food gets rotten and difficult to eat" Respondent 1.

From these views, it is undeniable that socioeconomic status has a direct link to food security. Residents of informal settlements are generally low-income earners, which has implications on the diet or type of food they can afford to buy to sustain them for a month. Lack of access to electricity worsens the circumstance of food insecurity because buying food such as milk and frozen meat in bulk is not an option. Yet, this could reduce the cost of food on a monthly basis as compared to buying single items on a day to day basis. According to Naicker et al. (2015), residents of informal settlements face a much higher level of food insecurity due to very low income and lack of full-time employment. This contributes to undernutrition or malnutrition because some of the coping strategies employed during food insecurity include decreasing of the variety of foods eaten. As such, consumption of vegetables, fruit and protein would decrease. Although household income did not improve amongst the residents of Slovo Park, having access to electricity helped households save the little money they earn by enhancing the opportunity to buy food in bulk due to better storage capacity. This also had a direct impact on food security.

5.1.5 Improved livelihoods

A resident who relies on income generated through rentals indicated that access to electricity has enhanced their livelihoods. Even the Project Officer from CoJ highlighted that "those with rental business have dramatically increased their fees after electricity installation" Respondent 12. However, the landlord expressed her concerns that the upgrading might have negative effects on their livelihoods. For example, relocation of rentals will limit the demand and provision of housing might mean they can no longer have shacks rented in the yards. This was a view stated by Respondent 2, who indicated that "I mainly rely on the income I get from the rentals. If the upgrading, for example, housing provision would mean I can no longer accommodate rented shacks, then this upgrading will have a negative impact on my livelihood".

The above statement indicates that stand owners benefiting from rentals would prefer not to be disadvantaged by the upgrading, especially during the housing provision. Once again, it is evident that the community of Slovo Park bought into UISP without fully understanding what it entails and this is a concern. Relocation of some of the community members is inevitable in many cases of in situ informal settlement upgrading. This is mainly to reduce overcrowding in informal settlements and avoid using unsuitable areas within the settlement. However, Huchzemeyer (2006) highlighted that the UISP process considers the socio-economic viability indicators that will trace the households' livelihood strategies. UISP intends to respond flexibly to demand, rather than simply allocating the same product equitably to all households within a community or every informal settlement.

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5.2 Limitations of UISP

5.2.1 Ineffective community participation in planning UISP

It was discovered from the interviews that the community was frequently invited to an information session hosted by the Slovo Park Community Development Forum (SPCDF). During these meetings, different opinions were shared but not necessarily considered. The aim of these meetings was to share information on the plans derived for the upgrading and provide progress report. Respondent 7, who is also a committee member in the SPCDF, expressed the following when he was asked if he perceived community as actively involved in the planning of the in situ upgrading programme. “Yes, under the guidance of SERI who also helped us with the court case against the City of Johannesburg”. While the following respondents’ views to the same question were as follows: “the committee in representation of the community was actively involved. I would not say the community was passively involved” Respondent 5. “Not directly, the community was frequently invited to meetings which were basically information sessions regarding the upcoming implementations” Respondent 1. The municipal official indicated that “all inputs, audio recorded and/or written were taken into consideration when developing layout draft mindful of geotechnical, and environmental impact assessment advice” Respondent 12.“…but community participation was limited to the SERI, Centre for Urbanism & Built Environment Studies (CUBES) and the Slovo Park committee. The ward councillor including the Community Development Workers (CDW) were not participating. My view is that individual residents must be afford an opportunity to come up with the intervention such as reclamation facilities without necessarily being led by a team, which in my view do not necessarily share their interests” Respondent 11. “…beneficiary education of prescripts of the UISP policy is critical so that the community can buy into a programme they understand holistically, and this is something the municipal officials are not satisfied that it was fully conducted” Respondent 12.

Community participation is a crucial aspect of the UISP process, in fact, it is what distinguishes UISP from all other housing strategies under the umbrella of the NUSP. Failure to facilitate this important stage of the UISP process has the potential to create community’s misunderstanding and conflict during implementation. Although a community may elect representatives, it is important that the representatives share the same ideas as the community. This helps eliminate resistance or failure to comply with the regulations of the products received from the upgrading programme. It also helps ensure that the products provided are suitable to the needs of the community. Conducting a real community participation would require committees representing beneficiaries to become involved at all levels from strategy level down to project implementation level. El Menshawy et al. (2011), also indicated that real community participation is essential. Wekesa et al. (2011) also emphasised that the physical planning aspect of the process should not be concluded at the top level, but should be based on the inputs derived from public participation in order for the end product to be accessible and affordable to the real end-users.

5.2.2 UISP, a prolonged programme

During an interview, Respondent 12 indicated that:

“Quality of lives among dwellers improve as delivery of constitutionally rights services is effected. The provision of water, toilets, electricity, and other amenities improve lives…”. “It has to be noted that this is 100% government subsidised programme, so full implementation of upgrading can take 10 years depending on population of occupants; land rights; suitability of ground in terms of habitability; and availability of funds from coffers to attend to each activities of every phase. Other factors which may derail completion is migration of residents” Respondent 12. Yet the respondents indicated that: “If this was not a prolonged process, it could be effective and efficient. We have tolerated bad living conditions for more than 2 decades in Slovo Park, therefore the incremental development process undermines the urgency of basic services. I would suggest that the duration intended to complete this programme be reduced to a shorter period so that our children can have a better future. We are no longer thinking of ourselves but our children” Respondent 1. “….Government should source out funds to simultaneously provide most of the basic services. This development will take a long time to be completed and most of us might not be alive to see most of the services. For example, our leaders, Mohau and Mampara passed on without witnessing/enjoying the fruit of their tireless efforts” Respondent 4.

These perceptions indicate that UISP has shortcomings in improving the quality of life of beneficiaries living in informal settlements and this is due to the lengthy period of completing a comprehensive UISP. Funding has been highlighted as a factor that delays implementation completion as this is a 100% government funded programme. However, these delays contribute to other factors which will further delay completion of an effective UISP process that would improve the quality of life of beneficiaries living in informal settlements. This includes migration of residents into the settlement. According to Amirah et al. (2011) city authorities have been unable to manage rapid urbanisation which resulted in the development of informal settlements. This has mainly been due to lack of financial and technical capacity. El Menshawy et al. (2011) also indicated that informal settlements upgrading is often avoided because it requires a large financial input to make provision of the entire infrastructure systems. As such upgrading stages would spread the costs over a longer period. According to Huchzermeyer (2006), municipalities apply for UISP funding which provides a one-off project funding of land rehabilitation. Beyond this, the relevant municipality is responsible for bulk infrastructure and maintenance of services post-implementation. This must fall under an approved municipal IDP which implies that products/projects will be provided on the priority and funds availability basis.

Interviewee responses		Overview
5.1 Success factors of UISP	• Regulating of informal settlement	Social networks are maintained, and livelihoods are uninterrupted. Stand numbers are allocated and electricity cables are installed to each shack, particularly the stand owner’s shack.
	• Community Empowerment	Electrification project offered temporary employment to residents. It is also acknowledged that UISP still require the establishment of Community Builder Programme.
	• Safety within the community	Crime rate is reduced within the settlement due to the provided public lights.
	• Improved livelihoods	Stand owners increased rental fees subsequent to the electrification project.
	• Improved food security	Households are able to buy food in bulk and store in the refrigerator for the month.
5.2 Limitations of UISP	• Ineffective community participation in planning UISP	Indirect community participation resulted in the physical planning aspect of the process unknown to the beneficiaries. Thus, residents are unable to upgrade top structure. Affordability of the provided services presents a potential threat to the success of UISP. Poor socio-economies could result in the displacement of the beneficiaries.
	• Overcrowding	Excess rentals contribute to insufficiency of services provided by UISP, i.e. reliability of electricity.
	• UISP, a prolonged programme	A minimum of 10 years to complete UISP process is too long and opens opportunities of overcrowding.

Table 1: Overview of interview responses

5.2.3 Overcrowding

Participant in the interviews were concerned about excess rentals in Slovo Park and indicated that they contribute to the unreliability of electricity. Each stand has more than three shacks and this overloads the transformers, thus, power-cuts are frequent while the city responds to power delays. When asked to point out contributors that lead to the failure of the plans of in situ upgrading to focus on improving the quality of life in Slovo Park, respondents pointed out that “implementation of an informal settlement upgrading is a long and delayed process. Even people that did not live here initially, move here due to the attraction that the

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initiated implementation brings, which in my view will hinder the success of the plan. The community is growing despite some families moving to other places. The identified land is already getting occupied by people that were not initially earmarked for that land" Respondent 7."So far, this plan is unsuccessful because we still have excessive rentals and overcrowding which makes the provided services insufficient…. Government has the powers to identify suitable land and do relocations. The sooner this is done the sooner the effectiveness of this upgrading will be satisfactory. At the moment, although we have access to electricity we are overcrowded, as such this electricity is unreliable because the population exceeds the electricity capacity, thus the transformer bursts frequently. It is clear that the same will happen with all the other services government intends to provide for us" Respondent 8. It was also discovered during an interview with a renting participant that simultaneously, she feels disadvantaged by the delays in implementing the relocation phase. In her view, the in situ upgrading implemented in Slovo Park, which she also fought for will not benefit her because she does not have tenure security. Respondent 3 expressed these views by saying that "I am yet to be relocated. So, I cannot say I have security of tenure".

Poor planning of in situ upgrading has compromised the efforts of improving quality of life of beneficiaries' post-implementation because access to electricity is unreliable in the Slovo Park informal settlement due to overcrowding. Not only that, individuals identified for relocation are not made aware of the details of implementation. According to Nikuze, et al. (2019), application for UISP funding should cater for both in situ upgrading and the relocation site. The local municipality has the responsibility to identify suitable vacant land for relocation. UISP principles and approaches apply also to the relocation site and this is done to minimise the additional stress that comes with relocation. Institutional incapacity in terms of financial and technical resources are compromising the effectiveness of UISP in improving the quality of life of beneficiaries living in informal settlements.

6 CONCLUSION AND RECOMMENDATIONS

The existence of informal settlements in urban areas has been perceived as a result of ineffective housing policy, insufficiency of housing finance, unequipped public utilities and local municipalities to create tenure security to the ever-growing population in cities. Eradication of informal settlements in a form of relocation has been prominent in South Africa, especially through the BNG projects, in which qualifying households are provided with low-cost housing and basic services on an identified suitable site. This strategy has been criticised for its disregard for the impact it has on livelihoods and social networks critical for survival of the residents. ISUP is considered a "progressive informal settlement eradication vehicle" designed under the NUSP as it seeks to respond flexibly to housing demand and move beyond providing low-income housing in the peripheries of the city. Thus, integrating informal settlements into the larger fabric of the city, both geographically and socially. This paper reveals that in situ upgrading programme has regularised the settlement by officially allocating stand numbers and securing land tenure as the first step towards improving the quality of life of the residents of Slovo Park. As such, UISP has had a positive impact because it acknowledges the community's social networks by introducing minimal interruption to their current livelihoods while waiting for incremental upgrading implementation. CoJ officials confirm that the Slovo Park informal settlement is on course to ultimately be an approved settlement for township establishment and then to have a project subsidy number for permanent purposes.

The paper reveals that residents of Slovo Park are content with access to electricity because some componenta of their quality of life have improved since the installation of electricity within the community. These include the improved safety due to public lights installed, the use of electric appliances such as stoves to prepare meals and kettles for heating water to wash which have reduced health issues related to the previous use of paraffin stoves. The convenience of using electricity for preparing for work has added more time for resting. The likelihood of shack fires has declined drastically, and food security has improved because there are opportunities to buy food in bulk and store in the refrigerator. For stand owner's, access to electricity opened an opportunity for rental fee increase, which has made a significant improvement to their livelihoods.

Considering the above, various recommendations can be delineated including the following:

(1) that in situ upgrading is complementary to the community's socio-economic status. UISP should consider the socio-economic circumstance of the community. This paper reveals that Slovo Park has excessive rentals, and this is because rentals are a source of income to supplement low-income earners and in the case of

retired individuals, rentals are the main source of income. Therefore, if the plan is to eradicate informality, UISP should incorporate formal structures for rental in addition to housing to allow continuous access to this income. This way, the provided infrastructure will match the expected number of people in a community. If not, households will continue perpetuation of renting shacks, which will defeat the purpose of the in situ upgrading programme. The aspect of community participation plays a significant role in this. Top-down planning and implementation process allowing for little or no input from beneficiary communities should be avoided because they result in community resistance to possessing a sense of responsibility to ensure compliance with the city's regulations.

(2) That UISP addresses overcrowding as the first step. It is recommendable that every informal settlement upgrading begins with addressing overcrowding. This will ensure that services provided are adequate and reliable. This paper reveals that there is a concern that Slovo Park will remain overcrowded for a long time because individuals previously identified for relocation have not been relocated to the identified suitable site. Yet, other people are migrating to that site. If most people cannot be accommodated on the identified vacant and suitable land, they will remain in the community, overstretching the resources provided for the reduced population of Slovo Park. This will defeat the purpose of the upgrading process because the quality of life of residents of Slovo Park will remain unchanged. Therefore, if relocation of some of the residents was recommended, it is advisable that this is executed before basic services are provided. This will help with monitoring and discouraging migration into the settlement.

(3) That UISP facilitates community empowerment for the sustainability of the upgrading. The paper reveals that there is an expectation from the community that local development must involve the local community by means of job creation even if it is a temporary offer. Nonetheless, this is also an important aspect of the community participation process, it is as significant as the in situ upgrading planning process. An informal settlement such as Slovo Park has a high unemployment rate and an unskilled population. As such, they can only offer labour resources during a project and temporarily enhance their livelihoods. The challenge with this is that post-implementation, the livelihood circumstance of this community members remains unchanged. This is a factor identified by the CoJ municipal officials which recommended the need for an improved procurement processes that will cater for local needs in terms of introducing a delivery vehicle that will promote a Community Builder Programme. It is assumed that this would empower the community and enhance their skills. Community empowerment would not only enhance the livelihoods of the residents of this informal settlement but would also ensure sustainability of the provided services. This would be a significant effort toward improving the quality of life of residents of informal settlements.

7 LIMITATIONS OF THE STUDY

Most of the residents of Slovo Park informal settlement do not understand the English language fluently. As such, the researcher had to translate interview questions from English to either IsiZulu or Southern Sesotho during the interview in order to accommodate the interviewee. This limitation contributed to time consuming task of translation of all transcripts to English. Fixing of appointments with the relevant municipal officials proved to be another limitation to the study. The researcher had to postpone the interview because municipal officials were unavailable on dates or times previously arranged. Additionally, the research had limitation by methodology, as such further study can be conducted using quantitative approach, with a larger sample and in other informal settlements to get a broader view of the topic.

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Energy Issues in Building and District Assessment Schemes and Benchmarking Systems

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1 ABSTRACT

In the Canton of Zurich an increasing number of customers in their business area for building energy solutions have been identified who have their properties certified with sustainability systems. They have to create regular reports or use benchmarks to optimise their properties with regard to energetic aspects.

A large amount of detailed information is available on the use and differences of rating and certification systems. For stakeholders in the energy market sector, however, it is important to have the necessary information available on energy monitoring data and GHG (greenhouse gas) emission reporting for value creation. One promising concept is the 2000-Watt-Area.

A 2000-Watt-Area (200WA) is a new form of settlement. It has achieved a reputation for energy efficiency, renewable energies and climate friendliness and reflects the values of a responsible society.

In this work we try to find answers to the following questions:

- Which evaluation criteria are the basis for the 2000WA?
- How much can these urban areas lower their GHG emissions?
- What role do the instruments of energy efficiency and renewable energies play in this?
- What is the relationship between these and what statements can be made with regard to mobility?
- How can the Facility Manager help to transform successfully into 2000WA?

The paper is based on literature research and three interviews with stakeholders in the Swiss construction sector (a district representative, an energy consultant, a technology provider). The findings qualify the concept of 2000WA and put it into a wider international context of certification and benchmarking systems.

It was found that 39 2000WA are in operation, implementation and transition in Switzerland. From the experience gained from these districts it can be seen that the 2000WA concept is trying to include important aspects of a sustainable transition of districts. While many districts were new developments (34), only 5 were districts in transformation. The number of districts in transformation need to increase considerably if the GHG emission reduction goals in Switzerland are to be met. Facility managers can play an important role in this transition. But they need to enhance their skills and responsibilities in order to fulfil their roles as transition managers. Evaluating the 2000WA can be a key to this and has the potential to enhance the reduction of GHG emissions in districts and cities.

Keywords: 2000-Watt-Site, benchmarking system, certification system, energy monitoring data, greenhouse gas emissions

2 INTRODUCTION

2.1 Renovation and transformation

Climate change challenge the ambitious goals that regulators have put in place by setting more and more aggressive building and community energy-related requirements based on the Sustainable Development Goals of the UN. The concept of Energy Master Planning (EMP) can help to initiate a better planning and implementation process to fulfil these goals. In the EU, reaching for the climate gas reduction goals of the Paris Agreement, stakeholders on all geographical and organisational levels from nations, regions, cities and communities are challenged. Following bottom-up approaches for energy planning on the neighbourhood level is a promising attempt to reduce energy demand, increase energy efficiency and lower the carbon footprint in a multi-stakeholder approach.

In the context of the 2012 EU directive (EED 2012), several important measures have been adopted throughout the EU to improve energy efficiency. These include national long-term renovation strategies for the building stock in each EU country, mandatory energy efficiency certificates accompanying the sale and rental of buildings, the preparation of national energy efficiency action plans (NEEAPs) every three years, minimum energy efficiency standards and labelling for a variety of products, as well as obligation schemes for energy companies to achieve yearly energy savings of 1.5% of annual sales to final consumers. However, Member States have yet to fully implement the Directive and additional support in building capacity and know-how is needed (EPBD 2018). Significant additional energy savings, reduced emissions, and increased energy security can be realised by considering holistic solutions for the heating, cooling and power needs of communities, on neighbourhood and district scale, comprising collections of buildings. As a result, considerable literature has become available including both guidance and assessment tools aimed at EMP at the neighbourhood and district level as e.g. campuses (DOE 2013; Huang et al. 2015; EnergyPlan 2019; BREEAM 2019; DGNB 2018). But the existing guidance and tools do not seem to be fully solving the challenges. The energy planning consists in determining the optimal mix of energy sources to satisfy a given energy demand. The major difficulties of this issue lie in its multi scales aspect (temporal and geographical), but also in the necessity to consider the quantitative (economic, technical) but also qualitative (environmental impact, social) criteria (Schiefelbein et al. 2017).

In order to be able to apply principles of a holistic approach to neighbourhood and districts, often coined community energy planning in the literature, and to provide the necessary methods and instruments to master planners, decision makers, and stakeholders, it is essential to identify and frame the constraints that bound the options towards an optimised energy master planning solution (Haase and Lohse 2019). Existing master planning guidance available indicates that identifying and establishing project goals is a critical first step (Jank, 2017).

In a new initiative of the European Commission, Positive Energy Districts are envisioned as "are energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while securing the energy supply and a good life for all in line with social, economic and environmental sustainability." (JPI UE 2020).

In many cities, the necessary legal and strategic frameworks for the realisation of PED/PENs are not yet in place. Very often, there is also a lack of a planning culture in city administrations or the personnel resources available might be insufficient. In particular, the transformation of large (brownfield) areas to climate neutral city districts has a big potential for the development of PED/PENs but needs cooperation between administration, industry, and research. Especially in case of heterogeneous ownership structures, cooperative planning processes are indispensable. Far less common in EMP guidance and related literature is information on the identification of constraints that limit energy technology options and how stakeholders influence the decision-making process. Literature in this area mentions options analysis or prioritization, or optimization analysis (EED 2012; Jank, 2017; Fox 2016; Zhivov et al. 2014; Robinson et al. 2009), yet, options analysis or optimisation is clearly influenced by project energy-related constraints. Sharp et al. (2020) compared EMP in several countries and analysed these constraints (Sharp et al. 20120). The results show that successful energy master planning is highly dependent on a thorough understanding of framing goals and constraints, both local and regional, and their associated limitations that will dictate the optimum master planning design. Haase and Baer (2021) pointed out that as more and more countries push to improve energy efficiency, environmental impact, and the resilience of their buildings and neighbourhoods, the need for early and comprehensive energy master planning on neighbourhood and district level is critically important. In addition, certification schemes could help to enhance the improvement of our cities and districts.

Therefore, it was interesting to explore what has been developed in Switzerland (Energie Schweiz). In particular, the concept of the 2000-Watt society seems a valuable contribution to the discussion of further implementation of PEDs.

2.2 2000-Watt-society

The 2000-Watt Society is a vision for a liveable future (2000-Watt-Society). People in such a society care for a high quality of life that meets the goals of sustainability. They appreciate the resources the earth provides, use them sensibly and share them equally around the globe. The 2000-Watt Society gathers interested people who know that quality of life is not inextricably tied to a constantly higher material standard of living. This vision is based on the view that a future society should represent a sustainable and socially just society. For every person on earth, 2000 W of continuous power (primary energy) are available. This must be enough to ensure prosperity and a high quality of life. Today, the primary energy consumption per capita worldwide is on average 2500 W – with enormous country-specific differences. At present, each Swiss inhabitant uses about 4700 W. The CO2 emissions caused by this level of energy consumption must not exceed 1 tonne per person per year (2000-Watt-Society).

Thus, drastic climate change can be actively counteracted. The goals of the 2000-Watt Society are scheduled to be met between the years 2050-2100. A rescheduling of these goals towards 2040-2050 is currently under development. One tool to achieve this vision in by the introduction of a certification scheme, 2000-Watt-Sites. This certification scheme is in place since 2008 and thus some experiences could be gained already.

2.3 2000-Watt-Sites

The development of districts requires a distinct understanding of the situation now as well as a vision of the future district to be able to develop suitable pathways for this transition. In order to be able to do that a district needs to be modelled that consists of several buildings, sufficiently described so that the future district can actively manage their energy consumption and the energy flow between them and the wider energy system. The energy master planning process requires an analysis of different scenarios, which include new construction to different levels of energy efficiency, major renovation of all or some buildings comprising building stock under consideration with Deep Energy Retrofit of these buildings, minor renovations with energy-related scope of work, or demolition of some old buildings. Such analysis requires building energy modelling.

A 2000-Watt-Site (200WS) is a new form of settlement (2000-Watt-Areal, 2000-Watt Areal in transition). It has achieved a reputation for energy efficiency, renewable energies and climate friendliness and reflects the values of a responsible society. The core idea of the 2000-Watt Site is an ongoing evaluation process of a site's sustainability in terms of energy in development, planning, implementation and operation. Certificates are issued for a limited time period and must be renewed periodically. They are awarded in two stages: As a «site under development» until at least half of the total living space is in use, and after that as a «site in operation» (2000-Watt society, 2000-Watt Areal in transition).

The 2000-Watt Site certificate creates added value for all stakeholders – for investors, planners, users, law enforcement agencies and authorities: users enjoy a high standard of housing and living. They can live with the assurance that they are contributing to resource conservation and climate protection. Investors and owners are interested in value-preserving sites offering a high quality of living and working. The quality characteristics are useful for marketing and image-building. Due to the high level of acceptance, cooperation with authorities is much easier. It helps local municipalities to bring their concerns to bear at an early stage. The certificate is a guarantee of successful commercial implementation of their energy and climate-policy goals.

2.3.1 Criteria used in 2000-Watt-Sites

The subject areas of the criteria for evaluation of 2000-Watt-Sites are shown in Table 1. In the management system subject area a maximum of 110 points is possible, followed by the subject area site utilisation and urban planning with 100 points. In the subject areas buildings and mobility 90 points can be achieved, while in the subject areas communication, cooperation, participation an supply and waste disposal a maximum of 70 points can be achieved.

Subject area	**Max. pts.**
1. Management system	110
2. Communication, cooperation, participation	70
3. Site utilization and urban planning	100
4. Supply and waste disposal	70
5. Buildings	90
6. Mobility	90
Site total	530

Table 1: Subject areas of the 2000-Watt-Sites.

2.3.2 Research question

In this work we try to find answers to the following questions:

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- Which evaluation criteria are the basis for the 2000WS?
- How much can these urban areas lower their GHG emissions?
- What role do the instruments of energy efficiency and renewable energies play in this?
- What is the relationship between these and what statements can be made with regard to mobility?
- How can the Facility Manager help to transform successfully into 2000WS?

3 METHODS

The paper is based on literature research and three interviews with stakeholders in the Swiss construction sector (a district representative, an energy consultant, a technology provider). The findings qualify the concept of 2000WS and put it into a wider international context of certification and benchmarking systems.

3.1 Literature review

There are several publications about 2000-W-Society and 2000-W-Sites available (2000-Watt-Society; Energiestadt 2021a, Energiestadt 2021b, Energiestadt 2021c). However, most of the literature is in German only. The 2000-Watt-Society published a number of documents that are downloadable from their website.

The programme “Energieforschung Stadt Zürich» (energy research of the city of Zurich) has conducted extensive accommodated research of all 2000-Watt-Sites that were realised in the city of Zurich in the past 15 years. Energy Research City of Zurich was a ten-year programme and focused on topics at the interface between social science research and the application of new or existing efficiency technologies, which are particularly interesting in an urban context. Focus was put on application-oriented research for more energy efficiency and renewable energies (Stadt Zurich, Stadt Zurich and ewz, SIA380). The research results and findings are generally publicly available and are available to all interested parties so that the City of Zurich Energy Research has the greatest possible impact - also outside the city of Zurich. Research has being carried out in two subject areas.

The topic of households started with the residents of the city of Zurich, who consume energy at home, at work and on the go and, as decision-makers, play a central role in the implementation of the 2000-Watt society in many respects. In particular, social science aspects that promote or prevent conscious use of energy were examined. In field trials with households in the city of Zurich, it has been investigated which obstacles in the city of Zurich are relevant in everyday life and which measures are used to overcome them.

The topic of buildings started with the building infrastructure, which is responsible for around 70 percent of the final energy consumption in the city of Zurich (Stadt Zurich). In scientifically designed and accompanied implementation projects, renovation strategies for buildings were developed and implemented together with the owners and other decision-makers in order to make a significant contribution to the renovation and renewal of the building fabric in the city of Zurich (Stadt Zurich). The focus was put on increasing energy efficiency in the heating sector and minimising electricity consumption. In addition, there exist a number of certification schemes in Switzerland (NNBS 2018), including the system of the Swiss Council for Sustainable Building (SGNI).

3.2 Interviews

The first interview was conducted in March 2021 a district representative near Winterthur, in the North of Zurich. The district consists of 51 living units in 8 row houses. The whole district was constructed in the 1970s and is due for retrofitting. The energy supply system was due for renewal a couple of years ago and in 2018 the oil boiler was renewed. This was a lost opportunity for a comprehensive energy retrofit and the interview was focusing on the process, the incentives and professional support from industry.

The second interview was conducted in April 2021 with an energy consultant in the south of Zurich.

The third interview was conducted in May 2021 with a technology provider from a Swiss certification body. The interview was focusing on the tools and incentives in the Swiss market. The certification that forms the basis for the 2000WS was critically discussed with the interviewee.

4 RESULTS

It was found that 39 2000WS are in operation, implementation and transition in Switzerland. From the experience gained from these districts it can be seen that the 2000WS concept is trying to include important aspects of a sustainable transition of districts. While many districts were new developments (34), seven of these sites are in operation, while additional five districts were in transformation.

4.1 In operation and transformation

Table 1 summarises the 2000WS which are in operation or in transformation. A total area of 101265526m2 is covered, certification was registered between 2017 and 2021. The areas can be found in Bern, Lenzburg, Zurich, Chur, Winterthur, Oberkirch (LU) and Lausanne.

Site	Location	Certification	Area size (m2)	Achieved	Further information
«Erlenmatt West»	Basel	2017 (re)	25 600	66%	http://erlenmatt-west.ch/
«Stöckacker Süd»	Bern	2020 (re)	1 750 000	74%	http://www.stoeckackersued.ch/
«Burgunder»	Bern-Bümpliz	2017 (op)	7 660	61%	https://www.npg-ag.ch/projekte/siedlung-burgunder/
«Im Lenz»	Lenzburg	2018 (re)	61 400	63%	https://www.imlenz.ch/de/home
«Freilager»	Zürich	2018 (re)	7 050 000	74%	https://freilager-zuerich.ch/
«Hunziker Areal»	Zürich	2021 (re)	41 000	91%	https://www.mehralswohnen.ch/
«Kalkbreite»	Zürich	2021 (re)	6 393	89%	https://www.kalkbreite.net/
«Sihlbogen»	Zürich	2021 (re)	2 100 000	89%	https://www.bgzurlinden.ch/home
«City West»	Chur	2020 (tr)	26 500	57%	https://www.citywest-chur.ch/
«AXA»	Winterthur	2019 (tr)	32 000	63%	https://www.rwpa.ch/axa-gebaeude-g
«Campus Sursee»	Oberkirch LU	2019 (tr)	142 065	67%	https://www.campus-sursee.ch/2000-watt-areal/
«UNIL Dorigny»	Lausanne	2019 (tr)	90000000	65%	https://www.unil.ch/index.html
«Campus Mythenquai»	Zürich	2019 (tr)	22 908	68%	https://www.swissre.com/about-us/our-global-presence/campus-mythenquai.html

(op) in operation

(re) in operation, re-certifiied

(tr) in transformation

Table 2: Information about the certified 2000-Watt-Sites in operation (op, re) and in transformation (tr)

4.2 Evaluation criteria

A certification is an affirmation or a marketing strategy that companies, cooperatives, property owners or organisations adhere to specified standards or guidelines. Certification for a 2000-Watt-Site is carried out by independent certification bodies using a catalogue of criteria that must be met. The opinions and arguments for certifying or not certifying the area differ depending on the building owner. For sustainable companies, certification is a demonstration of their pioneering role. For cities, municipalities, universities and other training facilities, the role model role is completely at the centre. For settlements, certification brings further advantages, such as a certificate represents a high-quality development for the public and the community and higher rent can be charged. As fossil energies will become more expensive in the future, renewable energies and buildings will be subsidised depending on the location of the municipality or canton.

Buildings and areas can be certified after commissioning. The qualitative and quantitative requirements must simply be met and the evidence must be available. With the recertification, the quality assurance processes are periodically checked for the target direction of the area level and if so needs to be adapted to the latest development. Recertification is open to anyone interested in the new 2000-Watt area in transformation. Three sites are reported here in more detail as they were recently recertified as depicted in Table 3.

«Hunziker Areal» Zürich
Rezertifiziert 2021

«Kalkbreite» Zürich
Rezertifiziert 2021

«Sihlbogen» Zürich
Rezertifiziert 2021

Table 3: Three example sites from Zurich

4.2.1 Hunziker area in Zurich, certified in 2017

Since 2015, the cooperative has been offering more than living space for 1200 people and 150 workplaces in the north of Zurich. Several housing cooperatives joined forces and in 2007 founded the cooperative “more than living”. They had the idea of living together and to adopt new structural innovations. In 2010, “more than living” took over the 41000m2 Hunziker area - once a concrete factory that was getting on in years - from the city of Zurich under construction law. In the articles of association of the cooperative it was noted that the principles of the 2000 Watt society are practiced and lived in. The value of 30kWh / m2 according to Minergie-P specifications is adhered to throughout the area. The waste heat is used for heating the entire area monitored by the neighbouring city data centre. The cooperative covers 20 percent of the electricity consumption via the photovoltaic systems on the roofs. The buildings are very striking due to their diversity, which were built by five architectural teams as part of the overall urban planning concept.

A total of 13 buildings were built. The Hunziker Areal is their first pioneering work of a holistic understanding of sustainability. The cooperative provides answers to new, changed housing needs and sustainable social change.

The Hunziker area was built for a long-term living cycle with various constructions and the latest building technology. For the 370 residential units, the area offers various typologies for different needs and budgets. A wide variety of offers, e.g. from studios to cluster apartments with larger communal areas enable a high mix of residents. There are occupancy regulations in the cooperative and residents do not have a private car. In the area, people live actively with one another instead of an anonymous neighbourhood. This principle means that numerous common ground floor uses and open spaces are available to residents for free use. There they celebrate together, plant vegetables and run their own workshop. Since the area was strictly planned and later also built according to the sustainability criteria of the 2000 Watt Society, the area achieved very good values in the certification. The area is one of a total of five pilot areas that were the first to receive the label for the operation phase and are allowed to pass it on. 2000-Watt area offers living perspectives with development potential for tried and tested and new forms of living. With the incentive to be able to combine several things, such as living, working, attractive business and participation processes, and the diversity of living realities, a social, sustainable and lively quarter was created. Thanks to the sustainable, energy-saving building, the consistent use of renewable energies and innovative technologies, many resources are saved in everyday life. Above all, giving up one's own car is exemplified. This shows that it works and that the goals of the 2000 Watt society can be met. A three-year research monitoring project was successfully developed to optimise the operating values and checked with the financial help of the Swiss Federal Office of Energy (SFOE 2008).

Briefly summarised it is the vision of the cooperative to continue to adhere to the goals of the 2000 Watt society. Building energy-efficient buildings, using the latest technologies and few cars or hybrid cars support an environmentally friendly lifestyle and save valuable resources. The “more than living” cooperative attaches great importance to high-quality architecture, good quality in construction and sustainability in the maintenance of the buildings.

4.2.2 Kalkbreite in Zurich, certified in 2017

The Kalkbreite Cooperative fulfils all the necessary Minergie-P-Eco-Bau requirements in terms of energy and ecology. The building only needs a little added heat, which is generated by means of a groundwater heat pump. 15% of the electricity required is produced by the company's own photovoltaic system on the roof. Although the buildings are equipped according to Minergie-P-Eco and have a healthy ecological construction method, they have to reveal the built-in grey energy. During construction there is a need for grey energy (SIA 2032).

The building can only achieve optimal energy savings when it is in operation. They depend on how the heating is used in the apartments, how often the residents ventilate and whether the lights are left on unnecessarily. Depending on this, the hot water also plays a major role, as it has to be heated up with energy first. Mobility is classified as the second largest energy consumer in our society. Mobility needs are very individual and it is difficult to influence them with sustainability, since everyone drives what they want. Kalkbreite has taken a number of measures to enable residents to use their mobility in a more sustainable manner. Charging stations have been set up for electric cars, which are charged by the photovoltaic system on the roof.

In the Kalkbreite area, the average space consumption per person, including the share of shared space, is 33.5m2. This land consumption is much lower in the cooperative than in new buildings, where it is 45m2 or more per capita. Since the Kalkbreite has large building parts of 16.5m and complex corner situations, due to the location, larger apartments were created during construction which made it difficult to achieve the objectives. The heating consumes less energy than the hot water preparation. The hot water is produced with heat pumps and stored in storage tanks on each stairwell. No solar panels are needed for hot water preparation. The electricity is generated with the photovoltaic system and covers around 20% of consumption.

The heating is operated sustainably and environmentally friendly and set to a comfort temperature of a maximum of 20 degrees in living and sleeping rooms. The bathrooms are heated to 21 degrees with an outside temperature of -8 degrees. Five times less energy is used in Kalkbreite than in an average house or ten times less than in an unrenovated house built between 1960 and 1980.

That is why the usage behaviour of the residents is decisive for achieving the savings potential. Incorrect ventilation can cause apartments to cool down. Then it needs energy again to reach the normal living temperature. When the sun is shining in summer and winter, residents have to use the sun protection correctly, otherwise the apartments may overheat. Since the rooms are very well insulated, the sun can heat the rooms strongly and dissipate excess heat poorly. In summer it is important to use the shading intelligently.

The Kalkbreite Cooperative has built in comfort ventilation, which ensures a constant, low exchange of air with filtered outside air. The heat exchanger extracts heat from the exhaust air and preheats the supply air. With this comfort ventilation, residents can sleep at night with the window closed without any problems and, if necessary, open and close the windows manually. Several data such as electricity, warm, cold water, heating and waste are measured in the Kalkbreite and clearly shown in the utility bill. This means that residents can see their consumption and thus motivate them to reduce it for the next year.

In order to maintain living comfort, a glass collection point was even set up within a few walking meters. The City of Zurich will provide additional waste collection points.

Those at the desk and carrying out housekeeping are at the heart of the Kalkbreite Cooperative. They serve several purposes, such as the reception for guests of the pension and tenants of the flex rooms and are also available as a contact person for various matters of the residents and commercial tenants. On the ground floor of the building there is a bicycle parking lot, which is equipped with a practical bicycle parking space, as well as a bar and a large tram hall of the Zurich public transport organisation (ZVV). In addition, the Kalkbreite Cooperative offers a subsidised youth apartment for shared apartments for young people from 16 to 25 years of age. The cooperative is very committed to a healthy mix of families and, above all, to sustainability for the sake of the environment.

4.2.3 Sihlbogen in Zurich, recertified in 2021

With the Sihlbogen development, the Zurlinden building cooperative has created a lively centre in Zurich Leimbach. Due to the proximity of the city and nature, this area offers a high quality of living and great access to public transport. The Sihlbogen consists of three buildings on two construction sites. The two residential buildings on site B were completed in 2013 and offer car-free living. The residential and commercial development on site A was completed in 2015. Site A takes on the role of a new district centre and offers several shopping opportunities and services.

The settlement includes 220 units, which consist of family and old people's homes and studio apartments and create a good mix, which contributes to a pleasant atmosphere in the area. The three buildings were designed to be compact, resulting in low resource consumption during construction and operation.

In site A, a conventional solid construction method was used, while in site B a load-bearing structure made of wood was used. The heat is generated through several sustainable channels: pellet heating, biogas heating, air-water heat pumps and the use of waste heat. Photovoltaic panels were set up on the roofs to produce electricity for their own use. The Sihlbogen location has excellent public transport connections. As a resident, one can live well without an own car. Since the residents of site B do not have their own car, they receive a Rail-Check voucher for public transport. The 2000 Watt society relies on car sharing. Two mobility cars and one rental electric car are available on the Sihlbogen area. The residents can use a self-produced app to communicate, which supports active social coexistence.

Since the beginning, the Sihlbogen development has been planned and built according to the goals of the 2000WS. In 2015, the Sihlbogen received the 2000WS in development certificate and was later duly certified in 2017. Before recertification in 2021, the cooperative received the 2000WS in operation certificate. As in Kalkbreite, the Sihlbogen was a pioneering project in sustainable construction and commissioning.

The Zurlinden building cooperative has been committed to sustainable building for more than 10 years. The strategy of the cooperative is based on the 2000 Watt society. The SIA norm 2040 is the most important instrument for the implementation. The architecture competition was based on the specification as early as 2015. Building an object according to the 2000WS means thinking holistically and, in addition to operation and grey energy, also considering mobility (according to SIA norm 2039), waste management and building technology.

In today's construction market, innovation is in demand, new building products are being researched and developed. Sustainable, environmentally friendly criteria such as system separation, interchangeability, life cycle costs, renewable raw materials and short delivery routes are in the foreground. With renewable energy, the energy costs are minimal, so that investment costs pay off over time. In this cooperative, a ZVV subscription is also included in the rental price to encourage the use of public transport.

subject area	Hunziker Areal		Kalkbreite		Sihlbogen	
1. Management system	83	75%	92	84%	107	97%
2. Communication, cooperation, participation	70	100%	70	100%	56	80%
3. Site utilisation and urban planning	100	100%	84	84%	88	88%
4. Supply and waste disposal	53	76%	60	86%	62	89%
5. Buildings	88	98%	76	84%	76	84%
6. Mobility	88	98%	90	100%	85	94%
Site total	482	91%	472	89%	474	89%

Table 4: Distribution of points in the three example sites

Table 4 summarises the results from the 2000WS certification and shows the distribution of points that each of the three example sites have achieved. The percentage of achievement, which must exceed 67% (according to the certification rules) has been achieved in all 2000WS (see also Table 2). Please note, that maximum achievable points differ for the different subject areas (as shown in Figure 1). All three example sites achieved 91% (Hunziker Areal), 89% respectively (Kalkbreite and Sihlbogen). The Hunziker Areal achieved 100% in two subject areas (communication, cooperation, participation and site utilisation and urban planning). Kalbreite achieved 100% in two subject areas (communication, cooperation, participation and mobility).

Detail	Hunziker Areal	Kalkbreite	Sihlbogen
Type of use	mixed use	mixed use	mixed use
Energy standard	Minergie-P-ECO	Minergie-P-ECO	SIA 2040
Heat production	District heating system with server waste heat from the city data centre (heating and hot water)	Ground source heat pumps	pellets, heat pump, biogas, waste heat
Cold production	electricity	free cooling (ground water)	industry cold for large distributer
Electricity	-	PV, eco power tariff	PV, swiss electricity mix

Table 5: Energy supply details of three example sites

Table 5 shows the details of the energy supply of the different example sites. All sites build upon the efficient building energy standard which minimises energy demand. For heat and cold production, different systems are in use (heating solutions ranging from connection to district heating with utilisation of waste heat, GSHP, and pellets). Two sites have included PV systems on-site, which produce 15% (Sihlbogen) and 20% (Kalkbreite) of the energy need on-site.

In various cantons there are general restrictions on the use of new instruments in the energy sector or restrictions on instruments that move away from energetic building regulations in the direction of operating permits. In these cases, an additional tightening of the cantonal area regulations at the communal level is not permitted. The scope for action for new energy requirements must therefore be clarified on a canton-specific basis. At the municipal level, depending on the existing legal regulations, the legal basis for binding regulations must often first be created (successful examples exist. Additional agreements between the municipality and the site authority are always possible).

Three distinct advantages could be shown:

(1) Proof of 2000-Watt compatibility: As part of the building application, the compatibility of the 2000WS with the goals of the 2000 Watt society is demonstrated.

(2) Mobility concept: A mobility concept shows how systematic mobility management should be set up and operated in planning and implementation.

(3) Monitoring / Controlling: Monitoring in the operating phase allows the municipality to gather its own experience with the real behaviour of the buildings and their users. Current practice ranges between a “monitoring light” (only for operating energy) and a more comprehensive monitoring / controlling concept for operating energy and the mobility caused by a site.

5 CONCLUSION

The number of districts in transformation need to increase considerably if the GHG emission reduction goals in Switzerland are to be met. It was found that 39 2000WA are in operation, implementation and transition in Switzerland. From the experience gained from these districts it can be seen that the 2000WA concept is trying to include important aspects of a sustainable transition of districts. While many districts were new developments (34), only 5 were districts in transformation. The number of districts in transformation need to increase considerably if the GHG emission reduction goals in Switzerland are to be met.

The proof of the concept and the need for monitoring and controlling results are demonstrated on sites where they are implemented and operate as planned. This is an important factor for the further replication of the concept. In many cities, the necessary legal and strategic frameworks for the realisation of PED/PENs are not yet in place. Very often, there is also a lack of a planning culture in city administrations or the personnel resources available might be insufficient. In particular, the transformation of large (brownfield) areas to climate neutral city districts has a big potential for the development of PED/PENs but needs cooperation between administration, industry, and research. 2000WS can help to enhance the transition and decarbonise our cities and districts. There are several stakeholders that can play an important role in this transition. Facility managers can play an important role in this transition. But they need to enhance their skills and responsibilities in order to fulfil their roles as transition managers. Evaluating the 2000WA can be a key to this and has the potential to enhance the reduction of GHG emissions in districts and cities.

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🏆 *reviewed paper*

Enhancing Identity through Streetscape Composition

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1 ABSTRACT

Each city or an urban space has a unique identity and a character of its own. Therefore, there is a special pleasure in looking at a city and its components. The lived experience added to a place is considered significant to people through time. Think of a city and directly its streets come to your mind, according to Jacobs (1961). People experience the city through moving in a linear path formed by elements, such as; building façades, trees, curbs, and other elements. Streetscape skeleton, along with other physical design elements, form the vista that any individual recognises when arriving at an urban place or a street. Due to the dynamic development of cities, a key question concerning the quality of life is always asked. According to the World Health Organisation (WHO) the standard indicators of the quality of life is physical and mental health, and social belonging. This paper aims to identify the most important physical features in streetscape design elements according to users, as well as showing which of the physical features could enhance identity and character of a place. Literature reviews and the analysis of a case study in downtown Alexandria in Egypt are used as the research methodology and procedures for this paper. The results show a hierarchical ranking of elements to take into consideration to design a future guideline or a framework to enhance the identity of a street or an urban space. Findings show that the Physical Setting is the most noticeable quality of place to users. It is also clear that the Softscape elements are considered the most important when answering the question of the important physical features with the largest impact on identity and sense of comfort.

Keywords: Streetscape, Character, Urban Design, Identity, History

2 INTRODUCTION

When Kevin Lynch (1960) explained the five elements of a city, i.e. landmark, path, node, district, and edge, he stated that the path is the most important element. IN 1961, Jane Jacobs said in “The Death and Life of Great American Cities” that “Streets and their sidewalks, the main public places of a city, are its most vital organs. Think of a city and what comes to mind? Its streets. If the city’s streets look interesting, the city looks interesting; if they look dull, the city looks dull”. Scholars suggest that streets are used as social spaces rather than just movement channels. Universal design principles of streetscape elements may bring streetscapes to become more user-friendly, sustainable, and functional.

As people use urban places in their daily life, they are affected by the experience. This lived experience is affected by various dimensions, such as morphological, perceptual, social, visual, functional, and temporal dimensions (Carmona et al., 2010). The elements that contribute to these dimensions are the streetscape elements and their composition. That is why the design of streetscape can determine the people’s perception of the city’s identity and character (Wibisono, 2001). Unlike squares that need something, an object or an event, to keep people coming, streets are necessary urban spaces (Gehl, 1987).

The case study chosen is characterised by its remarkable history and significant buildings, which create the identity of the place. The unique location of Alexandria has made it an attraction to various civilisations ever since the Ptolemy times. This has caused Alexandria to become the window to the cultures and arts from European countries. Ever since Muhammed Ali and his family allowed for interactions with foreign colonies, Alexandria has witnessed its own renaissance during the second half of the nineteenth century, resulting in a city with a unique character. However, in the past century, Alexandria has witnessed a rapid change due to globalisation and urbanisation. This change was clearly uncontrolled, causing deterioration of the existing conditions of heritage spaces as a result of general cultural ignorance, lack of maintenance and regulations, and natural conditions. These factors directly impacted the urban environment and hindered the preservation of its historic part (Getty, 2009).

Historic Urban Landscapes (HUL) have received more attention after the United Nations Educational, Scientific and Cultural Organization (UNESCO) recommendations in 2001 aimed at protecting historic urban settings from deterioration and fragmentation resulting from uncontrolled urban development (Bandarin, 2015). Governments and cultural heritage organisations appreciate the importance of preserving diverse physical cultural heritage through various ways. The question that remains is whether they understand the importance of cultural memory and whether they take account of social identity in their plan in order not to affect the human psyche negatively.

3 THE METHOD

Interactive and comparative methods of research are used to explore the dimensions of the paper. Two-phases of data collection have been employed. The first phase is the literature review on identity, its components and principles and its relation with streetscape design and elements. The second phase are surveys conducted both on-site and online. The on-site survey was aimed at static users; those who have constant contact with the place such as shop owners, vendors and residents, and the online surveys aimed at mobile users; those who are considered visitors and shoppers. The survey questions aimed to identify the importance of the case study in terms of memory and identity, as well as the important physical streetscape features. The qualitative data resulting from the surveys will show the important physical attributes in streetscape design that enhance identity and character.

4 IDENTITY

4.1 Place and Space

The terms "space" and "place" tend to be used interchangeably. However, after being better defined the two terms represent separate concepts, interacting in a dynamic relationship. According to the English Longman Dictionary (2001), place is defined as "any area, place, position or status in space" and "a point, particularly within a wider area". It defines space as "the amount of an area available to be used". Specific to an architectural aspect, spaces are conceived as abstract geometries explained in terms of distance, direction, shape, size, and volume, detached from material form and cultural interpretation (Gieryn, 2000).

According to Edward Relph (1976), in order to change a space to become a place, meanings, individuals, groups, or societies are added. Yi-Fu Tuan, a Chinese-American geographer and philosopher, said "Place is security, space is freedom: we are attached to the one and long for the other". Mumford (1961) wrote of the modern metropolis, that it is a place where individuals "are progressively reduced to a bundle of reflexes, without self-starting autonomous goals". In Proshansky's, "The city and self-identity" he defines place identity as "those dimensions of self that define the individual's personal identity in relation to the physical environment by means of a complex pattern of conscious and unconscious ideas, beliefs, preferences, feelings, values, goals, and behavioural tendencies and skills relevant to this environment". All these views argue along the same axis, that eventually a space is a part of the creation of a place. Space is considered a blank slate that is yet to be coloured with personal experience to add meaning and memory.

4.2 Urban Identity

Identity is a subjective feeling of self-sameness and continuity over time in different places and social situations (Kroger, 2000). Identity implies the distinction from other things and the recognition as a separate entity. It is not in the sense of equality with something else, rather the individuality and oneness. Identity serves as the base for recognition. In parallel, Lynch (1981) also defines identity as "the extent to which a person can recognise or recall a place as being distinct from other places". Goldsteen and Elliot (1994) assert that "the word identity has distinctive advantages in terms of open spaces, streets, and spaces between buildings because it encompasses the notion of a specific location and the unique relationship between the place and its context". Identity in an urban environment is to a greater or lesser degree defined by the environment's elements and activities or events taking place within that environment (Cheshmehzangi and Heath, 2012; Zakariya and Harun, 2013). According to Kevin Lynch (1960), "an environmental image may be analysed into three components: identity, structure, and meaning". These three components work together to present a workable image.

Due to rapid urbanisation, industrialisation, and commoditisation of place, placelessness lies deep in globalisation that generates standardised and inauthentic urban landscapes (Arefi, 1999). In this regard, Relph (1976) describes placelessness as "an environment without significant places and the underlying attitude which does not acknowledge the significance in places". This phenomenon affects the identity of many local urban places. The loss of meaning in a place results in the inability to continue to feel, to practice and to recall experiences (Hull et al., 1994). This loss could be the result of change or transformation of spaces or buildings, or the changes of uses and functions, or other reasons. However, it is eventually resulting in a feeling of detachment, thus weakening the place attachment, therefore; loss of identity. Researchers argue that the incapability of the modernist approach in facing the contemporary issues, including the deterioration of historic or unique streets and spaces, will lead to disintegrated self or group identity (Salama, 2009). Therefore, there needs to be an approach to conceive places contextually and understand the complexities of what gives places their identities.

4.3 Components of place

The concept of place is physical as well as psychological. Theorists, such as Canter (1977), Edward Relph (1976), Montgomery (1998), and Falahat (2006) have stated the three components of place, as shown in Fig. 1. They each classified the components into three categories differing in naming but with the same meaning. The three components are; physical setting, activities, and meaning. The physical setting is the real physical being of the place. It consists of the buildings, landscape, and the aesthetic quality. The physical setting influences the symbolic meaning of the landscape. The activity component is the events that take place in any space that respectively results in the experience of the user. The meaning is the resulted outcome based on the human interaction with the place or the activity. Place attachment is embedded in the feeling, emotion, and behaviour reflected by people from interactions. These three components do not effectively exist individually, but rather the wholeness of their complex interaction helps define the identity and character of a place.

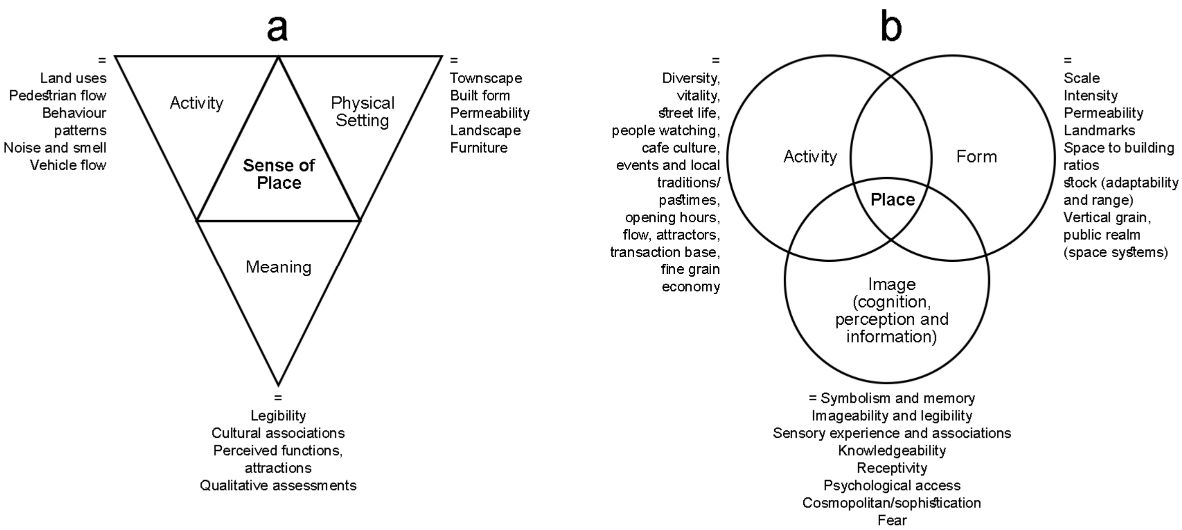

Fig. 1: Components of Place suggested by (a) Punter (1991), and (b) Montgomery (1998), adapted from Carmona et al. (2010)

It is important to note that a place could not be separated from people who invest meanings in them, as stated by Soja (1996) and quoted in Gieryn (2000), "places are also interpreted, narrated, perceived, felt, understood, and imagined". Meeting the biological, mental, and social needs of a human, the physical setting will be the result of a series of perceptions, satisfaction, and finally a sense of place (Falahat, 2006). Places are dynamic and will continue to regenerate as people struggle to adapt to new meanings that might detach them from their culture and identity.

The loss of the sense of place, or the identity of the place, will result in affecting people's perception and attachment to places. It is recommended by researchers that in order to capture the meaning of a place, the physical setting, the activity, and the sense of place should be complementarily taken into account (Agnew and Duncan, 1989). Therefore, it is clear that assessing the significance of people's psychological connections with places eventually results in the assessment of place quality.

4.4 Qualities of Place (Principles of Identity)

The identity of a place is enhanced by five main qualities, or principles, stated by theorists, such as Breakwell (1986), Twigger-Ross and Uzzell (1996) and later added on by Lalli (1992) and Vignoles (2006),

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as shown in Table 1. These qualities are: distinctiveness, continuity, significance, compatibility, and cohesiveness. These qualities can either strengthen or weaken the identity of a place. They are also called principles of identity of place. The purpose of these qualities, or principles, is to show the relation between places and the way people identify with them.

<table>
<tr><th>Theorists</th><th>Qualities of place</th></tr>
<tr><td>Breakwell (1986)</td><td rowspan="2">Distinctiveness
Continuity
Significance (self-esteem)
Compatibility (self-efficacy)</td></tr>
<tr><td>Twigger-Ross and Uzzell (1996)</td></tr>
<tr><td>Lalli (1992)</td><td rowspan="2">Cohesiveness (rootedness)</td></tr>
<tr><td>Vignoles (2006)</td></tr>
</table>

Table 1: Qualities of place according to various theorists (by author)

The first four principles were identified by Breakwell (1986) and later on modified by Twigger-Ross and Uzzell (1996) and Lalli (1992). The first principle, distinctiveness, explains the uniqueness in the relation that a person has with his/her environment distinct from any other relationship. Research by Feldman and Hummon (1990) focused on settlement identity as the distinctiveness associated with being a 'city', 'town', or 'country' person. This distinctiveness associates the lifestyle with the place to create a memory. Lalli (1992) discussed that specific place identification is that "the bond to a particular part of town also contributes to one's differentiation from residents in other town areas". This explains that place identifications can be a great contributor to the distinctiveness principle.

The second principle, continuity, refers to the long-term relationship between people and place created by their life experience over time. There are two types of continuity; place-referent continuity and place-congruent continuity. Place-referent continuity is explained by various theorists as when the place acts as the referent to past selves and actions and that for some people, maintenance of a link with the place provides a sense of continuity to their identity. This is "maintained by fixing aids for memory in the environment ... creating coherence and continuity in one's self-conceptions" (Korpela, 1989). Therefore, place-referent continuity refers to the maintenance of continuity via specific places that have emotional significance. On the other hand, place-congruent continuity differs from place-referent continuity in terms of specificity. It refers to the maintenance of continuity via characteristics of places which are generic and transferable from one place to another. People will choose an environment that manifests the values that they highly esteem and personified of objectified in their objects of identification (Graumann, 1983).

The third principle, significance, also referred to as self-esteem by Twigger-Ross and Uzzell, shows "the positive evaluation identified concerning a person's feeling of worth or social value" (Twigger-Ross and Uzzell, 1996). There is a significant difference between evaluation and the feeling of self-esteem itself. If, for example, a person says "I like the Docklands", this is called evaluation. On the other hand, saying that "living in the Docklands makes me feel good about myself", this is called self-esteem (Twigger-Ross and Uzzell, 1996). There is also a clear evidence of positive self-esteem through association with a prestigious place (Lalli, 1992). The two are related; however, an evaluation may affect the person positively, but not convey the same positiveness on a person's self-esteem.

The forth principle, compatibility, also referred to as self-efficacy by Twigger-Ross and Uzzell, shows that the environment has the capabilities to meet individuals' demands. Self-efficacy is "regarded as high when the individual believes he/she can perform an act or complete a task", as explained by Twigger-Ross and Uzzell. This results in creating a manageable environment where residents can develop a predictive system that allows them to judge whether a setting supports their goals and purposes (Winkel, 1981).

The fifth principle, cohesiveness, also referred to rootedness by Lalli, refers to maintaining a sense of intimacy, homogeneity, and compactness in the built environment. It's also emphasised by the emotional ties or the personal belonging developed by an emotional connections. This principle strengthens attachment which results in reinforcing personal identity of place.

In conclusion, the principles of identity have clarified the meanings and role emotionally salient places have on a person's identity. Thus, suggesting that identity process has a dynamic relationship with the residents' built environment. Breakwell's (1986) identity process theory was designed to examine threats to identity; showing that there is a clear link between identity and the physical environment.

5 STREETSCAPE

Streetscape is a distinct component of street design and it must receive separate planning and design attention. Streetscapes are the three-dimensional outdoor spaces that surround roadways and are outlined by buildings that form the "streetscape skeleton". The overall design of streetscape is affected by various design elements. However, the proportions and scale of streetscape skeletons are significant factors in affecting the comfort and productivity for users (Alexander et al., 1977; Cullen, 1971; Gehl, 2010; Jacobs, 1961).

Enclosure provides streetscape with a sense of spatial identity (Cullen, 1971). Enclosure helps intensify the feeling of negative space, thus the perception of the boundaries and components of the space itself. Enclosed spaces are perceived by users as safe-feeling and memorable, thus; an identity is linked to the space for the user. While enclosure speaks of proportions it does not account for scale. The terms "scale" and "human scale" are commonly used interchangeably. However in urban design literature, there are definitive interpretations of the boundaries of human scale (Alexander et al., 1977). Scale is conveyed by furniture, planters, ornaments, or even by the size of surrounding structures and spaces. Theorists also discuss that scale can be conveyed by the context of speed, given that a wide street may feel more appropriate when cars are in high speed (Ewing and Handy, 2009). On the other hand, human scale refers to the appealing scale for users on foot, or pedestrians. There are several interpretations of specific dimensions and limits of perception and social interaction prescribed by various theorists and authors to specify efficient design guidelines for the ideal feeling of human scale.

5.1 Streetscape Character

The character and design of streetscape are some of the determining factors in the success of highlighting the city's cultural identity (Pegler, 2006). Streetscape character is affected by design guidelines and design elements. That explains the approach of using streetscape as a focal urban aspect in many cities to invigorate places and enhance the sense of place with all the accompanied values and harmonies.

The appearance and relationship between the exterior features of a city and the design elements of the street determine the character (Wibisono, 2001). Streetscape spans from the façades of a building on one side to the other. According to Hartanti (2012), streetscape consists of three layers; vehicular lane, public frontage, and the private frontage, as shown in Fig. 2.

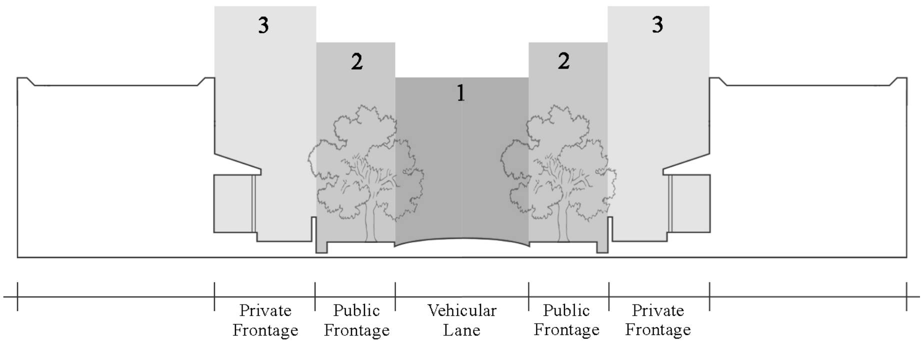

Fig. 2: Layers of streetscape according to Hartanti (2012), adapted by Aurbach (2005)

The private frontage is the privately owned land extending from the building façade to the plot boundary. That space may include arcades, porches, stoops, fences, yards, alleys and in-fill spaces, special activity spaces, and special event spaces. The public frontage is the publicly owned space extending from the private plot boundaries to the edge of the vehicular lane, and it is known as the roadside. That space includes sidewalks or pathways, street corners and curbs extensions, street planters, trees and other vegetation landscaping, and other street furniture as fixtures, seating, and utilities. The vehicular lanes are the spaces extending from curb to curb, or from pavement edges from one side to the other if there are no curbs. This space is used as thoroughfare including travel lanes and parking lanes.

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According to Mansouri and Natsumoto (2009), streetscape composition is divided into two systems; static system and dynamic system. The static system includes the buildings envelope, the street sky, openings, the road, urban furniture, and green infrastructure. The dynamic system includes the mechanical system, which is the vehicles, and the human system, which are people and creatures.

5.2 Streetscape Design Elements

Streetscape design elements - according to the Downtown Development Association of the City of Cheyenne in Wyoming and the Downtown Alliance of the Grand Rapids Neighbourhood in Michigan - are divided into sidewalks, street corners and curb extensions, trees and landscape strips, movable and fixed planters, seating, trash/ash receptacles, public art, screening, fencing, railings and walls, café spaces, special event spaces, alleys and in-fill spaces, fixtures or utility zones, utilities, and lighting. Streetscape design elements can be divided into four main categories: hardscape, softscape, furniture, and external influencers, as shown in Table 2. Buildings and trees may also be called streetscape skeletons, given that they are dominant objects according to their proportion and scale.

Main categories	Sub-categories
Hardscape	Sidewalks (pathways)
	Street corners and curb extensions
Softscape	Trees and landscape strips
	Planters (movable – fixed)
Furniture (fixtures)	Seating
	Trash/ash receptacles
	Signage
	Screening
	Fencing, railing, building façades and walls
	Fixtures and utility zones
	Utilities
	Lighting
External Influencers	Special activity spaces
	Special event spaces
	Alley and in-fill spaces
	Public art

Table 2: Categorization of streetscape design elements (by author)

6 CASE STUDY: ELMANSHEYA SQUARE IN ALEXANDRIA, EGYPT

6.1 Background of Alexandria

Alexandria is the second capital of Egypt and its major port. Due to its strategic location and rich lands, Alexandria has been a jewel amongst the Mediterranean cities. It features a fusion of communities; Greek, Italians, Armenians, Muslims, Christians, and Jews. Given that it is one of the oldest cities in the world, Alexandria holds a rich history and a piece of mystery around every corner. Ever since Muhammed Ali and his family allowed for interactions with foreign colonies, Alexandria has witnessed its own renaissance. During the second half of the 19th century, this renaissance resulted in a city with a unique character.

For the past few decades, due to urbanisation and globalisation, significant rapid change has taken place in Alexandria. The struggle between its symbolic Mediterranean significance, history, urban form, identity, and economic and political agendas and new cultural interventions is causing the historical districts to lose their identity and sense of connection to the past. This change, over time, was clearly uncontrolled, causing deterioration of the existing conditions of heritage spaces as a result of general cultural ignorance, lack of maintenance and regulations, and natural conditions. These factors directly impacted the urban environment and hindered the preservation of its historic part (Getty, 2009). As a result, certain historical features in old streets and urban plazas started to fade away, causing Alexandria to suffer from a loss of identity.

6.2 Background of ElMansheya Square

ElMansheya Square is located in the district of AlGomrok, part of the city centre. Over its history, this area had other names: Place d'Armes, Grand-Place, Place des Consuls, Place Mohamed Ali, and now Midan ElTahrir or "Liberation Square". During the 19th century, ElMansheya Square was considered the commercial centre of Alexandria. The commercial centre later moved eastward to Saad Zaghlul Square, where the Cecil and Metropole hotels are still located.

When the French expedition led by Bonaparte embarked in Alexandria in 1798, the area of ElMansheya was an open field. The military maps of this period mark an undefined open space as an "Esplanade", also known as a promenade (Awad, 1996). In 1814, the site was described by the British traveller Bramsen: "The large square near the sea is spacious; it has been improved and covered with gravel by the Europeans who came here to breathe the sea breezes". This confirms with Captain W. H. Smith's map of 1833 indicating the space as "parade gravée". During the second half of the 19th century, Ali Pasha Mubarak, an Egyptian public works and education minister, described the area as partly open vacant land, used by Bedouins. It was also called "Kom ElHallah" (Awad, 1996).

The square appears fully developed in Charles Muller's map of 1855, as shown in Fig. 3 to the left. The new Place des Consuls was developed by Mancini, who also designed most of the buildings surrounding the square. The surrounding rectangular buildings are three or four stories high residential buildings of an Italian-oriental aspect, similar to those of Italian cities such as the port of Trieste in the mid-18th century Austro-Hungarian Empire.

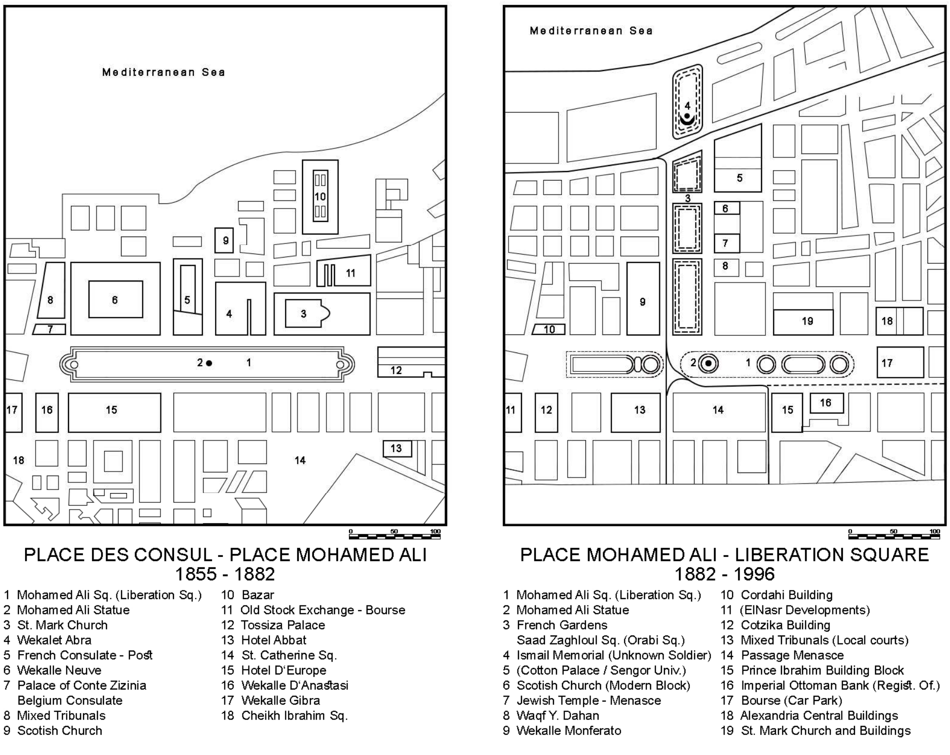

Fig. 3: Place Des Consul (left) by Charles Muller, and Place Mohamed Ali (right) by Mancini, adapted by Awad (1996)

6.3 French and Italian Influences

The Palace of M. Tossiza, the Greek Consul, was designed by Macini. It stood majestically on the Eastern location of the square, along with the elegant Palais of Count Zizinia, Belgium's acting Consul. The Place Des Consuls was dominated by commercial and business activities. They ranged from numerous large wakalas, which are buildings famous during the Islamic period that housed merchants and their goods serving as a centre for trade, storage and transactions, such as Gibra, D'Anastasi, and Neuve, with ground floors reserved for commercial enterprises and public services and the upper floors reserved for offices and residential use.

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In John Murray's "Handbook for Travellers in Egypt" in 1880, he mentioned that among these commercial enterprises were David Robertson and Co. Booksellers, Rocheman Jewellers, Boret the hairdresser, and photographers as Fiorillo, and general outfitters like Cordier. Also there were numerous cafés; such as the glamourous Le Café de France No27, hotels; such as Hotel d'Europe, and restaurants. Other businesses included insurance companies; such as Peel & Co., the Lebon Gas Co., and the Italian postal services and banks like the Anglo-Egyptian Banks.

The most noted building on the square was the French Consulate. Its gardens were open to the public on weekends and special occasions. In 1866, La Bourse building, for stock exchange, was created. The Tossiza Palace was used to house the new stock exchange building.

Some of the religious buildings included the Anglican church of Saint Mark, and located near the square were the Scottish church, the German and French Protestants, the Roman Catholic, the Greek Orthodox, the Maronite and Armenian churches, and ElCheikh Ibrahim mosque. The presence of Muslim, Coptic, and Jewish places of worship in proximity to one another affirms the multi-ethnic composition of the cosmopolitan city of Alexandria.

During the ruling of Khedive Ismail, a statue of Mohamed Ali was designed by the French sculptor, Jacquemart. The equestrian statue of the city's modern founder with its white carrara marble base, later designed by French architect Ambroise Baudry 1871-1873, stood as a landmark in the Mohamed Ali Square.

Place Mohamed Ali was targeted and destroyed by the bombardment of July 11th, 1882. Only two buildings survived of the destroyed square, namely the stock exchange and the Saint Mark church. A military tribunal was set up in front of the Tossiza Palace, called the Ismail Memorial or the "Unknown Soldier".

The rapid post-1882 development and government compensations resulted in a climate of political stability, sustained economic growth, and administrative reorganisation. A small group of notable family names controlled most financial activities in the city. These agents and bankers, who have become real estate promoters and main shareholders of development companies, were responsible for the development of a great part of ElMansheya, rue Sherif Pasha, and buildings on rue Rosette. They also created the Municipality of Alexandria in 1890, thus controlling the city's fate. This gave them the opportunity to further promote the European character of the city.

At the beginning of the 20th century, the Europeanisation of the urban morphology continued, creating a new urban space, La Place des Jardins Français in 1909. The Place des Jardins Français was enhanced by the elegant new French consulate in 1909 designed by the French Bureau of Public Works and led by the French architect Victor Erlanger. French influences seemed to have inspired the area and complemented the French garden landscape (Awad, 1996). The gardens were in the French style characterised by an ordered and symmetrical geometric plan. The French influence continued during the Post World War I period, and due to the increase in the price of cotton, Egyptian economy prospered and enriched the city's merchants.

In the 1960s, the gardens were completely removed and replaced by a bus station, making it one of the most crowded areas of the city. Then in the 1980s, a new plan was generated and the station was removed, turning it once more into a public square. However, the new design wasn't the original French Gardens, as shown in Fig. 4.

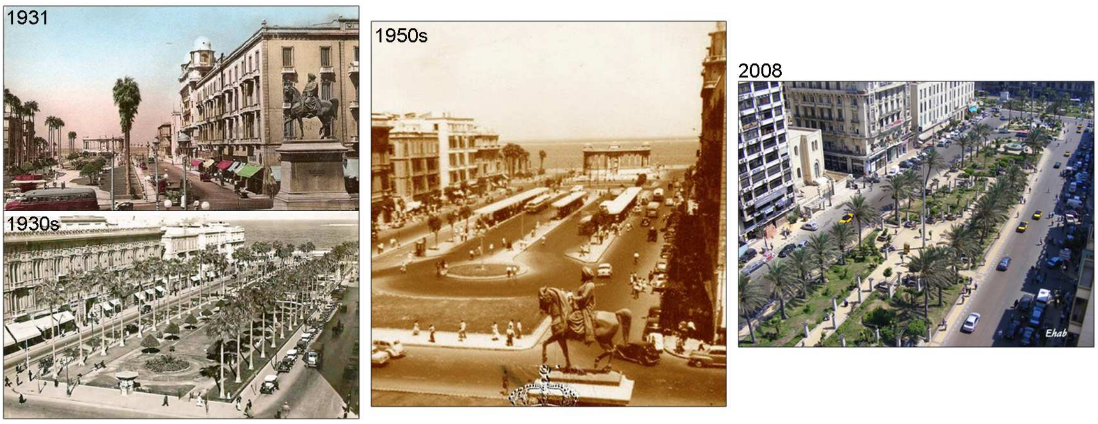

Fig. 4: Four photos of Oraby Square during different historic times showing different plans of the square. (a) French Gardens in the 1930s, (b) Tram and bus station in the 1950s, and (c) Current state of Oraby Square in 2008, all adapted by F. Hussein (2020)

6.4 Current state

The urban character of ElMansheya Square is continuing to degenerate due to various factors. The main reasons of such degradation were the lack of maintenance and lack of strict regulations and application of such regulations on the state's behalf. The degraded of the urban environment is very clear by observation, given the current state of the buildings, the crumbling sidewalks, and flooring of the passages. Demographic pressure has led to overcrowding in public spaces. Traffic chaos and the presence of street vendors occupying every available inch of pavements in a poor state are a consequence of mismanagement and the decline of the state's role in the conservation of the built environment and the organisation of urban space.

The current state of ElMansheya Square decreases the possibilities that the square could hold as an open public urban space. The unique design of the gardens, the statue of Mohamed Ali and the Unknown Soldier as landmarks, the skeleton of the heritage building façades, and the timeless importance of the area, all provide social, economic and environmental values that could generally enhance the quality of life of the inhabitants of the area, as well as providing stable, secure and profitable revenue capable of sustaining their future and the future of the square.

7 PUBLIC PARTICIPATION

Kevin Lynch (1960) developed the concept of imageability, which is the ability of urban elements to evoke a strong image for an observer. As cities grow, planners and designers strive to improve liveability in the built environment, thus improving the quality of life. There must be an accurate framework that contributes to quality streetscape. One of the effective methods to ensure quality streetscape is taking public opinion into consideration. Public participation can present variables that help develop an urban space or a liveable street better to carry out the intended activities and create memory as well.

Traditional surveys and hand-out questionnaires may have some spatial scale limitations leading to lack of precision and measurement inaccuracies. However, given the developed web-based strategies to record crowd-sourced perceptions, more precise and spatially extended measurements are available. Therefore, surveys have become an indispensable tool for collecting data. The survey questions aim to identify the importance of the case study in terms of memory and identity, as well as the important streetscape elements with the highest influence.

7.1 Survey

The surveys conducted in this case study were both on-site and online. The on-site survey was aimed at the static users; those who have constant contact with the place, such as shop owners, vendors, and residents. The online survey was aimed at the mobile users; those who are considered visitors and shoppers. Interviewees were told a brief introduction about the qualities of place and the main four categories of streetscape elements. It was also explained to them the main effects of streetscape elements on the qualities of place, and vice versa. The architectural and urban design principles were briefly shown to interviewees through different examples in the city of Alexandria, as to further show the streetscape elements surrounding any user. The qualitative data resulted from the survey will show the important design attributes in streetscape design that enhance identity and character.

The survey sample was calculated according population. According to demographic statistics from the Central Agency for Public Mobilisation and Statistics (CAPMAS) (City Population, 2021), the population of ElMansheya is estimated to be 24,087 covering an area of 0.6523 km2. In order to conduct the survey, a sample of about 300 interviewees was targeted, allowing a margin of error of 5%. Therefore, the required number of interviewees is estimated to be around 1200 interviewees to achieve an estimated response rate of 30%.

The survey questions aimed to explore the memories, emotions, and experiences between the interviewees and the case study. The survey was divided into three parts. The first part consisted of general questions about gender, age, reasons of visiting ElMansheya Square, duration of time spent on site, and the frequency of visits. The second part addressed the local identity of ElMansheya in terms of the existing memories of visitors and inhabitants and the ranking of the qualities of place. The third part consisted of likert questions that investigated the level of agreement of the interviewee with the streetscape elements of the site and the ranking of the important physical features that could enhance the identity and character of the site.

7.2 Survey Results

As a result of the nature of ElMansheya Square, being a commercial centre for downtown Alexandria, and the wide variety of products available, shopping was expected to be the main reason for visiting ElMansheya Square. Also, given the fact that a garden exists, it was expected that a fair number would visit ElMansheya Square for leisure purposes as well, such as jogging, walking and just enjoying the gardens. However, this purpose was presented in only 22% of the interviewees. About 20% visited ElMansheya Square on a regular basis a few times a month. Only 13% visited the gardens daily, and it is expected that the majority of this percentage were workers in the site. A vast 52% of participants visited ElMansheya Square and spent hours there. Given the fact that the most important reason of visiting was for shopping, then it is expected that the hours were spent in the shops and the commercial centres rather than in the gardens themselves.

A vast majority of 57% agreed that the Square was not linked to any personal memories and that was mainly because of the result of the current state of the Square. Many participants agreed that if the Square was in a better state, then maybe it would have been linked with memories and the possibility of future memories as well. This shows the strong relation between the physical aspects of the place and the memories it shares with participants.

Concerning safety and comfort, approximately 57% agreed that they do not feel safe and comfortable in ElMansheya Square as opposed to the 43% who did. The main reason that explained this reading was the lack of security members and the constant presence of homeless people and street vendors. Also, a major factor that contributed to this percentage was the lack of proper maintenance of lighting fixtures for a well-lit safe garden space.

About 62% agreed that ElMansheya Square had a unique identity. This high percentage proves that the Square already has potential to stand out and just needed some tweaking. The potential and scope of improvement expanded when the participants acknowledged the unique identity and special character that ElMansheya Square had.

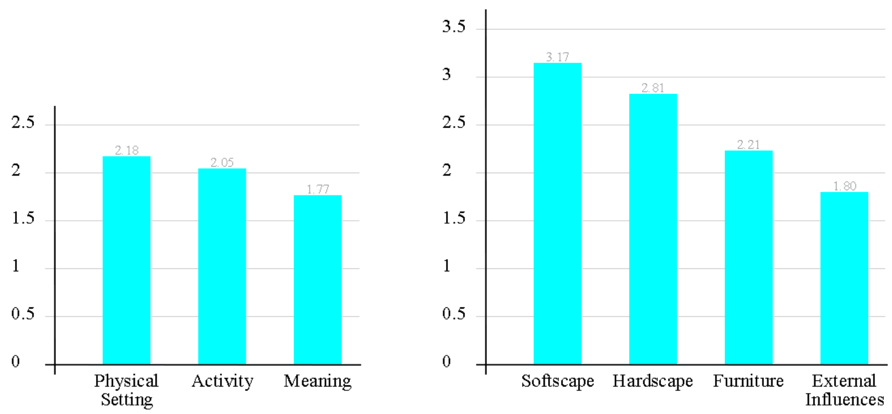

Fig. 5: Scores for the ranking of "Qualities of Place" left and "Elements of Streetscape" right, (by author)

When given the chance to arrange the qualities of place, participants agreed that the main quality was Physical Setting ranking first with a score of 2.18, followed by Activity and Meaning with respectively, as shown in Fig.5 to the left. This reading shows the strong impact of the Physical Setting on a space. It also shows that the possibilities behind a well-prepared and maintained setting are vast and encourage a large scope of improvements.

Also the most important element in streetscape composition was the Softscape elements ranking first with a score of 3.17, followed by Hardscape, Furniture elements, and External Influences respectively, as shown in Fig.5 to the right. Many participants agreed that the softscape features, most significantly tree canopies and grass cover, made a strong impact on the sense of comfort of the space. Another important aspect was that the greenery increased the feeling of "fresh air" and canopies and hedges somehow acted as a buffer from the vehicular lanes surrounding the gardens. Various older participants asked that facilities for elderly and handicapped users should be added, such as ramps, benches, and properly paved walkways.

Another important reading was the 71% that agreed that ElMansheya Square was properly used as an open space. This compliments the 57% that agree that the gardens encourage a wide range of activities, but only if well-prepared and constantly maintained. Along the survey, several participants noted the same things to be changed in ElMansheya Square in order for them to feel more of a sense of belonging to the space. Various participants asked for more security presence, pedestrian streets surrounding the gardens from specific sides, designated shops for current street vendors, and the total absence of homeless people and beggars. Other aspects consisted of suggestions such as no fencing for the gardens' perimeter; however hedges were a preference, better pavements and ramps, constant maintenance of furniture elements, cleanliness of gardens, and increasing lighting fixtures.

In this context, related institutions must analyse public open spaces in the city from a participatory perspective to develop the three qualities of place. The improvement strategies suggested should be based on a combined approach of urban design principles and heritage conservation laws. This will provide for a more balanced way to provide a strong future basis for user-and-urban-oriented design decisions, with respect to the historic importance of the site and its envelope.

8 CONCLUSION

The findings in this paper indicate that application of streetscape elements composition requires a deep understanding of various factors, such as the urban context, existing environment, socio-economic, community, and cultural conditions, and the historic background. The community character and identity is strongly related to the values and traditions of a community and needs to be celebrated through elements and layers of streetscape, along with the overall imageability. Streetscape composition should focus on the main intervention tools that enhance identity and character. The introduction of theoretical guidelines to develop and revitalise historic spaces is crucial. Intervention tools can vary from removing unsympathetic elements and activities to completely redesigning a space with the surrounding envelope. The extent of each interventional decision taken is based on its importance and effectiveness.

However, all intervention methods were highly recommended in ElMansheya Square to better enhance the gardens in terms of identity and character. This will eventually result in a proper urban space that acts as the lung for the neighbourhood and probably surrounding ones, as well as an attraction point for tourists and outsiders given the historic importance of such an amazing site.

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Exploring 4IR Technologies as a Solution to Improve the Traffic Flow on the Roads: a Case of the City of Johannesburg

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1 ABSTRACT

Globally, countries are challenged with traffic congestion and many solutions have been done to encounter this challenge. Many developed countries have managed to deal with the challenges of the traffic congestion through the implemented strategies by each country with challenge. This paper is set to study the drivers of the traffic congestion which results to numerous negative impacts and address the environmental and socio-economic challenges created by high usage of private vehicles in the City of Johannesburg, South Africa. Further, the authors consider solutions to reduce traffic congestions through the assistance of the 4IR technologies. The methods selected on this study follow both quantitative and quantitative approach using different graphs for traffic analysis illustrating the traffic data, and the use of ArcGIS software will be deployed to create a map indicating roads with high volumes of traffic. The preliminary results indicated that many private vehicles on the roads have a greater contribution in traffic congestion especially when accidents happen, rotational load shedding in the city, different peak hours of the day which this has a negative impact on the economy as it reduces the productivity of the city. The implications of the study indicate that the usage of private vehicles is more reliable than the use of public transport which results to high traffic congestion volume during different intervals and there are less technological efforts deployed to reduce the ever-rising challenge of traffic. However, the study recommends the adaptive traffic signals, real-time traffic monitoring, smart corridors, and pedestrian tracking systems with advanced V2I technologies. With this, there are possibilities of reducing the traffic congestion in the City of Johannesburg.

Keywords: Traffic congestion, 4IR, City of Johannesburg, private vehicles

2 INTRODUCTION

Globally, countries are challenged with traffic congestion and many solutions have been done to encounter this challenge. Many developed countries have managed to deal with the challenges of the traffic congestion through the implemented strategies by each country with challenge. The Republic of South Africa is a developing country with urbarnazation taking places daily, people moving from rural areas and other countries to cities for better opportunities. The City of Johannesburg Metropolitan Municipality which is located in the Gauteng province (state) contributes a lot to the economy of the country and afford a lot of opportunities to both its citizens and people from other countries. This leads to population growth, the infrastructure to service the city becomes overwelmed and different challenges arise which needs soution at some point. The movement on the roads becomes too much at points leading to traffic congestion and this is a global challenge when a city is too populated. Operations of the city becomes very slow as people spent time in traffic jam resulting to the affect in the economy and other importance services. Therefore, need for viable solutions that are used by the developed cities such as making the City of Johannesburg to be intelligent. An intelligent city uses the information to make their cities more livable, sustainable, and enjoyable compared to traditional towns. While smart cities are the future of urban landscapes, every piece of technology in a network needs to work together flawlessly so that community leaders can implement strategies to accomplish their goals (Giarratana, 2019).With the adoption of the fourth industrial technologies in the city, this could control the traffic jamming and make the city to more effecient, and resulting to a productive economy.

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3 LITERATURE REVIEW

3.1 Modes of transportation on the roads

Transportation is the physical movement of passengers and goods from geographical location to another to enhance their utility (Akintayo, 2010). There are different kinds of transportation on roads which entail public and private transportation. These modes includes bus, minibus taxis, motor vehicles and motorbikes. All these modes of transportation use the roads at once and there are no designated times to use the roads. These leads to roads being flooded during the certain peak hours, in the morning, midday and early in the evening. Further, road transportation has average operational flexibility as vehicles can serve several purposes but can rarely operate outside roads. Road transport systems have high maintenance costs, both for the vehicles and infrastructures, which are related to low life spans. They are mainly linked to light industries and freight distribution, where rapid movements of freight in small batches are the norm (Rodrigue, 2020) .

3.2 Road Traffic congestion

Traffic congestion is a worldwild challenge created by many factors including urbanization, avoiding use of urban public transport, many private motor vehicles on the road, not many option of origin to destination roads, multi-functional traffic robots, non-proper manual systems and more technological systems deployed. As different road users form different locations moves towards the city at certain periods or intervals road become congested and the movement becomes very slow. Consequently, Giarratana (2019), states that congested roadways wreck havoc on the economy and culture of urban areas. Traffic causes significant problems for every aspect of a city, from the motorists that travel on public roads the roadways to the organizations that operate within cities to the residents that call them home. Some of the major complications that are directly linked to traffic include accidents, air pollution, noise pollution, reduced emergency assistance and reduced productivity. Accordingly, traffic congestion is a significant problem in many cities around the world. Jakarta, one of the most populous cities, faces this problem. However, there is different approach implemented to reduce the traffic jamming in the city such as strict policies and legislative frameworks on travelling patterns for road users, congestion charging and parking pricing reduce traffic congestion most if they are implemented for car based travel (Ilahi et al., 2020)

3.3 Fourth Industrial Revolution technologies (4IR) deployed for traffic control

The use of technology has ease down the pressure that canno be dealt with manually by people. According to McGinnis (2020), states that the Fourth Industrial Revolution is a way of describing the blurring of boundaries between the physical, digital, and biological worlds. It’s a fusion of advances in artificial intelligence (AI), robotics, the Internet of Things (IoT), 3D printing, genetic engineering, quantum computing, and other technologies. It’s the collective force behind many products and services that are fast becoming indispensable to modern life. Think GPS systems that suggest the fastest route to a destination, voice-activated virtual assistants such as Apple’s Siri, personalized Netflix recommendations, and Facebook’s ability to recognize your face and tag you in a friend’s photo.

4IR technology has a positive in traffic control. Artificial Intelligence (AI), for example, can improve urban planning by optimising routes for transport operators, reducing commuters' journey times particularly significant move given our urban layout. Municipal governments could utilise traffic data for the planning of roads and the monitoring of traffic patterns. This has already been successfully piloted in cities in the United States as the use of an AI system which detects vehicles in images from traffic cameras, the information is sent to a control centre, where algorithms analyse traffic density. The system detects congestion and direct traffic lights to re-route traffic, based on real-time data (Marwala, 2020).

The 4IR introduces technologies such as smart roads. Smart roads are roads that think, feel, predict the needs of the people and the vehicles that travels on them. Roads that have an environmental conscience help cause positive changes on the vehicles and improve overall safety with the aim of making difference to the world (Emilee, 2016). Consequntly, Adetayo (2017) mentions that smart-roads are also a form of stylized road infrastructures that communicate with vehicles, users, and components of traffic management to enhance safe, reliable, comfort, efficient, affordable, and digitilized means of transportation. The typical smart-road will be more animated than the conventional, it will come with sensors, data capture capabilities, ability to respond to changes in the environment and will be able to communicate with the vehicles.

4 STUDY AREA

The city of Johannesburg is located in the Gauteng province, and it is been regarded as one of the biggest metropolitan areas in South Africa, (The local government handbook, 2014). City of Johannesburg (COJ) covers an extent area of 1.645 square kilometers, (Smith, 2013). In the past decades the administration of the City of Johannesburg Metropolitan Municipality was decentralized initially into 11 regions these new regions were subsequently reduced in number to 7 regions (A-G) in 2006 (Smith, 2013).

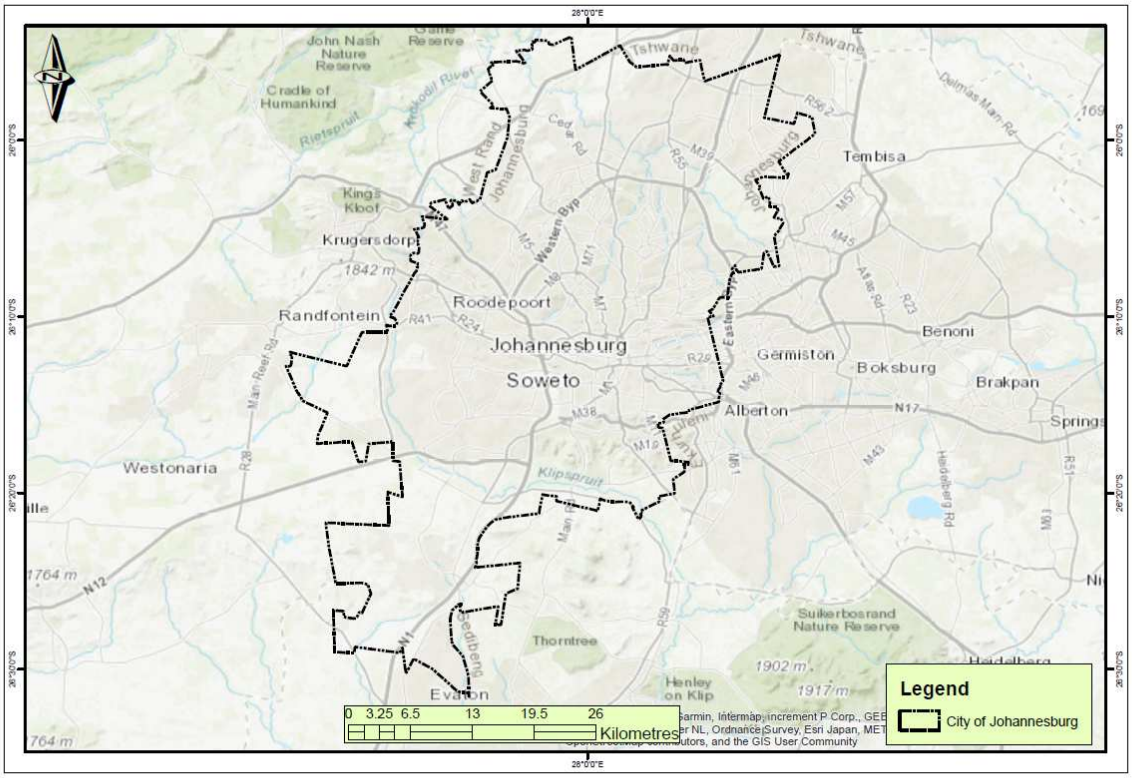

Figure 1: COJ Map [Source: Authors, 2021]

According to (SAIRR, 2014) South Africa's large population lives in urban areas, as an aftermath of urbanization over past years. High economic development in such urban areas has also attracted people to cities looking for better opportunities.

5 METHODOLOGY

A mixed method research design was adopted were quantitative data and spatial data analysis was used. Various research instruments were employed in the study such as Tomtom traffic index which provide accurate traffic information in real-time and statistics of previous information . This assisted to give the inside of the study to identify the traffic flow that happens, daily, monthly and yearly. Accordingly, a survey was conducted were road users were provided with questionnaire to understand the road patterns and what causes traffic congestin mostly. 30 road users who were provided with questionnaire are daily road users as they might have different experiences taking place daily. Purposive sampling was adopted as it is necessary to extract the necessary information of areas and times that are mostly affected by the traffic congestion. ArcGIS assisted with creating the City of Johannesburg map showing most roads that are affected by traffic jamming towards and out of the city. Map creation indicating the most areas affected by traffic, statistics from Tomtom and documented studies were the main sources of data. Comparative analysis was conducted in order to see the changes on traffic when the city was affected by the COVID 19 pandemic especially in 2020 and in 2021 when restrictions were eased down and there was lot of movement on the roads daily, and to identify the fourth industrial technologies deployed in the developed cities managing to control the traffic congestion. Further, content analysis was employed to review previous documented studies. Secondary information used was obtained from larger data base such as Scopus, Science direct, Sage and Google scholar.

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6 RESULTS AND ANALYSIS

6.1 Roads affected by traffic congestion in the COJ

The City of Johannesburg (COJ) is one of the busiest areas in the republic which makes the movement on the road busy and mostly leading to high level of traffic congestion. There are several factors that leads to traffic congestion in the COJ such accidents, multi-funtional traffic robots especially when there is load-shedding (no electricity power), traffic officers normal routine of ensuring non-corruption activitties are taking place, the huge population number of people travelling towards the city creates traffic congestion. Which becomes a very huge concerns for all users travelling times to places of interest and affecting the productivity of individuals impacting the economy negativily.

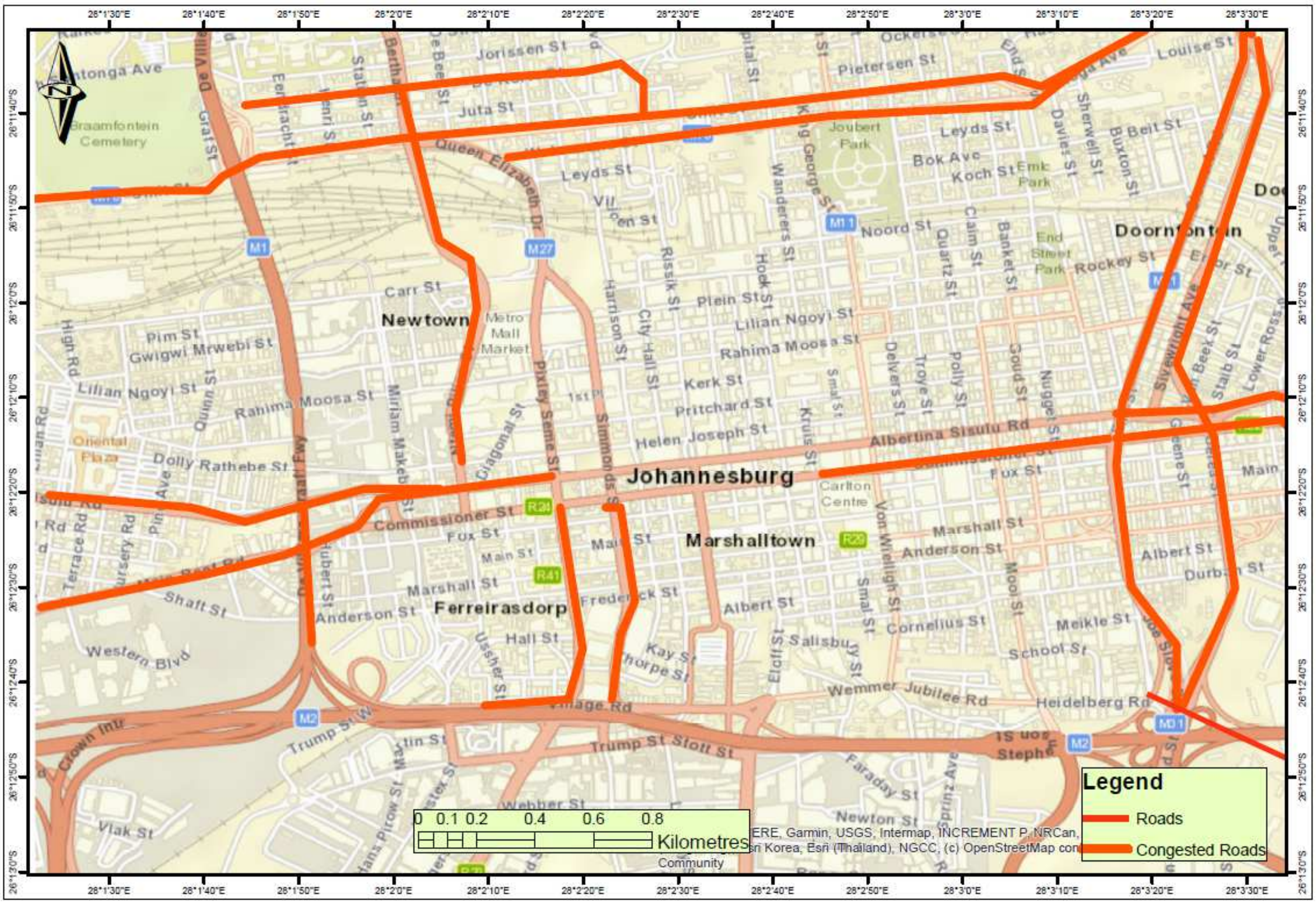

Figure 2: COJ traffic congestion Map [Source: TomTom, 2021]

The above figure 3 indicates the City of Johannesburg road network and the roads that are mostly congested. Roads that that highly congested are represented by the orange colour and mostly used major roads in the city are represented by the red colour. The main reef road and Albertina Sisulu road from the west of the map, mostly during peak hours have a high traffic congestion normally when road users are going to work in the morning and during midday towards the city. Consequently, the same amount of traffic congestion is noticed during later in the day and early evening when road users travel back home from different places of interest. De Korte street and Smith street from the north of map is mostly congested during the midaday as this roads service the Braamfontein area which serves as a CBD providing major economical services and also in the early evening when road users travel back home. Sivewright Avenue and M31, noticable is affected by high level of traffic congestion in the early evening from the Doornfontein area as most road users use the road to connect to the M2 and M31 which are the major roads serving travellers different urban areas of the city of johannesburg metropolitan area.

6.2 Congestion levels in the City of Johannesburg

The level of traffic congestion differ by months which this is sometime caused by different activities that take place daily.

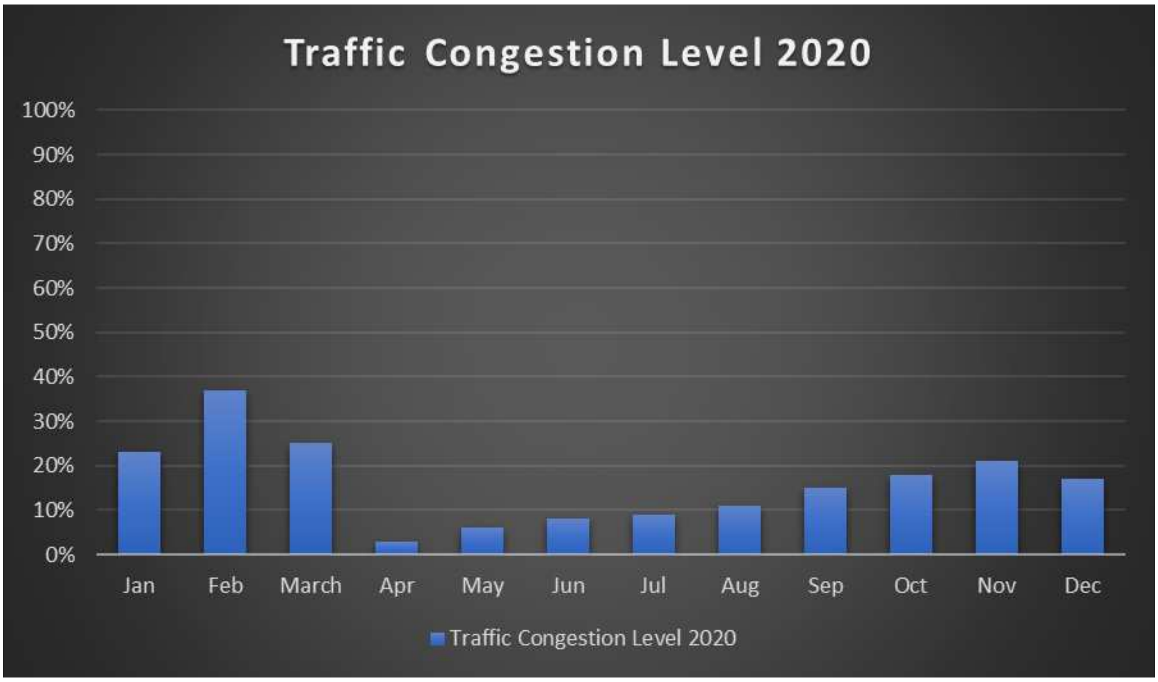

Figure 3: Traffic congestion level 2020 [Source: TomTom, 2021]

In the year 2020 traffic congestion in the early months of the year was high due to the normal state of the cities functionality and in the middle of the year traffic congestion dropped. This was due to the global pandemic that hit the country and the restrictons were put in place as the coutry was shutdown to a lockdown strictly movement was implemented and monitoring. Travelling was not permitted and only allowed due to certain conditions. During the first month of the year, January had average of around 25% percent as some of the workers and users of the road had to start travelling making daily trips. In February, the rest of the firm and institutions re-open, workers and users of the road also had to start travelling making daily trips which made the rate of traffic congestion to go up by 13%. In March, there was a reduction in traffic congestion as the pandemic was in the country, with announcement of awareness for travelling, travelling to certating areas of interest by the road users decreased by 11%. Consequently, in April, the traffic congestion dropped immesely to 3% as in late much the country was shutdown to lock down and only a certain percentage of movement was existing. Further, in the middle to later on year the restrictions were being eased to open some areas of economy from around late May to Novemember which is why the graph is scaling up from May to Novemebr. Further, in December, as it was the festive season, restrictions were lifted to combat the pandemic and the movement was restricted a bit and other operations in the city went on break due to festive, therefore, the traffic congestion reduced by 3%.

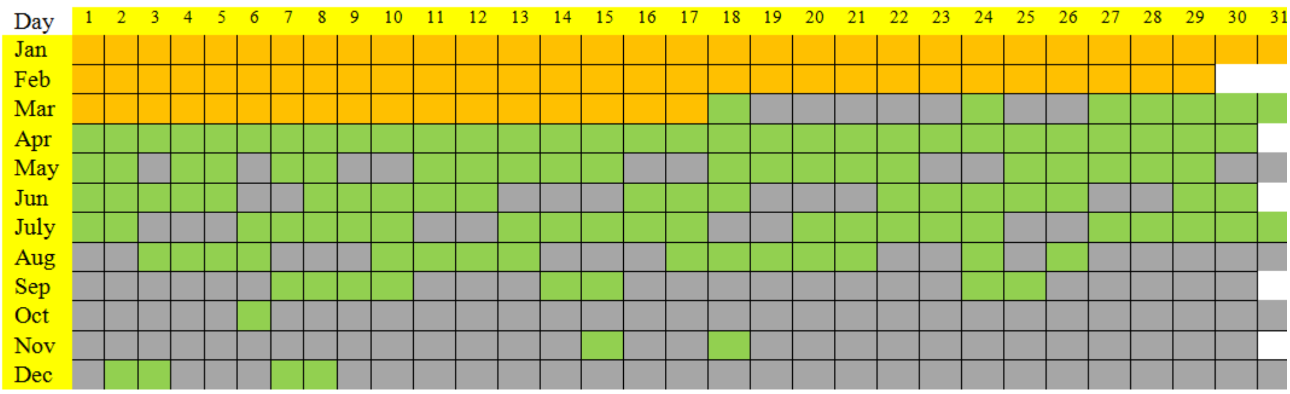

Figure 4: COJ Days with traffic flow [Source: TomTom, 2021]

The above figure 4 indicates the days with and without traffic congestion in the City of Johannesburg from January to December 2020. The Orange colour indicates the day with high level congestion at peak hours of the day. The green colour indicates days wereby there was less traffic congestion and the grey areas indicates the day with average traffic congestion and affected by the pandemic restrictions. As seen on the above table from January to the middle of March the daily traffic congestion was high and later on the month the traffic

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eased down due to travelling restrictions introduced to the country. As it can be noted the pandemic had an major effect on travelling in the year 2020 as from April the high level of congestion were eased down.

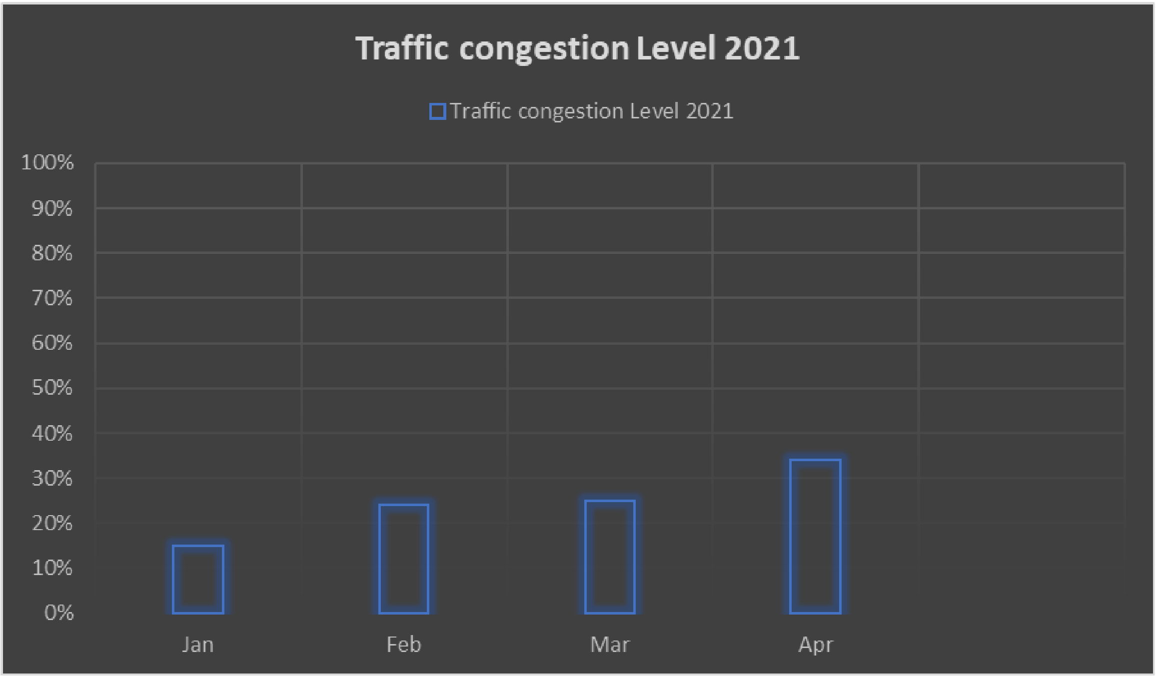

Figure 5: COJ Traffic congestion level 2021 [Source: TomTom, 2021]

In 2021, the restrictions were eased down due solutions were identify to combat the pandemic and most operations were operating but must converted to take places from home than office and lot of online working was happening. The traffic congestion in 2020 early in the year compared to 2021 was slightly more less the same in January and February but in 2021was a bit lesser. In March and April 2021 traffic congestion was very high as more economic activities were opened and more daily trips by users of the road were taken.

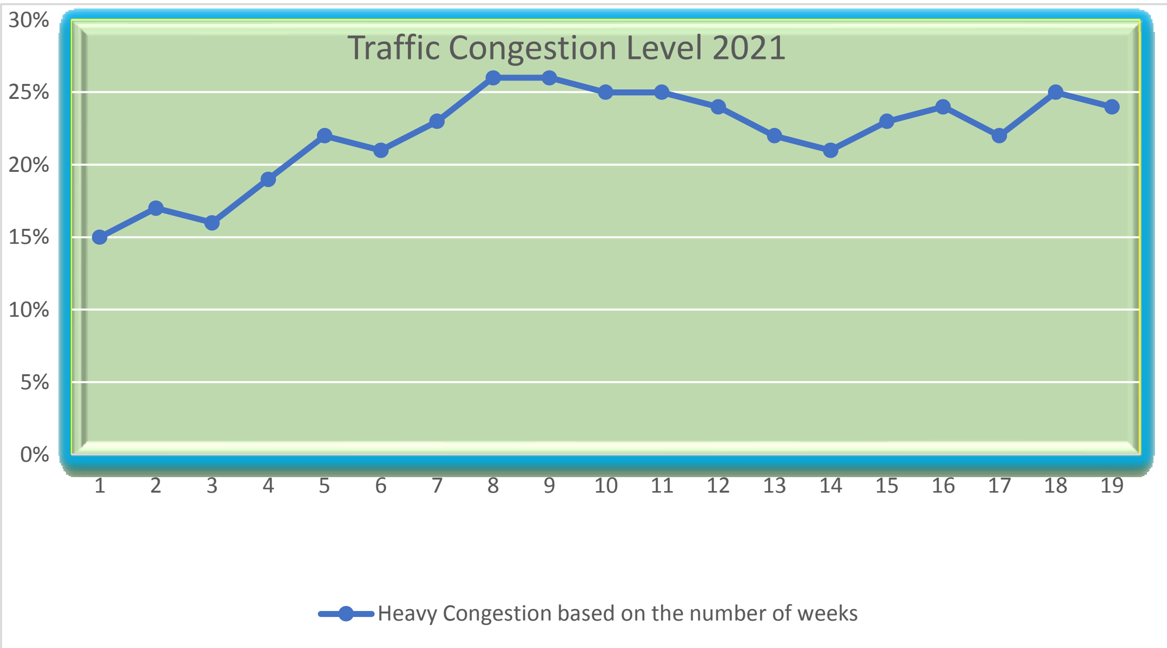

Figure 6: Weekly congestion level 2021 [Source: TomTom, 2021]

The above figure 5 indicates the level of traffic congestion in the City of Johannesburg from the first week of January to the second week of May. The above indicates that traffic congestion level in the first week of January to the fourth week the traffic congestion was between 15% to 20% as some of the operations in the city were still not open and due to working from home. In the first week of February to the last week of

February the level of congestion was going high and in the last week of February had the high level of traffic congestion due to the economy opening up. In the weeks of March and April the level of traffic congestion were declining due to some restriction in the country and holidays inbetween resulting in less travelling. However, the level of travel congestion was high at peak hours of the day.

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12:00 AM	1%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%
2:00 AM	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%
4:00 AM	0%	0%	0%	0%	0%	0%	0%
	0%	1%	2%	2%	1%	1%	0%
6:00 AM	1%	30%	29%	28%	28%	27%	3%
	3%	48%	45%	45%	43%	42%	6%
8:00 AM	5%	34%	31%	31%	29%	29%	9%
	7%	18%	18%	18%	18%	19%	12%
10:00 AM	8%	15%	16%	16%	16%	18%	15%
	10%	16%	17%	17%	17%	19%	17%
12:00 PM	10%	17%	18%	18%	19%	23%	18%
	8%	18%	18%	19%	19%	26%	17%
14:00 PM	7%	18%	19%	19%	20	28	14%
	7%	23%	24%	24%	24%	34%	11%
16:00 PM	7%	38%	38%	38%	38%	43%	10%
	8%	42%	41%	40%	40%	37%	9%
18:00 PM	8%	22%	21%	21%	22%	24%	10%
	9%	11%	10%	11%	11%	16%	11%
20:00 PM	5%	5%	6%	6%	7%	9%	9%

Figure 7: COJ rush hour [Source: Authors, 2021]

The above figure 7 indicates the rush hour times in the City of Johannesburg wereby traffic congestion take place. As indicated in the above figure, it can be noticed that most days with high trafic congestions are Mondays to Fridays during 6:00 am in the morning to 8:00 am in the morning whereby most of the users are travelling to work and other city operations, and from 16:00pm to 18:00pm when most of the road users are travelling back home. With the introduction of the fourth industrial technologies, it will be workable to bring a solution when knowing when is the traffic congestion challenge is at its highest and how it can be combated.

7 CONCLUSION

Not only can traffic make the most patient people frantic, but traffic can also have a significant drag on the economy. A trip that should take no longer than 20 minutes can turn into several grueling hours, which caused by bumper-to-bumper traffic. Traffic congestion is the result of cities having more drivers than in the past with outdated maintenance, planning, and infrastructure that is not able to handle the needs of public roads (Giarratana 2019). While not often thought of in this way, traffic congestion is becoming a national crisis and needs to be addressed by city planners using advanced technology to help alleviate stress on public road infrastructure. City of Johannesburg must handle millions of drivers on the road at once. The city feels the stress of drivers battling traffic daily. Having a hundred of thousand of drivers stuck in traffic can waste a lot of potential hours and millions of Rands on the economy. Therefore, there is a need to deploy the 4IR technologies to control the traffic congestion and ease down the pressure on the roads daily for swift and smooth movement. Traffic will continue to plague cities as more drivers hit the roads each year, and city engineers will need to look to cutting-edge technology to help the public have a healthier and happier life. Therefore, urban planners, policy and legislative framework makers need to find the right balance that our public spaces need to build a better future for our growing urban centres. The, city has no some sort of alternatives of controlling traffic congestion, the traffic jamming continues till the traffic flows. The traffic signal robots has proved that they are not enough to control the traffic jamming in the city, however, the situation becomes worse when there is no electricity for the robots to operates. Which this calls for more technological innovations that could assist the traffic officers to keep traffic flowing the roads.

8 RECOMMENDATIONS

Traffic congestion is not a new phenomenon, howerever, there are strategies that are being impleted globally through the use of technology to this challenge. The study recommends the use of adaptive traffic signals which allows cities to gain better insight about traffic, including the flow and the length of time cars idle at lights and The information can then be used to modify the timing of traffic signals so that they coincide with traffic patterns during the day, real-time traffic monitoring as this technology illustrates where public buses, taxis, and other modes of transit are located, it shows where parking spaces are available and so on, and smart corridors which this make sections of roads feature technologies that alert drivers of the upcoming traffic conditions, including any accidents that lie ahead, how long it will take them to reach a particular destination, impending weather events, and other obstacles that could impact driving (Giarratana, 2019). Smart corridors keep motorists “in the know” so that they can plan ahead, which in turn can help to ease traffic.

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Finding Suitable Measures for Mobility Behaviour Change

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1 ABSTRACT

This paper presents a decision support tool for public authorities and planning experts developed within the scope of the transnational project SaMBA, which focuses on reward and pricing policies to induce changes in the mobility behaviour of citizens. The tool presents incentive-based measures to promote low carbon mobility and raise awareness of the value of behaviour change policies as a foundation of strategic planning. Based on a user-defined goal and characteristics of the target area with influence on mobility or mobility behaviour, a list of recommended measures including details regarding implementation and impacts derived from best practices is provided. The tool is implemented with Microsoft Excel, which allows access for a wide audience, and ArcGIS, which provides additional analysis and visualisation options for users with GIS experience. The goal was to develop an extendable planning tool, which can be used as a foundation of the identification of potential measures and action areas.

Keywords: Sustainability, Incentives, Decision support, Behaviour change, Mobility

2 INTRODUCTION

An important topic and enormous challenge in the field of urban growth is the future of mobility. Urgent problems in this regard still are the high modal split and the energy demand of the private car, which are related to several issues including congestion, pollution or noise. Although motors have become more energy-efficient, the energy demand has increased due to the higher weight and the higher motor power of modern cars. Furthermore, the occupancy rate has decreased. In Austria, the number of cars has increased by 26% between the years 2000 and 2016. The number of kilometres travelled by car has increased by 28% at the same time (VCÖ 2018). In addition, citizens in some areas are still strongly car-dependent in their everyday mobility. The transport sector is the second largest producer of greenhouse gas emissions in Austria. In 2019, it was responsible for 30% of all emissions (Umweltbundesamt 2021). Many cities and regions already address these challenges by an improvement of public transport networks, an extension of walking and cycling infrastructures or testing innovative and smart mobility solutions to promote sustainable mobility and increase the quality of life. These measures certainly create a necessary and adequate basis, but for optimal use, they require additional awareness-raising approaches including incentive and reward systems to motivate people to use these new offers and change their mobility behaviour in favour of sustainable solutions. This is the context of the project SaMBA (Sustainable Mobility Behaviours in the [1]Alpine Region), which is implemented in the years 2018-2021 and promotes mobility behaviour change by reward and pricing policies. One output of this project is a tool presenting incentive-based measures to promote low carbon mobility and raise awareness of the value of behaviour change policies. The tool supports decision-making processes and the choice of appropriate measures and incentives addressing the mobility behaviour of residents. Based on a user-defined goal and the characteristics of the target area, the tool provides a set of suitable measures and their impacts. It contains two components implemented with Microsoft Excel and ArcGIS to combine the advantages of both approaches. The functionalities of the tool have been tested in the Salzburg Region, Austria and other SaMBA pilot regions.

3 STATE OF THE ART

3.1 Incentive theories

In the last years, governments have started to consider behavioural science to gain a better understanding of human actions as a foundation of the development of policies promoting sustainable behaviour (Mont et al. 2014). The SaMBA project aims at the support of this development by promoting mobility behaviour change as an important current topic. For implementing mobility behaviour change policies, it is necessary to

[1] https://www.alpine-space.eu/projects/samba/en/home

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understand the basics of human behaviour. According to the Fogg Behaviour Model, behaviour consists of the factors motivation, ability and triggers, which have to come together at once for an action to be performed. To promote behaviour change, a person needs sufficient motivation, the ability to perform a certain action and a trigger for the target behaviour. Motivators can e.g. be hope, social acceptance or pleasure, but also pain or fear. Elements of ability are e.g. time, money or physical effort. Different types of triggers can e.g. help to motivate people to perform a behaviour or make a behaviour easier (Fogg 2009). In the case of the SaMBA approach, incentives are considered as motivating as they encourage people to perform certain actions. The SaMBA tool is based on the fact that people are pulled towards a behaviour that leads to a reward and pushed away from a behaviour that leads to negative consequences. This is also referred to as incentive theory, which is one of the major theories of motivation. It suggests that people are more motivated by outside incentives rather than by internal drives. According to incentive theory, incentives cannot only be used to promote certain actions, but they can also help to stop certain behaviours. However, incentives are only effective if the offered reward is obtainable and people consider it as important for themselves (Cherry 2020).

Due to the value and the effectiveness of incentives, incentive-based approaches regarding mobility behaviour change are already used in policy planning in some cases. They address different target groups, e.g. commuters, pupils, tourists or the general public, and topics like the promotion of public transport, active modes or sharing systems. These measures cover different spatial levels including urban, suburban and rural target areas. However, most of the examples collected during the SaMBA project focus on urban and suburban areas. Incentives come in a variety of forms, but a major group of them is based on rewards like money or vouchers for shops and restaurants. Others are e.g. raffles, activities like bicycle tours or practical rewards, e.g. cycling gear.

A major group of measures is based on technical approaches. Many of them use mobile applications that can also contain a gamification component. An example is TrafficO2[2], a mobile app that provides challenges and information to promote sustainable transport. The users can collect points for using sustainable modes to win prizes and discounts.

Gamification in general is also a common approach, especially when designing measures for children. An example is the Traffic Snake Game[3], where children can collect stickers for their class every time they walk, cycle, use public transport or a shared ride on their way to school. The goal is to collect as many stickers as possible to win prizes.

Another approach used in a variety of best practice examples is promoting a certain transport system with the help of discounts on the user fee. An example is CAMPUSbike[4], which is a programme that offers students in different German cities free bike rental for the first 30 min of the rental term.

Besides policies with an incentive or a reward, pricing approaches can also be used. They mostly include congestion charges like an example from London[5], where a daily charge for driving a vehicle within the charging zone needs to be paid. Some pricing approaches are included in the tool, however, the focus is on measures including a positive incentive.

3.2 Existing tools on sustainable transport

Another important foundation of the development of the SaMBA tool was the analysis of already existing tools to simulate the impacts of policies in the field of sustainable transport. These tools can be split up into different categories depending on their type. It can be distinguished between applications, Excel tools, models and other forms.

Most tools fall in the category of applications, which include web or software applications. As examples, “IMPACT”[6], which analyses changes in transport systems, the “Multi-Actor Multi-Criteria Analysis” tool[7],

[2] http://www.traffico2.com/en/
[3] https://www.trafficsnakegame.eu/
[4] https://www.nextbike.de/de/campusbike/
[5] https://tfl.gov.uk/modes/driving/congestion-charge
[6] https://www.ait.ac.at/en/solutions/impact-assessment-for-transformative-mobility-systems/
[7] http://www.mamca.be/en/

which measures the impact of policies on different stakeholders, or the “HIGH” tool[8] for analysing different impacts of transportation policies can be named.

Another way of analysing the impacts of policies is the development of Excel-based models. Examples are the “FLOW” tool[9], which concentrates on changes in the transport infrastructure and the “VMT reduction: Phase One – Scenario Assessment Tool”[10], which considers the impacts of CO_2 emissions and travelled miles.

Some other tools appear in form of a model, which can for example be mathematical, like the “Integrated Transport and Health Impact Modelling Tool”[11] or agent-based like the “Mobility Transition Model”[12].

4 STRUCTURE OF THE SAMBA TOOL

4.1 Framework

Although some tools regarding mobility and sustainable transport solutions already exist, only a few include a GIS component and are linked to the promotion of mobility behaviour change with the help of incentives. This is a gap that the SaMBA tool addresses by utilising Microsoft Excel, which provides a comprehensive but easy to use database with recommendable measures, and an additional ArcGIS component with more analysis options for users with experience in this field.

The primary target group of this tool includes policymakers, public authorities and planning experts, but also sectoral agencies, education and research and infrastructure or service providers. Therefore, the tool needs to be easy to use and to be open to a wide audience without any restrictions. It also is designed for transnational applicability. The main functions of the tool can be exploited by using the Microsoft Excel component on its own, which does not require expert knowledge and provides an environment most users are familiar with. Furthermore, it does not require constant maintenance after the end of the project and allows an easy extension. However, presenting results is limited to diagrams and tables. Since the tool has a spatial context, an optional GIS component has been developed to provide more detailed analysis and visualisation options. The main purposes of the GIS component are to improve the required user input by pre-processed spatial statistics or data and to identify and visualise mobility demands and potential action areas in a spatial context as an element of decision support. However, it addresses a smaller target group and is limited by the availability of standardised geodata on a transnational level. For maximum benefit and to circumvent the specific disadvantages, both approaches were implemented. The final tool does not require expert knowledge in the field of GIS, but it is helpful for more in-depth analysis and the visualisation of the results.

4.2 Building blocks

To be able to recommend suitable measures, the tool requires a dimension, a goal and a set of parameters for the characteriation of the target area. Based on these user inputs, a list of suitable measures is presented. Furthermore, the impacts of a measure are described based on best practice examples (cf. Fig. 1).

Based on the objective to introduce incentive-based measures that promote low carbon mobility and climate and environmental protection, four important dimensions for mobility behaviour change have been defined for the SaMBA tool. They include public transport, active modes, multimodality/access and sharing systems. Each goal embedded in the tool is assigned to the appropriate dimension for better clarity and structuring (cf. Fig. 2). Dimensions and goals have been defined with the help of pilot activities carried out during the project and regional, national or international strategic documents. One of the most important regional documents in this regard is the Mobility Concept of the Federal State Salzburg, which describes future strategies for sustainable mobility and transport policies. It defines goals including the promotion of eco-friendly and multimodal transport, the promotion of alternative and innovative approaches like sharing systems and the provision of equal mobility options for all residents (Land Salzburg 2016). Similar objectives are presented in the Austrian Traffic Master Plan, which introduces Austrian-wide transport political goals for all modes (BMVIT 2012). The European Commission has published a strategy on low

[8] http://www.high-tool.eu/index.php?id=home
[9] http://h2020-flow.eu/
[10] https://www.wsdot.wa.gov/research/reports/fullreports/765.1.pdf
[11] https://ithim.ghi.wisc.edu/
[12] https://www.top-ix.org/it/2018/06/04/disegnare-mobilita-sostenibile-con-motmo/

emission mobility, focusing on improving the efficiency of the transport system, promoting low emission alternative energy and zero-emission vehicles (European Commission 2016). The Transport Protocol of the Alpine Convention describes characteristics of a sustainable transport policy, which include e.g. reduction of negative effects on the environment, improved accessibility, optimisation of the use of existing infrastructures and measures against noise or emissions (EU 2007).

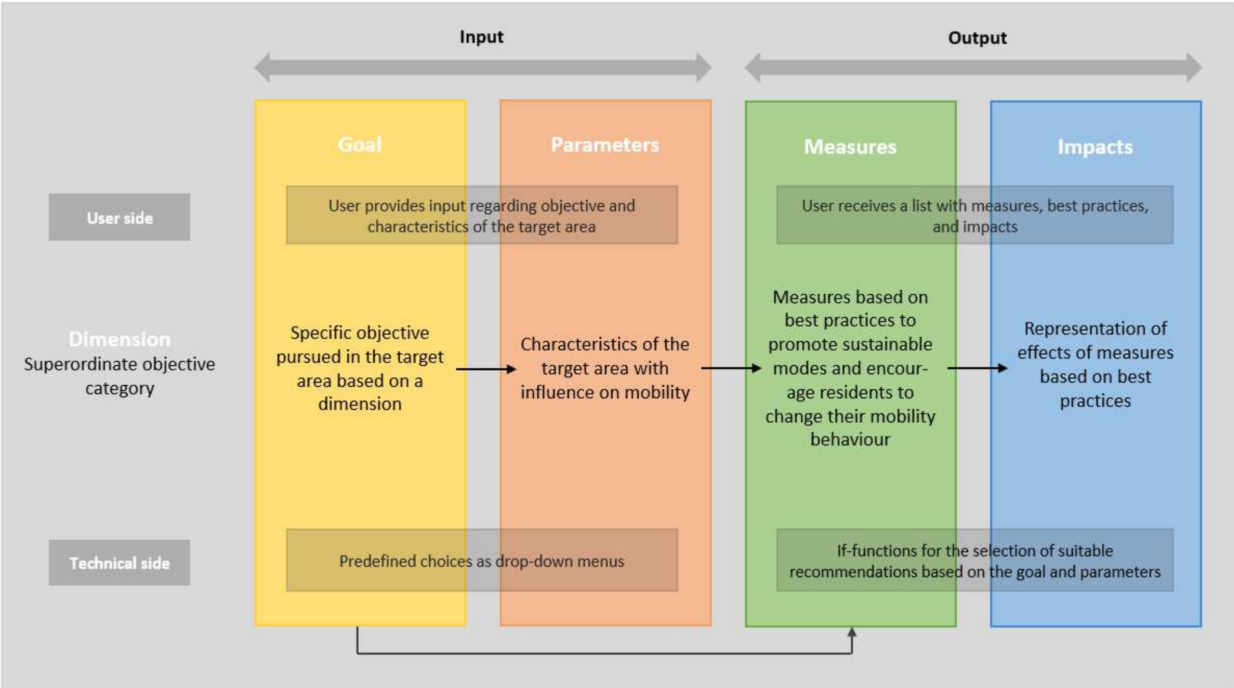

Fig. 1: Central building blocks of the SaMBA tool

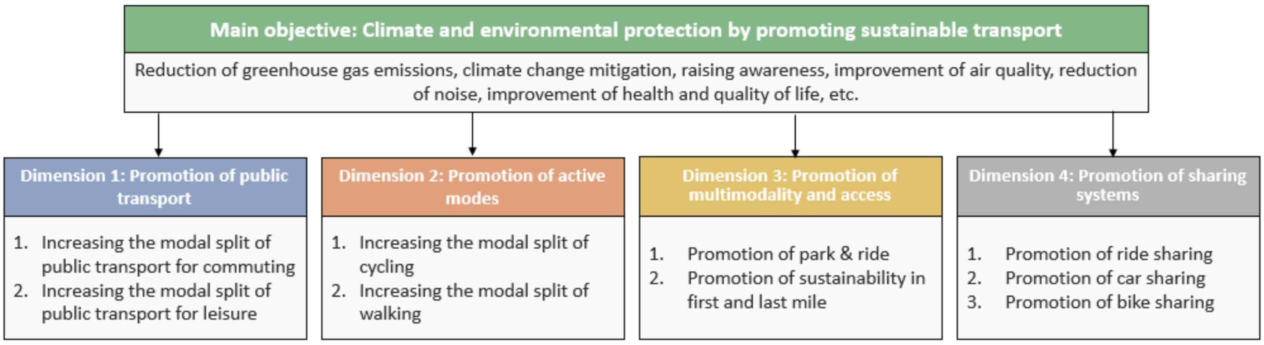

Fig. 2: Dimensions and goals

In the next step, the characteristics of the target area in terms of mobility and mobility behaviour are defined with the help of a parameter set. This set includes e.g. transport infrastructure and services, demography, topography and settlement (cf. Fig. 3). All parameters are embedded in Microsoft Excel, but some of them currently are not part of the GIS component due to data availability issues.

Based on the selected goal and the parameters, the SaMBA tool recommends measures that are suitable for the target area. In the context of the presented project, measures are defined as policies including an incentive to motivate citizens to change their mobility behaviour in favour of eco-friendly modes. Measures are presented along with their impacts, which are defined as effects based on an indicator. Mostly, they are quantitative and include e.g. changes in the modal split or the amount of CO_2 emissions saved. However, also qualitative impacts like health benefits from active modes are described since in some cases no specific studies on the impact and no quantitative data exist. Measures will not have the same effects in different target areas since they depend on many factors and details that are beyond the scope of the project. Therefore, the tool provides results and impacts derived from best practice examples.

Parameter name	Categories	Excel	GIS
Type of the target area	Urban, suburban, rural	✓	✓
Topography	Flat, hilly, steep	✓	✓
Quality of footpaths and sidewalks (density of footpaths, presence of sidewalks, street lighting etc.)	High, medium, low	✓	✓
Quality of cycling infrastructure (density of bicycle lanes, presence of adequate bicycle parking facilities, street lighting, pavement quality etc.)	High, medium, low	✓	✓
Quality of public transport (frequency, vehicle type, persons living in walking distance to a public transport stop etc.)	High, medium, low	✓	✓
Presence of high commuter flows (in and out)	Yes, no	✓	✓
Presence of a university or a university catchment area	Yes, no	✓	✓
Presence of a primary school	Yes, no	✓	✓
Presence of a secondary school	Yes, no	✓	✓
Presence of a bike sharing system	Yes, no	✓	✗
Presence of a car sharing system	Yes, no	✓	✗
Presence of a park & ride system	Yes, no	✓	✓

Fig. 3: Parameters

5 TOOL FUNCTIONALITIES

5.1 Workflow

Fig. 4 presents the workflow of the SaMBA tool. The starting point is the selection of a dimension and a goal with the help of dependent dropdown menus in Microsoft Excel. For higher user-friendliness, the tool only shows parameters that are relevant to a selection. Parameter inputs can also be selected as categories from dropdown menus. The user is not obligated to fill in all listed parameters, however, with a larger amount of input, the results will be more customised and adapted to the characteristics of a target area. After filling in the parameters, Microsoft Excel with the help of If-functions filters measures that are embedded in a database. As a result, the tool provides a list of recommended measures including a measure name, a best practice and indicators (e.g. modal split) the measure has impacts on. Further details regarding the implementation and the impacts are displayed when the user clicks on the name of a best practice example. Besides worksheet functions, the Microsoft Excel component also uses the programming language Visual Basic.

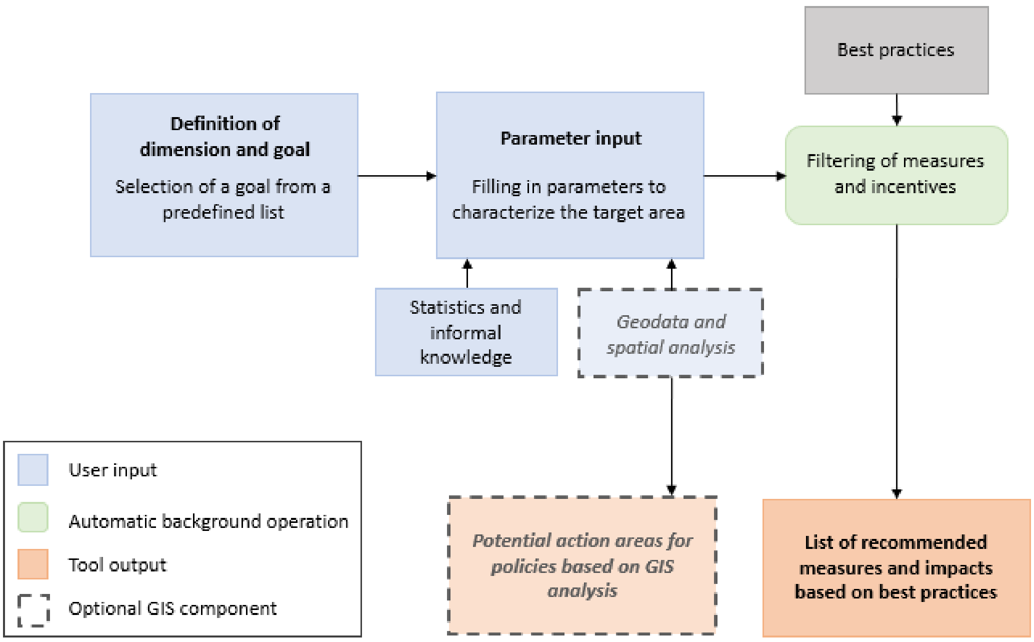

Fig. 4: Workflow of the SaMBA tool

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The additional GIS component can be used in two ways. Besides sources like municipal statistics and informal knowledge, parameter inputs can also be derived from a GIS analysis of the region. The latter will help to get more exact values, consider areas beyond predefined borders or focus on small areas that are not listed in official statistics. With the help of spatial data regarding demography, topography, settlement structure, commuter flows and transport infrastructure or services, the required input parameters can be modelled in ArcGIS. The GIS component also offers methods for the assessment and comparison of mobility demands or potential action areas for behaviour change policies. Framing conditions based on the settlement structure (e.g. urban-rural-typologies and topography) and infrastructure quality for walking, cycling, public transport and intermodal trips are used for the identification of potentials. The idea is to detect action areas with an adequate infrastructure quality and a high potential for mobility behaviour change measures.

5.2 Interface and output examples

The Microsoft Excel component consists of six different worksheets. The first one is an introduction describing background information and the purpose of the tool. The second sheet represents the main user interface including all inputs and outputs. It also provides an export function, which transfers the sheet to a PDF document. For users who want to gain further insight into the collection of all integrated measures, an additional overview table is provided in the third sheet, which also allows filtering the measures by a goal. The fourth sheet contains a glossary defining important terms. The databases containing the inputs for the dropdown menus and the If-queries for the identification of recommendable measures are included in the fifth and sixth sheets, which are only open for tool developers. Fig. 5 shows the main user interface demonstrating inputs and outputs for promoting the use of public transport among commuters based on exemplary user inputs from a municipality in the Salzburg Region.

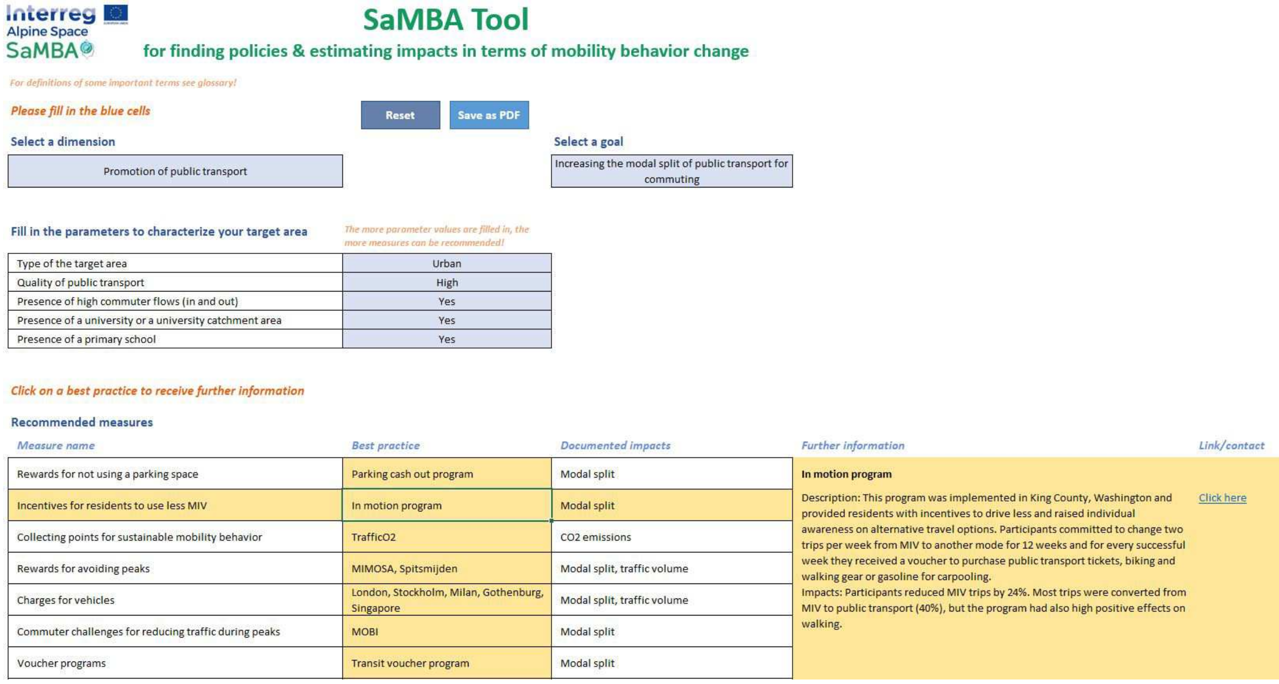

Fig. 5: Main user interface of the SaMBA tool

The impacts of measures are represented with the help of best practice examples. If no measure can be recommended for the target area, general suggestions (e.g. that it is required to improve the infrastructure before implementing behaviour change policies) are provided. Currently, the recommendation of measures and their impacts are only depicted in the Microsoft Excel component.

The ArcGIS component consists of 13 different models developed for parameter calculation and the estimation of potentials and demands. Fig. 6 shows the quality of public transport in a part of the Tennengau Region, which is located to the South of the city of Salzburg, based on a 250m raster. The results can also be transferred to other spatial levels like municipalities or settlement cores. The quality of the public transport system presented in the map is based on the “ÖV-Güteklassen” (classification scheme for public transport quality in Austria) and the walking distance to a public transport stop. The map shows that most municipality centres have very good public transport infrastructure, especially in the municipalities located in the

Northern part of the study area, which is nearer to the city of Salzburg. One reason for this is the existence of a train line.

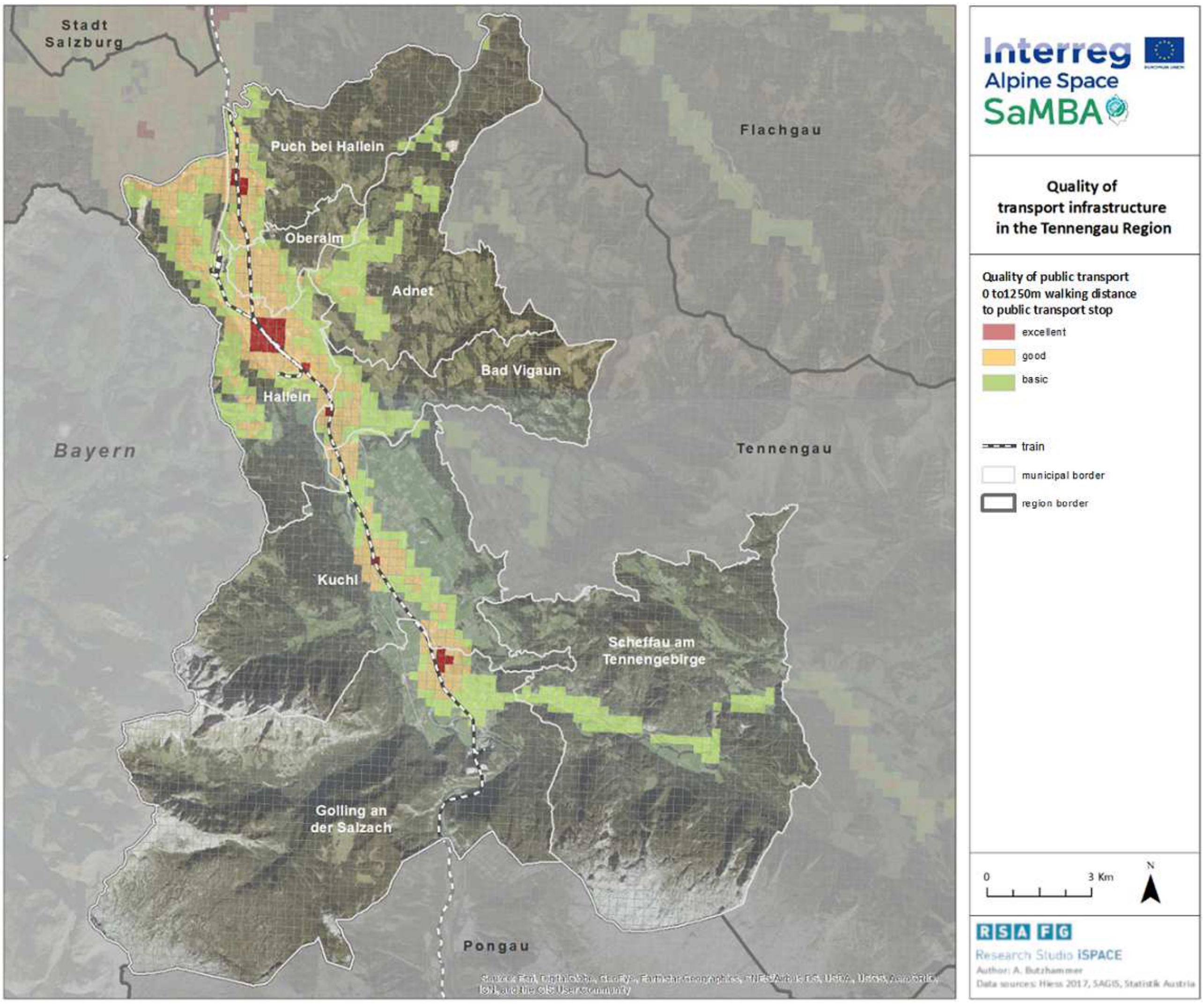

Fig. 6: Quality of public transport

Fig. 7 demonstrates the identification of potential action areas with the help of two maps covering the municipalities Hallein and Kuchl, which are located in the Tennengau Region. The first map represents the conditions for walking to public transport stops based on settlement structure, slope and the distance to the next public transport stop. Furthermore, the service interval and the vehicle type are considered, since for most persons the motivation to walk to a public transport stop with good service quality is higher. This output can e.g. be combined with potential modes for the first mile to public transport stops for commuters to determine action areas for measures that promote public transport and walking in the first mile. This is displayed in the second map, which shows the share of commuters with good first mile options for cycling, walking and the car. In this case, a potential action area for promoting public transport and walking in the first mile in the North of Hallein could be identified.

6 DISCUSSION AND OUTLOOK

The SaMBA tool provides decision support as a foundation for public authorities in strategic planning introducing recommendable measures that aim at a mobility behaviour change of citizens. The tool has the potential to be adapted in different ways. For an easy modification of the tool, the demonstration of possible extensions by additional goals, parameters or measures and further insight into the utilised spatial analysis methods, a guideline including detailed documentation of the tool workflow, the implementation process and all GIS models and Excel statements is provided.

The Microsoft Excel component provides an intuitive and uncomplex way to gain insight into different approaches. This component is considered a comprehensive database that easily presents existing solutions to allow an overview and a quick finding of measures for the user. Since its required inputs can be based on statistics and informal knowledge, it is of especially high importance in regions with limited geodata availability. Because the Microsoft Excel component does not require expert knowledge, it is open to a large user group, but it is limited regarding its outputs as it only allows diagrams and tables and no more comprehensive visualisation options.

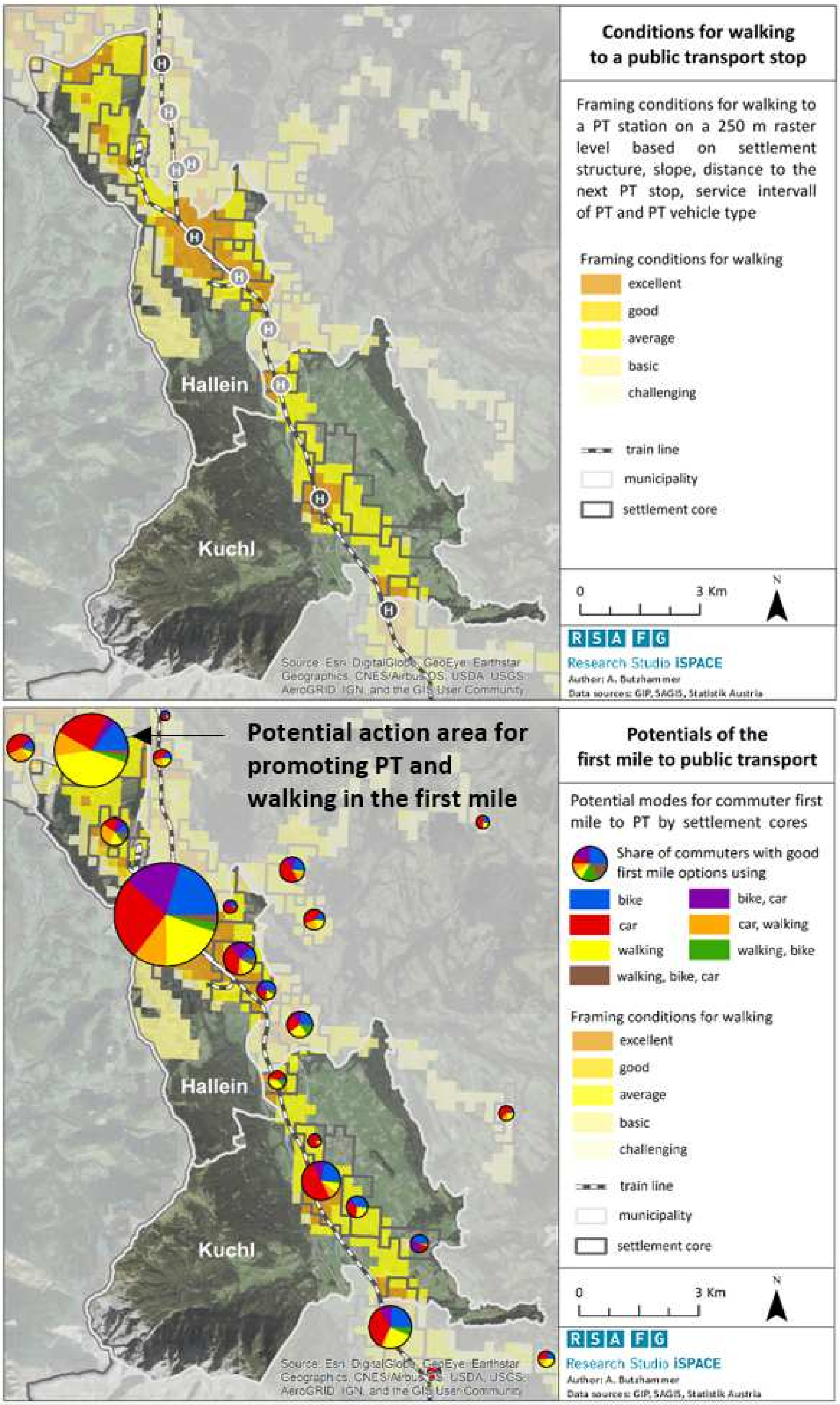

Fig. 7: Conditions for walking to the next public transport stop and potential action areas

The underlying concept of the tool is designed for transnational applicability, which means that the presented goals and parameters have no regional specification. The GIS component, however, is dependent on data availability in the target area, but it contributes to improvements in the results of the tool. GIS supports the development of regional analyses to identify suitable measures and to compare different target areas.

At the moment, one weakness of the tool is the strong dependence on best practices, especially in the field of impacts of measures. Currently, the tool does not allow a direct transfer of impacts or their calculation in the target area of the user. To address this issue, appropriate adaptations in the long term can help to estimate regional impacts of measures based on an interconnection with traffic information, commuter flows and effects on modal split and CO2 emissions. The tool has the potential to be further developed to allow the construction of scenarios and to simulate potential effects on congestion, occupancy of public transport, pollution and necessities to improve existing infrastructure.

Currently, although GIS and Microsoft Excel are considered components of one tool, they are not strongly interlinked. ArcGIS can present possible action areas, but it does not recommend suitable measures for these areas. An improvement in this regard would lead to more comprehensive analysis and interpretation options. Furthermore, a combination with other tools is thinkable for the future.

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Gähnende Leere oder beliebter Park? Nutzung eines innerstädtischen Universitäts-Campus zur Zeit der Corona-Pandemie am Beispiel des Campus Süd des Karlsruher Instituts für Technologie (KIT)

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1 ABSTRACT

Nur selten liegt ein großer Universitätscampus zentral in einem Stadtgebiet, wie das in Karlsruhe der Fall ist. Die angrenzenden Stadtteile sind von der direkten Nachbarschaft des Campus über die Jahre geprägt worden – eine hohe Zahl an Studierenden-WGs und die größte Dichte an Studierendenverbindungen in Karlsruhe sind dafür nur zwei Indizien. Innerhalb der Stadtviertel sind v.a. in den Sommermonaten häufiger Studierendengruppen anzutreffen, welche die Grün- und Parkflächen auf und außerhalb des Campus zum gemeinsamen Lernen und Verweilen nutzen. Doch seit Beginn der Corona-Pandemie und der damit verbundenen Maßnahmen zur Eindämmung der Verbreitung des Virus fehlt dieses öffentlich sichtbare studentische Leben in der Stadt Karlsruhe. Studien-, Lehr- und Forschungsbetrieb finden seit März 2020 überwiegend nicht mehr auf dem Campusgelände statt. In dieser Zeit konnte beobachtet werden, wie das Gelände als geschätzter innerstädtischer Naherholungsraum immer stärker genutzt wurde. Im Rahmen einer schriftlichen Anwohnendenbefragung in den umliegenden Stadtvierteln und einer mündlichen Passantenbefragung auf dem Campusgelände im März 2021 wurde die Bedeutung des innerstädtischen Campusgeländes für Anwohnende und Campus-Angehörige erforscht. Es kann bereits gezeigt werden, dass der Campus Süd des KIT für die Stadtbewohnenden und Campus-Angehörigen ein geschätzter innerstädtischer Naherholungsraum ist. Die Freiflächen des Campus fördern den Austausch und die soziale Interaktion. Durch seine sehr gute Anbindung mit jeglichen Verkehrsmitteln und der hohen Zufriedenheit mit der Erreichbarkeit des Geländes, kann die zukünftige Campus- und Stadtentwicklung aus diesem Potenzial weiter schöpfen. Die vermehrte Nutzung des Campus als Spazierfläche kann durch entsprechende Installationen im Hinblick auf die Bedürfnisse dieser Nutzendengruppe, wie beispielsweise Ruhebänke, öffentliche Cafés oder Bücherschränke, die Verweildauer auf dem Campus und so die Aufmerksamkeit auf wissenschaftliche Themen erhöhen. Dennoch sollten bei der zukünftigen Campus- und Stadtentwicklung immer auch die Vorteile eines in sich geschlossenen Campus bedacht werden. Die Idee der in sich geschlossenen Anlage fördern eine größere Ruhe, Kontemplation und Freiheit der Planung für die Campusentwicklung. Es ist daher zwingend notwendig, nicht nur eine Wunschvorstellung zu formulieren, sondern den Ist-Zustand der jeweiligen Campusnutzung am Standort zu evaluieren, um für die jeweilige Stadt die geeigneten Maßnahmen zu einer gewinnbringenden und angestrebten Verknüpfung von städtischem und wissenschaftlichem Alltag auf einem Campusgelände zu entwerfen.

Keywords: University Campus, Campus and City, Urban Design, Open Space

2 HINFÜHRUNG

Universitäten und Hochschulen treten in den letzten Jahrzehnten vermehrt in den Fokus der sie umgebenden Stadtentwicklung. Ihre Bedeutung wandelt sich dabei vom reinen Forschungs- und Lehrstandort sowie Wissensgenerator zu einem bedeutenden Bestandteil der Stadt, was bei einer näheren Betrachtung keine Besonderheit darstellen dürfte. Sie beeinflussen die städtische Infrastruktur, den Wohnungsmarkt und sind nicht selten wichtige Arbeitgeber mit einer Strahlkraft über die Stadtgrenzen hinaus. Zunehmend mehr Städte erfinden sich im Zuge dessen als ‚Wissenschaftsstädte' neu. Universitäten und Hochschulen erlangen identitätsstiftende Qualitäten für eine Stadt und stehen als Aushängeschild in (inter-)nationaler Konkurrenz, wenn es um die Anwerbung von Studierenden, Mitarbeitenden oder jungen Forschenden geht. Mit Konzepten zur besseren Integration von Wissens- und Stadtgesellschaft möchten Universitäten und Städte wertvolle Synergieeffekte generieren, um sich so gegenseitig positiv zu beeinflussen und voneinander zu profitieren (siehe dazu beispielsweise DEN HEIJER 2018). Je nach Anlage des Campus ist jedoch die (nachträgliche) Integration in das Stadtleben vor unterschiedliche Herausforderungen gestellt. Während Städte mit suburbanen Campussen eher Lösungen finden müssen, städtisches Leben auf den Campus zu integrieren, profitieren innerstädtische, ältere Universitäten, wie Heidelberg oder Freiburg, schon von der unmittelbaren Nähe von Wissens- und Stadtgesellschaft. Die Konzentration von Universitätsgebäuden auf einer zusammenhängenden Fläche und die Entstehung der heutigen Campusse kam im deutschsprachigen Raum erst allmählich zwischen den Jahren 1960 und 1980 auf. Die hier entstehenden Campusanlagen, wie beispielsweise das Neuenheimer Feld in Heidelberg oder der Campus Hönggerberg in Zürich, wurden bewusst auf die ‚grüne Wiese' verlegt, um sich dem Einfluss und der Ablenkung der Stadt zu entziehen. Ziel war es, einen reinen Wissens- und Forschungsstandort zu schaffen, der von äußeren Einflüssen so weit wie möglich ‚abgeschottet' ist (vgl. HÖGER 2007). Auch die Art der Gebäudestruktur und der Außenwirkung der Architektur lassen einen Campus häufig als einen „Fremdkörper im städtischen Gefüge" (ZIEGENBEIN 2009) erscheinen. Diesen Campussen wird heute eine Monofunktionalität nachgesagt, die keine angemessene soziale Umgebung schafft und negativ bewertet wird (siehe dazu beispielsweise NEGM et al. 2020). Angestrebt wird ein harmonischer Austausch zwischen Universität und Stadt, wie es im Laufe der Entwicklung der University of Cambridge beobachtet werden kann. Hier gibt es die Ansiedlung von Campusgebäuden an einem zentralen Standort schon deutlich länger. Harvard Square und Harvard Yard sind hier nicht nur Mittelpunkt für vergnügliche, erholsame Zwecke und städtischen Lebens, sondern eben auch Mittelpunkt des akademischen Alltags (HÖGER 2007). Einige städtische Campus-Anlagen, wie beispielsweise das bereits erwähnte Neuenheimer Feld in Heidelberg, kompensieren die Monofunktionalität des Campus durch die direkte Nähe zur urbanen Umgebung und deren Einrichtungen und Funktionen. Während das Neuenheimer Feld sich mit seiner geographischen Lage jedoch auch eher in einer ‚abgegrenzten' Lage befindet, finden wir in Karlsruhe einen traditionellen Universitäts-Campus in Innenstadtlage.

2.1 Campus und Stadt in Karlsruhe

Karlsruhe als Hochschul- und Wissensstandort beheimatet neun Hochschulen, eine bedeutende außeruniversitäre Forschung und ist mit dem KIT Sitz der größten deutschen Forschungseinrichtung. Das KIT entstand 2009 aus dem Zusammenschluss des Forschungszentrums Karlsruhe GmbH und der Universität Karlsruhe (TH). Beide Institutionen brachten zwei bestehende Campusanlagen mit in die Fusion. Die Universität Karlsruhe ist seit deren Gründung 1815 zentral in der Innenstadt angesiedelt. Das Forschungszentrum besitzt seit 1956 einen eigenen Forschungscampus angrenzend an den nördlichen Rand des Stadtgebiets, mitten im Naherholungsgebiet Hardtwald. Während der Sitz der ehemaligen Forschungseinrichtung, der Campus Nord, auch heute noch vor allem der Forschung vorbehalten ist und der Zugang wegen der Überreste der dort angesiedelten Kernforschung streng reguliert wird, findet die zentrale Lehrtätigkeit nach wie vor auf dem innenstadtnahen Campus Süd statt. Anders als beim Campus Nord wird hier lediglich die Zufahrt mit dem PKW reglementiert, für Fußgänger und Radfahrer ist der Campus Süd an vielen Stellen entlang der Campusgrenzen frei zugänglich. Die besondere Lage des Campus Süd wird mit einem Blick auf nachstehende Karte deutlich (ABB. 1). Der Campus Süd des KIT (hier schwarz schraffiert) liegt inmitten des Stadtgebiets Karlsruhe, u.a. in den beiden Stadtvierteln Innenstadt-Ost und Oststadt (türkis).

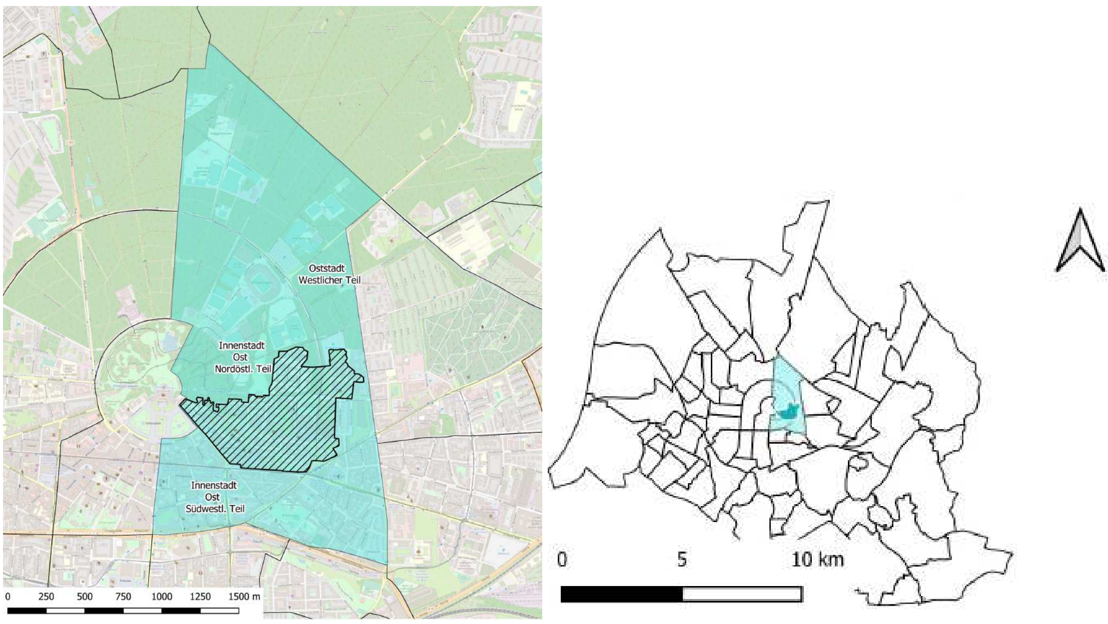

Abbildung 1: Lage des KIT Campus Süd im Stadtgebiet Karlsruhes (© Hanna Jäger). Datengrundlage: Stadt Karlsruhe 2016/17, Open Street Map

Die direkt an den Campus angrenzenden Stadtteile sind von dessen direkter Nachbarschaft über die Jahre geprägt worden. Neben einer hohen Zahl an Studierenden-WGs, Studierenden-Wohnheimen und der größten Dichte an Studentenverbindungen in Karlsruhe, finden sich in der direkten Nachbarschaft viele hochschulnahe Dienstleistungen, wie Copy-Shops, Reperaturläden für Fahrräder und studentische Gastronomieangebote sowie eine kleine Kneipenszene. Die Studierenden entwickelten sich über die Jahre zu einem wichtigen Teil des Stadtlebens in Karlsruhe. An den neun Hochschulen studieren heute rund 43.000 Studierende (STADT KARLSRUHE 2020). Sie sind mittlerweile maßgeblich prägend für die Altersstruktur und die Geschlechtsstruktur der jüngeren Altersgruppen der Fächerstadt, nicht zuletzt aufgrund der hohen männlichen Studierendenzahlen, die auf den technischen Schwerpunkt der Hochschule für Technik und Wirtschaft und des KIT zurückzuführen sind (STADT KARLSRUHE 2020). Mit 23.321 eingeschriebenen Studierenden im Wintersemester 2020/21 hat das KIT an dieser Entwicklung einen entscheidenden Anteil. Bedeutsam ist das KIT aber auch aufgrund seiner regionalen Strahlkraft als Arbeitgeber; im vergangenen Wintersemester beschäftigte das KIT 9.618 Mitarbeitende (KIT 2021).

2.2 Aktuelle Campus- und Stadtentwicklung in Karlsruhe

Jährlich zieht es tausende junge Menschen an Hochschulstandorte, um einem Studium nachzugehen oder in Forschungsinstitutionen zu arbeiten. Dies hat u.a. Auswirkungen auf den Wohnungsmarkt und das soziale Gefüge in den hochschulnahen Quartieren der Städte. Mit zunehmender Globalisierung und dem zunehmendem wirtschaftlichen Wettbewerb um Innovation und Kreativität rücken auch die wirtschaftlichen Effekte von Hochschulen im akademischen und öffentlichen Leben in den Fokus (GLÜCKLER 2018). Doch die Attraktivität eines Hochschulstandorts als Lebens- und Arbeitsmittelpunkt ist nicht an den Ruf einer Universität allein gebunden. Auch das städtische Leben und das Image der Stadt spielt bei diesen Entscheidungen eine nicht zu unterschätzende Rolle (beispielsweise KRAMER et al. 2014). Zur Attraktivitätssteigerung treten Universitäten nicht selten in den kommunalen Wettbewerb um Flächennutzung in der Stadtplanung und haben Interesse an Infrastrukturplanungen. Hochschulen und Forschungseinrichtungen sind andererseits auch wichtige Akteure der Wissensgenerierung für Städte. Wissenstransfer durch Auftragsforschung oder Förderung des Wissensaustauschs zwischen Stadt- und Wissensgesellschaft sind wichtige Bestandteile des akademischen und forschenden Lebens. Universitäten beteiligen sich dazu aktiv an politischen Prozessen der Entscheidungsfindung (vgl. GLÜCKLER 2018). Diese Prozesse bleiben für Einwohnende einer Stadt meist unsichtbar, wenn sie nicht eine direkte Beziehung zur Universität oder zur Stadtplanung haben. Anders sieht dies bei Baumaßnahmen aus, die beispielsweise rund um einen Campus diese Annäherung oder gar ‚Verknüpfung‘ von Campus und Stadt ‚sichtbar machen‘.

In Karlsruhe rückt die besondere Lage des innerstädtischen Campus des KIT und die direkte Nachbarschaft von Wissens- und Stadtgesellschaft bei allen jüngeren Campus- und Stadtentwicklungsprozessen in den Fokus. Südlich an den Campus angrenzend befindet sich der Stadtteil Innenstadt-Ost (Südwestlicher Teil), der seit 2017 städtebauliches Sanierungsgebiet ist. Hier steht, neben umfassenden Maßnahmen zur Verbesserung der Infrastruktur und des städtischen Lebens, die Verknüpfung von Campus und Stadt im Mittelpunkt. Vorschläge zur Gestaltung von neuen Eingangssituationen und grenzübergreifenden Maßnahmen zwischen Campusgelände und Wohngebiet sind bereits im Bau. Ähnliche Ziele finden sich im Masterplan des KIT von 2016. Auch hier ist als wichtiger Maßnahmenpunkt die Verbindung von Stadt und Wissenschaft aufgeführt (STADT KARLSRUHE 2017, KIT ZUKUNFTSCAMPUS 2016). Entlang der südlichen Campusgrenze wird beispielsweise eine neue U-Bahntrasse verlaufen, die die bisherige überlastete Straßenbahntrasse ersetzt und deren Linien die Innenstadt Karlsruhes mit dem gesamten Umland verknüpft. Durch die Verringerung des Verkehrsaufkommens zwischen Campus und Wohngebiet entstehen neue Freiflächen, die genutzt werden sollen, um u.a. die Eingangssituationen zum Campus attraktiver und sichtbarer zu gestalten. Ein erster Schritt in Richtung Öffnung stellt das ebenfalls hier entstehende neue Gebäude des KITs dar, dass mit einer offen gestalteten Erdgeschosszone künftig Wissens- und Stadtgesellschaft näher zusammenbringen soll. Ein weiteres solches Bauprojekt entsteht an der östlichen Campusgrenze, auch hier sind offen gestaltete Erdgeschosszonen vorgesehen, die die Stadtgesellschaft ansprechen sollen. Ein weiteres interessantes Projekt in diesem Zusammenhang wurde bereits 2018 von KIT und Stadt gemeinsam initiiert. Unter dem Slogan „Student*INNENstadt – Karlsruhe weiterdenken“ beteiligten sich 3.000 Studierende aller Karlsruher Hochschulen und entwickelten gemeinsam Ideen für eine studierendenfreundliche Stadt. Die hier zusammengetragenen Vorschläge und Wünsche sollen bei den weiteren Maßnahmen in der Stadtentwicklung Karlsruhes berücksichtigt werden (STADT KARLSRUHE

2019). Im Vordergrund steht dabei immer die Prämisse: Wissens- und Stadtgesellschaft einander näherbringen und den Austausch fördern. Um miteinander in einen Austausch zu gelangen ist es dabei hilfreich, sich auch in einem gemeinsamen Raum zu begegnen. Doch wie nah sind sich Wissens- und Stadtgesellschaft in Karlsruhe aktuell und welche Herausforderungen treten auf, wenn bauliche und infrastrukturelle Maßnahmen Raum verändern und auf das Handeln im Raum einwirken wollen?

3 INNERSTÄDTISCHER CAMPUS ≠ IN DER STADT

Der Campus Süd des KIT befindet sich zwar in Innenstadtlage, dennoch wirkt er nicht als Teil der Innenstadt, wie es beispielsweise der Marktplatz tut. Er wirkt eher wie ein besonderer Stadtraum, in dem andere Regeln gelten. Aus der Tradition der Universität heraus sind die Liegenschaften in der Obhut des Landes Baden-Württemberg und nicht der Stadt Karlsruhe. Das Gelände ist an vielen Eingängen bzw. Zufahrten als ‚Privatgelände' gekennzeichnet. Am Zugang des Campus Süd ändert dieser Sachverhalt erstmal nichts, denn das Gelände ist, anders als der Campus Nord, nicht umzäunt und das Gelände ist frei zugänglich. Im Prinzip hat jeder die Möglichkeit, sich auf das Campusgelände zu begeben und sich dort aufzuhalten. Zwar finden sich entlang der Campusgrenzen noch Reste alter Grenzzäune, Hecken und Tore, dennoch ist der Zugang lediglich für den Autoverkehr tagsüber durch Zufahrtsschranken reglementiert. Der Zugang zu Fuß oder via Fahrrad ist an vielen Stellen rings um den Campus problemlos möglich. Dennoch wirkt der Campus als (Stadt-)Raum aufgrund seiner Anlage, der Wahrnehmung der Gebäudestruktur und der überwiegenden akademischen Nutzung auf viele Menschen ausgrenzend.

In der Humangeographie wird der Wirkung eines Raumes auf den Menschen und dem Wirken des Menschen im Raum eine große Bedeutung beigemessen. Raum und Handlung beeinflussen sich gegenseitig (z.B. WERLEN 2010). ‚Räume' entstehen nach dieser Annahme erst durch die Wirkung einer gebauten Umwelt und den daraus resultierenden menschlichen Aktionen in dieser. Übertragen auf den Campus bedeutet dies, der Campus als Konzentration von Gebäuden forschungs- und lehrorientierter Nutzungen wird erst zum Raum ‚Campus' durch die Menschen, die diesen Ort primär zum Forschen und Lehren aufsuchen und entsprechenden Tätigkeiten nachgehen. Der Raum wird dabei den Nutzungen ständig angepasst und verändert sich nach den Bedürfnissen der dort Tätigen. Das Zusammenspiel von Gebäudestruktur und Nutzungsprofil eines Campus lässt den Raum so als geschlossenen Ort wirken, der sich gegenüber anderen Stadträumen, wie beispielsweise einem Marktplatz, der für eine offene Kommunikation und einen Austausch der Menschen gedacht und angelegt ist, deutlich unterscheidet und sich demzufolge von anderen städtischen, öffentlichen Räumen abgrenzt. Die Gestalt von Räumen legt bestimmte Nutzungen nahe, fördert oder verhindert sie (vgl. STURM 2018). Dies zeigt sich am Campus Süd des KIT beispielsweise durch das Nicht-Vorhandensein eines öffentlichen Cafés oder Spielplatzes sowie Zugangsbeschränkungen in der Cafeteria, Beschränkung in der Ausleihe und dem Angebot der Bibliothek. Mit dem Ausschluss öffentlicher Nutzungen werden damit folglich auch Personen ausgeschlossen. Diese Beobachtung macht auch STURM im Versuch, halböffentliche Räume zu beschreiben. Ein Merkmal halböffentlicher Räume kann die Beschränkung auf einen bestimmten sozialen Status der Nutzenden darstellen. Diese (Selbst-)Selektion im Alltag wird als selbstverständlich angesehen und entweder kaum wahrgenommen oder bewusst akzeptiert, um Konflikte zu vermeiden (EBD.). Diese Beobachtung und Erklärung kann auch auf das Campusgelände im Stadtraum übertragen werden. Somit ist der innerstädtische Campus zwar durch seine Innenstadtlage öffentlich zugänglich, seine Eigenschaften lassen ihn doch eher als halböffentlichen, einer bestimmten Nutzendengruppe zugeschriebenen Ort erscheinen. Diese Herausforderung stellt sich anschließend bei der Verknüpfung von öffentlichem und halböffentlichem Stadtraum. Doch die Situation bzw. der Alltag auf dem Campus hat sich verändert.

Im Sommer 2021 befindet sich das KIT bereits im dritten Online-Semester. Seit März 2020 sind die meisten Mitarbeitenden im Home-Office und der Lehrbetrieb findet überwiegend im Online-Format statt. Die größte Nutzergruppe des Campusgeländes sind die Studierenden. Viele haben ihr Studium im vergangenen Jahr jedoch als ‚Fernstudium' begonnen, da durch die fehlende Präsenz auf dem Campus die Notwendigkeit eines Wohnortwechsels in vielen Fällen nicht bestand. Dies hatte direkten Einfluss auf das städtische Leben. Mit ca. 4.000 weniger Einwohnern im ersten Quartal 2021 gegenüber dem ersten Quartal 2020 hat sich die Corona-Pandemie vor allem auf den Zuzug von jungen Studierenden deutlich bemerkbar gemacht (STADT KARLSRUHE 2021). Nach einem Jahr Corona-Pandemie konnte sich die Hochschullehre auf das Online-Format umstellen und es werden sich in Zukunft einige Online-Formate durchsetzen, sodass es nicht mehr für jede Lehrveranstaltung notwendig sein wird, am Hochschulstandort – sprich auf dem Campus vor Ort – zu sein, um dem Studium nachzugehen. Doch welche Potenziale stecken in einem Campusgelände für andere Nutzergruppen? Wie wird der innerstädtische Campus von Nicht-Campus-Angehörigen genutzt und wer nutzt ihn v.a. während der Corona-Pandemie, in der das akademische Leben weitestgehend vom Campus gewichen ist und somit die größte Nutzendengruppe weggefallen ist? Verändert sich die Wahrnehmung des Campus? Wie haben sich die Maßnahmen zur Eindämmung des Corona-Virus auf das Leben auf dem Campus ausgewirkt und welche Konsequenzen können aus dieser Erfahrung für die zukünftige Stadt- und Campusentwicklung gezogen werden?

4 MASSNAHMEN ZUR EINDÄMMUNG DER VERBREITUNG DES CORONAVIRUS IN KARLSRUHE MIT FOKUS AUF AUSWIRKUNGEN AUF DIE CAMPUSNUTZUNG

Die Maßnahmen zur Eindämmung der Corona-Pandemie haben das öffentliche Bewegen von Menschen im Raum stark beeinflusst, davon blieb auch der halböffentliche Raum des Campusgeländes nicht unberührt. Im Folgenden soll daher ein kurzer Überblick gegeben werden, welche Maßnahmen v.a. den Zugang und den Aufenthalt im (halb-)öffentlichen Raum, wie es das Campus-Gelände darstellt, verändert haben.

4.1 Maßnahmenüberblick der Stadt Karlsruhe seit März 2020

Zum 18.03.2020 trat die erste Landesverordnung Corona in Baden-Württemberg (Corona VO BaWü) in Kraft, die u.a. folgende Reglementierungen für den öffentlichen Raum vorsah:

Es galt ab 23.03.2020 eine Kontaktbeschränkung im öffentlichen Raum. Zunächst durften sich nur noch zwei Haushalte bzw. nicht mehr als zehn Personen im Freien treffen. Mit dieser Kontaktbeschränkung wurden Spiel- und Sportstätten geschlossen und Gruppenansammlungen – wie beispielsweise eine Studierendengruppe auf dem Campus oder in öffentlichen Grün- und Parkanlagen – untersagt.

Der Betrieb von öffentlichen (kulturellen) sowie religiösen Einrichtungen, des Einzelhandels und der Gastronomie wurden ebenfalls verboten. Vor allem der Wegfall von Außengastronomie führte in Karlsruhe zu leeren öffentlichen Plätzen. Auch die Wochenmärkte und öffentliche Veranstaltungen im Freien mussten abgesagt werden.

Mit Schließung des Schloss- und des Zoologischen Stadtgartens fielen wichtige öffentliche Naherholungsflächen im Stadtraum auf bestimmte Zeit weg. Hinzu kam wenig später ein Betretungsverbot von weiteren öffentlichen Plätzen, wie beispielsweise Aussichtsplattformen oder andere Stellen, an denen es vermehrt zu größeren Menschenansammlungen aufgrund touristischer Zwecke kommen kann.

Somit wurde die Bewegung im öffentlichen Raum stark eingeschränkt. Zunehmend konnte beobachtet werden, wie die Stadtbewohnenden auf andere innerstädtische bzw. innenstadtnahe Flächen auswichen. Der Hardtwald wurde als Naherholungsgebiet beliebter denn je. In einer Meldung vom 28.05.2020 verkündete die Stadt Karlsruhe, dass der „Stadtwald bei Erholungssuchenden jetzt besonders gefragt“ sei (https://corona.karlsruhe.de/). Die Menschen wichen auf andere Flächen aus. Zunehmend konnten auch auf dem Campus vermehrt ‚Spaziergänger‘ beobachtet werden.

Anfang Mai 2020 wurden dann mit Einführung einer (Alltags-)Maskenpflicht erste Reglementierungen wieder entschärft. Sportstätten, Spielplätze, Ausstellungen und Zoos wurden wieder geöffnet und im weiteren Verlauf öffneten allmählich auch Gaststätten und Sportanlagen wieder. Diese neuen Verordnungen sahen vielerorts Maskenpflicht vor, entsprechende Hygienekonzepte mit den sog. A-H-A-Regeln und hoben das Betretungsverbot im öffentlichen Raum wieder auf, sodass öffentliche Stadträume, wie der Botanische Garten und Schlossgarten, wieder für Passierende zugänglich wurde. Nachdem über den Sommer die Bewegung im öffentlichen Raum nicht mehr durch Betretungsverbote eingeschränkt wurde, folgte ab dem 19.10.2020 die Maskenpflicht im öffentlichen Raum, wenn der Mindestabstand nicht eingehalten werden kann (beispielsweise Innenstadt, Schlosspark, etc.). Anfang Dezember erließ die Stadt Karlsruhe die nächtliche Ausgangssperre. Von 23.03.2021 bis 22.05.2020 war in Karlsruhe die Bundesnotbremse in Kraft. Seitdem sind die Fortbewegung und die Möglichkeiten im öffentlichen Raum wieder gelockert worden.

4.2 Auswirkungen der Maßnahmen auf den Hochschulbetrieb und das Campusleben

Bereits am 13.03.2020 informierte das Präsidium des KITs alle Studierenden und Mitarbeitenden, dass „[m]it sofortiger Wirkung […] am KIT alle Veranstaltungen vom 17.03. bis einschließlich 19.04.2020

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abgesagt [werden]“ (E-Mail des Präsidiums vom 13.03.2020). Somit wurde der Einstellung des Studienbetriebs an Hochschulen aus der ersten Corona VO BaWü entsprochen. Dies betraf jegliche Lehrveranstaltungen, die laufende Prüfungsphase und sonstige Veranstaltungen, die in Präsenz geplant waren oder gerade stattfanden. Online-Formate konnten weiter bestehen. Sofern Veranstaltungen nicht zur Aufrechterhaltung des Betriebs am KIT erforderlich waren, wurde das Campusleben vom Campus verbannt. Der Vizepräsident für Lehre und akademische Angelegenheiten des KIT bat die Studierenden eindringlich darum, den Campus nicht zum Besuch von Lehrveranstaltungen oder zum Lernen zu betreten. Mit dem Ausschluss der Campus-Angehörigen vom selbigem, wurden auch alle Einrichtungen, wie Bibliothek, Cafeterien, die Mensa und das Studentenwerk, bis auf Weiteres geschlossen.

Von Mai bis Juli 2020 kehrten die ersten Studierenden während der ‚Sonderprüfungsphase‘ auf den Campus zurück. Auch Laborpraktika oder andere, wichtige Präsenzveranstaltungen, konnten mit der Einhaltung entsprechender Hygienekonzepte stattfinden und auch die Mensa und Cafeterien boten Essen zum Mitnehmen an. Dies bewirkte, dass sich wieder mehr Studierende und Mitarbeitende auf dem Campus fortbewegten und die Freiflächen nutzten. Da jedoch auch das folgende Wintersemester im Online-Format startete, ist das Campusleben im Mai 2021 noch nicht vollständig zurückgekehrt. Das KIT setzt seit März 2020 immer noch verstärkt auf eine Home-Office-Empfehlung für die Beschäftigten. Der Studienbetrieb befindet sich weiterhin überwiegend im digitalen Format. Anders als für den öffentlichen städtischen Raum hatte das Einsetzen der bundesweiten Notbremse Ende März für die Campusnutzung keine weiteren Auswirkungen. Nach der aktuellen Corona VO BaWü ist der Präsenz-Studienbetrieb der Hochschulen immer noch ausgesetzt, Ausnahmen werden zunehmend ausgeweitet (beispielsweise Laborpraktika, wichtige mündliche/schriftliche Klausuren etc.).

5 STUDIENDESIGN

Hatte dieses Aussetzen der überwiegend studentischen Nutzung vom Campus bereits einen Effekt auf die Nutzung, Bedeutung und Wahrnehmung des Campusgeländes bei den Nutzenden? Mit dieser Frage befasste sich im Wintersemester 2020/2021 und Sommersemester 2021 eine Studierendengruppe am Institut für Geographie und Geoökologie des KIT. Innerhalb des Studiengangs B.Ed. Geographie absolvieren die Studierenden in ihrem fünften und sechsten Fachsemester ein ‚Methodenorientiertes Projektseminar‘. Im Rahmen dieses semesterübergreifenden Seminars werden sie an das wissenschaftliche Arbeiten herangeführt, um so auf das Verfassen ihrer eigenen Qualifikationsarbeit vorbereitet zu werden. Das Seminar entstand aus dem Projekt LehreForschung heraus, das über mehrere Jahre vom Bundesministerium für Bildung und Forschung gefördert wurde. Die Inhalte des Projektseminars werden mit jeweils laufenden Projekten aus der Arbeitsgruppe Humangeographie des Instituts verknüpft, um Studierenden die Möglichkeit zu geben, Einblicke in aktuelle Forschungsprozesse zu erhalten. Lernziele des Seminars umfassen das wissenschaftliche Arbeiten mithilfe eigener Fragestellungen und einer eigenen empirischen Untersuchung. Für das vorgestellte Semester befassten sich die Studierenden mit der Fragestellung: ‚Campus in der Stadt: #Elfenbeinturm oder #Stadtviertel?‘ und untersuchten die Aspekte Wohnen, Verkehr, Arbeit und Bildung, Einkaufen und Versorgen sowie Kultur und Freizeit und die damit verbundene Verknüpfung zwischen Campus und Stadt in Karlsruhe. Darüber hinaus wurde auch gefragt, inwieweit die Corona-Pandemie die Nutzung und Wahrnehmung des Campus verändert. Um die aktuelle Campusnutzung und Bedeutung aufzunehmen, wurd eine mündliche Befragung auf dem Gelände selbst gewählt. Die Befragung fand zwischen dem 01.03. und 21.03.2021 mithilfe eines gemeinsam im Seminar entwickelten, standardisierten Fragebogens mit überwiegend geschlossenen Fragen statt. Die Auswahl der befragten Personen erfolgte zufällig. Aufgrund des sehr eingeschränkten Studien- und Arbeitsbetriebs auf dem Campus gestaltete sich die Erhebungsphase als schwierig. Die Studierenden befragten ausschließlich Studierende und Mitarbeitende auf dem Gelände. Zeitgleich startete die schriftliche Anwohnendenbefragung des Promotionsprojektes in die Feldphase, aus dem die Idee und die Betreuung des Seminars stammt. Im folgenden werden überwiegend die Ergebnisse der Studierendenbefragung diskutiert, die mit ersten Ergebnissen der laufenden Promotion ergänzt werden.

6 NUTZUNG DES CAMPUSGELÄNDES SEIT MÄRZ 2020

Im folgenden werden die Ergebnisse der Studierenden- und Mitarbeitendenbefragung aus dem Seminar vorgestellt und mit ersten Ergebnissen aus dem laufenden Promotionsprojekt ergänzt.

6.1 Zugang und Fortbewegung zum und auf dem Campus Süd

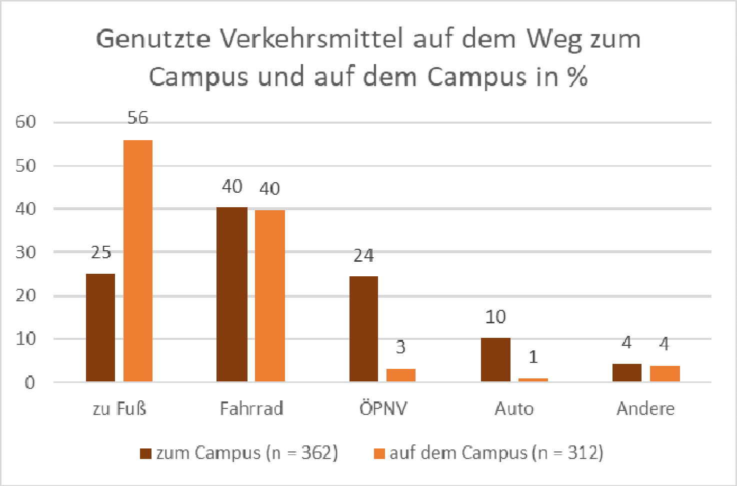

Abbildung 2: Genutzte Verkehrsmittel auf dem Weg zum und auf dem Campus (© Jung, Schuhbauer)

Die innerstädtische Lage des Campusgeländes lässt eine gute Erreichbarkeit aus den umliegenden Stadtteilen erwarten. Die befragten Personen gaben dazu Auskunft, wie sie sich zum und auf dem Campusgelände fortbewegen (ABB. 2). Dabei fiel auf, dass die Fortbewegung auf dem Campus sehr entschleunigt ist. Einen Beitrag dazu könnte der beruhigte Autoverkehr darstellen. Tagsüber ist die Zufahrt mittels Schranke reglementiert und auf dem Campus gilt überwiegend ein Tempolimit auf 30 km/h bzw. Schrittgeschwindigkeit (10 km/h). Die meisten befragten Personen gelangen mit dem Fahrrad zum Campus und bewegen sich mittels Fahrrad auf dem Campus fort (40 %, 146 Nennungen ‚zum Campus' und 124 ‚auf dem Campus'). Auf dem Campus bewegen sich über die Hälfte der befragten Personen zu Fuß fort (56 %, 175 Nennungen). Dieser hohe Anteil setzt sich aus den ankommenden PKW-Fahrer und ÖPNV-Nutzern zusammen, die auf dem Campus die Strecken zu Fuß zurücklegen. Der hohe Anteil an nachhaltiger Fortbewegung, mittels Fahrrad oder zu Fuß, spricht für einen sehr ruhigen Verkehrsbereich. Diese Beruhigung wirkt sich positiv auf den nachhaltigen Verkehr auf dem Campusgelände aus und kann einen wichtigen Beitrag zum Naherholungsaspekt des Geländes leisten.

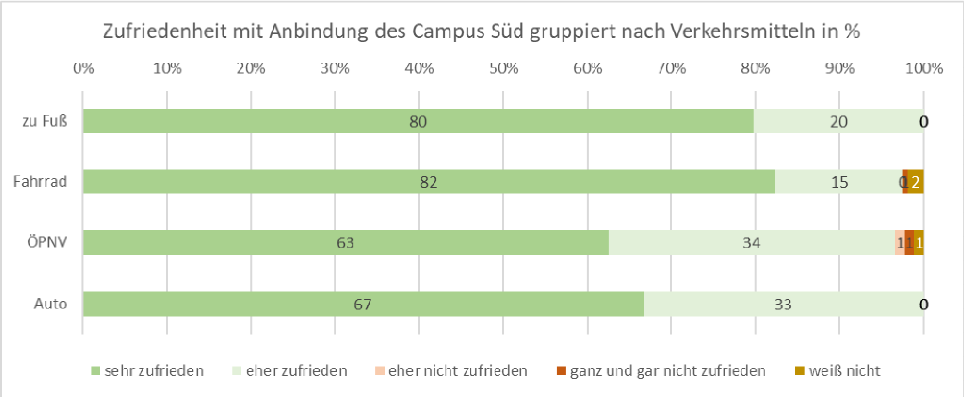

Abbildung 3: Zufriedenheit mit Anbindung des Campus gruppiert nach Verkehrsmitteln

Die Erreichbarkeit des Campusgeländes wird von allen befragten Personen mit unterschiedlichen Verkehrsmitteln als sehr zufriedenstellend bewertet (ABB. 3). Egal ob zu Fuß, mit dem Fahrrad, dem ÖPNV oder mit dem Auto – das Campusgelände ist in Karlsruhe sehr gut erreichbar und gut an Verkehrsnetze angebunden. Im Hinblick auf die Maßnahmen zur Verknüpfung von Stadt und Campus ist diese Wahrnehmung der Nutzenden sehr wichtig, denn Sie zeigt, dass es nicht nur theoretisch möglich ist, auf das Campusgelände zu gelangen, sondern dass die Anbindung auch sehr zufriedenstellend ist. Es gibt keine verkehrstechnischen oder infrastrukturellen Maßnahmen, die bzgl. der Erreichbarkeit des Geländes getroffen werden müssten.

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6.2 Campusaufenthalt der Studierenden und Mitarbeitenden

Der Aspekt des ‚Erholungsortes' verstärkt sich mit Blick auf die Freizeitaktivitäten der befragten Studierenden und Mitarbeitenden auf dem Campusgelände. Von insgesamt 313 Nennungen auf die Frage ‚zu welchen Zwecken die Freiflächen des Campus genutzt werden', antworteten 16 % (50) zum ‚Entspannen, Chillen, Erholen' (siehe ABB. 4). 9,3 % (29) nannten explizit das ‚Spazieren' gehen. Diese Aktivitäten werden wahrscheinlich v.a. zu Pausenzeiten, sowie vor und nach Studien- und Arbeitsbetrieb ausgeführt. V.a. der Austausch und das Aufeinandertreffen von Freunden, Kommilitonen und die gemeinsam verbrachte Zeit ist hier in allen genannten Kategorien anzutreffen. Sie alle zeichnen sich durch die soziale Interaktion mit Mitmenschen aus.

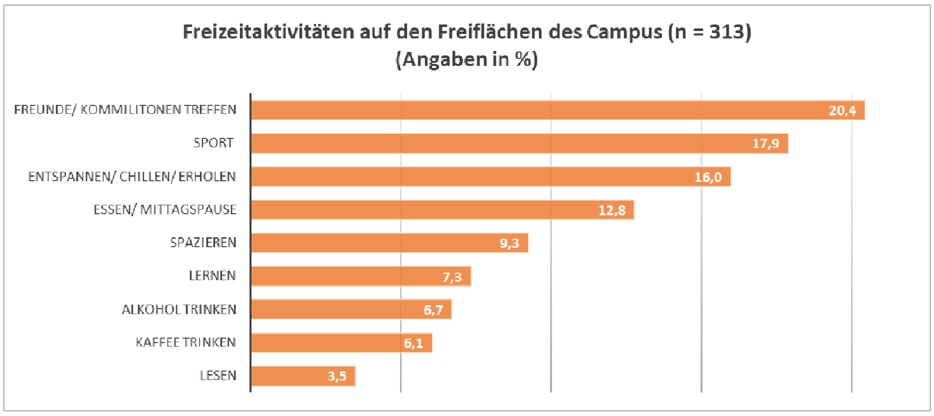

Abbildung 4: Freizeitaktivitäten auf den Freiflächen des Campus (© Heller, Hellriegel)

Die Freiflächen des Campusgeländes scheinen diesen Austausch in vielfältiger Form zu unterstützen. 20,4 % (64) treffen sich auf den Freiflächen v.a. mit Freunden oder Komm-ilitonen. Dies geschieht womöglich ebenfalls überwiegend während der täglichen Studien- und Arbeitszeit, wobei die Nennung von ‚Alkohol trinken' (6,7 %, 21) durchaus auch auf eine Nutzung des Campusgeländes in den Abendstunden schließen lässt. Anhand der hier getätigten Nennungen ist auffällig, dass sich die Freizeitaktivitäten auf den Freiflächen des Campus nicht wesentlich von anderen öffentlichen städtischen Räumen, wie beispielsweise einer Grün- oder Parkanlage, unterscheiden. Zum Aufenthalt im Tagesverlauf waren Mehrfachnennungen zu den gegebenen Kategorien aus ABB. 5 möglich. Daraus wird ersichtlich, dass 78 % der befragten Personen (341 Nennungen) sich üblicherweise am Vor- und Nachmittag auf dem Campus aufhalten. Dies deckt sich mit der gewöhnlichen Arbeits- und Studienzeit auf dem Gelände. Da hier die Formulierung ‚üblicherweise' in der Fragestellung gewählt wurde, ist davon auszugehen, dass sich die Antwort auf den regulären Campusbetrieb bezieht und nicht zwingend auf die aktuelle Nutzung.

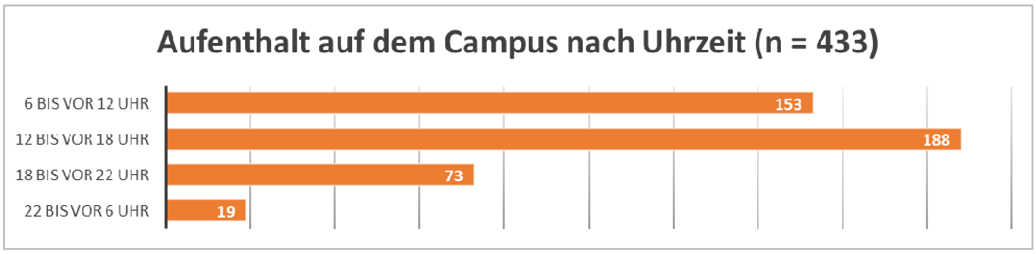

Abbildung 5:Aufenthalt auf dem Campus im Tagesverlauf

Der geringe Anteil an Aufenthalten in den Abend- und Nachtstunden kann hier zum einen mit der geringen Aktivität in den Abendstunden auf dem Campus erklärt werden. Der reguläre Studien- und Arbeitsbetrieb endet größtenteils um 18 Uhr auf dem Campus. Einige kulturelle Veranstaltungen sorgen während des Semesters dafür, dass auch abends Feste oder Veranstaltungen stattfinden und die Menschen sich hier aufhalten. Besonders während des Sommersemesters finden viele Festivitäten der Studierenden und Fachschaften statt, die viele Menschen auf den Campus locken. So auch das Unifest, das von Stadt- wie Wissensgesellschaft über mehrere Tage im Sommer gerne besucht wird und bereits auf eine lange Tradition zurückschauen kann. Im Wintersemester finden viele Veranstaltungen in den Gebäuden statt und haben nach außen weniger Präsenz. Nur 17 % (73 Nennungen) der befragten Personen gaben an, sich abends auf dem Gelände aufzuhalten und lediglich 4 % (19 Nennungen), dass sie dies nachts tun würden. Inwieweit diese

Wahrnehmung durch die Corona-Pandemie getrübt wurde, kann sich nicht so leicht feststellen lassen. Durch die Maßnahmen zur Eindämmung des Corona-Virus sind viele Festivitäten bereits im vergangenen Sommer abgesagt worden. Durch die geringe Aktivitäte auf dem Campus infolgedessen kann es durchaus zu einer geringeren Aufenthaltsdauer zur Zeit der Corona-Pandemie kommen, als dies zu einem früheren Zeitpunkt festzustellen wäre. Ein weiterer Punkt der zu einem geringeren Aufenthalt in den Abend- und Nachtstunden führen könnte, ist die spärliche Ausleuchtung der Freiflächen auf dem Campus. Dennoch ist an dieser Stelle nochmal auf die besondere Situation während der Corona-Pandemie hinzuweisen. Die wenigen Studierenden und Mitarbeitenden, die im Rahmen der Befragung auf dem Campusgelände angetroffen wurden, halten sich derzeit überwiegend tagsüber auf dem Gelände auf. Die im Titel dieses Beitrags erwähnte ‚gähnende Leere' zeigt sich hier in der generell geringen Nutzung des Campusgeländes derzeit von Studierenden und Mitarbeitenden und zeigt sich v.a. in der Nutzung des Geländes im Tagesverlauf.

6.3 Wahrnehmung des Campus aus Sicht der Anwohnenden

Abbildung 6: Assoziationen zum Campus Süd aus Sicht der Anwohnenden

Und wie empfinden es die Anwohnenden? In Kapitel 3 wurde bereits auf die Wirkung eines Raumes auf den Menschen und die daraus resultierenden Handlungen eingegangen. Nun stellt sich für diesen halböffentlichen Raum, der in Innenstadtlage für jeden zugänglich und wie bereits gezeigt sehr gut erreichbar ist, die Frage, wie wird er von außen wahrgenommen? Die Wahrnehmung lässt sich gut mithilfe von Assoziationen zu einem bestimmten Raum darstellen. Nachstehende Wortwolke (ABB. 6) zeigt die zusammengefassten Assoziationen der befragten Anwohnenden. Je häufiger ein Begriff dabei genannt wurde, desto größer erscheint er in der Abbildung. Die Frage lautete: „Was fällt Ihnen als Erstes ein, wenn Sie an den Campus Süd denken"?. Auf den ersten Blick fallen typische studentische Zuschreibungen auf. Daneben fällt auf, dass der Campus als ‚grün', ‚groß' und ‚weitläufig' wahrgenommen wird, der viele zur Tätigkeit des ‚Spazieren gehen' einzuladen scheint. Diese Form der Naherholung taucht sehr präsent in der Wortwolke auf. Durch die Mehrfachnennung der eben genannten Begriffe rund um das ‚Spazieren gehen' kann darauf geschlossen werden, dass viele Anwohnende den Campus neben dem reinen Hochschulstandort auch als Naherholungsort wahrnehmen und ihn beispielsweise für Spaziergänge in ihrer Freizeit aufsuchen und nutzen. Es wird im weiteren Verlauf des Promotionsprojektes noch herauszufinden sein, inwieweit sich die Wahrnehmung der ‚gähnenden Leere' zur Zeit der Corona-Pandemie auch auf die Anwohnenden übertragen hat.

6.4 Einfluss der Corona-Pandemie auf den Aufenthalt der Anwohnenden auf dem Campus

Die ersten Auswertungen zeigen, dass es tatsächlich seit März 2020 zu einer Veränderung der Nutzung des Campus gegeben hat. Die umliegenden Anwohnenden des Campusgeländes wurden im Rahmen der Anwohnendenbefragung dazu befragt, ob sich ihr Aufenthalt auf dem Campus seit März 2020 verändert habe. Durch die Schließung öffentlicher Einrichtungen und das Betretungsverbot öffentlicher Anlagen und die sehr gute Anbindung des großen Campusgeländes liegt die Vermutung nahe, dass viele auf diese Fläche beispielsweise zum Spazieren gehen ausgewichen sind und so die Nutzungsintensität höher sein könnte, als noch vor der Pandemie. Von 399 Anwohnenden gaben 6 % (25) an, tatsächlich seit der Corona-Pandemie häufiger auf dem Campusgelände unterwegs zu sein. Hier könnte die Wertschätzung und die Wahrnehmung des Campus sich im letzten Jahr auch verändert haben. Auch interessant ist, dass 41 % (162) der Anwohnenden angaben, dass sich ihr Campusaufenthalt nicht verändert habe. Diese gehen entweder gleich oft oder gleich selten bzw. nie auf den Campus. Diese können auch wiederum in diejenigen aufgeteilt werden, die den Campus ohnehin schon häufig besuchen oder das Gelände nutzen und die, die den Campus nicht so regelmäßig nutzen. Die 53 % (212) der Anwohnenden, die den Campus seit Beginn der Corona-Pandemie seltener nutzen, sind mit hoher Wahrscheinlichkeit anwohnende Studierende oder Mitarbeitende, die das Studium und die Arbeit seitdem im Home-Office bewältigen. Es könnte aber auch auf die Beschränkungen im öffentlichen Raum zurückzuführen sein, sodass zugängliche ‚Stadträume' von den Anwohnenden nicht mehr so häufig betreten wurden und dies das Gelände des Campus in der Wahrnehmung als ‚öffentlicher Raum' einschloss.

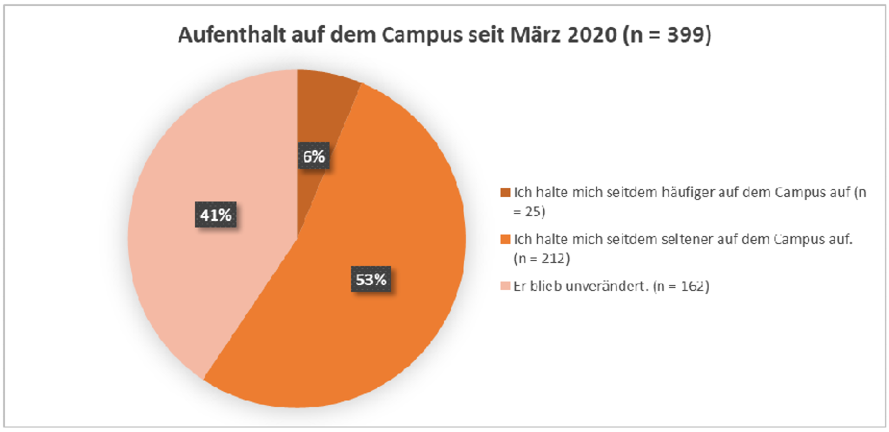

Abbildung 7: Aufenthalt auf dem Campus seit März 2020 (Anwohnende)

7 FAZIT UND AUSBLICK

Die Ergebnisse der Seminarstudie haben gezeigt, dass Campus-Angehörige wie Anwohnende das Campusgelände als geschätzten Naherholungsraum wahrnehmen und die Freiflächen überwiegend für soziale Aktivitäten des Austauschs nutzen. Dieses hohe Potenzial zur Ausübung sozialer Aktivitäten auf den Freiflächen des Campus kann in der zukünftigen Campusentwicklung weiter ausgeschöpft werden. Der Campus Süd ist bereits jetzt mit verschiedenen Verkehrsmitteln sehr gut aus allen Stadtteilen der Stadt Karlsruhe erreichbar und die Art der Anbindung bzw. die Wege zum Campus sind sehr zufriedenstellend. Die Verkehrsberuhigung auf dem Campusgelände durch die Reglementierung der Zufahrt mit dem PKW zeigt sich hier ebenfalls als eine zu fördernde Maßnahme, die den Campus als Naherholungsfläche attraktiv macht. Diese hohe Standortqualität des Campus als innerstädtischer Erholungsraum könnte in Zukunft noch gesteigert werden durch das Beachten der Bedürfnisse der Nutzendengruppe der Spaziergehenden, da sich die Hauptnutzungszeit, v.a. derzeit im Verlauf der Corona-Pandemie, überwiegend auf den Tag bezieht. Die Einrichtung von Ruhebänken, öffentlichen Toiletten oder beispielsweise Bücherschränken könnte zu einer höheren Verweildauer auf dem Gelände führen. Hier könnten dann weiter entsprechende Angebote das Interesse und die Aufmerksamkeit der städtischen Gesellschaft auf wissenschaftliche Themen und Forschungen gelenkt und ein Austausch zwischen Stadt und Wissenschaft initiiert werden. Die rein hochschulaffinen Nutzungen befinden sich hier erst hinter den Gebäudewänden, die für die Öffentlichkeit nicht frei zugänglich sind. Die neu entstehenden Gebäude entlang der Campusgrenzen könnten mit ihren öffentlich ausgerichteten Erdgeschosszonen dafür sorgen, die Grenze zwischen Campus und Stadt, nicht an den Gebäudewänden enden zu lassen. Hier entsteht neues Potenzial, Raum für Synergieeffekte und Austausch. Dennoch gleicht das Campusgelände derzeit eher einer „Wüste", als dass der im Beitragstitel aufgerufene ‚beliebter Park' in der Befragung ersichtlich wurde. Es muss sich zeigen, ob die leicht erhöhte Nutzung und Nachfrage des Geländes als innerstädtischer Naherholungsraum sich nach der Corona-Pandemie durchsetzen wird. Es wird angenommen, dass die ‚gähnende Leere' auf dem Campus durch das Fehlen der Studierenden und Mitarbeitenden dazu einen hohen Beitrag geleistet hat. Kehren diese wieder auf den Campus zurück, ist abzuwarten, ob sich der Effekt der erhöhten Nachfrage nachhaltig etabliert und sich das Potenzial des nachgefragten innerstädtischen Nacherholungsraumes weiter ausschöpfen lässt. Dabei stellt sich jedoch für die Zukunft die Frage: Wie offen sollte ein solcher Campus tatsächlich gestaltet werden? Die Vorteile eines halböffentlichen Raumes und die Idee der Campusanlage sollten bedacht werden. Sie fördern eine größere Ruhe, Kontemplation und Freiheit der Planung für die Campusentwicklung. Es ist daher zwingend notwendig den Ist-Zustand der jeweiligen Campusnutzung am Standort zu evaluieren, um für die jeweilige Situation die geeigneten Maßnahmen zur Verknüpfung von Stadt und Campus zu eruieren.

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🏆 *reviewed paper*

A Framework for an Effective Public Participation Process in the Urban Development of City Centers – the Case of Alexandria, Egypt

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1 ABSTRACT

In the past half-century, researchers started paying attention to enhancing the performance of urban spaces. Their perception of performance comprised urban climate changes, space synthesis, economic performance, and enhancing the quality of life in spaces. However, it has been agreed that Good Governance(GG) is the key to achieving any of the previously mentioned enhancement projects. Good Governance(GG) pillars ensures the participation of the public.

Public participation is a cornerstone in any planning process. Nevertheless, the way in which the participation practices are accomplished guarantees its effectiveness as a planning tool. In these regards, Good Governance (GG) stands as a keyword. Having good governance allows citizens to participate freely in development projects, ensuring the deep fulfillment of users' needs, and the efficient use of city resources and assets.

This paper proposes a framework for effective public participation based on Good Governance (GG) understandings. Considering the implementation challenges in different conditions, it focuses on the third world countries and Egypt in particular. It identifies the keys to a successful participation process by correlating effective participation practices to the levels of participation, types of stakeholders, the stages of urban development, the city systems, and the participation process. Finally, this paper validates the proposed framework by analyzing the Elkhaledin garden re-development project, one of the city center revitalization projects in the city of Alexandria, Egypt.

Keywords: stakeholders, participation, third world countries, urban development, governance

2 INTRODUCTION

Many cases considers governance as a separate element from governments, while in others, governance is equalized with the government. Therefore, a number of definitions were proposed to meet these interlocking interpretations. Keefer describes governance as no Sharpe definition would provide a convenient interpretation of the process (Peter Keefer, 2009).Weiss, on the other hand, lists seven different definitions of governance(Renée E. Weiss, 2000). The OECD compiles another seventeen definitions(OECD, 2009) describing governance as a political authority that exercises control over society. Not only do definitions vary across organizations, but they also vary within organizations. Even the World Bank has several definitions proposed.

A number of the above mentioned definitions include three words that demonstrate the governance system; Process, Power, and Management of the common affairs of a community (or a country, society, or nation). These numerous definitions suggest different criteria and standards against which the quality of governance can be assessed(Tosics, 2011). They claim that the presence of governance in a society is never enough to manage public affairs, good governance (GG) is a crucial element in the process. Good governance(GG) is a modern concept that does not only comprises the control of power and politics to control the public but incorporates all the authorities available(Rotberg, 2014). This new concept lies on three main pillars; Accountability, Participation, and Transparency.

Among the previously discussed pillars, public participation is considered the most accurate and illegible one to be used in such situations. Participation is widely considered to improve the quality and effectiveness of decision-making(Enserink, Witteveen, & Lie, 2009). It is used in many life aspects, from environmental development over urban and regional planning to general polities. Although its importance remains massive, it's not widely popular to use in most countries. Public participation alone does not ensure good governance (GG) practice. Even though it faces some serious troubles and challenges, the best way to achieve its goals is by ensuring the effectiveness of the public participation process. Integrating Demand for Good Governance (DFGG) mechanisms into projects involves setting up systems to ensure that beneficiaries have a greater voice in planning and that the project is downwardly accountable and responsive to their needs. It can be initiated and supported by government, citizens, or both.(Enserink et al., 2009).

This paper aims to study the effective public participation process in urban development projects, several researcher's proposals are analysed leading to the formulation of a framework that facilitates the flow of the process. This framework encompass four stages of the planning process, however, only the first stage will be tested in this paper by comparing its results with an urban development case study in Alexandria, Egypt that took place two years ago and the project reopening was ten months ago.

3 CONCEPTUAL FRAMEWORK METHODOLOGY FOR EFFECTIVE PUBLIC PARTICIPATION FRAMEWORK (EPPF)

This section introduces the proposal's theoretical framework. The framework decends from a3

combination of the concept of Hudson Smith and Wilcox. It includes four main elements; the levels of participation, stakeholders participating, communication tool, and stage of urban planning. The results produced four main participation templets for each of the stages of the planning.

3.1 Concept of the framework

Hudson Smith designed a matrix that links the levels of participation, forms of communications, addresses, and the communication tool(Hudson-smith, Evans, Batty, & Batty, 2002). Wilcox, a researcher, and planner submitted a matrix between the levels of participation, the phases of participation, and the stakeholders(Wilcox, Kean, Ritchie, Smith, & Wilcox, 1994). The proposed strategy combines the two strategies creating relationships between four elements by using the levels of participation as the link between the two matrixes. The levels of participation, the communication tool, the stakeholders participating, and the stages of the process became the parameters of the new approach proposed.

Wilcox studied the ladder of levels of participation and then added two other dimensions to the ladder. The phase or stage of participation and the fact that stakeholders may be at different levels or stages of participation(Wilcox et al., 1994). He proposed a set of questions that should help decide the approach:

Who are you? For example someone in a position of power controlling funds or other resources. Someone with influence because you are planning or managing a participation process. Someone with professional expertise or knowledge?

Figure 1: the proposal of Hudson, and Wilcox parameters. source, author.

What do you want to achieve by working in a participatory style? To try and develop plans that meet people's expectations. To give people a say in the plans. To give people control over the solutions. Who will have the final say over decisions? Yourself. A management team. Everyone who gets involved. A political institution or other body.

How ready are people, and organizations, to work in a partiipatory way? Do they have the desire? Do they have the skills? Do they have the authority?

On the other hand, Hudson's matrix is based on the concept of interactive participation. He believes that the key to successful participation is using the proper communication tool. He even gives big attention to new technological participation tools. He proposes a matrix that connects the participation tools with the levels of participation. His main goal is to transform participation from passive to interactive(Hudson-smith et al., 2002).

The framework fosters the concept of both Hudson, and Wilcox by combining them to create the relationship between the parameters. Different levels of participation are appropriate for different situations, at the same time there isn't one 'community' but many interests – or stakeholders – to consider. The process itself takes time could be months or even years, so the precision of who should be involved and when need to be as accurate as possible. To achieve the best results the participants must be informed clearly about the part they do in the process, in what stage of the planning process and how is the level of their participation and how to participate exactly.

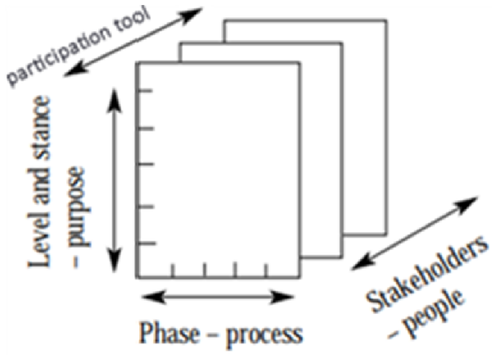

Figure 2: four-dimensional participation framework. Source, information based on Wilcox, 1994.

3.2 Parameters of the framework

3.2.1 Levels of public participation

The concept of involving the public in the development process is not new, a wide range of development agencies experimented with the people involvement technique. Many companies implement this technique to collect data, interactive analysis, develop power, and improve decision making. To achieve this goal, several researchers proposed their sets of participation levels. The typology used in this approach was proposed by Jules N. Petty in 1992. He divides the participation levels into seven different levels based on the extent of power given to the participants(Pretty, 1994). The typology seemed very convenient to the study as the participants (stakeholders) were the key elements that link all the other cornerstones to one another.

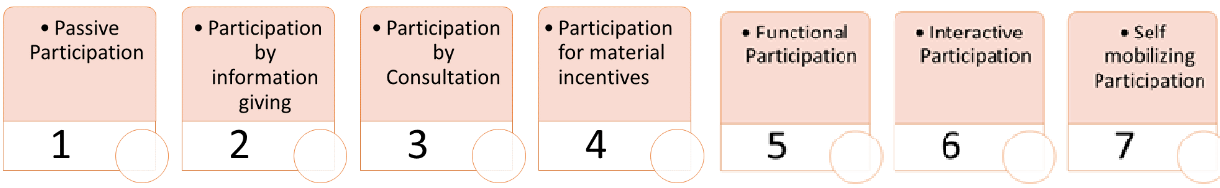

Figure 3: the levels of public participation according to Pitty.

3.2.2 The Stakeholders' Involvement concerning the Levels of Participation.

The urban crisis center created a table for all possible stakeholders appropriate for every different context. The center also highlights that there is always a large number of stakeholders involved but that doesn't mean that it is needed to coordinate with all of them all of the time. The first category and the most important stage is The Affected Population. The affected population comprises many categories under its umbrella, they can consist of citizens of several cultural, social, ethnic, and economic backgrounds, and they can also be direct or indirect affected population. The urban crisis center recommends the participation of the affected population in all the stages of participation. The second category of stakeholders in the international actors and donors, such as UN bodies, international humanitarian organizations. The job of these commits varies

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between the first four participation moods. National governments are also one of the important categories of participating stakeholders, they can be in form of planning offices, disaster management bodies, or specific ministries or departments. The next category is the local governments, which are the municipals, city councils, government institutions, their area of participation is mainly in the executive participation area. They're followed by the urban planning institutions, which could be specific government planning offices, their job in the planning and execution, and monitoring stages. The private sector is one of the acting stakeholders participating in the process, which could be any financial institution), large national businesses, and small local vendors.The private sector plays a big job in executing the projects, and planning stages. The next category is the community leader, this category is considered one of the most important categories of the stakeholders due to their ability to influence public opinions. The final category is civil society, local NGOs, community-based organizations, and non-state actors.

There is an ideal pattern for the participation of the stakeholders. This pattern was proposed by Zlatka Ljubimir, and the linkage between the levels of participation and the stakeholders was designed by Wilcox. However, this pattern does not happen in real-life participation projects because, as mentioned before, the city system controls the stakeholder's pattern of participation.

	passive participation	p. in information giving	p. by conultation	p. for material incentives	functional participation	interactive participation	self mobilization
Academia							
Affected population							
national governement							
local governement							
international actors and donurs							
urban planning institues							
private sector							
community leaders							
civil society							
NgGOs							

Table 1: interpretation of the participation of stakeholders in the ladder of participation of Petty.

4 PUBLIC PARTICIPATION IN EGYPT

The Arab Republic of Egypt is a transcontinental nation in the northeast of Africa and southwest corner of Asia via the Sinai Peninsula. According to the latest constitution declared in 2014, The republic is a unitary country with a decentralized public participation pattern.

The Egyptian administration is designed on a vertical structure. Under Law 43 of 1979, local administration is divided into 3 subnational levels. At each level, there is a governing structure combining representative councils and government-appointed executive bodies headed by governors, district officers, and mayors, respectively. Governors are appointed by the president, and they, in turn, appoint subordinate executive officers. The backbone of the state apparatus runs downward from the Ministry of Interior through the governors' executive(Constitution of the arabe republic of egypt, 2012).

In 2012, The Shoura Council agreed on several key principles to guide reforms in local governance, including the devolution of authority from the central level to the local level, and the decentralization of taxation and budgetary authorities.

4.1 Effective public participation framework

The latest Egyptian Constitution (2014) states that "Citizen Participation in public life is a national duty," but limits participation as "the right to vote, run for elections, and express opinions in referendums, according to the provisions of the law."(Constitution of the arabe republic of egypt, 2014) This limited view of citizen participation is debatable since electoral politics and referendums launched by the executive branch will not be enough to absorb the pent-up and ongoing demands of the public for significant quality of life changes and greater government responsiveness, accountability, and transparency(Constitution of the arabe republic of egypt, 2014).

4.2 Central level

At national level the Parliament adopts laws setting out the allocations of local authorities and carries out a tight form of legislative, executive and taxation/budgetary oversight(Constitution of the arabe republic of egypt, 2013, 2014).

Parliamentary oversight:

The People's Assembly holds overriding powers over the local councils:

- Members of the People's Assembly have the right to audit popular council meetings, participate in debates, and ask questions, offer suggestions and request information.
- The Minister in charge of local administration is required to present an annual report to the President of the People's Assembly on the activities and accomplishments of the local popular councils.
- The Assembly can take the form of a commission in charge of evaluating the activities and accomplishments of each local unit.

4.3 Executive oversight

Central authorities have the responsibility and power to create and disband local authorities. Irrespective of the established principle of electing local council, de facto "the possibility of nominating particular members – by central authorities – has not been excluded".

The Governors are appointed by the President of the Republic. The nomination of mayors and heads of urban subdivisions, as well as changes and transfers within or between local authorities, are carried out upon decision of the Prime Minister, with the agreement of the Governors in question.

4.4 Regional level

Law 475 of 1977 also divided the Republic into 7 economic regions without any administrative/political function. At regional level, within the governorates, the governors and the governorate local council have extensive powers over lower local councils especially at legislative and budgetary levels. In particular, they can approve or oppose decisions made by lower popular councils. Furthermore, governorate local popular councils have the power to stand in for local popular councils under the control of the governorate for projects that councils are unable to carry out themselves. As for financial issues, the Governor's approval is required for any taxes that a local town council plans to raise. They also have the power to oppose decisions made by local popular councils.

4.5 Local level

District local popular councils exercise oversight over the activities of local town and village councils within the district and can approve their decisions.They also have control over various local services covering more than one local unit within the district's framework.

Town popular councils: exercise powers of oversight over urban subdivision councils and guarantee coordination of their activities. They also control local services within the framework of the town or city's constituency. Urban subdivision popular councils have responsibilities and powers similar to those of town popular councils. The following tables propose a public participation pattern (based on the governance system of cities in Egypt previously mentioned) to ensure the effectiveness of the process, however, this paper will test the first table only.

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in stage 1 : Initiation (assessment and analysis)

	passive participation	p. in information giving	p. by conultation	p. for material incentives	functional participation	interactive participation	self mobilization
Academia			1				
Affected population							
national governement					1		
local governement							1
international actors and donurs		1					
urban planning institues			1				
private sector			1				
community leaders				1			
civil society				1			
NgGOs			1				

in stage 2 : Implement (design and monitoring)

	passive participation	p. in information giving	p. by conultation	p. for material incentives	functional participation	interactive participation	self mobilization
Academia					1		
Affected population					1		
national governement						1	
local governement						1	
international actors and donurs			1				
urban planning institues					1		
private sector						1	
community leaders					1		
civil society					1		
NgGOs			1				

in stage 3 : Design and Planning (design and function)

	passive participation	p. in information giving	p. by conultation	p. for material incentives	functional participation	interactive participation	self mobilization
Acdemia					1		
Affected population				1			
national governement				1			
local governement						1	
international actors and donurs			1				
urban planning institues					1		
private sector					1		
community leaders					1		
civil society					1		
NgGOs			1				

in stage 4: Evaluation(evaluation and implementation)

	passive participation	p. in information giving	p. by conultation	p. for material incentives	functional participation	interactive participation	self mobilization
Acdemia						1	
Affected population						1	
national governement						1	
local governement						1	
international actors and donurs						1	
urban planning institues						1	
private sector						1	
community leaders						1	
civil society						1	
NgGOs						1	

Table 2: effective public participation framework.

4.6 The re-development project of Elkhaledin Garden

The khaledin Garden is located in front of the Mosque of the Leader Ibrahim, and is slightly higher than the surface of the ground, including a garage with its area below, and the garden includes a group of statues of influential Egyptian figures, such as Sayed Darwish, pioneer of Arab music, Abdullah Al-Nadim, the preacher of the Arab revolution, Hassan Iskandarani, nicknamed Amir The seas, and some other national symbols, whose names are engraved on marble pieces, have been extracted from the garden.

Figure 4: Ariel photo of the garden. Source, (Yom sabe3, 2021)

The garden began to deteriorate and the loss of its grass-planted ground, beginning with the January 2011 protests, as thousands flocked to it, despite the danger it poses to them with the increasing numbers, to erode its columns without any of them or those in charge of care.

Negligence struck the Immortals Park, which is part of the square of the Leader Ibrahim Mosque in central Alexandria, where it became a neglected garden for more than 10 years, despite its location in the middle of the Alexandria Corniche, and a garage under the garden turned into a den for outlaws, criminals and drug users at night.

Users and citizens began complaining about the situation of the garden, and years after, the government responded and the development project took place. The participation of the public need to be present in all of the development stages. However, this paper investigates the participation of the public in the first stage only.

5 DATA COLLECTION METHODOLOGY

Due to the complex and diverse themes of the research, data for this research were collected using both qualitative and quantitative methods. Field observations, case study analysis, interviews and mixed questionnaires survey were used to collect the relative data.

Interviews with local residents, users and passing by personals took place while investigating the area.

The following questions were asked;

- Did you complained about the situation of this garden before(Complaint official filing/ social media)
- Were you informed/invited to any session hosted by your governor/ district depute introducing any project in your city?
- Did you propose any ideas to renovate or use the garden before?

An 8 minutes questionnaire was also published on all social media platforms to investigates the participation of the public . The form of the question may be either closed ended format or open ended format. Therefore, due to research's nature and intended goals, structured questionnaire was designed with mixed questions. The questionnaire into five main sections; this first section is dedicated mainly to know more details about the participant's lifestyle and background. The second section investigates the participant's relationship with the city system and the local governance system. The third section discuss the participation of the users in the planning stages of the process. The fourth evaluates the participant's experience in the project. The fifth and final stage investigate the respondent's perception of public participation.

The target respondents are people from the eight mentioned categories in the questionnaire. For this questionnaire to success, users form all of the eight categories need to participate and take this questionnaire. The eight categories are (urban planning institutes, affected population, national government, local government, participation moderator, academic researcher, civil society, private sector).

5.1 The renovation project

Last year(2020), the people of Mahatet El Raml, woke up a day on heavy voices of demolishment. The responsibles responded to the needs of the citizens. The development work was being carried out at the

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highest level, and it contains the reopening of the garage to include two floors to accommodate 300 cars and a chain of stores, in addition to developing the upper yard, preserving statues, developing lighting systems, as well as adding many services to citizens and setting up a maintenance system to continue with us after.

The roof opposite the garage was a garden and then began to collapse from neglect, and the courtyard was replaced by a theater with cafeterias, and this was done two years ago, and the truth is that the people suffered from the control of thugs and street vendors, and with the darkness of the streets we see soil ready to receive drug users and a hotbed Street children who are exploiting the garden, besides the neglect that imposed control on the garden, but the governorate sought to develop it away from the control of these people, to open the mall and rent cafeterias towards the sea. As for the part of the garden and the seating of passers-by, some stairs resemble the Roman Theater as seating terraces, and I don't think it will be closed in the face of overpowering.

Figure 5: The location of Elkhaledin garden after development project.

As previously mentioned, the feedback was collected using two methods, the one to one interviews, and the survey feedbacks. The interviews were conducted with users, administration, and shop keepers of the aria.

5.2 Interviews feedbacks

The head of a central district indicated that the garage, in its current state, is not suitable for use, due to the weakness of the facilities because it is ramshackle, and a committee has been formed to study the construction situation of the garage and the committee's report recommended restoring the garage, which will cost the governorate more than demolishing and rebuilding it, what the current governor, Muhammad Abd, called Al-Zahir calls for a halt to restoration work and a comprehensive plan for the area as a whole.

Citizens, users, and even visitors to the place started raising complaints. "Unfortunately, it became a shelter for thugs and so-called revolutionaries until W.H.O. became deserted and permissible for thieves, pimps and girls of the night. Alas, I have lived near the mosque since 1958" (said a citizen living in the area)

"This garden and this project is a complete failure, even though its place is beautiful and promising, and unfortunately the place is not exploited at all "(an affected).

One of the interviews held was with an architech from the design team of the project who states that the design process did not take much time because they did not have any feedbacks from the public, and that they only inticipated their design vision.

Survey feedbacks:

500 citizens were asked 30 questions divided into 5 main categories: the first one for general informations, the second category mapes the relationship between citizens and government, the third section investigates the public participation of users in the development project, the fourth part allows the citizens to evaluate the project, and the fifth and final one investigates the citizen perception of good governance. However, this paper will discuss the participation of public in the development project of the garden. The following tables presents statistical results of the participants responses. The survey was shared on surveymonkey platform, and it is avaible in the following link: https://www.surveymonkey.com/r/CJPFV8S

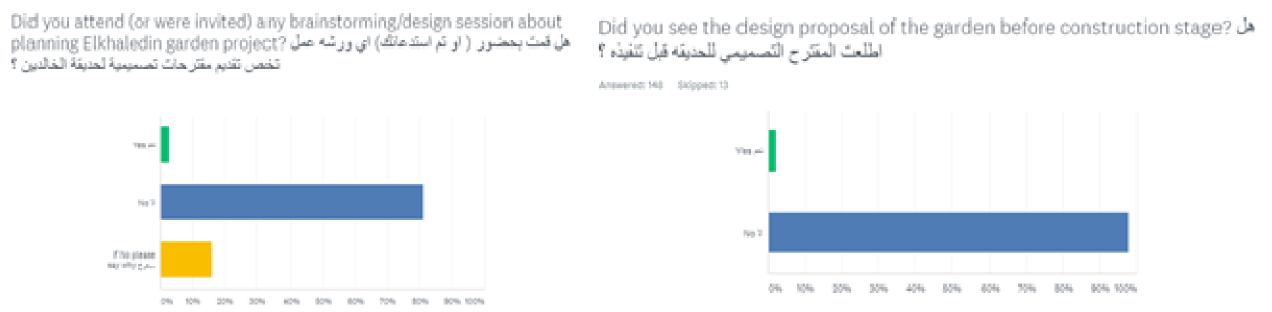

Figure 6: statistical review to the results of the survey's responds (part 1).

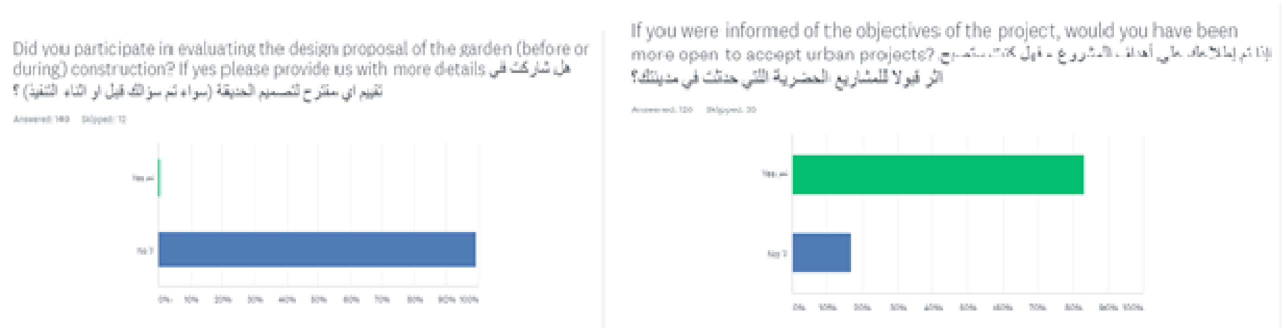

Figure 7: statistical review to the results of the survey's responds (part 2).

Figure 8: statistical review to the results of the survey's responds (part 3).

6 RESULTS

The results of the re-development project were divided between encouraging the new design and transformation and hating the outcome, the average rating of the project was 4.1 star (figure 8). Some citizens said " The garden was destroyed and turned into cafeterias, and the people of Alexandria would not have an outlet because the cafes on the sea corniche occupied the public walkway and took the sidewalks for their benefit without supervision until it became a knot for the Alexandrian citizen. Painting the seats so that the majority do not sit in them and have to enter the exaggerated cafeterias." While others were very happy with the results and enjoying how safe and clean the location became. Another citizen in Alexandria noted "The superiors will not let the people enjoy the development in the absence of oversight. It will not be in the interest of the simple citizen and not only in tourism development, as it does not increase his dissatisfaction, especially as the world is moving towards increasing green space." One of the residents, said that successive cafes are being built and the features of the park are being blurred, and the statues have disappeared in the middle of the cafeteria buildings. There is a garden that the largest part was completely covered with "tiles", but restoring the heritage form is more important than creating an income or financial return for the governorate.

Participants of the survey were asked if they agree with the development project or they would prefer other project in the exact same location. Results were fascinating; only 32.47% of the total number of participants were satisfied with the outcome that came out of the development project (transforming the garden into a food court) while 67.33% did not like the project and did not agree with the importance of creating a new food court in the city. 46.11% of the participants proposed alturnitve projects that in their

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opinion they need more than the food court. 70% of the participants agreed on renovating the garden while living it as it is (a public garden), others proposed projects like open auditoruim, cultural center, towers, and museums. Knowing that 77.75% of the total number of the survey‘s participants answered this question.

The participants were also asked if they have the chance to participate will they be opened to participate or not, 76.97% of the total number of particiants will participate, 21.71% will still stick to not participating. Some participants even commented “ yes, because it took my needs and aspiration into consideration, and now I feel as a part of this”. Knowing that 78% of the total number of the survey’sparticipants answered this question.

Participants were also asked if they would be more acceptable of the urban projects fostered by the governemnets if they were aware of the results. The results show that knowing the goals of the project has increased the rate of acceptance to 83.13% to 16.58 % who will not accept the projects even if they know the goals. However, 2.02% of the respondents noted that they will not link their acceptance with knowing the goals, but the quality of the goal and how helpful it is to the citizens. Knowing that only 60% of the total number of the survey’sparticipants answered this question.

When comparing the framework proposed with the participation pattern that actually happened in the situation (the green slots present the actuall participation pattern while the orange slots present the framework proposed), we can see that the not all the stakeholders where involved in the process. Academia where just used as information givers. The affected population where also information givers, they only provided the authorities with complaints explaining the situation. The nation government was consultant to the process while the local government was controlling the process. The rest of the stakeholders were not participants in this process.

The results of both; the interviews, and the survey concludes that the system is on th e right trac but it is on the first step to a sucessful effective public participation. The empowerment that was given to the locl government over the central government in this projects indicated a promessing decentrized government. Presenting an area for the Academic field is a new approach, even though their participation was not at the expected level. Responding to the complains of the affected population is also considered a type of participation. The urbn planning institute is usualy a part of any development project in the city but in this situation they were not part of this process. The private sector only participated as contractors and cafees owner but they were not part of the planning process. Community leaders, NGOs, civil socity, and international actors and donurs were not a part of this project even though they were recommended by the framework.

in stage 1 : Initiation (assessment and analysis)

	passive participation	p. in information giving	p. by conultation	p. for material incentives	functional participation	interactive participation	self mobilization
Academia			1				
Affected population							
national governement					1		
local governement							1
international actors and donurs		1					
urban planning institues			1				
private sector			1				
community leaders				1			
civil society				1			
NgGOs			1				

Table 3: comparison between what the framework proposal and the actual participation pattern.

7 FURTHER RESEARCH

Completing the investigation process requires more interviews with the current users, questionnaires to gether more detailed information about the participation process of this project. The investigation also needs to compare the participation process in the four stages of planning not only the first stage. The study also needs investiagting similar participaion of citzens in urban projects in unitary decentralized countries.

8 CONCLUSION

The paper presents an effective public participation framework for the stakeholders to participate in the decisions concerning their own cities. It proposes change conjointly with the governance system. The unitary system imposes different participation pattern than the federal system. This proposal connects the public participation levels with the stakeholders, the communication tool, and the urban development stages. The factors produce four tables, each table presents a development stage (assessment, design, monitoring , and evaluation). Each table proposes a relationship between the levels of participation, stakeholders participating and propose an effective public participation tool.

When applying the framework on the case of Alexandria, Egypt, the framework was compared with the actual situation that is happening now. This paper only compared the first table of the framework (the data collection stage) with what happened in the data collection stage in Elkhaledin garden case. The results indicates promising development process in Egypt's system. However, further research will provide more details about the process of public participation in the cities of Egypt and how to modify the current situation to ensure more effective public participation practice.

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reviewed paper

Gründerzeitliche Innenhöfe als Ressource zur Verbesserung des Mikroklimas

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1 ABSTRACT

Einige Bezirke von Graz weisen eine für die Gründerzeit typische Blockrandbebauung auf. Innerhalb dieser Blöcke sind große Freiflächen mit nur wenig Verbauung erhalten geblieben. Da Grünflächen einen großen Teil dieser Innenhöfe einnehmen, sind sie das Objekt dieser Forschung, in der herausgearbeitet werden soll, welche klimatisch beeinflussenden Merkmale für gründerzeitliche Grazer Innenhöfe charakteristisch sind.

Die Entstehung der Innenhöfe wird beleuchtet und festgestellt, durch welche Umstände es zu diesen durchschnittlich 0,62 Hektar großen Freiflächen kommen konnte. Das Untersuchungsgebiet bezieht sich auf die Innenhöfe der sechs Bezirke von Graz, die einen besonders großen Anteil an gründerzeitlicher Bebauung haben. Durch eine Fotodokumentation wurden 131 Innenhöfe von Graz aufgenommen. Alle der ausgewählten Innenhöfe weisen folgende Merkmale auf: Sie befinden sich in einem der Grazer Bezirke, der zum großen Teilen gründerzeitliche Bebauung aufweist, sie sind von gründerzeitlicher Bebauung umschlossen, sie werden vor allem der Funktion Wohnen zugeordnet oder sind zum Großteil von Wohnungen umschlossen, die Innenhöfe sind ganz oder zum Großteil geschlossen.

Bestimmte, dem Mikroklima zuordenbare, Häufigkeiten wurden anhand dieser Fotodokumentation mittels deskriptiver Analyse ausgewertet. Die Blöcke und Innenhöfe sowie ihre Bebauungen wurden über GoogleMyMaps vermessen. Als Ergebnisse lassen sich bestimmte Merkmale wie Bebauung, Grad der Versiegelung sowie Vegetation innerhalb der Innenhöfe in den jeweiligen Bezirken erkennen.

Diese großen privaten Freiflächen stellen eine wichtige Ressource für ein angenehmes Mikroklima im städtischen Wohnbereich dar. In Zukunft wird die Erhaltung sowie die Verbesserung dieses Naturraumes eine wichtige Aufgabe darstellen, da es zu immer mehr Wärmeinseln im urbanen Bereich kommen wird. Durch ein verstärktes Bewusstsein für die Relevanz der begrünten Innenhöfe im Stadtbereich könnten mehr Anreize für klimarelevante Projekte entwickelt werden.

Keywords: Gründerzeit, Mikroklima, Graz, Innenhof, Blockrandbebauung

Abbildung 1: Vergleich Satellitenbild Graz und Wien (Google Maps 2021)

2 EINLEITUNG

Graz ist die zweitgrößte Stadt Österreichs mit einer Größe von 127,58 Quadratkilometer und rund 300.000 Einwohnerinnen und Einwohner.[1] Die strukturierte Blockrandbebauung der Gründerzeit hat die Stadt mit vielen, meist größeren Städten, gemeinsam. Innerhalb der Blockrandbebauung sind halb öffentliche Freiräume zu finden. Verglichen mit anderen Städten findet man in Graz größtenteils wenig Verbauung in diesen Bereichen. Die Bebauungsdichten wurde in der Dissertation „Gründerzeitstadt 2.1“ mittels Referenzquartieren von Wien - Rudolfstadt und Graz - Herz-Jesu-Viertel miteinander verglichen, da sie als typische Bebauung von Gründerzeitvieteln angesehen werden. Das Quartier in Wien weißt eine

[1] Stadt Graz, Zahlen + Fakten: Bevölkerung, Bezirke, Wirtschaft, Geografie.

Quartiersdichte von 2,54 auf, das Quartier in Graz hingegen 1,31. Zur Veranschaulichung wurden beide Quartiere abgebildet[2] (siehe Abbildung 1).

2.1 Entstehung der gründerzeitlichen Innenhöfe

Die Entstehung der Blockrandbebauung mit ihren Innenhöfen ist der industriellen Revolution geschuldet. Durch die Industrialisierung und die damit in Verbindung stehende Landflucht kam es in vielen Städten Europas in den Jahren von 1850 bis 1900 zu einem starken Anstieg der Bevölkerung. Großstädte wie Wien und Berlin sind in kürzester Zeit so stark gewachsen, dass sich die Bevölkerungsanzahl in nur 50 Jahren mehr als verdreifacht hat (siehe Abbildung 2). [3] [4] [5]

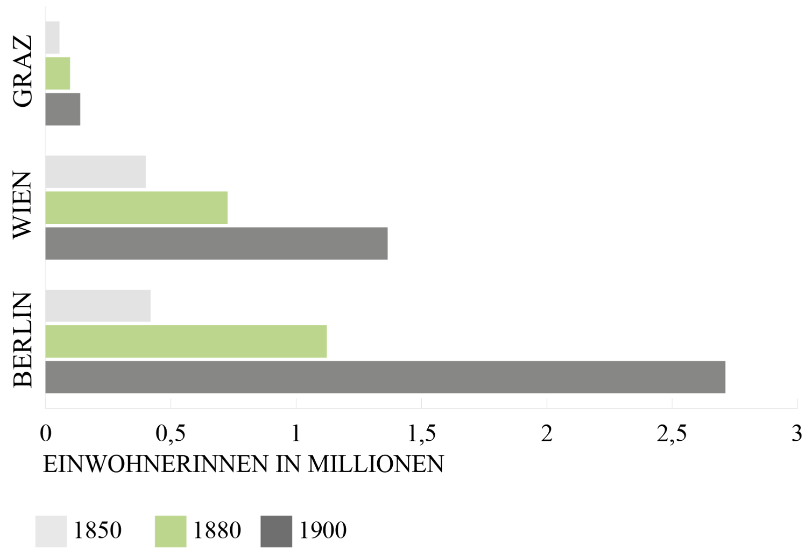

Abbildung 2: Anstieg der Einwohnerinnen- und Einwohnerzahlen in der Gründerzeit

Um in dieser kurzen Zeit möglichst viel Wohnraum zu schaffen, wurde das Rastersystem aufgegriffen und Wohnblöcke entstanden. Durch fehlende Planungs- und Bodenrechte gab es keine Enteignungen für den Straßenbau. Meist wurden in großen Städten große Blöcke gebaut, um möglichst wenig Bauland an den Straßenbau abgeben zu müssen. Jedoch war das Bauland so wertvoll, dass die inneren Bereiche des Blocks mit Wohnungen verbaut wurden. Diese Bebauung entstand vorwiegend nicht nach einer gewissen Zeit, sondern wurde gleich in der Entstehungsphase mitgeplant. Ein großer Teil der noch freien inneren Bereiche der Blöcke wurden mit Wohnungen verbaut. Oft wurde der noch freie innere Bereich der Blöcke als Erschließungsbereich genutzt. Nur wenige Bereiche blieben als Grünflächen frei vom Wegesystem.[6] [7] [8]

Auch kleinere Städte wie Graz wuchsen in der Gründerzeit, gemessen an ihrer Ursprungsgröße, stark an. Jedoch musste, aufgrund der geringen Bevölkerungszahl, nicht annähernd soviel Wohnraum auf engstem Raum geschaffen werden, wie in größeren Städten. Ein planvolleres Handeln war möglich. So wurde zwar auch Graz im Rastersystem erweitert, jedoch war die Notwendigkeit, die inneren Bereiche der Blöcke zu bebauen, nicht gegeben. Die Bodenpreise waren somit auch nicht so stark gestiegen wie jene in größeren Städten und die Blöcke wurden kleiner gehalten. Weiters kam Graz zugute, dass das Baugeschehen meist von den dort lebenden Bürgerinnen und Bürgern bestimmt wurde und nicht von Grundstücks- und Gebäudespekulantinnen sowie Grundstücks- und Gebäudespekulanten. Somit wurde mehr auf qualitätsvolles Wohnen geachtet als auf den Profit.[9]

[2] Pirstling, S 65-92.
[3] Wiener Stadt- und Landesarchiv, Wienbibliothek im Rathaus, Bevölkerung.
[4] Statista GmbH, Einwohnerzahl von Berlin in ausgewählten Jahren von 1600 bis 2019.
[5] Stadt Graz, Bevölkerungsstatistik der Landeshauptstadt Graz.
[6] Pirstling, S14.
[7] Peters, S 10-13.
[8] Moravanszky, S 23.
[9] Bouvier, S 4.

Die Größe der Blöcke der gründerzeitlichen Blockrandbebauung ist eng mit dem Straßenraster verwoben. Die freibleibenden Flächen innerhalb des Blocks wurden, je nachdem wie teuer das Bauland war, so eng als möglich bebaut. Große freibleibende Grünflächen waren in den meisten Städten eher eine Ausnahme. In Graz hingegen waren diese die Regel.[10] Als Gründe für die großen Grünflächen innerhalb der gründerzeitlichen Bebauung in Graz können zwei ausschlaggebende Faktoren genannt werden:

- planvolles Bauen aufgrund der geringeren Bevölkerungsdichte und somit geringerem Bedarf an Quartieren
- günstigere Bodenpreise, kleinere Blockgrößen

Diese Innenhöfe bilden heute oft grüne Freiräume mit einem eigenen Mikroklima.

2.2 Klima in Graz

Durch die Stadtklimaanaylse, welche die Stadt Graz in Auftrag gegeben hat und vom Institut für Geographie und Raumforschung an der Karl-Franzens-Universität Graz durchgeführt wurde, wurden relevante Klimadaten der Stadt Graz aufgezeigt und grafisch dargestellt. So entstand die Stadtklimakarte von Graz. In Abbildung 3 ist ersichtlich, dass vor allem der Innenstadtbereich und die Bereiche mit gründerzeitlichen Blockrandbebauungen stark von Überwärmung betroffen sind (dunkelrote Bereiche zeigen eine sehr starke Überwärmung, hellrote Bereiche zeigen eine starke Überwärmung). Gründe hierfür sind die dichte Bebauung und die geringe Luftzirkulation. Weil Graz aufgrund seiner Tallage recht windarm ist, ist die Durchlüftung stark eingeschränkt. Die Bildung von Wärmeinseln ist die Folge.[11]

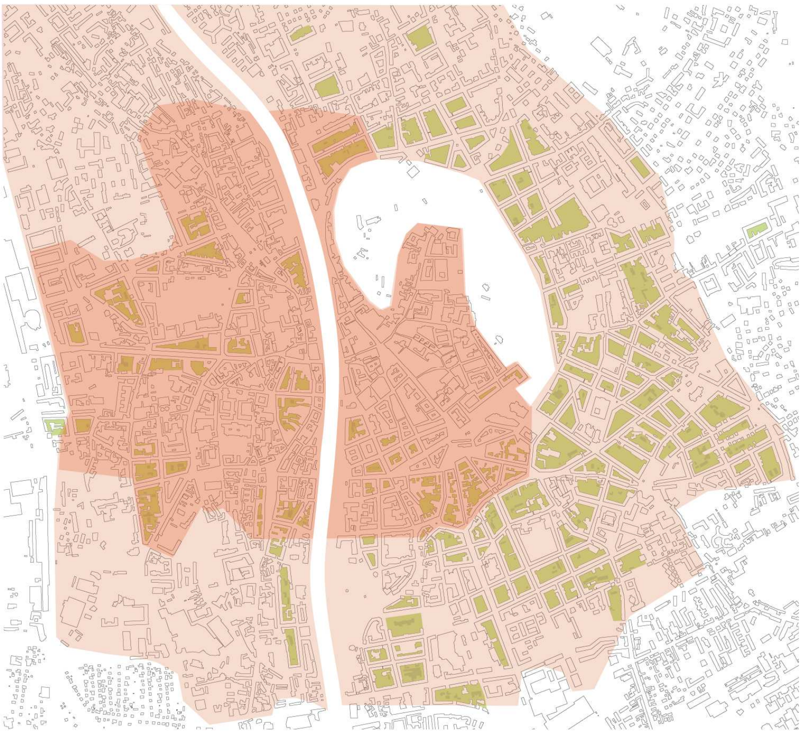

Abbildung 3: Wärmebereiche der Stadt Graz nach Daten der Stadtklimaanalyse

In der Beschreibung der Stadtklimaanalyse wird darauf hingewiesen, dass Bereiche der Stadt Graz mit überwiegend begrünten Innenhöfe im Bereich des Gründergürtels ein bioklimatisch behaglicheres Wohnklima aufweisen, obwohl sie sich innerhalb der Wärmeinseln befinden.[12]

Ausschlaggeben für ein besseres Wohnklima sind die Strömungsverhältnisse innerhalb der Innenhöfe, welche im direkten Zusammenhang mit dem Gebäudeabstand stehen. Beim Innenhof des Typs Lichthof ist der Gebäudeabstand sehr gering. In Graz ist diese Bebauungsform im Stadtkern zu finden. Hier kommt es zu einer relativ geringen Durchlüftung, da der Großteil der Strömung über die Häuser geführt wird. Im gründerzeitlichen Innenhof ist das Verhältnis Hofabstand zu Gebäudehöhe größer und somit vorteilhafter.

[10] Vergleiche Luftbilder Google Maps, Wastlerplan
[11] Lazar/Sulzer, S. 169.
[12] Lazar/Sulzer, S. 224-225.

Hier herrschen gute Lichtbedingungen und es kommt zur Ausbildung kleinräumiger Zirkulationen. Baumbestände verlangsamen zwar die Zirkulation, jedoch sorgen sie auch für Beschattung und verringern die Maximaltemperaturen. In Abbildung 4 wird dies dargestellt. Die blauen Pfeile stellen die kalte Luft, die roten Pfeile die heiße Luft und die orangen Pfeile warme Luft dar. Die schwarzen Pfeile veranschaulichen Zirkulationen, die je nach Außentemperatur unterschiedliche Erwärmungen aufweisen können. Durch begrünte Innenhöfe wird die Luftfeuchtigkeit erhöht, was dem Wohnklima im trockenen Stadtklima zugute kommt. Besonders vorteilhaft ist es, wenn die Häuserreihen Baulücken aufweisen. Eine Bebauung der Innenhöfe wirkt sich wiederrum negativ auf die Ventilation aus. Dadurch bleiben im Winter auch Emissionen bei nur langsamer Verdünnung in den Innenhöfen. Im Sommer kommt es, wenn wenig Durchlüftung gegeben ist, vor allem bei stark versiegelten Innenhöfen zu starken Aufhitzungen. Laubabwerfende Bäume verbessern die bioklimatische Bedingungen hier besonders und dienen auch noch als Staubfilter.[13] [14]

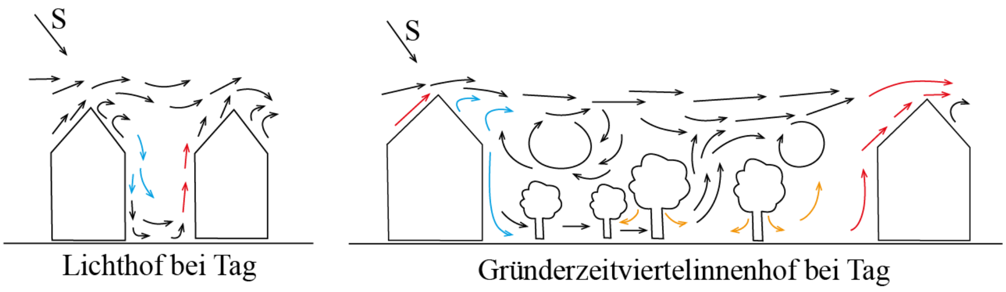

Abbildung 4: Vergleich Zirkulation Lichthof und Gründerzeitviertelinnenhof[15]

2.3 Forschungsfrage

Aus der Stadtklimaanalyse ergibt sich, dass Innenhöfe wertvoll für das Mikroklima sind, wenn sie nicht bebaut sind und Bäume beziehungsweise entsprechende Grünflächen beinhalten. Dies ist der Grund, warum in dieser Arbeit die Versiegelung und Vegetation der Innenhöfe im Fokus steht.

Dazu wurden verschiedene Parameter, wie die Anzahl der Bäume oder versiegelte Flächen in einzelnen Innenhöfen, mittels deskriptiver Analyse ausgewertet.

Die Forschungsfragen lautet: Wie können gründerzeitliche Innenhofe zu einer Verbesserung des Stadtklimas beitragen?

3 METHODE

3.1 Untersuchungsgebiet

Das Untersuchungsgebiet der gründerzeitlichen Innenhöfe bezieht sich auf Graz. Der Grazer Stadtraum wurde auf sechs Bezirke eingegrenzt, da in diesen heute noch ein großer Teil der Bauten der gründerzeitlichen Stadterweiterung von Graz erhalten ist. Es handelt sich um die Bezirke Innere Stadt, St. Leonhard, Geidorf, Lend, Gries und Jakomini, welche sich außerhalb des Altstadtkerns entwickelt haben. Diese halböffentlichen Bereiche werden in Graz als Innenhöfe bezeichnet. Im Zuge dieser Forschungsarbeit ist der gründerzeitliche Grazer Innenhof wie folgt definiert:

- Der Innenhof befindet sich in einem der Grazer Bezirke, der zu großen Teilen gründerzeitliche Bebauung aufweist.
- Der Innenhof ist von gründerzeitlicher Bebauung umschlossen.
- Der Innenhof wird vor allem der Funktion Wohnen zugeschrieben oder ist zum Großteil von Wohnungen umgeben.

[13] Lazar/Sulzer, S. 236-239.
[14] Laue, S. 46-47.
[15] Lazar/Sulzer, S. 226.

- Der Innenhof ist ganz oder zum Großteil geschlossen.

Von anfangs 246 Innenhöfen erfüllten 131 die oben bereits angeführten Kriterien und wurden für diese Arbeit in die Liste der gründerzeitlichen Grazer Innenhöfe aufgenommen. Bei alle denen sind klare gründerzeitliche Strukturen abzulesen. Dies wurde zuerst durch die Analyse von Luftbildern und Katastern festgelegt und in Tabellen eingetragen. Durch eine Begehung wurde die Annahme überprüft. Um eine bessere Vergleichbarkeit gewährleisten zu können, wurden Innenhöfe ausgewählt, bei denen die umliegende Bebauung größtenteils dem Nutzen „Wohnen" entspricht. Dies wurde im Zuge der Begehung festgestellt. Indizien für „Nicht-Wohnen" waren Beschriftungen an Haustüren, die auf eine gewerbliche Nutzung hinwiesen, wie Firmenlogos, Arztpraxisschilder, Schriftzüge von Dienstleistungsanbieterinnen und Dienstleistungsanbietern, Beschriftung als Universitätsgebäude oder Schule. Die Abbildung 5 zeigt die ausgewählten Innenhöfe grün eingezeichnet.

Abbildung 5: Mapping ausgewählter Innenhöfe

3.2 Messungen GoogleMyMaps

Um Daten über die Blockgröße, Innenhofgröße und Bebauung des Innenhofes zu bekommen, wurden Satellitenbilder, die über GoogleMyMaps frei zugänglich sind, vermessen.

3.3 Fotodokumentation

Bei der Fotodokumentation wurden zuerst alle in Frage kommenden Innenhöfe auf einem Schwarzplan erfasst und nummeriert. Dann fanden Begehungen statt, um alle 131 Innenhöfe bildlich zu erfassen. Hierfür wurden die Innenhöfe von mindestens drei unterschiedlichen Blockseiten mehrmals fotografiert. Diese rund 4.000 Fotografien wurden in Anbetracht der drei Kategorien Eigentumsverhältnisse, Nutzung, und Mikroklima untersucht und statistisch bewertet. Bei der Kategorie Eigentumsverhältnisse konnten keine

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Faktoren festgestellt werden, welche sich direkt auf das Mikroklima auswirken könnten. Deshalb wird auf diese Kategorie in diesem Paper nicht näher eingegangen. Bei der Kategorie Nutzung wurde der Aspekt „Geschätzte aktive Nutzung des Innenhofes durch die Bewohnerinnen und Bewohner“ auf die Bezirke hin ausgewertet und beschrieben. Die Kategorie Mikroklima wurde in die Parameter Bodenbelag und Vegetation unterteilt. Bei dem Bodenbelag wurde zwischen Asphalt, Beton, Pflastersteinen, Kies, Erde und Wiese unterschieden. Bei der Vegetation wurden Bäume und Sträucher aufgenommen. Mittels deskriptiver Analyse wurden alle Innenhöfe bewertet. Da nicht alle Innenhöfe zu 100 Prozent begangen werden konnten, wurden die Ergebnisse danach gewichtet, wie viel vom Innenhof bewertet wurde. Eine Skala der Häufigkeit wurde erstellt und von eins (nicht vorhanden) bis vier (oft /viele vorhanden) bewertet. Diese Bewertung erfolgte je nach Größe des Innenhofs, da eine nummerische Bewertung verfälschte Ergebnisse je nach Größe des Innenhofes ergeben hätte. Als Beispiel kann hier die Kategorie Bäume angeführt werden in dem „1“ kein Baum vorhanden und „4“ viele Bäume vorhanden beschreibt. In Prozenten wird dargestellt, wie häufig die angegebene Skalenbewertung vorkommt (Tabelle 1). Diese Häufigkeiten wurde für jeden Innenhof, für jeden Bezirk und gesamt erstellt. Weiters wurden Mittelwerte und Standartabweichungen berechnet. Die statistischen Analysen wurden mit dem Programm Excel Version 14.0.0 durchgeführt.

Vegetation Baum						
Skala	Innere Stadt	St. Leonhard	Geidorf	Lend	Gries	Jakomini
1	11%	0%	0%	0%	3%	0%
2	15%	3%	0%	17%	0%	4%
3	74%	61%	44%	62%	89%	72%
4	0%	36%	56%	21%	8%	24%

Tabelle 1: Häufigkeit Vegetation Baum

4 ERGEBNISSE: MERKMALE DER INNENHÖFE HEUTE

In der Tabelle 2 wird die Anzahl der ausgewählten Innenhöfe je nach Bezirk veranschaulicht. Die Anzahl wird in absoluten Zahlen und in Prozentwerten von allen ausgewählten Innenhöfen angegeben.

Ausgewählte Innenhöfe nach Bezirken						
Bezirk	Innere Stadt	St. Leonhard	Geidorf	Lend	Gries	Jakomini
Anzahl der untersuchten Innenhöfe (%)	16 (12%)	37 (28%)	25 (19%)	10 (8%)	15 (11%)	28 (21%)

Tabelle 2: Anzahl der ausgewählten Innenhöfe

Die ausgewählten gründerzeitlichen Innenhöfe machen eine Gesamtfläche von 79,49 Hektar (ha) aus. Die größten gründerzeitlichen Blöcke mit Innenhöfen befinden sich im Bezirk Lend mit durchschnittlich 1,41 ha Blockgröße und 0,81 ha Innenhofgröße. Im Mittelwert sind die ausgewählten Innenhöfe 0,62 ha groß. Die kleinsten Blöcke sowie auch Innenhöfe sind im Bezirk Innere Stadt mit einem Mittelwert von 0,85 ha und beziehungsweise 0,36 ha zu finden. Die gesamten Innenhofflächen nach Bezirken sind in Tabelle 3 dargestellt.

Fläche der ausgewählten Innenhöfe gesamt nach Bezirken						
Bezirk	Innere Stadt	St. Leonhard	Geidorf	Lend	Gries	Jakomini
Fläche in Hektar	5,82	22,84	16,30	8,05	11,23	15,24

Tabelle 3: Innenhofflächen nach Bezirken

4.1.1 Bebauung der Innenhöfe

Die Innenhöfe der Bezirke Lend und Gries sind mit 23,38 bzw. 23,95 Prozent Bebauung die am stärksten bebauten Innenhöfe von Graz, gefolgt vom Bezirk Innere Stadt mit 21,82 Prozent. Der Mittelwert der Innenhofbebauung von allen Bezirken in Graz liegt bei 15,94 Prozent und lässt erkennen, dass die restlichen Bezirke klar darunter liegen. Die geringste Innenhofbebauung ist mit 4,08 Prozent im Bezirk Geidorf zu lokalisieren.

4.1.2 Bodenbelag

Die Versiegelung der Innenhofflächen durch Beton oder Asphalt ist in den Bezirken Innere Stadt und Lend am höchsten. Hier sind 20 Prozent der Innenhöfe zu mehr als einem Drittel versiegelt. Die geringste Versiegelung, in 53 Prozent der Innenhöfe sind unter 10 Prozent der Innenhoffläche versiegelt, ist im Bezirk Lend zu finden. Im Bezirk Geidorf sind 47 Prozent unter 10 Prozent versiegelte Innenhoffläche.

Der Wiesenanteil, also nicht versiegelte Fläche, liegt in allen Bezirken, außer Innere Stadt, über 41 Prozent der Innenhofflächen. Im Bezirk St. Leonhard ist der Wiesenanteil am höchsten. Bei 61 Prozent der Innenhöfe liegt der Wiesenanteil über 71 Prozent.

4.1.3 Vegetation Baum/Strauch

In fast allen Innenhöfen, ausgenommen Innere Stadt, sind Bäume zu finden. Den höchsten Wert weißt hier der Bezirk Geidorf auf. Hier wachsen in über 71 Prozent der Innenhöfe viele Bäume. Im Bezirk St. Leonhard ist der Bewuchs mit Bäumen ähnlich stark. Ähnliche Werte sind auch für den Bewuchs mit Sträucher festzustellen. So liegen wieder die Bezirke Geidorf und St. Leonhard im Spitzenfeld und der Bezirk Innere Stadt an letzter Stelle.

4.1.4 Verkehrsflächen

Im Durchschnitt sind in 39 Prozent der Grazer Innenhöfe Garagen vorhanden. Mit 53 Prozent gibt es im Bezirk Innere Stadt am meisten Garagen in den Innenhöfen. Autoabstellplätze sind durchschnittlich in 60 Prozent der Innenhöfe vorhanden. Diese Werte sind mit 83 Prozent im Bezirk Lend und 78 Prozent im Bezirk Gries am höchsten.

4.1.5 Aktive Nutzung der Innenhöfe

Die geschätzte prozentuelle aktive Nutzung der Innenhöfe durch Bewohnerinnen und Bewohner wurde anhand von bespielten bzw. brachliegenden Flächen geschätzt. Hierbei würde festgestellt, dass die höchste aktive Nutzung im Bezirk Lend vorhanden ist. Am wenigsten werden die Innenhöfe in den Bezirken St. Leonhard und Geidorf aktiv genutzt. Durchschnittlich wird bei 29 Prozent der Innenhöfe die gesamte Innenhoffläche aktiv genutzt.

5 DISKUSSION

Die Bezirke mit den größten Innenhofflächen in Gesamtflächen gesehen sind St. Leonhard und Geidorf. Dies deckt sich mit den beliebtesten Wohngegenden innerhalb der gründerzeitlichen Bezirke von Graz. [16]

Die Bereiche der gründerzeitlichen Blockrandbebauungen sind, wie in der Karte der Stadtklimaanalyse ersichtlich ist, die Bereiche, welche am stärksten von Überwärmung betroffen sind. Gründe hierfür sind die starke Bebauung sowie die windarme Lage von Graz, durch die es zu einer schwachen Durchlüftung kommt. Die Bereiche mit sehr starker Überhitzung decken sich mit den Bezirken Lend, Gries und Innere Stadt. Das sind auch die Bezirke, bei denen unter den Merkmalen die höchste Bebauung der Innenhöfe festgestellt wurde. Eine Bebauung der Innenhöfe wirkt sich negativ auf die Ventilation der Innenhöfe aus und erhöht somit die Temperaturen in den bereits als Wärmeinsel herausgestellten Bereichen. In diesen Bezirken wurden auch die meisten Verkehrsflächen festgestellt, was sich wiederum negativ auf die Emissionswerte auswirkt.

Die Versiegelung ist in den Bezirken Lend und Geidorf besonders gering. Dies hat jedoch im Bezirk Geidorf bessere Auswirkungen, da hier auch die Bebauung der Innenhöfe gering ist. Eine starke Versiegelung trägt zur starken Aufhitzung der betroffenen Stadtbereiche bei. Der Wiesenanteil, welcher eine nicht versiegelte Fläche darstellt, ist in allen Bezirken relativ hoch – außer im Bezirk Innere Stadt.

Der Baum- und Strauchbestand ist in den Bezirken St. Leonhard und Geidorf besonders hoch. Laubabwerfende Bäume verbessern die bioklimatischen Bedingungen und fungieren als Staubfilter. Begrünte Innenhöfe führen zu geringeren Maximaltemperaturen und erhöhen die Luftfeuchte, was wiederum zu einem behaglicheren Wohnklima beiträgt.[17] Somit ist es vor allem innerhalb der Wärmeinseln besonders wichtig, die Wohnqualität durch begrünte Innenhöfe zu verbessern.

[16] Stadt Graz, LQI Umfrage 2013.
[17] Laue, S. 46-47.

Obwohl die Begrünung der Innenhöfe höchstwahrscheinlich eine Auswirkung auf die Lebensqualität der Bewohnerinnen und Bewohner hat, ist eine aktive Nutzung der Innenhöfe im Bezirk Lend am höchsten sowie in den Bezirken St. Leonhard und Geidorf am geringsten.

Die größten Innenhöfe befinden sich im Bezirk Lend. Dies steht jedoch nicht in Relation mit der Innenhoffläche im Gesamten. Hier steht der Bezirk Lend an vorletzter Stelle. Das Ergebnis der durchschnittlich größten Innenhöfe lässt sich darauf zurückführen, dass es sich beim Bezirk Lend um den Bezirk mit den wenigsten Innenhöfen unter jenen, die für diese Arbeit herangezogen wurden, handelt.

6 CONCLUSIO

Durch seine zum großen Teil stark begrünten Innenhöfe innerhalb der gründerzeitlichen Bebauung kommt es in Graz zu einer Verbesserung des Mikroklimas in Bereichen der Stadt, welche als Wärmeinseln gelten. Ausschlaggebend hierfür ist eine geringe Bebauung der Innenhofflächen, da es nur so zu der gewünschten Zirkulation innerhalb der Blockrandbebauung kommen kann. Begrünte Innenhöfe tragen zu einer Verbesserung des Mikroklimas bei, da es vor allem durch Laubbäume zu zusätzlicher Beschattung in den warmen Sommermonaten kommt und sie auch als Staubfilter fungieren. Ein weiterer positiver Effekt stellt sich durch eine Erhöhung der Luftfeuchtigkeit infolge von Begrünung ein.

Die beschriebenen positiven Effekte lassen sich vor allem in den Bezirken Geidorf und St. Leonhard erkennen. Hier sind sowohl große, als auch zum Großteil unbebaute Flächen mit üppiger Vegetation vorhanden. In jenen Bezirken, die als die wärmsten Zonen von Graz gelten, ist hingegen eine starke Bebauung und weniger Vegetation zu finden, obwohl dies für eine Verbesserung des Mikroklimas besonders wichtig wäre. Somit kann klar von einer weiteren Bebauung der Innenhöfe abgeraten und zu einer Begrünung und Entsiegelung geraten werden.

7 REFERENZEN

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How COVID Affects Decision Making in Planning? The Use of ICT in Planning Boards' Hearings

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1 ABSTRACT

The purpose of this study is to examine the effect of COVID-19 on decision-making in planning. Put differently, how the shift to video-conference meetings has influenced the processes associated with land use planning.

We discuss this issue by looking at the shift of Israeli planning boards to online meetings. Since March 2020 decision-making has changed from face-to-face meetings between planners, public officials, and stakeholders to an online mode of decisions and meetings using a range of tools including, but not limited to Zoom and Teams. The lessons learned in Israel are relevant and applicable to other countries where similar shifts to online \ virtual hearings took place in 2020.

Everywhere, and globally, state and local governments have found new ways to enable the continuation of planning hearings and meetings; these remain uninterrupted, amid new requirements for social distancing. New laws enabled planning boards at the local, regional, and national levels to make decisions without meeting face-to-face. Notably, the Israeli regulations are but one example. In other countries, such as in the US and the UK, national and local governments have introduced similar policies and guidelines that enable, or even mandate, planning boards to shift their mode of operations to include online meetings -usually through ZOOM, TEAMS, SKYPE softwares (Thomas, 2020).

COVID19 has therefore had a major impact on the way planning is conducted around the world. These new regulations are important, as they have facilitated the continuity of policymaking in the field of planning. They also enabled planning boards to cope with their workload as no meetings had been held for months due to social distancing requirements.

The shift to online decision-making was praised by the professionals and media as rather successful (Steuteville, 2020), saving time, travel costs, and making planning more accessible via the use of Information and Communications Technology (ICT). On the face of it, COVID19, as a crisis, also held the promise of expediting the assimilation of technology in the planning process. It was therefore an opportunity to reconsider the way in which planning is carried out and to make it better, less bureaucratic, and more transparent.

To examine these issues, we initiated a survey among practicioners who participated in online (Zoom) meetings held by planning boards. In particular we ask:

- What do participants in online decision-making think about this new mode of communication? How satisfied are they?
- Compared with face-to-face engagements, what are the major pitfalls and advantages of online decision-making in planning?

The findings suggest that attendees is online meetings acknowledge the importance and advantages of ICT in facilitating planning discussions during the pandemic. However, they also flag some problems and challenges associated with this tool.

Keywords: virtual hearings, decision making, pandemic, Covid-19, planning boards

2 INTRODUCTION

2.1 Goal of this paper

The focus of this study is on the effects of COVID-19 on decision-making in planning. Put differently, how does the shift to video-conference and online meetings impact processes associated with land use planning?

The stage for this review is Israel, where national legislation made it possible for planning boards to switch rapidly to online meetings in March 2020 following the outbreak of COVID19. The government has found new ways to enable the continuation of planning hearings and meetings; these remain uninterrupted, amid new requirements for social distancing (Shahak, 2020). New laws enabled planning boards at the local, regional, and national levels to make decisions without meeting face-to-face. Notably, the Israeli regulations are but one example. In other countries, such as in the United States and the United Kingdom, national and local governments have introduced similar policies that enable, or even mandate, planning boards to shift their mode of operations to include online meetings -usually through a range of information and communication technologies (ICT) such as Zoom and Teams software (Thomas, 2020).

COVID19 has therefore had a major impact on the way planning is conducted around the world. These new regulations are important, as they have facilitated the continuity of policymaking despite the spread of the pandemic. Following, the objective of this study is to examine how COVID19 has impacted the planning bureaucracy. Specifically, its effect on the way in which decisions are discussed and reached. With respect to planning boards, the objective here is to analyze how – and if- the adoption of ICT platforms and mandatory requirements for online meetings has affected the planning process.

3 LITERATURE REVIEW

3.1 The death of distance

In the age of the COVID pandemic, a universal experience shared by people the world over has been the shift from commuting to workplaces and interacting in close proximity in the outside world to suddenly working remotely from home and interacting only over the internet. Prior to the pandemic, the word "Zoom" was likely only known in the business world as referring to a software used for conducting the occasional remote meeting. Nowadays, it has become synonymous with the current method of interacting, learning, and earning a living. Interestingly, while this shift from in-person to remote interaction has certainly been exemplified by the pandemic, it was foreseen as looming on the horizon as early as the 2000s.

In her seminal book, Cairncross (2001) observed that the rapid development of mass communication and the internet was bringing about a technological shift which would fundamentally alter the way we live and lead to what she termed the "death of distance".

In essence, distance would no longer be a key determinant of spatial organization in human relations and societies and would be continually rendered less significant. For example, workers gain the freedom to live farther from their employers who increasingly have to locate their services where key staff live rather than where the market is (Cairncross 2001, p.5-6). Such consequences, though still taking shape, appear to be liberating and democratizing as more and more people gain access to communications technology at a lower cost and are less restricted by distance. In this context, the proposed study intends to examine whether the death of distance can be tested in the field of land use planning (specifically- decisions made in the planning process). Moreover, we inquire whether bureaucratic shifts in decision-making ascertain and help cement the presumption about the death of distance.

3.2 COVID-19 as crisis and opportunity

Though Covid-19 has certainly thrown the world into crisis, some researchers see this as an opportunity as well. In having altered people's movements and patterns of work and leisure, scholars opine that it is time to rethink cities and the way we make decisions about them and about our land use. While existing research takes a stab at envisioning what the urban built environment post-Covid, most studies do not touch upon the way Covid has impacted planning and decision making nor the ways those decisions are made. If anything, this demonstrates the existing gap in the current state of knowledge regarding online decision-making and the way in which decision makers interact post-Covid-19. A major part of the literature such as that of Goode (2020) and Kim (2021) is concerned primarily with investigating how cities can prepare for and ensure their resilience in facing pandemics.

Lai, et al (2020) relate to COVID-19 as an opportunity for cities and urban planning. Indeed, they write, "The COVID-19 pandemic has opened up a crucial time-window of opportunity for urban scientists, planners and designers by unravelling before us the largest natural experiment in multiple aspects of urban activities and population mobility." (Lai et al, 2020 p.3). As well they also acknowledge the role of technology in the pandemic, noting that "Surveillance and contact tracing are key to fighting COVID-19 pandemic. Lai et al. however, do not tie technology to the form of decision making in planning and do not focus on how technology changed the way decision makers come together and deliberate planning matters following the pandemics. This issue also accentuates existing knowledge gaps: key scholarly contributions (e.g. Grant 2020; Ahmadpoor & Shahab 2021) are primarily concerned with how cities can prepare and make themselves resilient in the face of pandemics. They do not relate to online decision-making nor explore the way in which decision makers interact post COVID19. This paper fills these existing gaps in the literature.

3.3 Hyper connectivity in the workplace and COVID 19

The introduction of ICT technologies has been responsible for reshaping the way people interact, collaborate, and even think. This shift was already well underway even before the Covid era and was made even more acute as a result. Prior to Covid-19, many governments worldwide were in various stages of adopting ICTs in order to pivot towards 'e-government' - the full digitization of the public sector for delivering services to citizens more efficiently and transparently, and making these services more accessible, user-driven, and proactive (OECD 2019). In this respect, Deloitte (2018) reports that as the available array of new communications tools continually expands, they stand to make workers and their workplaces more connected, efficient, and productive. Many companies have begun to use these technologies such as videoconferencing and chats to restructure horizontally into a more networked team format (Deloitte, 2018. p.81). Indeed, Deloitte presents data showing that face-to-face meetings and phone meetings are declining in favor of work collaboration platforms (Deloitte, 2018 p.82).

Indeed, Quiggin (2020) suggests that preliminary figures show the pandemic has provided as opportunity to experiment with workplace productivity from home. Given that most workers spend an hour commuting to and from work on average daily, the time saved by working remotely could add up to a significant gain in productivity for the labor force as a whole (Quiggin, 2020). This view is echoed by Maurer (2020), who reports that initial skepticism of remote working has been largely diminished. Citing a survey of over 800 employers, Maurer writes that productivity has been shown to be "the same as or higher than it was before the pandemic, even with their employees working remotely" (Maurer, 2020).

However, there is growing concern in the corporate world that these new tools may actually harm productivity by subjecting networks of teams attempting to collaborate to an unending whirlwind of constant emails, videoconferences, and messages. This is especially true as research shows that people's communications habits and tools from their personal lives are infiltrating their work lives. (Deloitte, p.81). In the same vein, the Economist Team (2020) reports that the shift towards collaborative, remotely-based working brought about by the pandemic has not been liberating for workers, but instead has only increased the amount of work and the intrusion into people's lives.

3.4 Hypotheses

The foregoing analysis suggests that planning boards may encounter difficulties and quite a few challenges while applying this mode of communication and collaboration. Thus, we make several hypotheses based on the literature. These hypotheses relate directly to the research questions listed above: Hypothesis 1: The shift to online meetings by planning boards has had both positive and negative impacts on decision-making. Hypothesis 2: Participants prefer online meetings to face-to-face meetings.

4 METHODOLOGY

Following the data gathered through exploratory interviews and the literature review, we compiled a structured survey designed to answer key questions. The survey was disseminated among decision makers and other participants in planning board meetings at the local, regional, and national tiers of government. We sent the survey to experts, consultants, landowners, and community members who have participated in online meetings. Overall, 182 respondents answered the survey's questions.

Figure 1 depicts the division of respondents' opinion of the suitability of online meetings in facilitating discussions on planning and land use issues. Here the opinion is largely (but not overwhelmingly) in favor of using online meetings for this purpose at 67% (48% responded suitable and 19% very suitable). Roughly a third of respondents were of the opinion that online meetings are unsuitable vehicles for facilitating planning discussions. It is possible to interpret these results in a variety of ways in light of the literature reviewed in this paper. On one hand, it could be said that the majority that expressed faith in the online meeting format confirms the view of researchers such as Milz & Gervich (2020) that virtual participation is a real alternative

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to in-person planning boards' meetings. On the flipside, the fact that almost one-third of respondents disliked online meetings could be said to validate the warnings of Milz & Gervich who point out the negatives such as loss of visual cues and the lesser degree of sincerity and comprehensibility.

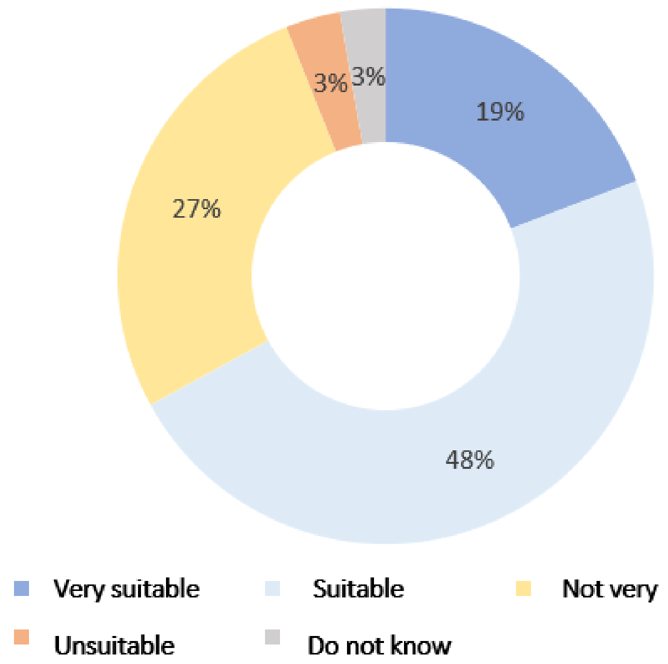

Fig. 1: Are online meetings suitable for discussions over planning and land use issues? (n=182)

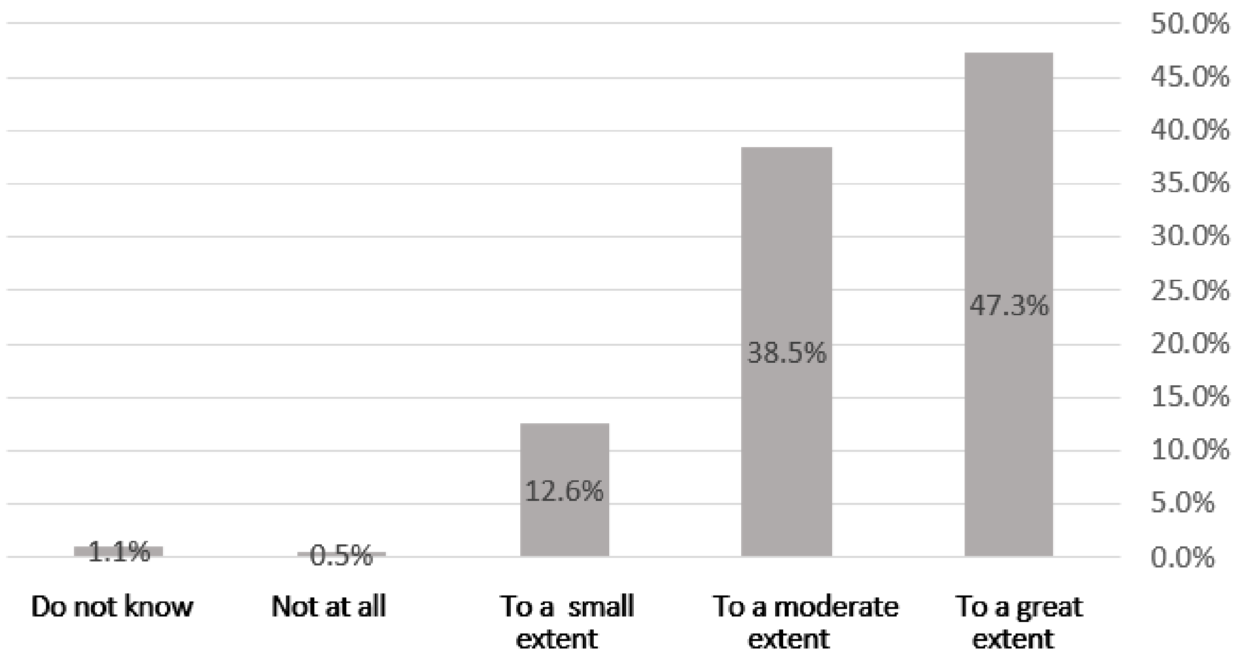

Fig. 2: Are online meetings suitable for discussions over planning and land use issues? (n=182)

Figure 2, curiously shows that the overwhelming majority of respondents (85.8%) felt satisfied that ICT can help attendees to express themselves in these virtual meetings, with a very small majority feeling they were barely or not at all able to express their views. With such a large percentage of respondents satisfied that they were able to express themselves in virtual planning meetings, it seems that such exercises in decision-making are occurring in line with the prescriptions of Sager (2018) and Davoudi (2018) for open communication, and the bringing together of many viewpoints and interests within the complex process of planning.

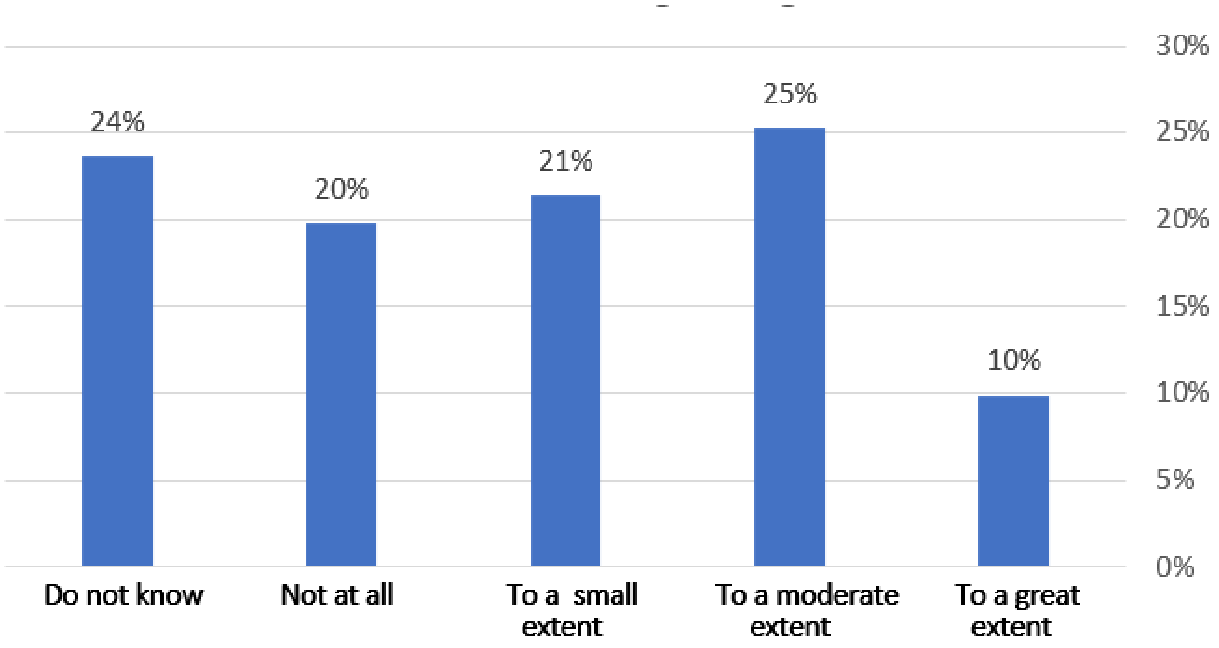

Fig. 3: To what extent did online meetings enable participants to build trust during hearings? (n=182)

The issue of trust in policy studies is quite complex. Many indicators are used in planning literature to measure trust. Survey respondents were asked about the relationship between trust building in the planning process and the use of ICT. Figure 3 displays the fact that respondents were strongly divided when it came to their opinions of the ability of virtual meetings to enable the building of interpersonal trust. This may be explained by the assertion of Willson (2000), who found that compared to face-to-face meetings, online discussion is usually rated lower by participants in several categories, among them the sincerity of the speaker. A further explanation may be the fact that according to Milz & Gervich (2021), the loss of visual communication cues in a virtual meeting may result in increased levels of disagreements and conflict. With more conflict and disputes occurring, it would be no surprise then that trust would suffer in the process.

As planning is a process involving stakeholder of varying backgrounds and interests, the idea that trust is lacking in virtual meetings is a worrying indicator for its potential to lead to facilitate virtual decision-making in land use planning.

Following, we asked respondents what are the major advantages of virtual hearings, compared with face-to-face engagements. Respondents mentions several key factors that make virtual meetings before planning boards more advantageous, including: the ability of ICT to allow more people to attend; the ability of virtual hearings to facilitate more polite discussions among participants; the ability to save time in arriving to meetings; and the ability of virtual hearings to accelerate change in government.

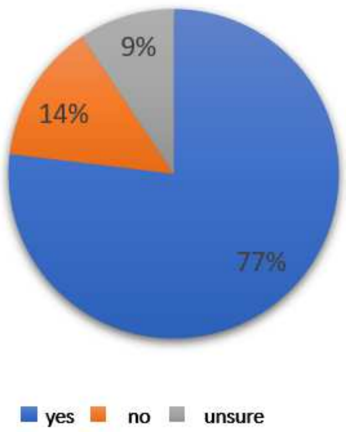

Fig. 4: Do you believe planning boards should continue using virtual meetings post pandemics? (n=182)

Respondents were also asked whether, after the pandemics, planning boards should continue utilizing ICT to facilitate online, virtual, hearings, at least as another option for deliberations. Respondents were quite adamant in their view that virtual meetings by planning boards should remain an option in the planners' toolkit (Figure 4). These findings bear out the views of several authors such as Gladovic et al (2020), Shapira & Youtie (2001), and Milz & Gervich (2021), who wrote that virtual participation vis ICT usage can be viable alternatives to face-to-face meetings given the many advantages afforded.

5 CONCLUSION

The study yields some insightful perspectives into how COVID19 has influenced planning decision-making. Results shed light on the challenges of using ICT technologies; the capacity of online decision-making to ensure the flow of planning decisions, to improve engagement and to accelerate technological change in government. In particular, the findings point to the positives and limitations of moving decision-making to online platforms.

6 ACKNOWLEDGEMENT

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🏆 *reviewed paper*

How to Make Existing Urban Structures Climate-Resilient?

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1 ABSTRACT

We are currently faced with a variety of serious crisis: climate, health and migration, all of them deeply interwoven. And all of them particularly apparent within the dense city structures. Urban open space becomes - once more - crucial in facing the accompanying negative effects like rising heat, density and infection. Evidentially green and blue infrastructure provides a cooling effect, a qualitative life space and a healthy environment – considered in a holistic and large-scale view guaranteeing good living conditions throughout the city. Before the background of urban densification the streetscape holds a huge potential in this regard. The street system forms a stable network of open space defined by building structure. It is entirely publicly owned and thus more easily accessible to public authorities for the immediate development and implementation of necessary measures. Furthermore, a change in mobility patterns is to be expected, that will initiate a debate about new functions of the street system. Last but not least, a variety of studies indicate, that the desealing of surfaces and the integration of trees and other vegetation - including green facades - offer a particular climate adaptation potential especially within the streetscape.

Although within the scientific society and politics well-known, the implementation of green and blue infrastructure measures is confronted with a variety of barriers - starting with administrative, technical and legal frameworks but also to a great part through missing awareness of and acceptance by neighbours and local stakeholders. This paper focusses on the latter presenting supportive processes and actions which are needed for transforming existing urban structures towards climate resilience in this regard. The findings are based on lessons learned in the Smart Cities Demo project LiLa4Green (Accompanying Living Lab for the implementation of green-blue infrstructure measures in the Smart City Vienna, 2018-2021).

LiLa4Green focusses on the visibility and traceability of the additional value of potential green and blue interventions within the streetscape opening up the discussion and mutual learning with the diverse involved parties on site. Main goals set are a) to cooperatively highlight existing challenges and elaborate potentials of green and blue design measures on site; b) to literally show options of participatorial developed interventions within the streetscape by effectively implementing commonly accorded small-scale measures; and c) to visualize potentials and alternatives virtually by means of an AR tool to enable low-treshhold participation in an early planning stage and to raise awareness for the topic. Multifold methods such as potential analysis, design studios, climate measurements and simulations have been applied to accomplish these goals - accompanied by a continuous Living Lab process on site.

In the course of LiLa4Green several barriers and restrictions but also potentials for making existing urban structure more climate-resilient became evident. All in all, the project managed to start a transition towards climate resilience in one of the densly built areas of Vienna. Three key elements proved to be essential 1) find solutions which fit to the local setting and set concrete actions 2) raise awareness and involve local networks, stakeholder and neighbours and 3) embed measures and demonstrations into a continuous process.

Keywords: urban structure, climate adaptation, green-blue infrastructure, living lab, public space

2 INTRODUCTION

The Paris Agreement, which entered into force in November 2016 (UN, 2015), has been a milestone in global climate policy stressing protection and adaptation as equally important and strenghtening the efforts of countries world-wide to achieve their climate targets. Likewise, Austria committed itself to the agreement and even strives for climate neutrality by 2040, intended trough the preparation of an amendment to the Climate Protection Act. This will mean a great effort in all sectors and at all scales. Action is urgently needed as the impacts of climate change are already tangible, especially within the dense urban areas due to urban structure and materiality. Natural surface has largely been replaced by sealed cover and building sites, that multiply the amount of heat storing materials in the third dimension.

Besides climate change, growing cities such as Vienna are currently faced with additional serious crisis such as health and migration, all of them particularly apparent within the dense city structures and deeply intervowen. Urban open space becomes - once more - crucial in facing the accompanying negative effects like rising heat, density and infection. Before the background of urban densification the streetscape holds a huge potential in this regard. The street system forms a stable network of open space defined by building structure. It is entirely publicly owned and thus more easily accessible to public authorities for the immediate development and implementation of necessary measures. Furthermore, a change in mobility patterns is to be expected, that will initiate a debate about new functions of the street system. Cities and settlements that are no longer designed to be “car-friendly” but “more human” and designed for active mobility improve social contacts, well-being and health (APCC 2018). Last but not least, reduced car traffic opens space for unsealing and greening. A variety of studies indicate, that the desealing of surfaces and the integration of trees and other vegetation - including green facades - offer a particular climate adaptation potential especially within the streetscape (Demuzere et al. 2014, Hagen et al. 2014, Stangl et al. 2019, Reinwald et al. 2019). Evidentially green and blue infrastructure plays a decisive role for the quality of life in cities by providing a healthy environment for recreation, a cooling effect reducing the heat island effect and by increasing the biodiversity (Reinwald et al. 2019).

Due to advancing climate change and the manifold benefits of green and blue infrastructure, many cities have already developed strategies and are setting measures for realizing climate resilient and green urban structures. The city of Vienna was one of the first which committed itself to a strategy for counteracting the UHI (e.g. MA22 2015). Vienna is also one of 15 European cities in the “Deep Demonstration” program (based on the EU initiative EIT Climate-KIC), which aims to network and support cities and regions in order to promote climate neutrality. But not only Vienna, also numerous medium-sized cities such as Graz and Linz, and even smaller cities such as Weiz, Kufstein, Perchtoldsdorf or Traiskirchen are actively committed to climate change adaptation and climate protection. The realization of green-blue infrastructure measures will be key for a successful realization.

However, the implementation of green and blue infrastructure measures is challenging as it addresses various urban issues (green and open space, traffic and pipeline infrastructure, water and sewage infrastructure, etc.) and stakeholders (Tötzer et al. 2019). Greening measures are confronted with a variety of barriers - starting with administrative, technical and legal frameworks but also to a great part through missing awareness of and acceptance by neighbours and local stakeholders.

The lessons learned from the Smart Cities demonstration project LiLa4Green[1] (Accompanying Living Lab for the implementation of green-blue infrastructure measures in the Smart City Vienna, 2018-2021) presented in this paper illustrate supportive processes and actions which are needed for transforming existing urban structures towards climate resilience. In the course of the project it became evident what it takes to realise green-blue infrastructure projects (urban green and urban water areas) in a densely built area of the city of Vienna (Tötzer et al., 2019). The project has been carried out by an interdisciplinary project consortium consisting of partners in the fields of planning, participation and communication, landscape architecture, climate modelling and software engineering. The central approach applied was a Living Lab, which has been set up throughout the entire project duration for involving citizens, stakeholders and decision makers in the implementation process. The Living Lab aimed at building a co-creative environment, raising awareness for the positive effects of green-blue infrastructure measures and increasing the acceptance and willingness to implement and invest.

[1] LiLa4Green is funded by the Climate and Energy Fund and implemented under the “SMART CITIES – FIT for SET” programme.

3 LILA4GREEN SET-UP – THE LIVING LAB PROCESS

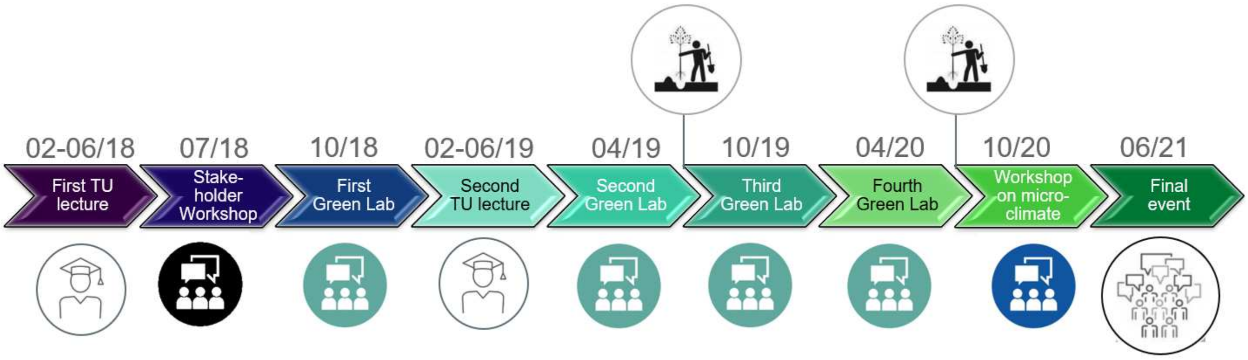

Fig. 1: Structure and timeline of the LiLa4Green project

The Living Lab (LL) structure worked as a framework for the entire project so that the basic structure of the LL had to be defined in the very beginning (Fig.1). Basic characteristics have been identified which are crucial for the success of the LL process: openness, realism, empowerment, spontaneity, sustainability and value as well as the local context. As the Living Lab aimed at the cooperative development of resilient solutions for the urban common ground (the streetscape) in a changing climate the involvement of local inhabitants and stakeholders at eye level was a key factor of success. Therefore the research team of LiLa4Green collectively formulated basic principles for its specific "Urban Living Lab" (ULL) to be concerted at the very beginning of all common events. One key basic principle was that the ULL should aim at a cocreative process involving urban Stakeholders and local Citizens to work out new products, services, technologies and social innovations in an experimental way (Fig. 2r.). The ULL therefore should aim at finding sustainable solutions for climate change adaptation measures in the urban open space by keeping the user in mind at the same time. The ULL should work as a eye level planning system and an alternative to top down city planning strategies.

After the defintion of the ULL characteristics a basic lay-out of the workshops had been designed. The core elements of the LiLa4Green ULL were the "Green Workshops" (GW) which were held on site and worked as different stages of envolvement. These workshops consisted of five steps towards a cocreative process of changing the local environment. The first step was taken hosting a "start-workshop" where local and city-wide stakeholders were invited to discuss the setup of the project and share their knowledge with the research-team and each other. Based on this interrogational setup the project also invited the participating stakeholders to involve themselves in the further steps (see below GW#1 to GW#4) as well as to formulate potential questions which could be answered throughout the LiLa4Green project. In this way the stakeholders where motivated to stay involved within the project also taking part within the following GWs. To find the right tool-set for the different workshops a screening of methods has been undertaken. 15 participatorial methods where collected and screened for their adaptiveness onto the layout of our ULL. This pool of methods was used for the design of the upcoming workshops each based on the respective foregoing event.

Preliminary to the GWs the neigbours had to be informed and their interest to involve themselves had to be raised. Therefore a set of methods was created to reach out on the public on different levels. Besides the classical communication strategies of posters, flyers and spreading these through multipliers, on-street campaigns were set up. Using transport-bikes and folding-chairs the passers-by were being informed and asked to interact (Fig. 2l.). As one interactive element they were asked to put flags on the perceived "hottest" and "coolest" spots within the research area. These spots were documented and continuously updated in a digital map on the project website (Fig. 4r.).

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Fig. 2: On-street activation in the case study area “Quellenstraße Ost” (l., ©PlanSinn_Brossmann) and co-creative design process within GW#3 held at Stadtraum in 2019 (r., ©PlanSinn_Meinharter).

Alltogether four “Green Workshops” where defined as linear events following a red line of interaction between the research team, the stakeholders and the neigbours. As it was planned in the setup of the framework to react on the outcomes of the GWs for the design of the oncoming workshops a basic flexibility in the structure and content of each meeting was taken into account.

The first “Green Workshop” (GW#1) was defined as an “exchange of knowledge” involving the participating neighbours as experts of their local district. The setup of the event was a “marketplace of ideas”, in a first step presenting the topics of climate change, open space usage and adaptation strategies on the base of the potential analysis (see chap. 4) by the research team and in a second step collecting the neighbour’s information on the surrounding urban open space and its interaction with everyday life in form of table discussions. The GW#1 concluded in a collective discussion highlighting amongst other findings the participating neighbours’ demand for an exemplification as a first step to be done to visualize possible changes in the streetscape.

The second “Green Workshop” (GW#2) aimed at finding first steps. On the one hand this workshop worked as an intersection between the intended design studios at the TU Wien and the Living Lab by offering a collective decision process. The GW was therefore defined as collective jury where students presented and discussed their ideas for a green-blue design intervention and the participating citzens could vote for their favorite design to be actually realized within the streetscape on site (Fig.3). Crucial for the success of the collective decision was a high correspondance of elected design and realized implementation requiring a lot of effort by all people involved (see chap. 5). On the other hand the GW#2 used the collective knowledge for testing the AR tool to be developed within the LiLa4Green project. The participants could vote and comment on the usability and effect of the presented web-based AR tool giving valuable feedback for its further development e.g. in changing to an AR app (see chap. 6).

Fig. 3: Participants of the GW#2 with the elected favourite design (©PlanSinn_Schopper).

The third “Green Workshop” (GW#3) served for identifying potentials in the urban open space. Based on the design implementation a lot of trust was built up between the participants and the research-team opening way to the next step. The GW#3 aimed at a co-creative design process for the complete research area by means of a specifically tailored game in divided groups. In the first phase the participants could playfully decide on and create adaptation activities based on given information on climate simulations and all other data collected in the project beforehand. In a second phase the participants had to take decisions within their range of collected ideas regarding a limited budget forcing them to focus. At the end each group presented a map of negotiated adaptation ideas. This "plan of action" builds the framework for all further implementations and activities in the case study area. In this workshop also the further developed AR app was tested and the results of the comments by the participants were compared to the first step of the development. Therefore, the participants themselves could identify the development of the tool related to their comments in the GW#2.

Finally, the fourth "Green Workshop" (GW#4) aimed at a collective implementation of specific adaptation ideas. Due to the Pandemic this workshop - planned as a collective realization workshop - had to be transferred into a digital format. A ZOOM Meeting was held with different breakout rooms related to the identified actions from GW#3. Despite of the complicated situation two of the commonly accorded adaptive actions could be implemented in summer 2020 (see chap. 5). All of these activities were accompanied by a frequent news mail to keep all participants of the GW informed. Furthermore, an Explain Video was created and put on the project website to activate citizens to take part and / or comment on the further steps.

The Green Workshops themselves were accompanied by a survey process which was set up before GW#1 consisting of a pre- and a post-survey. The participants answered an online questionnaire at their first attendance and were invited to fill out a second one after the GW#4. The final results are expected at the end of the project.

4 HIGHLIGHTING CHALLENGES AND POTENTIALS

At the beginning it was essential to get to know the overall frame conditions and the case study area itself in detail. Starting point of this process has been an extensive analysis concerning the need for and potentials of green-blue measures within our case study area as well as a specific analysis of existing strategies of the City of Vienna regarding climate adaptation within the streetscape. Following the co-creative approach, the early involvement of citizens and stakeholders was essential to pick up local knowledge and to raise awareness for and acceptance of the following process on site (see chap. 3).

As a case study served the area of "Quellenstraße Ost" within the Viennese district of Favoriten - representative for a dense city structure with very high impacts of urban climate on the one hand and an urgent need for public green and open space due to the prevailing demographic and ownership structure on the other hand. The current climatic conditions were mapped using objective microclimate simulations of a typical heat wave day with ENVImet. To evaluate the model results perceived data from interviews on the streets have been mapped in personal heat maps and discussed within the GW#1 (Fig. 4).

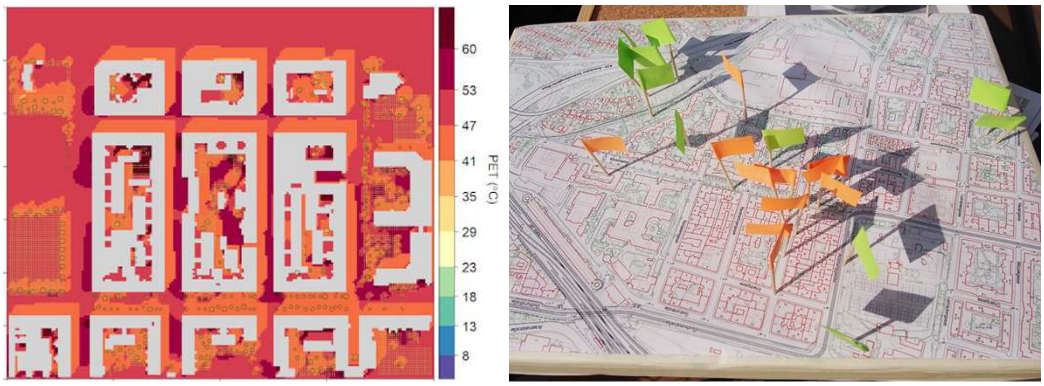

Fig. 4: ENVI-met simulation map on PET at 2pm (l., ©weatherpark) and personal heatmap of neighbours (r., ©PlanSinn_Matejka).

Previous to the potential analysis the intention was to analyse existing strategies of the City of Vienna to be able to tie in to concrete aims and measures already formulated within those papers. Main sources were the Urban Development Plan 2025 (MA18 2014) with its specifications "Green and open space" (MA18 2015), "Public space" (MA19 2017) and "Mobility" (MA18 2015) and the Urban Heat Island Strategy (MA22 2015). All strategy papers highlight the importance of urban green and open spaces in terms of ecology, urban climate and social relevance. The potential of street trees as well as the need for green links with a high quality of stay are explicitly mentioned. Through all strategy papers the streetscape as "urban and public open spaces that are accessible anytime for everyone and primarily in public ownership" (MA18 2017, p.6) stands out to hold the greatest potential for the transformation to green infrastructure within the urban

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structure. The strategy papers have been scanned regarding the statements about the intersection of streetscape, green infrastructure and urban climate leading to consensual planning principles serving as important basis for the specific potential analysis within the study area “Quellenstraße Ost”. These consensual planning principles are: the greening of streetscapes with high quality of stay; creation of public and usable open spaces within the streetscape; creation of micro open spaces (Mikrofreiräume); upgrading of forecourts of public (education) buildings; completion of missing links within the urban green net; inclusion of semi-public and private green areas into the urban green net; inclusion of building related greenery such as facades and roofs; innovative temporary and multi-functional solutions; implementation of microclimatic design measures; awareness raising and involvement of citizens; rethinking and discussion of existing legal frameworks.

The consensual planning principles served as important basis for the subsequent analysis of potentials within the case study area “Quellenstraße Ost” (Fig. 5l.): The case study area is characterized by a very heterogenic city structure including large building complexes with generous greenery. Nevertheless, public green is limited to a single park in the very east. Green links are missing connecting with the recreation area in the east and the surrounding districts. The potential analysis highlighted potential green links inside (orange arrows) and outside (green arrows) the case study area regarding the future urban development and its consequences especially for the dense block structure in the north-west. It became apparent that this block structure (the so called “Kreta”) with its high percentage of sealed surfaces and missing greenery stands out as an isolated area with urgent need for action and a high potential for green-blue measurements. Furthermore, this area adjoins to several education buildings (orange) with high potential to upgrade the forecourts on the streets (purple stripes) including a feasible reduction of moving and stationary traffic (purple).

Besides the involvement of citizens and stakeholders also the involvement of students from Architecture and Planning as future urban planners has been an important issue within the LiLa4Green project structure. The first of two design studios held at the TU Wien had been set up within the analysis phase. Within “Grün’o’polis – grüne Wege in der Stadt” (WS 2018) interdisciplinary teams of 3 students each worked on the analysis of a wider area surrounding the study area of “Quellenstraße Ost”. Strategies and concepts had to be developed on a larger scale confirming to a great extent the potentials elaborated within the potential analysis. Further the students proposed first ideas of design measures on a block respectively street scale strengthening their concepts and giving an idea of how the streetscape could be developed in a greener and user-focused way. The results have been publicly presented on site followed by a poster exhibition that has been visited by neighbours, local initiatives, stakeholders and decision makers helping to raise the awareness, initiate a discussion and to foster acceptance for the topic and for green-blue design measures within the streetscape (Fig. 5r.).

Fig. 5: Potential analysis map of “Quellenstraße Ost” (l., ©TUWien) and poster exhibition of the design studio “Grün’o’polis” in the Ankerbrotfabrik in 2018 (r., ©Hagen).

5 IMPLEMENTING SMALL-SCALE MEASURE

An important result of the GW#1 had been the “demand for action” meaning the request of the participants to discuss based on an exemplification – is to say on a concrete implemented object instead of on mere theoretical aspects of potentials, visions and wishes in advance (see chapter 3).

The second design studio “Green up – cool down” held at the TU Wien tied in at this point. Master students from Architecture were to design ideas for a green-blue design element to be implemented within the streetscape of the dense block structure of “Kreta”. Important aspects have been the transparent process on site, the involvement of neighbours and local initiatives at an early stage, a precise framework for the design and the collective decision of which idea would be effectively built and implemented. The design course was held during the whole process in the Stadtraum am Kempelenpark opened for the public and on its corresponding terrain. Several inputs and workshops have been held for the students involving also local initiatives such as the Materialnomaden dedicated to the reuse of construction material. The specific guidelines for the design included: the layout of a parklet on two parking-lots within the focus area regarding all legal constraints necessary for the approval of implementation; the integration of green-blue elements; a modular system enabling the construction, deconstruction, storage and reconstruction of the design element; consideration of social aspects resp. multifunctional use; proposal of location and adjacent cooperation partner for stewardship and irrigation; costs within the budget of the funding programme “Grätzloase” by the City of Vienna. The 9 final designs have been publicly pitched and put to the vote during the GW#2. The living lab decided on the project “Follow the water cycle” by Jana Faraj Allah and Mais Msto that has been further developed and effectively implemented in summer 2019 on the Randhartingergasse by the whole student collective (Fig.6l.). As local partners served the Stadtraum am Kempelenpark together with the Egyptian Culture and Music Association directly adjoining the parklet.

Fig. 6: Parklet “Green up – cool down: Follow the water cycle”, Randhartingergasse in summer 2019 (l.: ©Grätzloase, r.: ©KLIEN).

The implementation process itself enabled further involvement of the neighbours and local partners in the set-up and maintenance of the design object. The parklet has been used by the direct neighbours and passers-by fostering its appropriation e.g. in form of gardening and gathering. A discourse has been initiated as well on additional benefit as on existing disapproval – the latter without any vandalism during the entire summer. Altogether the intervention can be considered as very successful resulting in concrete interests in “adopting” the parklet in 2020 and in the impulse for additional parklets within the district. Furthermore, the parklet has been recognized beyond the district by the Smart City Award 2018, as best practice for the Grätzloase and within the initiative Children`s University (Kinderuni, Fig. 6r.).

Subsequent to the implementation of the parklet the GW#3 aimed at an intense discourse on further potential green-blue design measures within the study area “Quellenstraße Ost” (see chapter 3). The Erlachgasse turned out to be an important starting point for implementation including a desired micro space at the entrance of the language school at the corner of the Absberggasse, an artistic green intervention at the crossing at Randhartingergasse and a temporary collective street-event. The choice of the Erlachgasse confirms the findings of the potential analysis highlighting the significance of this street as connecting pass and living space.

Despite of the unpredicted Corona situation - hindering the planned face-to-face exchange and cocreation with the neighbours – LiLa4Green achieved the implementation of the two desired design interventions in summer 2020. The parklet has been submitted and reconstructed by the language school Eurasya on two parking lots in front of their entrance in the Erlachgasse (Fig.7l.). In the meantime, they achieved a permanent permission guaranteeing a micro space during the entire year serving as common open space for the students and passers-by as well as for the children of the adjacent kindergarten. With respect to the artistic intervention the artist and landscape architect Hannes Gröblacher designed a temporary “magic

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carpet" of grass floating above two parking lots at the crossing Erlachgasse/Randhartingergasse (Fig.7r.). The magic carpet has been publicly inaugurated in September serving neighbours and passers-by as urban green lounge. Both interventions initiated again a discussion on benefit and disapproval continuing the desired process of discourse and awareness raising.

Fig. 7: Reconstructed parklet in front of the language school (l.) and the magic carpet (r.), Erlachgasse in summer 2020 (©Hagen).

After summer, the magic carpet has been moved within the study area to the courtyard of the primary school opposite of the Stadtraum at the crossing of Kempelengasse and Quellenstraße. In summer 2021 a further design intervention will be implemented in cooperation with the primary school – once more in cocreation with the artist and landscape architect Hannes Gröblacher. The dead-end street in front of the school's entrance will be temporarily redesigned giving the impulse for permanent change into a green forecourt and public open space. The potential analysis highlighted this street section as one of the hot-spots for the implementation of green-blue infrastructure measures - also regarding the Viennese strategy to improve the forecourts of education buildings.

6 ENABLING LOW-TRESHHOLD PARTICIPATION BY VISUALISATION

An additional ambition of the LiLa4Green project was the elaboration of an alternative and innovative form of participation tool to enable low-threshold participation in an early planning stage and to raise awareness for the topic. Different ideas for measures to increase awareness and participation of stake-holders and inhabitants were discussed and refined. A broad range of possible measures were identified, ranging from electronic tags for marking hot areas in a street, to a heat simulation tool for explaining effects of heat in cities and finally to an augmented reality (AR) app for visualizing greening and cooling measures in a realistic way. A selection process of the project team favoured the augmented reality app with the reasoning that an innovative technology would possibly raise more awareness than other lower technology approaches.

The basic idea of the augmented reality app is to project 3D modelled objects of a greening project (like trees, water ponds or built design interventions) at exactly the same position where the measures would be placed in the real world. Participants would be able to observe the measures and even walk around and interact with the objects using the AR tool. In advanced applications, the participants can be invited to vote and comment on alternative options for a greening project.

A first implementation of the augmented reality application was designed with the goal to have a very low technological barrier for installing and using the app. This resulted in a browser based augmented reality solution. A test with participants during the GW#1 proved the assumption correct that such an application raises awareness of the topic, however, it also showed that some participants were more concerned with issues of the app on their personal mobile phone than with the topic itself. Also, it became apparent that the selected technology was not sufficient to provide a gameful user experience since the users could not freely walk around the projected AR objects (Fig. 8l.).

Those observations together with the feedback of the participant lead to a new implementation with modified requirements. It was decided to use special hardware devices for the AR application (iPads with Lidar sensors) in order to provide a high level and playful AR experience. This increases the barrier of use, but it allows the participants to focus on the topic and not on installation issues on their mobile devices.


Fig. 8: Testing of the browser-based AR tool in GW#1 (l., ©PlanSinn_Schopper) and of the advanced iPad-based AR tool in GW#2 (r., ©GrünStattGrau_Formanek)

The new version of the AR application was made available in the Apple application store under the name L4G AR Viewer and was tested during two different events. Prepared iPads were given to the participants together with explanations of the planned greening measures, resulting in more vivid discussions and interactions between Living Lab staff and participants (Fig. 8r.).

During the finalization of the tool for the app store, a new functionality was added which allows the use of the application without any preparation of models and markers. In this basic mode, the app allows the planting of virtual trees in streets and on sidewalks. Screenshots of those planted trees can be shared with other persons. This mode can be used to raise basic awareness of the greening topic, especially with younger persons. First tests using this functionality are scheduled with school kids throughout the end of the Lila4Green project.

7 CONCLUSIONS

In the course of LiLa4Green several barriers and restrictions but also potentials for making existing urban structure more climate-resilient became evident. All in all, the project managed to start a transition towards climate resilience in one of the most densely built areas of Vienna. Three key elements proved to be essential 1) find solutions which fit to the local setting and set concrete actions 2) raise awareness and involve local networks, stakeholder and neighbours and 3) embed measures and demonstrations into a continuous process.

To accomplish the associated aims for building a co-creative environment, for raising awareness for the positive effects of green-blue infrastructure measures and for increasing the acceptance and willingness to implement and to invest the following aspects appeared to be crucial:

(a) transdisciplinarity: to build up a sound base for decisions and actions a comprehensive scientific background is necessary. In the case of LiLa4Green this involved various disciplines and methods such as the potential analysis and microclimate maps.

(b) interplay between external impulses and local involvement: every external impulse can only be successful when locally accepted. Local involvement at an early stage guarantees awareness for and identification with implemented measures. This link is facilitated by the living lab.

(c) experiments: interventions are useful and important, because they are visible and tangible. Above all they initiate controverse discussions constituting a crucial step for involvement and for awareness raising. It is necessary though to install an accompanying communication process e.g. within a living lab.

(d) continuity in the process: it is essential to let the participating and observing people know that the process is still ongoing. This can be achieved through different channels such as newsletters, on site visits, websites and activities on site.

(e) low threshold participation: to gain the confidence and engagement of the involved parties it is necessary to approach all participants at eye level and to appreciate local knowledge. Low threshold tools should therefore be selected when preparing the process to foster successful participation.

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(f) legacy of the LL: the living lab should be embedded into existing local networks in order to guarantee a continuity after the end of the research project. Within Lila4Green these have been the area renewal office, the Stadtraum on site, the collaboration with local partners such as the Egyptian Culture Association or the Materialnomaden, the language and primary schools and many more.

The Living Lab proved to be essential for framing the entire process and for embedding the various elements of the project (awareness raising, implementation of green measures, testing and co-development of AR tool, involvement&training of students and pupils, etc.). Making existing urban structures climate-resilient is a complex issue that requires the consideration of the specific local setting and the involvement of diverse stakeholders and actors. Thus, the process towards transformation is as crucial as the measures themselves.

The LiLa4Green project has been nominated as official IBA Candidate (International Building Exhibition Vienna 2022) and was part of the IBA interims-exhibition "How will we live tomorrow?" in October 2020.

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ICT Usage to Improve Efficiency in the City of Johannesburg Public Transportation System

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1 ABSTRACT

Information communication simplifies the way of living as everyone is updated with everything happening around them. With technology, information distribution becomes more efficient and convenient, and everyone could have access to the same information which on most occasions is accurate. Globally, developed countries have implemented different techniques in information dissemination for public transport through technology which today these technologies are adopted in public transport everywhere in the world including developing countries. South Africa is a developing country that has numureous public transportation systems for commuting and with the City of Johannesburg (COJ) having all forms of public transportation available in the country. Currently, the city has various forms of public transport including both formal and informal public transportation such as ride-share services (uber and taxify), Bus Rapid Transit system (BRT) known as Rea Vaya, High-Speed Trains (HST) known as Gautrain system and traditional public transport systems (mini-bus taxis, Putco Bus, metro rail). This paper seeks to identify whether the high usage of ICT could assist to integrate both formal and informal public transport systems through different dynamics to deliver sustainable and convinience public transportation systems. The study adopted a case study research design and a mixed method approach that facilitated the gathering and analysis of both quantitative and qualitative data from the public transport officials and commuters. Statistical, content and document analysis were used to glean more information. Preliminary results indicated that Innovative formal public transportation such as Gautrain system, Rea Vaya bus, uber and taxify deployed the usage of ICT which makes commuters to be informed with the whereabouts of the innovative public transportation, however, commuters still struggle with convinient movement in and around the city due to numerous factors. Consequently, informal public transport such as mini-buses (taxis) which transport 60% of commuters daily in and around the city does not have the usage of ICT in any form but can be efficient at certain times and can also be frastruating at some times as there is no form of communication. The implications of the study indicate that the city has the high availability of public transportation which is disjoint from each other affecting reliabilty and efficiency for commuting as there is lack of formal information communication within these different public transportation systems as all of them are interested in benefiting individually. The study recommends a development of an integrated online application which will provide information on both formal and informal public transpotation plartforms in the City of Johannesburg for commuters to be able to be informed of the availability of public transport in the City for Johannesburg 24hours for conviniency. Further, this app could assist commuters to identify the movement of the innovative formal public transport in-real time to create seamless travelling if necessary, for commuters. With efficient and integrated public transport system in the city will result in more usage of public transportation.

Keywords: ICT, formal public transport, informal public transport, integration

2 INTRODUCTION

Contemporary public transportation systems are tailored towards improvement of mobility. Mobility infrastructural developments continue to be a necessity across all epochs of life, in light of this and the emergence of the fourth industrial revolution era, cities are investing on new innovative systems to improve connectivity. Within the South African context, the City of Johannesburg Metropolitan Municipality has implemented various innovative transportation systems. Currently the city has various forms of both formal and informal public transports such as ride-share services (uber and taxify), bus rapid systems (Rea Vaya) and high-speed trains (Gautrain), traditional public transport systems (mini-bus taxis, Putco Bus, metro rail).

To ensure synergies are shared between traditional public transportation and innovative public transport systems, the use of technology and big data which are now available and can be mined due to the emergence of the fourth industrial revolution are proposed. The objective of this paper is to identify a strategy to integrate the existing formal public transport with the informal public transport within the City of Johannesburg. As various modes of public transports serve a different purpose to different communities. The paper identifies the mostly used public transportation modes and assess the different information dissemination of the existing public transport. The integration of public transport will not only make trips faster but also safer since stations will be in close proximities and commuters do not have to travel long distances to catch another mode of transport.

3 LITERATURE REVIEW

3.1 Urban public Transportation

Cities and metropolitan areas are centres of diverse activities, which require efficient and convenient transportation of persons and goods. It is often said that transportation is the lifeblood of cities. Vuchic (2017) states that high density of activities makes it possible and necessary that high capacity modes, such as bus, light rail and metro, be used because they are more economical, more energy efficient and require much less space than private cars. Moreover, public modes of transportation provide service for all persons, while cars can only be used by those who own and can drive them (Nur & Gammons, 2019). Thus, cities need and benefit from public transportation services, which offer greater mobility for the entire population than people in rural areas can enjoy. Transit systems are also needed in urbanized areas to make high-density of diverse activities, such as residences, business offices, factories, stadia, and other activities physically possible, while keeping cities liveable and attractive for people (Vuchic, 2017). Urban Public Transportation is defined as a form of travel offered locally that enables more people to travel together along designated routes (Vassilis, et al., 2019). Typical examples of forms of public transportation include buses, trains, and in other countries trams, high-speed rails, airlines, and coaches dominate public transportation between cities. Most public transport services operate on stipulated timelines. Some transportation systems operate on a full capacity basis, which means the vehicle will not start until it’s full. However, many cities across the world provide shared taxis when the essence of time is a factor (Viergutz & Brinkman, 2018).

Urban Public Transport is a system that is used to serve all individuals moving from origin to destination and a certain fare should be paid for a trip taken (Lyons, 2019). Public Transport offers different kinds of service including the operation of a certain system depending on the service providers. Mostly, each and every system has start and end time, some operate 24hrs for example mini-bus taxis and ubers/taxify in South Africa, during the week and weekends operations are different, and these systems have certain intervals of operation(Zhong-Ren et al., 2012).

3.1.1 Bus rapid transit (BRT) system

When buses are physically separated, through some investment, from cars, this has become to be known as a Bus Rapid Transit (BRT) system. Basso et al., (2019) define the Bus Rapid Transit as a system with high-quality bus-based transit system that delivers fast, comfortable, and cost-effective services at metro-level capacities. It does this through the provision of dedicated lanes, with busways and iconic stations typically aligned to the center of the road, off-board fare collection, and fast and frequent operations” (Walters, 2013). Due to the BRT containing features similar to a light rail or metro system, it is much more reliable, convenient and faster than regular bus services. With the right features, BRT can avoid the causes of delay that typically slow regular bus services, like being stuck in traffic and queuing to pay on board (Basso, et al. 2019).

Buses represent the most widely used transit technology. Virtually every city in the world that has transit service operates buses. Large cities with rail transit also operate extensive bus networks, usually on lines with lower passenger volumes or as feeders to rail lines (Basso, Feres, & Silva, 2019). The BRT service is easy to introduce or modify, basic service requires only purchase of vehicles, garage and maintenance facilities, and organization of service. Stops along the lines can be simple (Ordóñez Medina & Erath, 2013). Therefore, buses represent the most economical transit mode for lightly travelled lines. This flexibility of bus routes is an advantage for any necessary changes, but it is a disadvantage for major bus lines: they lack permanence, efficiency in carrying heavy passenger volumes, and image of permanent, physically fixed routes desired by passengers(Basso et al., 2019).

Earlier, the public transport industry structure typically was of two types, the publicly owned monolithic companies that operated the entire system as in Paris, New York, or Moscow, or a collection of small private operators like in Lagos, Nairobi, and Bogota (Viergutz & Brinkman, 2018). However, the emerging industry structure is the one where a public entity determines the routes and schedules and contracts operations from private operators. This practice has become common in London (for its bus services), Bogota (for its BRT system), and a host of other cities. Such an arrangement allows the public sector to ensure that good public transport is available to all citizens and, at the same time, allows private sector efficiencies to be tapped for operations (Viergutz & Brinkman, 2018). However, such a contractual arrangement would not have been possible if technology had not permitted a detailed tracking of vehicles(Walters, 2013). The ability to track vehicles has made it possible to easily enter into fleet operating contracts as it is possible to monitor the implementation of the contract more effectively. Thus, it is possible to verify whether buses completed the entire journey, whether they were on time, and a host of other metrics (Luke & Heyns, 2020). This allows for contractors to be paid based on actual performance and also facilitates rewards and penalties for over- and underperformance. The BRT system is made possible through the implementation of ICT.

3.1.2 Uber and taxify

Uber is an application that connects passengers with drivers who have a contract with Uber (Contents, 2019; Coppola & Silvestri, 2019). To order a vehicle it is necessary to own a smartphone and to register within the mobile application by entering your name, e-mail address, a cell phone number and a credit card number that is to be billed automatically at the end of the ride. According to Pojani and Stead (2015), among the biggest disruptions in the current transport system has been the arrival of aggregator platforms that have allowed car sharing systems like Uber, Lyft, Didi, and Ola to emerge. Essentially, such platforms match the demand for trips to the supply of trips(Hensher, 1998). Passengers book for rides to travel from a certain point to another and the platform locates available taxis, or other vehicles that are available, and match the two. This has proved immensely convenient to both passengers and to taxi operators and is, therefore, disrupting the market. All this is possible through the employment of Information and Communication Technology. This was launched early in April 2016, the Delhi-based start-up provides people with an opportunity to share rides with others while also helping them reach their destinations faster and in a more cost-effective manner by reducing the waiting period for a cab or an auto by connecting a network of people who are driving on the same route (Basso et al., 2019). The app plugs the demand and supply gap between drivers and riders by allowing a person with seats to spare, be it in a car, an auto, or even a cab, to share his or her route online and connect with a person heading the same way using various route matching algorithms(Coppola & Silvestri, 2019).

Passengers can request a ride and if accepted by the pooler, it will direct them to the “pikup” point determined by the app. Once the ride is complete, a cashless payment process is initiated through card-less banking payments, further making the process less cumbersome by avoiding the hassle of change(Coppola & Silvestri, 2019). The entire operation is simple and allows a convenient way of traveling. The prices are also transparent and listed on the app in the form of rate cards that are fixed based on the distance covered. Walter (2013), alludes the entire process of uber makes it less expensive and auto rates since it is immune from surge pricing and other time-based charges. The app also allows a female-only option that matches female riders with seekers. There is also an SOS feature, where apart from a person’s registered contacts, Pikup will also receive a real-time update on a user's whereabouts through SMS and call (Basso, et al. 2019).

3.1.3 Minibus taxis

The minibus taxi industry which is mainly operated using 16-seater minibus taxis is responsible for providing public transport services to a significant number of commuters (Baloyi, 2013). This is due to network flexibility that this mode of transportation mode offers, it is more accessible than trains (rail transport) and, therefore, more intensely used. It is also much faster than the bus services as it does not operate on a fixed schedule (Binza & Siyongwana, 2012). Though the minibus taxi industry offers better services mentioned above the industry is not subsided by the government. Baloyi (2013) notes that the minibus taxi industry plays an important role in both rural and urban public transportation systems, both in mobility and economic terms. The industry employs a large number of people and circulates significant large amounts of money. Although the way the taxi industry is organized varies across countries and even within countries, some factors are shared at varying latitudes of the globe.

The biggest challenge with the integration of all public transportation is the resistance by taxi owners, operators and drivers (Machiavelli, 2019). These role-players are prepared to sabotage any development that that is meant to improve travel conditions for the general public. Just like every other capitalist, taxi owners are concerned with the generation of profit more than the improvement of the mobility systems. In that case, a system that will ensure profit for taxi owners and decrease in the usage of public transport needs to be put in place.

3.2 Information and dissemination

Information Dissemination is defined by Gkania and Dimitriou (2019) as an active distribution and the spreading of information of all kinds to the users or those audiences that deserve it. In developing effective dissemination strategies, plans and policies for public transport companies there is a need to understand the scope and characteristics of their current and potential users. Appropriate dissemination is a significant aspect in attaining user satisfaction and increasing usage(Koutsopoulos, Ma, Noursalehi, & Zhu, 2019). According to Pojani (2015), in the dissemination and utilisation processes five fundamental processes need to be analysed namely:

(1) User: the potential user of the product to be disseminated (NCDDR, 1996). The user is the receiver of information which can only be considered effective if the user is able to successfully utilise the information received to maximum satisfaction.

(2) Source: the agency, organisation or individual responsible for creating new knowledge or a product for conducting dissemination activities.

(3) Content: the knowledge of the product itself; an example in public transport content consists of travel times, routes, fares and timetables (NCDDR, 1996).

(4) Medium: ways in which knowledge is shared or the product described and packaged or transmitted, for example, SMS's, e-mails, mobile apps, public information displays and social media.

(5) Context: the way the product or knowledge is developed and disseminated, including contextual factors related to the source, the user, the content and dissemination medium (NCDDR, 1996).

There are typically great reasons why associations choose to disseminate information, they are normally related but can be categorised to underline the motivation and significance of effective information dissemination.

According to the NCDDR the following categories are reasons for information dissemination:

(a) Judgement: Information is disseminated with the expectation that individuals within an organisation will improve their knowledge and subsequently improve their judgements in future situations.

(b) Awareness: Information is disseminated with a specific end goal to teach, clarify and advance an idea, procedure or standard. For instance, technical stipulations explaining systems, capabilities, instruction about alternative transport to avoid congested routes, notification of train delays, are all ways in which information is disseminated (NCDDR, 1996).

(c) Response: information is often disseminated with the sole expectation that it will bring about some feedback that may require additional data to be created. Examples include advertising, questionnaires, market survey, etc.

(d) Collaboration: Information is regularly disseminated in order to share knowledge and ways of communication. Examples incorporate workflow systems to encourage the flow of information between systems in order to accomplish a common purpose, e.g. control systems where probes may identify and transmit notices about specific events (NCDDR, 1996).

3.3 Information and Communication Technologies ICT

There is no single universal definition of Information and Communication Technology (ICT), the term is generally accepted to mean all devices, networking components, applications and systems that combined allow people and organizations (i.e., businesses, nonprofit agencies, governments and criminal enterprises) to interact in the digital world (Agarwal et al., 2018; Azolin et al., 2020; Litescu et al., 2015). ICT applications aim to provide information through innovative services relating to different modes of transport and traffic management that enable various users to be better informed and make safer, more coordinated and smarter use of transport networks. The use of ICT guides and inform commuters how a certain public transport system works, and this information is provided in a portable manner.

The use of ICT in urban public transportation helps in allowing data to be compiled on the speed of vehicles in different parts of the city, or different sections of the road network, the time taken to move from place to place, the distance travelled, the points at which the vehicle stops and for how long and other important information for commuters (Litescu et al., 2015). This helps in getting an idea of the level of congestion at different points of time in the day and the choke points in the city that need attention. This also helps in planning routes and schedules on a more scientific basis. It also helps in monitoring driver and vehicle behaviour for corrective action. It provides information on the exact time at which a vehicle reached a certain place and the route it followed in moving from place to place. This allows contracts to be monitored and a verification of whether contracts terms have been met.

3.3.1 Social Media

In the 21st century, the use of Information and Communication Technology has revolutionised and subjects such as social media has transformed the way people interact and share information in essence the way individuals communicate. According to WeAreSocial (2020), there are 3.8 billion social media uses in the year 2020, these statistics might have increased during the Global corona virus lockdown across the world.

Social media platforms are defined as web-based services that enable people to disseminate and receive information in real time (Gal-Tzura et al., 2014). Social Media may be used for various functions such as promoting businesses, for customer relations and for real time information notices. For this reason, the use of social media grows day by day and various sectors have begun to take social media marketing seriously as they are able to reach a wider audience through this medium (Musakwa, 2014). Social media is utilised by individuals of different ages, nationality employment status and with diverse interests. The social media community comprises a rich sample of members which allows these platforms to be powerful tools that are suitable for collection of transport data, by surveys or other ways (Gal-Tzura et al., 2014). Social media can be seen as a tool that is used for transport related applications and transport companies use this platform to communicate with their users (Amey et al., 2011; Bregman, 2011; Gal-Tzura et al., 2014). The core purposes of social media use across organisations are information sharing and updates, advising the public on travel disruption, handling travel queries, and responding to queries and messages. The information posted by organisations includes updates on travel delays, marketing and promotion deals which is done to expand brands and to have direct interactions with users (GalTzura et al., 2014).

Transport companies also use marketing concepts such as “seasonal goodwill messages” sent to commuters and was seen on many of the sites. This was consistently informal in nature and seemed to be aimed at promoting the concept of timeliness, community and friendly service (Litescu et al., 2015). The magnitude of the organisation overall does not influence its use of social media. Large organisations do not necessarily use social media as a strategic tool. The transport sector and commercial sales sector will not utilise social media in the same way, each sector uses social media in various ways and one more than the other. According to Gal-Tzura et al. (2014) “the longer the social media sites have been established, the more likely the use becomes focused”. A trend for interaction was noted with some associations that use social media in a highly interactive way setting an example for other organisations (Litescu et al., 2015).

3.3.2 Mobile transport Application

While gaining knowledge about the main part of public transport trip might have been historically possible, information on the critical secondary connections was not. This was particularly the case in developing cities with limited, if any, formal, fixed route and schedule bus systems covering only a small part of the entire conurbation with service (Coppola & Silvestri, 2019). Today’s ICTs provide the ability to map the entire formal and informal public transport systems, providing passengers with a complete picture of travel options, from actual origins to actual destinations. That information can be made available anywhere, at home or work, at stops, stations and terminals, and even on-board. People need travel information for their trips from their origins to their destinations. It also helps reduce uncertainty for people making new trips. Public

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transport systems typically focus on providing service information to the public. This information covers routing and stops, schedules, and fare payment.

Information Technology has developed over the years with internet connectivity and mobile devices presenting an opportunity to tackle private mobility (Speed and Shingleton, 2012; Dickinson et al., 2015). The availability of smartphones allows users to access travel information about their travel issues, to view where others might be in their social network and share information (Dickinson et al., 2015). Application developers have recognised this potential and as result there have been great developments in a range of apps that track users, share travel information and provide real time public transport information as they enable access to data resources that were once perhaps difficult to access (Litescu et al., 2015). Smartphones are the ideal travel instruments as they can be used on the move and to share and, access information on travelling (Dickinson et al., 2014). The trends of applications have been focused more on travel information and route planning. However, more recently transport companies have developed apps to facilitate a more collaborative use where commuters may purchase tickets in advance through these mobile apps and use their smartphones as tickets (Koutsopoulos et al., 2019). These apps assist users to join social networks and to make better use of their collective travel resources, thus potentially allowing users to be interactive on social media. Analysis of the collaborative travel apps currently available indicates that they operate according to various forms of exchange, each social app serving its purpose. Travel apps are unlikely to play a role in these settings through person to person connectivity of smartphones which makes them a useful facilitating tool (Dickinson et al., 2015).

3.3.3 Real time information dissemination

ICT has made it possible to locate a vehicle and also track its movement from a central control station. This has been possible due to a global positioning system (GPS) device being fixed to a motor vehicle and programmed to continuously communicate its location to a central control centre (Machiavelli, 2018). This information can simultaneously be communicated through specially developed apps to individual mobile phones. Similarly, GPS embedded on most smartphones allow the location of a person using that phone to be communicated to a central control centre, thereby allowing an assessment of the level of crowding in any area. The ability to accurately track a motor vehicle has led to many possibilities that were not otherwise feasible (Vuchic, 2017).

3.3.4 Public information Display

Public Information Display systems are defined by Vuchic (2017) as an automated system for supplying users of public transport with information about the nature and state of a public transport service, through visual, voice or other media. Public Information Displays are becoming very common in modern public transportation. Realtime information displays are prominent in the transportation sector. These systems show real- time information by providing features such as next departure of trains and buses at stations and stops (Machiavelli, 2018). Research has shown that this kind of information is appreciated by commuters and the installation of PIDs is to improve significantly traveller information and the quality of service. In evaluating PIDs, commuters often question their reliability and comprehensiveness (Dziekan and Kottenhof, 2007).

4 STUDY AREA

The City of Johannesburg is the focus area of study. The city is home to 7 regions and is the largest city in the country and contributor to the country’s GDP. The City of Johannesburg is the biggest contributor to South Africa’s economic growth and is also the most polluted city in the country as of the 2011 population survey (Stats SA, 2012). The city was founded prior to the discovery of gold which led to high employment of the South African populace through gold mines (Rand Refinery, 2013). The city is home to numerous townships, one of which is Soweto, the oldest and big township in the country.

The establishment of the gold mines in the area led to the flooding of South Africans from different provinces into the City of Johannesburg for “greener” pastures. This extended to neighbouring countries where people came into the city for mostly unskilled labour (Rogerson & Rogerson,2014). This led to a need for more public transportation, improved transport infrastructure in the city such as roads and railways which led to the improvement of public transportation, specifically the railway systems.

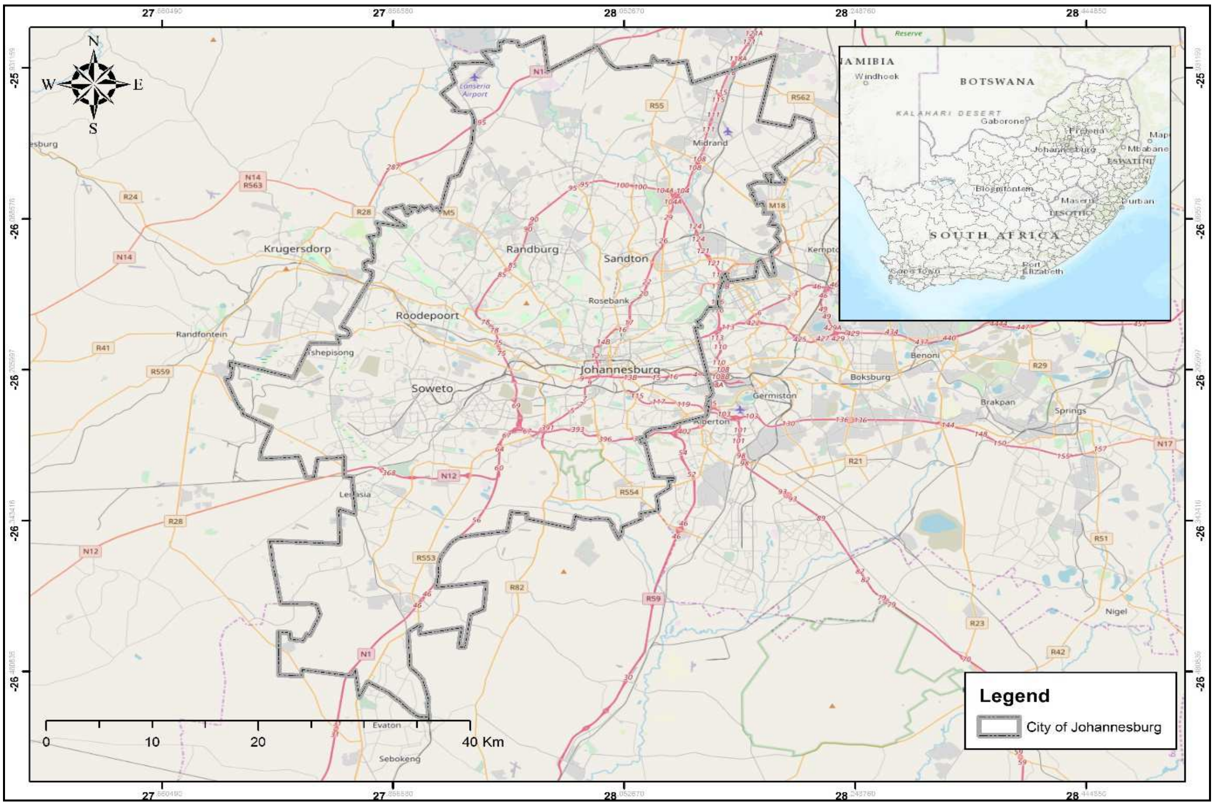

Figure 1: Study Area. Source: Author, 2021

5 METHODOLOGY

A mixed method research design was adopted where qualitative data and quantitative data analysis was used. Various research instruments were employed in the study. Five interviews were carried out with officials from different departments, including the Department of Transport and Metropolitan Municipalities transport planners whom assisted in providing insights for the study about the possibility of integrating the different public transport modes of formal and informal public transport in general, and how to integrate the different entities of UPTs in the city. Accordingly, commuters were also interviewed to understand how commuting is with and without information dissemination. 10 different daily commuters were interviewed who may have different experiences taking place daily. Purposive sampling was adopted as it was necessary to conduct interviews with informed officials and commuters. Interviews, observations and documented studies relating to this study were the sources of data. Further, content analysis was employed to review previous documented studies and used to for strategies to explain the methods of integrating both formal and informal public transportation. Secondary information used was obtained from larger data base such as Scopus, Science direct, Sage and Google scholar.

6 RESULTS AND ANLYSIS

6.1 Bus Rapid Transit System (Rea Vaya)

This mode of transport uses various forms of information dissemination for commuters which include plartform timetabling, online fixed timetables and public information display system in the stations and inside the bus.

The above figure shows a public information display system, these systems are not working in many Rea Vaya station. There are no clear indications on when the bus will be arriving at the stop and when it will depart from that station. Passenger of the Rea Vaya Transit complain that there is no specific time for travelling and buses stop and leave whenever. This is frustrating for workers who made 51% of the study group, this is because they are sometimes late for work due to the inconsistencies of the travel time. Consequently, on the stations where this system work's, the bus that does not arrive at the stipulated times.

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Figure 2: Rea Vaya PID‘s [Source: Author, 2021]

6.2 Gautrain system

This mode of public transportation has trains and a buses, and it has most improved information dissemination in the city of Johannesburg as stipulated by commuters. There is availability of a mobile app that provide the operations of the Gautrain including the departure and arrival times, the movement of the train in real-time, how one can switch inbetween from Gaubus to Gautrain with reasonable time intervals allowing commuters for switch inbetweens. The stations have the PID’s in the station and inside the trains that functions very well.

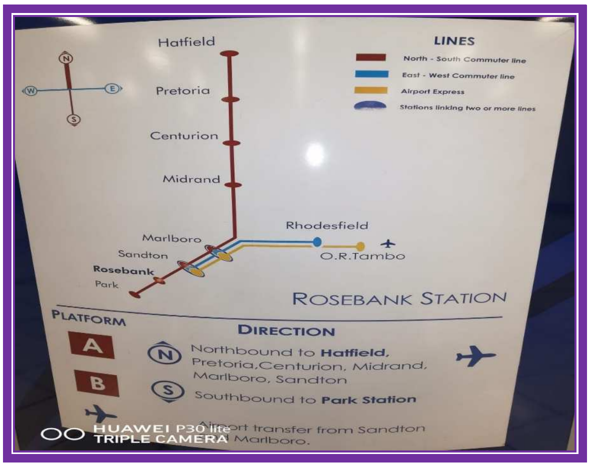

Figure 3: Gautrain map [Source: Author, 2021]

The above figure shows the Gautrain railways. These maps are placed at the entrance of everything station so that commuters know how the trains moves and how the stations are following each other. This also shows the directions of the railways, so that people who are going to the ORTIA can know where to get off and how they can change trains. Only 29% of the commuters were aware of this map, other commuters said they rely on the PIDs inside the trains that show which stop is next.

6.3 Public information display

In an age of mass public digital communication, large screen displays are emerging everywhere, particularly in well trafficked public places such as train stations, airports, hotels and shopping malls. These public displays have been receiving considerable attention as highly effective and visually compelling communications platforms, delivering information and related advertising (Lee, 2016). The figure below shows an example of a PID system and the information that is normally displayed for passengers.

Figure 4: PIDs [Source: Author 2021]

The survey revealed that 73,3% were aware of PIDs while 26,7% were not. It indicates that most respondents are aware that there are Public information Displays. Public Information Displays (PIDs) provide new possibilities for transportation companies to provide information at different stages of the journey. Public displays with interactive functionality provide the opportunity to support different users in their interaction, through specific support functions by providing information on schedule, calculate fares and train and bus routes. Gautrain has public information kiosk that offer users with the type of information they would need for their trip. These PIDs provide real-time and punctual information to commuters and 94% of the commuters were happy with these systems and the accuracy of the information.

6.4 Uber and taxify

This mode of transportation is convinient and reliable. It takes a certain number of people, it can be one to four if its a normal car, and if passengers are more than that they can be able to request for a large car that will be suitable for a group. It is expensive if is used by one individual compared to local minibus taxis and lesser if its used by a group as the prices are fixed based on the trip distance.

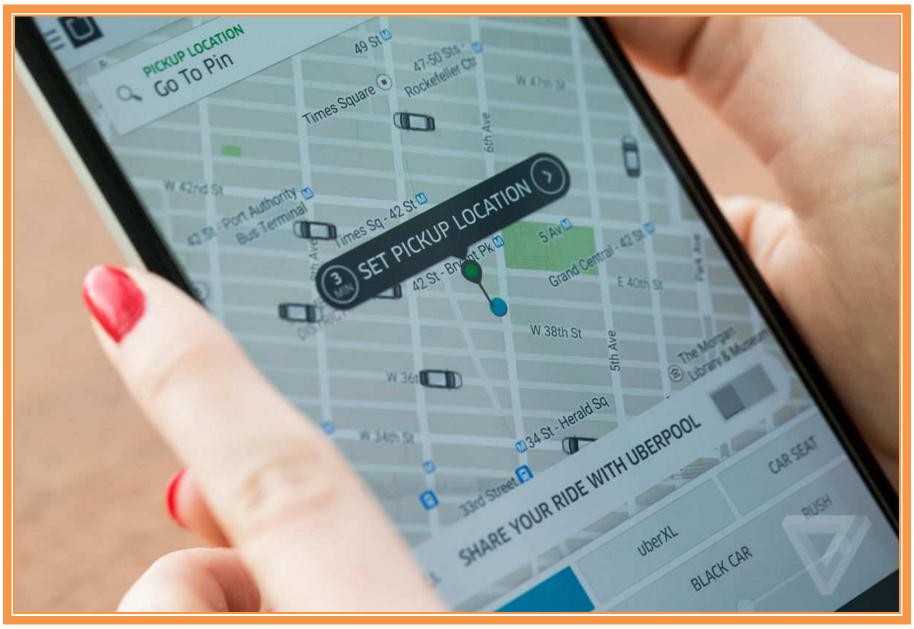

Figure 5: Uber App [Source: Author, 2021]

The above figure 5 indicates the application that is used for a uber/taxify for one to be able to request or use this mode of public transport. Many commuters deem this mode of public transport to be reliable as picks an individual at any convinient place from orig to destination without any unneccessary stops made. Commuters when requesting a ride can be able to see where the mode of transport is and the wait mostly is not more than five minutes if its a long time to wait. Further, the payment methods are done both electronically through the app and cash payment at the end of the journey.

5.5 Minibus Taxis

The operation of minibus taxis in the city of Johannesburg does not use any kind of technology to operate. Commuters commute in the designated taxi ranks (stations) and along the streets for conviniences. Areas differ from one location to the next depending on how the area is busy. The busy the area no more minibuses taxis are available and commuting is easy. In the locations that are not busy, it is hard for commuters to get minibus taxis.

Figure 6: Bree Taxi Rank [Source: Author, 2021]

The above figure indicates the one of the Johanessburg taxi ranks (minibus taxi station) where coummuters take the minibus taxis from origin to destination. Mostly, formal taxi ranks are designed in such manner and the only information that is provided are boards indicating where taxis travel to. There is no timetabling provided for commuters to know the times of taxis depature, on some occassions taxis take long to get to the rank and on some occassions they operate quickly. However, commuters use this mode of transportation without being aware of the timebling scheduling. Commuters use this mode mostly as it deliver commuters close to places of interest penatrating inside locations.

7 MOBILE APP IN REAL-TIME INFORMATION OF PUBLIC TRANSPORTATION

Previously, a passenger could, at best, come to know when a bus or a train left a certain station and when it reached another station. This was possible only due to human communication because someone recorded the time of arrival and departure at each station and conveyed this through a telephone system or a written report (Haris, et al., 2019). It was not possible to track the movement of the bus or train between successive stations. As a result, it was not possible to inform waiting passengers at a bus stop as to when their next bus was due. Commuters either depended on a pre-published schedule and hoped it was reliable, asked other waiting commuters, or just tried their luck. In contemporary urban public transport, it is possible not only to track the location of a bus or a train between stations' but it is also possible to know how fast it is moving and get a more precise estimation of when it would arrive. In fact, it is also possible to get a complete mapping of all public transport systems that a passenger proposes to use over a journey. The use of ICT has since become crucial to communicate real time information to commuters without guessing and relying on past experiences. Further, when one needed a taxi, the most common way of getting one was to get on to the street and flag one there. There was uncertainty on when one would arrive and, at odd hours of day, whether one would arrive at all.

The paper has indicated the modes of urban public transport that use ICT for information dissemination which indicated that this system provides information easy and commuters can be able to plan their daily trips and travelling becomes more simple even when switch inbetweens are neccessary. With the introduction of online application for minibus taxis can also make ridership simple for commuters wereby commuters book taxis online, or through an app, and track their movement until they arrive at the passenger’s doorstep. This saves the passenger from the stress of waiting endlessly, not knowing when a taxi would arrive.

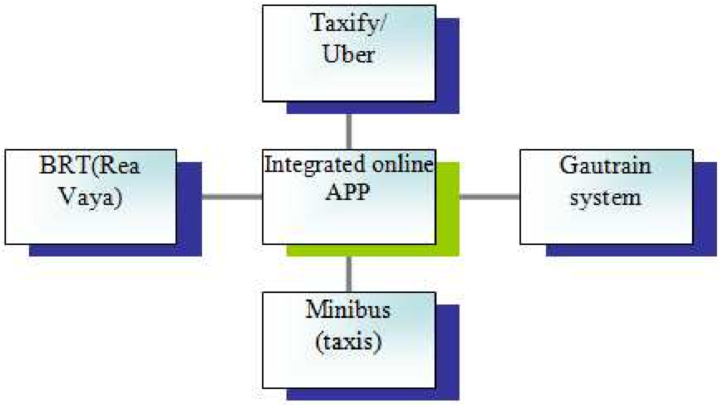

Figure 7: Integrated Information Dissemination for UPT [Source: Author, 2021]

The above figure 7 indicates an online information dissemination that can be used to integrate the different modes of public transportation that are mostly used in the city of Johannesburg. Commuters can login to an app indicating all these modes of public transport availability, real-time tracking and the fastest mode to reach the desired destination and allow commuters to make calculations for smooth switch in-betweens to create seamless travelling. The application could be used to book trips for any public transport mode and allow a commuter to connect trips switching from Gautrain system to uber/taxify or from Rea Vaya to a taxi. With such communication between these mostly used modes of public transport in the city, commuting would be much quicker and could attract more private vehicle owner to switch to public transport. Therefore, a positive change as this could reduce the traffic congestion challenge having roads that are mostly used by urban public tranport.

8 CONCLUSION

The world is making a rapid transition towards the fourth industrial revolution that is mainly characterized by technology and the internet. The latest technological innovations are rapidly and radically transforming the transport sector, creating the base for mobility solutions, which, accompanied to the cultural and socio-economic changes taking place all over the world, open the door to new future scenarios (Coppola and Silvestri, 2019). The use of Information and Communications Technology together with the Global Positioning System assists all stakeholders in urban public transportation to know the number of trips taken in a day for every vehicle and the time it used to travel. This in turn helps vehicle owners and operators with accountability and not being robbed by drivers. Commuters prefer multimodality as compared to only one option for public transportation. This helps the commuter utilize all available transport options to the current situation they find themselves in. This answers the questions of modern commuter’s choice since commuters can choose from a wide range of public transport systems and what can assist them to reach such decisions. Through the use technology, it is possible not only to track the location of a bus, taxi or a train between stations, but it is also possible to know how fast it is moving and get a more precise estimation of when it would arrive. In fact, it is also possible to get a complete mapping of all public transport systems that a passenger proposes to use over a journey. Sophisticated apps developed by many public transport operators allow a passenger to plan his or her journey across multiple modes, with an accurate estimation of the time it would take to complete the journey.

The demployment of technology is beneficial to contemporary urban public transport in that commuters avoid catching taxis on the streets by signalling their destinations, which has proven not to be safe. Taxis can be booked online which means reliable departure and arrival times. This will notify people in case of emergency in the traffic flow and assist commuters not to stress by not knowing when a taxi will arrive. Taxis can even be booked before they depart from the taxi rank, and the current systems for minibus taxis can stll be used for commuters who prefer the system of going to taxi ranks.

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9 RECOMMENDATIONS

The study has revealed the most used public transport modes in the City of Johanesburg which function differently and these modes of public transport they function from the early hours of the morning till late hours of the evening. Therefore, recommends an online information dissemination application for both formal and informal public transportation application that will inform commuters the real-time information whereabouts of the transportation modes, departure and arrivals time as to assist commuters to plan they trips properly. Further, assist commuters which mode is good for commuting at that particular moment indicating traffic congestions and delays, also assisting with the integration for seamless travelling on how commuters can switch inbetween different modes for smooth commuting with no delays.

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Improvement of Human Thermal Comfort in Built Environment using BIM simulation methods, case study in Alexandria, Egypt

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1 ABSTRACT

Recently, there has been a high demand for urban sprawl because of rapidly increasing population. On the other hand, Building Regulations do not consider either human thermal comfort or energy consumption in the built environment. The quality of outdoor spaces in the built environment could be determined by many factors. This paper will investigate the impact and effect of three factors which are building orientation, relationship between building height and street width and microclimate conditions. This paper introduces a method to evaluate the efficiency of the outdoor built environment through the simulation process using Building Information Modelling (BIM) technology. This research aims to solve the problems of thermal comfort and energy consumption in the built environment. These problems were mainly the result of building codes that were not sensitive to the built environment as the codes focus on the buildings themselves. The case study is located in downtown Alexandria city, Egypt. Its area is approximately one square kilometre. This research supports urban planners and designers in making decisions before implementation to reach thermal comfort in the built environment. It contributes to revealing the importance of factors affecting the outdoor built environment and taking them into consideration while establishing new codes or amending existing building regulations.

Keywords: Built Environment – Building Regulation – Building Codes - Thermal Comfort – Energy Efficiency – BIM.

2 INTRODUCTION

Of all the design fields, urban design has the greatest impact on the nature of cities and city life. No matter How logically the land-use pattern is prescribed by city planners, the beauty and utility of its buildings and the nature of the landscape, it is the overall combination of forms and spaces as seen in time and over time that gives a city its character. City planning has broadened its scope of concern in an attempt to be comprehensive in its outlook. Landscape architecture has considerably extended its domain of interest from a horticulture base to include urban environments, while architecture has many practitioners who focus on different aspects of the built environment. Architecture has contracted its scope of concern spinning off sub-fields as new environmental problems have arisen. One of the current generation's challenge is to understand the broad impact of our built environment on thermal comfort better. Building regulations may be the only comprehensive ones that can contain all factors to achieve a better built environment and healthy cities in the future and improve the existing built environment.

Building Information Modeling (BIM) It is to provide users with the ability to integrate, analyze, simulate and visualize the geometric or non-geometric information of a facility. One of the most significant characteristics of BIM is that it can provide the required information in an organized pattern.

3 BUILT ENVIRONMENT

The term 'built environment' refers to aspects of our surroundings that are built by humans, that is, distinguished from the natural environment. It includes not only buildings, but the humanmade spaces between buildings, such as parks, and the infrastructure that supports human activity (Committee on Physical Activity 2005). The Centre for Digital Built Britain defines the built environment as; 'All forms of buildings (residential, industrial, commercial, hospitals, schools), (Lang, 2005). Broadly defined, the built environment includes the buildings and spaces we create or modify (Karen and Oleru 2008)(McClure and Bartuska 2007). The built environment is a material, spatial and cultural product of human labour that combines physical elements and energy in forms for living, working and playing (WIKI 2012) (Blog 2015) (Matt 2015). In recent years, public health research has expanded the definition of "built environment" to include healthy food access, community gardens, “walkability", and “Bick ability” (built environment 2021).

Well-being in the built environment is a topic that features frequently. However, despite this surge in attention, there are still many questions on how to nurture, measure, and design for well-being in the built environment effectively (Luo, et al. 2018). Physical and physiological well-being depends on current states as well as on previous history of exposures, while anticipation of future events can drive neural mechanisms and psychological balance. For example, solar ingress in built spaces might be favoured, particularly in a cold climate or season, to bring passive heating and decrease lighting energy use (Mangone, Kurvers and Luscuere 2014). However, bright sunlight could cause glare and reduce visual task performance. Yet, direct exposure to natural light particularly in the morning (Baron 1990) (Mangone, et al., 2014) is beneficial.

The building industry appears to be entering another period of change in essence of minimising energy, carbon and environmental footprints of various building types (Owusu and Asumadu 2016). Globally, energy demand of buildings amounts to one third of world energy use. This change is being driven by a need to optimise and conserve resources, especially energy (Freedman 2015). The architects as important stakeholder has important roles to play in accomplishing this onerous goal (GANIYU and ADETUNJI 2015) (Newton, et al. 2012) (Pickles 2011) (Lehmann, 2011; Shanghai Manual, 2011) (Janda, 2009) (Toledo, 2006).

4 BUILDING REGULATIONS

Regulations are designed to protect buildings and the people and property inside them from any extreme events. They also ensure system safety, as well as accessibility and practical and achievable levels of energy efficiency (Francis & Steven, 2018). Building codes underpin the work of architects, engineers, builders and developers (USAID, 2013).

The existence of building regulations goes back almost 4,000 years. The Babylonian Code of Hammurabi. The protection of the health, safety, and welfare of the public is the basis for licensure of design professionals and the reason that building regulations exist. (Francis & Steven, 2018). The beginning of modern codes can be traced to the 1897 publication of the NFPA’s National Electrical Code. Early attempts to prevent fires, predecessors of today’s zoning laws and safety codes included requirements for wider streets, limitations on building spacing and height, and elimination of thatched roofs and wooden chimneys in cities. Sanitation concerns were the moving force behind some early codes and over the years, have led to plumbing standards, lighting and ventilation requirements, minimum room dimensions and other health and safety requirements we take for granted in today’s building codes (Report: The Value and Impact of Building Codes 2013) (Ching 2016) (Bank 2015) (Jawaida, Pipraliab, & Kumarb, 2018).

5 BIM INTEGRATION

The concept of building information model BIM was coined by Charles M. Eastman at Georgia Tech (Eastman, et al., 2008) and from 1970s he has worked on an extension of the BIM. His main research focuses on product modelling, data modelling and information modelling in engineering (Eastman, 1994) (Sacks, et al., 2010). The concept of BIM means building a building virtually prior to building it physically, in order to work out problems, and simulate and analyse potential impacts (Morlhon, et al., 2014). BIM can be used as a tool for generating and managing data during the life cycle of structures. BIM covers building geometry, spatial relationships, geographic information, and quantities and properties of building components (Namlı, et al., 2019) (Salman, et al., 2012) (Lee, et al., 2006) (Kymmell, 2008).

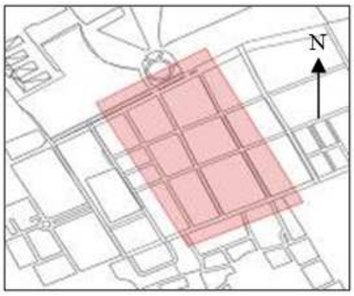

Fig. 1: Selected Block to be studied

Recently, BIM, has been able to digitise a great amount of building information and that is why it has received much attention in the field of construction project management (Wang, et al., 2014). Applying BIM in delivering construction projects has been on the rise (Guo & Feng, 2019) (Oraee, et al., 2019).

Meadati (2007) expresses that BIM is only used at an early stage and tries to integrate BIM by the 3D as-built model to increase the capability of BIM during the maintenance period. In terms of automation in BIM, several scholars have worked on this area, and accuracy and reliability of the model were their main concerns (Meadati, 2007).

6 CASE STUDY

6.1 Description

The case study is located in downtown Alexandria city, Egypt. Its area is approximately one square kilometre. A block bounded by 3 streets in two perpendicular directions will be studied as shown in figure 1.

6.2 Methodology

An analytical comparison of two cases using BIM simulations and software aimed to find solutions to the current situation and achieve better results in the future. Autodesk Revit was used to create a 3D model of the case study as shown in fig.4, B and to produce shadows results. DesignBuilder software was used to run a full simulation process on both cases as shown in fig 4, A&C. The following are the steps followed for both cases before the debate process, and the determinants change for each case.

(1) Surveying and noting the study area, building height and street widths as shown in figure 2.

Fig. 2: Fouad street live shots

(2) Drawing a site map on the Architectural Revit program using BIM technology as shown in figure3.

Fig. 3: The development of work on building the case study. Left: autocad site map, Middle: Google site map, Right: Revit 3d model as masses

(3) Determine the parameters and build the three-dimensional model of the case study based on the difference between the relationships between the width of the street and the height of the buildings and the determination of setbacks.

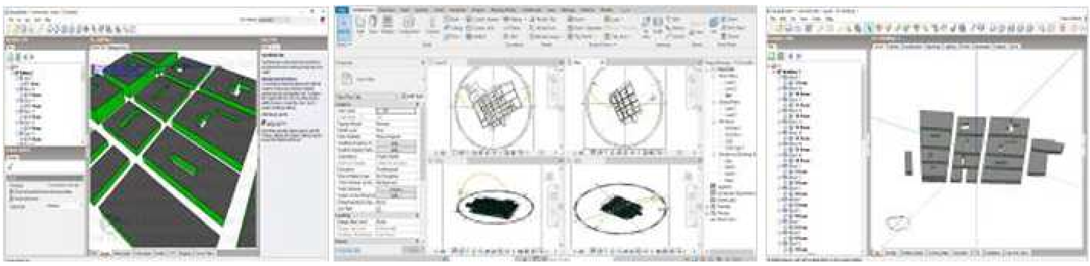

Fig. 4: Screen Shots While building 3d model and run simulation. Left: DesignBuilder Simulation, Middle: Autodesk Revit, Right: BesignBuilder model

(4) Definitions and Abbreviations of parameters used to determine and limit the case study simulation cases are: H = Hight of the building, W = Street width, X = Setback Value from property line

6.3 Solar and Energy Study

Each case will study the sun moving from sunrise to sunset by using BIM simulation and its effect on building façades and thermal comfort in the built environment.

The simulation was conducted in the summer and winter seasons, and the results were extracted for the two days representing each season. June 21st is the representative day of the summer. December 21st is the representative day of the winter. The effect of the movement of the sun, shade and shadows was observed in areas of the street and also on the facades of the buildings at three times of the day, which were eight in the morning, twelve noon, and five and four in the afternoons in summer and winter respectively.

6.4 Case I (Explore, Parameter's Equations & Simulation study)

The first case represents the current situation that has been established in the implementation of Egyptian Building Law No. 119 of 2008. The determining factors for the first case are only the relationships between street width and building height. As the executive regulations of the Building Law stipulates, the height of the building must be equal to 1.5 the width of the street.

H = 1.5 x W X = 0

These equations mean that the height of the buildings is equal to one and a half times the width of the street, without any setbacks from the property line, with regard to construction on the whole plot of the land area, but with the presence of internal skylights that differ between residential and service.

6.4.1 Study Simulation in summer

The simulation results in summer show first a site plan view to illustrate areas of shade and shadows on street level and then in a perspective view with coloured façades that represent the temperature on each façade.

Fig. 5: Site plan Shade and Shadow in summer. Left: 8 o'clock, Middle: 12 o'clock, Right: 17 o'clock

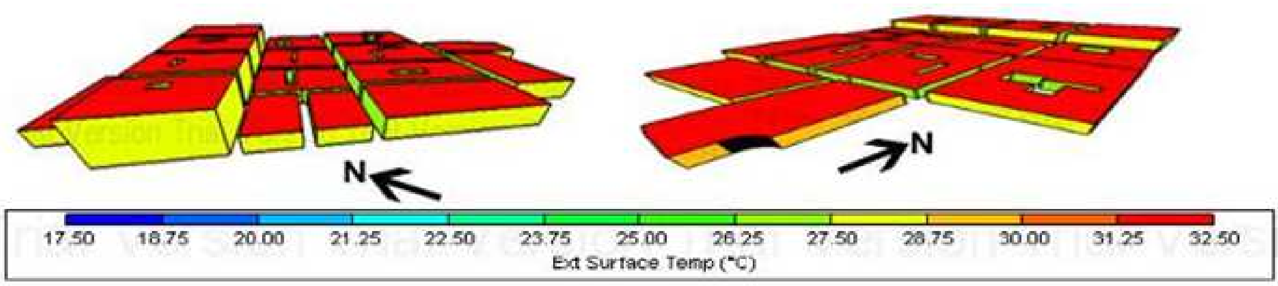

Fig. 6: Exterior surface temperature (°C) in summer. Left: Show South, West façades, ight: Show North, East façades

6.4.2 Study Simulation in Winter

The simulation results in winter show a site plan view and a perspective view which illustrate the difference between the degree of inclination of the sun.

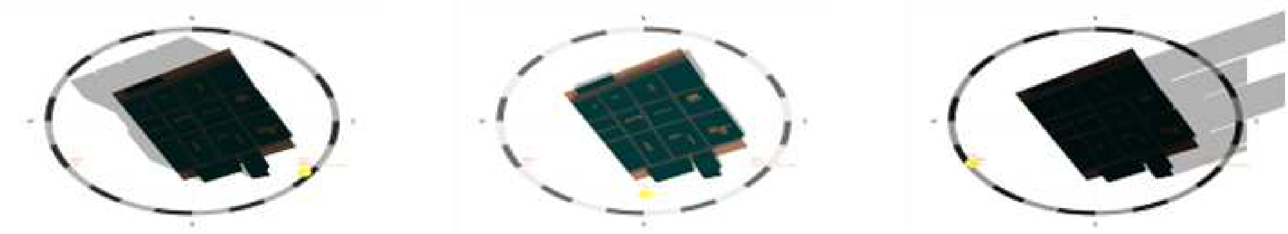

Fig. 8: Site plan Shade and Shadow in winter. Left: 8 o'clock, Middle: 12 o'clock, Right: 16 o'clock

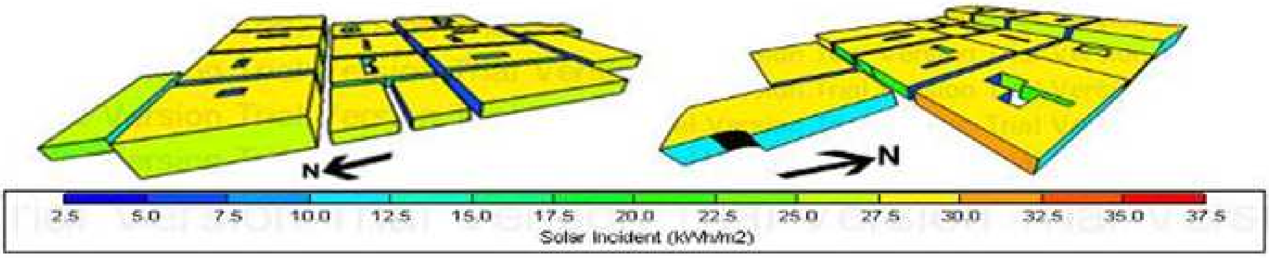

Fig. 10: Solar Incident (Kw/m2) in Winter. Left: Show South, West façades, Right: Show North, East façades

6.5 Case II (Explore, Parameter's Equations & Simulation study)

The second case represents the proposed case for amending the Building Regulation, taking into account the orientation for buildings and the voids related to this orientation. The factors affecting the second case are not limited to building height and street width, but extend to orientation, setbacks.

H = W X = 2.5

These equations mean that the height of the buildings is equal to the width of the street. There is a setback from the property line of two and a half meters, which means that building on a part of the area of the land lot, while maintaining the presence of an internal light-well.

6.5.1 Study Simulation in summer

The simulation results in summer show a site plan view to illustrate areas of shade and shadows on street level and then on a perspective view with coloured façades that represent the temperature on each façade.

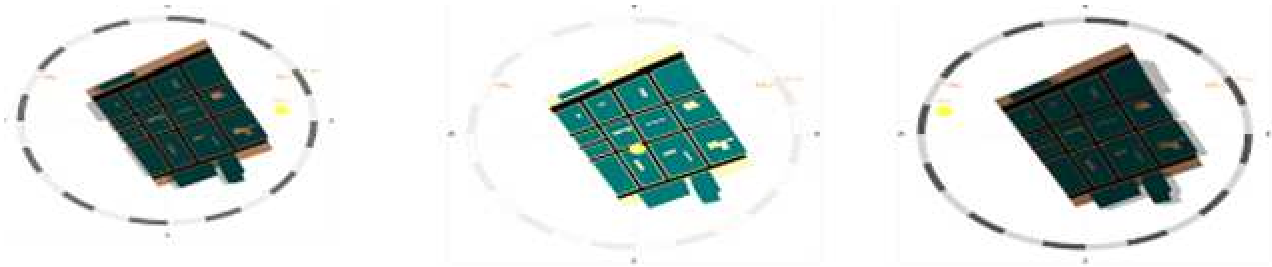

Fig. 11: Site plan Shade and Shadow in summer. Left: 8 o'clock, Middle: 12 o'clock, Right: 17 o'clock

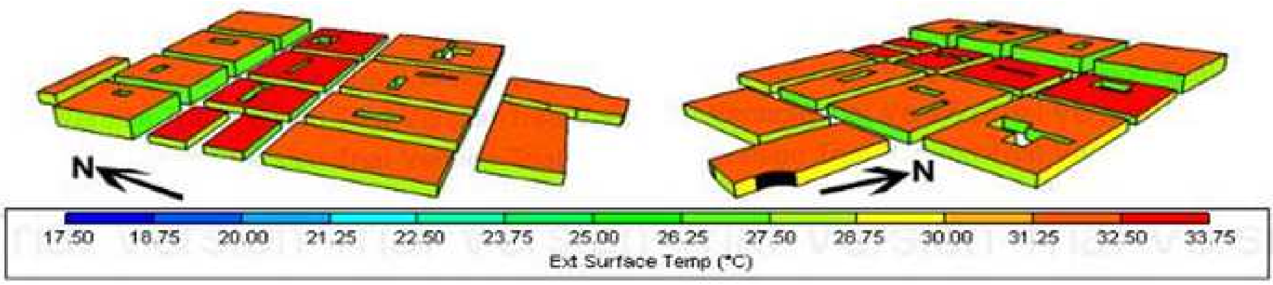

Fig. 12: Exterior surface temperature (°C) in summer. Left: Show South, West façades, Right: Show North, East façades

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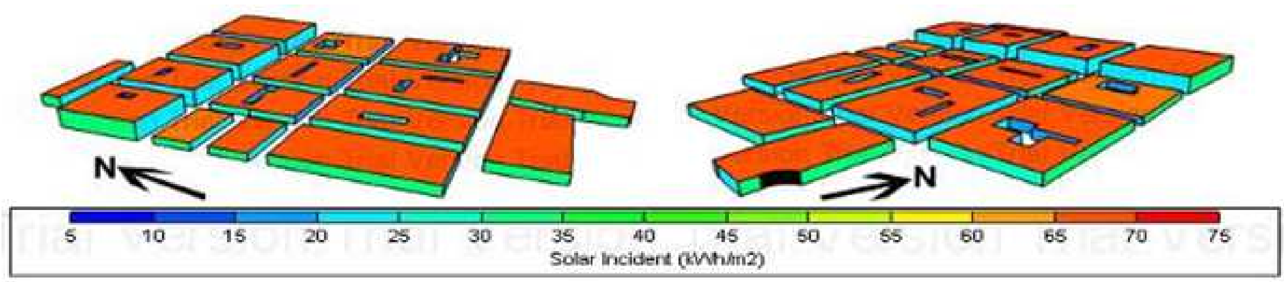

Fig.13: Solar Incident (KWh/m2) in Summer. Left: Show South, West façades, Right: Show North, East façades

6.5.2 Study Simulation in Winter

The simulation results in winter show a site plan view and a perspective view which illustrate the difference between the degree of inclination of the sun.

Fig.14: Site plan Shade and Shadow in winter. Left: 8 o'clock, Middle: 12 o'clock, Right: 16 o'clock

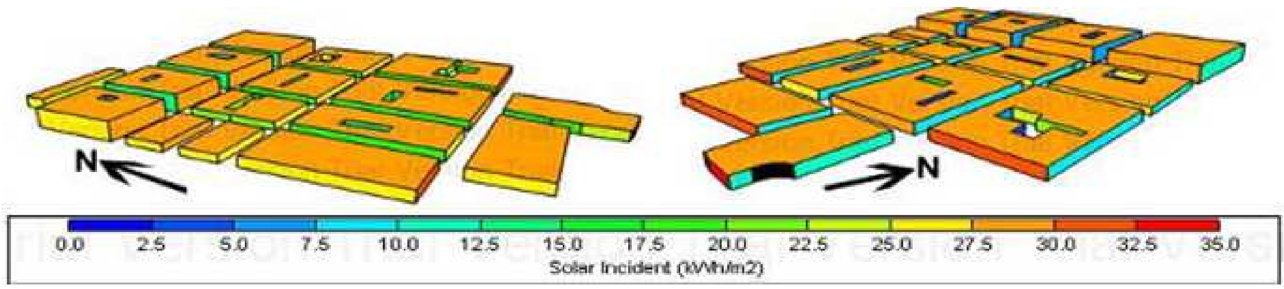

Fig.16: Solar Incident (KW/m2) in winter. Left: Show South, West façades, Right: Show North, East façades

6.6 Results

By comparing the results between the two cases, we will find that changing the equations affecting the height relationship with the width of the street beside setback value that are corresponding with the building volume, affected the shade and shadow areas, the exterior surface temperatures of roofs and façades with different orientations, as well as the amount of solar incident.

7 DISCUSSION

In the summer it is best to have more shaded areas as protection from the sun and to cool down the atmosphere in streets and inside buildings. It is desirable to decrease temperatures of the roofs and façades and thus the need for energy consumption in cooling or HVAC systems will decrease accordingly. Also, this gives designers an opportunity to use responsible and local building materials.

By looking at the results shown in Table 1, it is noticed that in Case II, the temperature to which the roofs are exposed decreased by two degrees Celsius, while on the southern façade it decreased by 3 degrees Celsius. On the other hand, the eastern façade was not significantly affected, in contrast to the western façade, which decreased by more than 4 degrees Celsius.

As for the winter season, the best situation in it differs like in the summer because we are looking for warmth and we contribute to increasing the temperatures exposed to the façades and surfaces in order to reduce the need to operate artificial heaters that consume large quantities of energy and harm the personal health and the built environment. Also, intend to have higher temperatures in spaces inside and outside buildings would affect production process as it will be more comfortable for human beings to work and produce effectively.

	Case I	Case II
Summer Condition		
Shade and Shadow	Small as shown in fig. 5	Wide as shown in fig. 11
Exterior surface temperature values for each façade (°C) as shown in fig. 6&12		
Roofs	(31 - 33) °C	(29 – 31) °C
South	(25 - 28) °C	(23 - 25) °C
West	(27 - 29) °C	(22.5 – 26.5) °C
East	(25 - 27) °C	(25 - 27) °C
Solar Incident Values for each façade (KWh/m^2) as shown in fig. 7&13		
Roofs	(65 – 75) KWh/m^2	(60 -70) KWh/m^2
South	(25 - 35) KWh/m^2	(15 - 30) KWh/m^2
West	(40 - 50) KWh/m^2	(30 - 45) KWh/m^2
East	(30 - 40) KWh/m^2	(20 -35) KWh/m^2
Winter Condition		
Shade and Shadow	Spread as shown in fig. 8	Shrunk as shown in fig.14
Exterior surface temperature values for each façade (°C) as shown in fig. 9&15		
Roofs	(15 - 16) °C	(17 – 18.5) °C
South	(18 – 19.5) °C	(18.5 – 20.5) °C
West	(16.5 - 18) °C	(17.5 - 19) °C
East	(14.5 - 16) °C	(16 - 17) °C
Solar Incident Values for each façade (KWh/m2) as shown in fig. 10&16		
Roofs	(25 - 30) KWh/m^2	(27.5 - 30) KWh/m^2
South	(17.5 - 25) KWh/m^2	(22.5 - 35) KWh/m^2
West	(15 – 22.5) KWh/m^2	(17.5 - 25) KWh/m^2
East	(7.5 – 17.5) KWh/m^2	(10 - 15) KWh/m^2

Table 1: Results: comparison for both cases I & II

By observing the results shown in Table 1, we will find that Case II is better in terms of the temperatures exposed to surfaces and facades which are higher than in Case I. For example, the southern façades in Case II are a degree and a half higher than that of Case I. The surfaces have increased temperatures by two degrees Celsius. The façades of the eastern and western buildings rose by one degree.

8 CONCLUSION

Building Regulations affect the built environment directly. Thermal comfort in the built environment which means in streets and the surrounding buildings cannot stand alone without considering interior thermal comfort in buildings. Building regulations should also give more concern to the outside of buildings as well as organising and considering the building itself. Architects, designers, constructors and stakeholders must be aware of new techniques that appear in this field and know how to use them, benefit from them and upgrade them to contribute to improving human well-being. The use of Building Information Modelling technology is increasing and it is the upcoming future.

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Integrating User Needs in Sustainable Neighbourhood Transition of the Smart City – Expanding Knowledge and Insight among Professional Stakeholders

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1 ABSTRACT

Climate neutral and social inclusive cities are set high on the European Agenda. The smart city approach is considered to be one measure within socio-technical systems to reach this ambition. In recent years, smart city initiatives were criticised for having fallen short of their objectives to meet user needs and public value creation (Hollands, 2008; Cardullo et al., 2019). Besides accelerating citizen participation activities, we assume that capacity building among professional stakeholders with the help of (social) learning can contribute to the development of more citizen-centred solutions in the built environment. Especially when resources or citizens availabilities are limited, capacity building among professional stakeholders can be an important contribution to get a better understanding and insight of public value creation in the built environment.

In elaboration of this assumption, we set the spotlight on Zero Emission Neighbourhoods (ZEN) as one smart city approach to reach more climate neutral cities through an integrative approach to transform socio-technological systems. We ask how citizen needs could be better integrated in the development of smart city projects within the built environment. In particular, we investigate how professional stakeholders, such as developers, landowners, planners, civil servants can gain more insight and knowledge of citizen needs and values to create solutions that are in line with their demands and thereby foster public value creation in a better way. Building on theoretical concepts for innovation and learning and findings from a case analysis of a Norwegian neighbourhood in transition, we present a concept for a workshop as a tool to detect market preferences through insight in citizen needs. We thereby contribute to elaborate on learning within multi-stakeholder settings and especially capacity building among professional stakeholders. Additionally, we provide practical guidance for using a tool that can be seen as a contribution to approaches towards stakeholder participation as well as for a methodology of local context-based tools for social learning.

Keywords: Zero Emission Neighbourhoods, Social innovation, Sustainable Transition, Multi stakeholder partnerships, User needs

2 INTRODUCTION

2.1 Climate neutrality in the build environment through the development of zero emission neighbourhoods

Developing the built environment of the future that is climate-neutral and at the same time socially inclusive is a major challenge for all actors involved – especially since the challenge is wicked, and situated between different sectors and actors. The aim is to find appropriate solutions within a holistic approach in collaboration between those involved and in all phases of development from the planning, construction and operation phase of the built environment.

The co-creation of solutions becomes even more important when ambitions for neighbourhood development are higher than existing laws and regulations are asking for. Reaching climate neutrality in the built environment is such a vision. Agreed during the UN climate mission in Paris, the participating countries have agreed to lower their carbon footprint towards zero until 2050. While translating these goals into national and municipal policies, some countries, regional or municipalities set their ambition even higher to become carbon neutral in a shorter timeframe. A special focus lies here on the built environment since it is one of the main sources of greenhouse gas emissions and on the energy sector that is to be transformed to renewable energy (Global Alliance for Buildings and Construction, 2019). Additionally, the neighbourhood gets more and more attention as it is identified as a main area to enable change and to realise diverse cross sectoral cutting effects and scale effects (Jank, 2017).

One integrative approach to reach for climate neutrality in the built environment is the concept of Zero Emission Neighbourhoods developed by the Research Centre for Zero Emission Neighbourhoods in Smart

Cities (ZEN Centre). A zero emission neighbourhood aims to reduce its direct and indirect greenhouse gas (GHG) emissions towards zero over its life time. With the help of life cycle assessment in all phases of neighbourhood development – including, planning, implementation and operation – the total number of emissions is assessed. These emissions are compensated through renewable energy production on site during the operation phase of the neighbourhood. The ZEN centre has developed key performance indicators (KPIs) within seven categories: GHG, energy, power, mobility, economy, spatial qualities and innovation, both to assess the status towards carbon neutrality and to help stakeholders to guide them to identify the right solutions (Wiik et al., 2019).

2.2 Co-creation and stakeholder's role in sustainable transition

An open dialogue and interaction of stakeholders involved in zero emission neighbourhood development, will facilitate co-creation of new solutions and innovation, which are needed to meet the challenges of the future and to achieve the sustainability goals that countries, cities and municipalities have committed themselves to. These challenges of the future need to be answered with tools and knowledge from a majority of actors (Schneidewind et al., 2016; Soma et al, 2018).

Nielsen et al. (2019) argue that the often very technical-oriented ambitions of smart city projects in the built environment have led to narrow dialogues which undermine the real power and capacity of stakeholders, including citizens to influence urban-planning outcomes. Fiskaa (2005) believes that neoliberalism in general has strengthened the position of landowners, business interests, and developers, in urban development. The politically driven neoliberal trend in our study country Norway has also given private entrepreneurs a prominent and driving role in urban development, that can create dependency on markets (Falleth et al., 2010).

Simultaneously, economically markets of the built environment are dependent on demand and interest of potential buyers. Smart city projects with high environmental ambitions and technological solutions do challenge stakeholders with the novelty of their concepts and technological solutions. ZEN neighbourhood developments are challenged by uncertainty and perceived risk – both from the stand-point of the citizen as end-users of buildings and infrastructure and of professional stakeholders as developers or land owners.

One approach to obtain a better insight in market preferences and citizen demands is direct participation to develop solutions for neighbourhoods that are in line with citizen demands. At the same time, the facilitation of participation processes is depending on the goal of participation, the degree of appropriate engagement, the stage of the project at which participation occurs, the capacity of stakeholders and the resources available (Raynor et al., 2018). Participation is embedded in a local context and its implementation depends on different factors. An additional approach is capacity building of professional stakeholders to develop deeper insight and understanding in citizens' needs and demands which will enable them to provide solutions closer to citizen needs.

2.3 Outline

This paper looks at how professional stakeholders, such as developers, landowners, planners, civil servants can gain more insight and knowledge of user needs and values to create solutions within neighbourhood developments that are in line with user needs and thereby foster public value creation.

Following the introduction, the paper provides a brief description of relevant theories and concepts in section 3 while section 4 is about the methodology that was adopted in this study. The results of the case study are presented in section 5 which describes the case study of a neighbourhood development in Ydalir, Norway and hence provides the context and need for a tool for capacity building and identification of marked preferences. Based on this analysis, the concept for the tool is developed and presented. Section 6 focuses on analysis and discussion. The concluding section 7 winds up the whole discussion.

3 LEARNING FOR SUSTAINABILITY - RELEVANT THEORIES AND CONCEPTS

In this section, we present relevant theories and concepts that help us to study how professional stakeholders obtain insight and knowledge on user needs and values. In this regard, we look at the following concepts: social innovation, social learning, capacity building, design thinking, and single- and double-loop learning. These concepts are mutually related and overlapping, at least to a certain extent. At the end of this section, we present a figure to illustrate how these concepts are inter-connected.

Social innovations are widely understood as new ideas that aim at meeting social goals (Hellström, 2004). Therefore, the role of social innovations within the development of socio-technological systems as highly ambitious neighbourhoods is to enable improvement of the well-being of citizens and the civil society in general. The involvement of citizens and stakeholders is one crucial element to enable social innovation within the quadruple-helix model (Carayannis et al., 2009), a model of cooperation among stakeholders from the public and private sectors and academia, with a strong emphasis on citizens and their needs. Social innovation within the Nordic model relates to activities that are social and representing both needs and ends, such as collaborations between multiple stakeholders in the community that initiate and drive developments to meet new challenges of the future (Copus, 2017).

Social innovation can be understood as output of social learning processes, which do occur in heterogenous setting of stakeholders with diverse values and conceptional frames, knowledge, interests, and resources (Beers et al., 2016). When these stakeholders share their knowledge in an interactive process – often generated in a workshop setting facilitated by a neutral person – they are likely to produce new knowledge and trust, and this lays the basis for joint action (Pahl-Wostl, 2006). Social learning emphasises the output of learning processes, which, besides joint action, can also result in new skills and capacities. Capacity building is defined as activities that strengthen the abilities, knowledge, skills and behaviour of individuals (individual capacity building) or organisations (organisational capacity building) (Ku et al, 2013; Farazmand, 2004). Capacity building is thereby understood as both a process for improving the capacities of individuals and, at the same time, as an outcome of that process (Jensen, 2017). In relation to citizen participation, capacity building is understood as either local government institutions aiming to enable citizens to participate or to build up human capital in the form of skills, experiences, and knowledge (Pretty, 1999; Jackson, 2001).

Design thinking as a process, is a user-centred approach to address wicked problems through collaborative problem-solving and ideation of diverse stakeholders (Brown and Wyatt 2010). Through an iterative process and a set of different methodologies, participants are designing products or services in this process that improve user experience and enhance public value (Mintrom, Luetjens, 2016). Enabling to understand the perspective of others, design thinking facilitates greater empathy and entails understanding different perspectives, cultures and contexts that will inspire a holistic solution. Design thinking can thereby help to promote and design solutions and systems that are more responsive to citizen needs (Raynor et al., 2018). Design thinking consists of four key characteristics. These are: (1) placing humans and their needs at the heart of the enquiry; (2) embracing optimism, openness, non-linearity, complexity, ambiguity and uncertainty; (3) adopting fast iterative and experimental processes through a variety of design methods and hands-on tools, and (4) using tangible, accessible and collaborative methods of communication to share with stakeholders throughout the project's development (Raynor et al., 2018).

Within social learning setting, the concept of single and double loop learning, which was originally drafted within organisational learning, focuses also on the ability to change existing values and conceptional frames and thereby also open up more radical innovations. Argyris and Schön (1996), who developed this concept, discuss about learning as understanding and eliminating the gap between the expected result and the actual result of an action. The gap between the expected results and actual results can be eliminated by either making changes or taking corrective measures within the existing values and norms (by changing strategies of action or underlying assumptions of the strategies that are within the values and norms) – that is, single-loop learning, or by changing the existing values and norms – that is, double-loop learning. While the single-loop learning focuses on doing things right within the realm of the existing norms and values, double-loop learning focuses on doing things right according to the nature of the circumstances and changing conditions and thereby enabling for more open and integrative innovation processes. Connection between the relevant concepts that we have presented above can be seen in several ways. One of the ways to look at the connection is illustrated in the following figure:

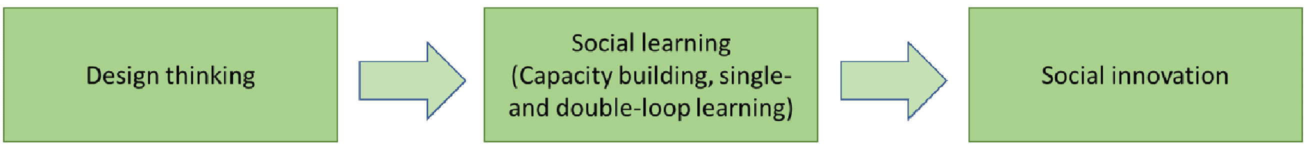

Fig. 1: Connection between the relevant concepts on innovation and learning

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As Figure 1 shows that design thinking can be seen as an overall approach that could guide to develop and conduct learning and capacity building processes, which in turn could lead to social innovation. This linear connection of the concepts functions as a kind of a theoretical framework for this paper.

4 METHODOLOGY

Our methodological approach is threefold: Firstly, we studied literature on concept and theories for learning in sustainable transition to develop our methodological framework for this study. Secondly, we conducted a case study for the neighbourhood of Ydalir in Elverum (Norway), aligned with 8 qualitative interviews with involved stakeholders, to identify challenges as well as needs and knowledge demands towards markets preferences. Ydalir is a demonstration site within the ZEN Centre. Thirdly, based on the results of the first two steps we developed a tool for capacity building among professional stakeholders to enable them to come up with social innovation in sustainable neighbourhood development and transition.

5 RESULTS OF THE CASE STUDY

5.1 Background information

The neighbourhood of Ydalir is a new development on a former sand quarry, located in the mid-size town Elverum in County Hedmark in Norway. It has a size of approx. 330 000 m2, and it is located 1.5 km from the town centre. The estimated timeframe for completion is 2035 and 800 to 1 000 residential units are planned (approx. 100,000 m2). The residential units are planned as a combination of detached houses and apartment buildings, and will be built around a school and a kindergarten, which were completed and opened in autumn 2019.

The main stakeholder is the project owner Elverum Vekst. Elverum Vekst (EV) is fully owned by Elverum municipality and aims to promote growth in both population and businesses. Operational activities related to area development and sale of plots are carried out through the subsidiary land development agency Elverum Tomteselskap (ETS). At the beginning of the development in 2015, 80% of the land in Ydalir was owned by the land development agency. Since then, two plots were already sold to local housing developers. Two private landowners count for the remaining 20% of the area. Other stakeholders involved are Elverum municipality, several local private developers who have signed intention agreements with ETS, consultant agencies, the local transportation agency, the local energy utility company that will deliver district heating and grid connection, and the local waste management company.

From 2016 to 2018, a masterplan for Ydalir was developed in a collaborative process facilitated by the project owner. Five workshops over a period of six months were dedicated to different aspects of the project development. These included topics such as aims and vision, energy, building and infrastructure, user and quality aspects, and transportation. The project owner, ETS, invited deliberately a wider group of participants to the five workshops, in order to integrate as many stakeholders as possible in the masterplan development and create knowledge and commitment for further development. The result of this process is the masterplan, which aims to ensure the realisation of basic qualities within the areas of urban design, energy and material use, blue green infrastructures and waste management, while also being flexible enough to accommodate individual solutions provided by the developer. The ambition for Ydalir is to become a zero emission neighbourhood. To reach this ambition, the masterplan consists of measures to follow in different areas, from local energy production to use of material with low embodied emissions, and measures to reduce mobility demand and strengthening the design of attractive public spaces.

At the beginning of the planning phase, a branding strategy was developed for Ydalir in 2016 to address potential buyers. A workshop was conducted with participants from ETS, local politicians, members of the administration of the municipality, and representatives for the focused inhabitant groups of Ydalir (families and young persons). The aim was to identify needs and values of the potential inhabitants regarding the neighbourhood development. Representatives from different potential user groups participated in the workshop: citizens who have just moved to Elverum, former citizens of Elverum who are living out of town and are considering moving back, as well as older residents living in Elverum.

5.2 Actual situation and need for deeper insight in market preferences

Stakeholders involved in Ydalir had expressed in former studies lack of knowledge in different thematic areas and a need for knowledge development and capacity building in them. Areas that were pointed out are knowledge on implementation of building solutions that go beyond existing building standard TEK 17, holistic and integrative project management for the whole neighbourhood development, system definition and geographical size of the ZEN neighbourhood (Baer, 2018). Uncertainty about the demand for residential units in Ydalir was already expressed at the beginning of the project in 2017, due to the stagnating population development in the city of Elverum. This perceived risk got more attention in a later phase of development, when the first developers begun to regulate their sites and started to sell the plots to future inhabitants of Ydalir. Initially, the landowners and developers considered the limited parking spaces per unit in line with high environmental ambitions as a challenge to sell the plots. Due to the influence of housing developers and landowners, the masterplan of Ydalir was reviewed and the parking regulations were watered down so that the number of parking spaces per unit was increased in 2019. The professional stakeholders expressed their interest and need to intensify joint marketing activities and develop better insight in market preferences and knowledge on "what sells" to include in the narrative of the marketing content for a ZEN area.

In September 2020, the land development agency initiated a first meeting with the developers who had bought properties in Ydalir or signed intention agreements to get feedback on the idea of joint marketing activities. The meeting was hold in the school of Ydalir, one of the first buildings in Ydalir, which was built to share rooms and facilities with the neighbourhood and to function as a neighbourhood centre. Professional stakeholders showed interest in gaining deeper insight in the content of marketing activities of ZEN areas and to intensify collaboration on joint marketing activities.

Citizen participation was mainly facilitated by following the plan and buildings law for public consultation of respective planning documents. From the project owner's and the developer's sides, citizens are mainly addressed as consumers, buyers and potential clients. Direct involvement in form of participation of representatives for potential client groups took place at a workshop for the branding strategy of Ydalir in 2017. Stakeholders involved describe the process so far as a confined culture for direct citizen participation.

To sum up, the professional stakeholders, mainly developers and land owners, perceived the risk that the development of a ZEN neighbourhood following higher environmental regulations was not in line with market preferences. Furthermore, there was perceived uncertainty among these groups about what a ZEN neighbourhood offers the market and why it is attractive for citizens to buy a house in Ydalir. The capacities and resources available in the demonstration site were geared towards building on the expressed need to get deeper insights in market preferences and appropriate marketing approaches of a ZEN area. At the stage when the project development of Ydalir was on the tipping point between the planning and the design phase and the first buildings were completed, stakeholders involved expressed a need for an "easy to handle" approach/tool to elaborate marketing activities. The goal of this tool was to cope with perceived risk and uncertainty through capacity building and deeper insight in market preferences and needs and how ZEN solutions could satisfy them.

5.3 Concept for a market preference tool

Building on the literature review of diverse approaches towards learning and knowledge development in transforming the built environment into a more sustainable one, as well as on the need analysis of the case study of Ydalir, we drew up a concept for a workshop design that focused on working with market preferences. We call it the Market Preference Tool (MPT), presented in figure 2.

The Market Preference Tool's main element is a workshop, which is aligned with a preparation and follow-up phase. We present the tool and the learning concept of the workshop in a chronological order. After a short introduction of the tool in its specific section of preparation, workshop and follow-up, we present how the tool was tested in the case of the neighbourhood of Ydalir in Elverum, Norway.

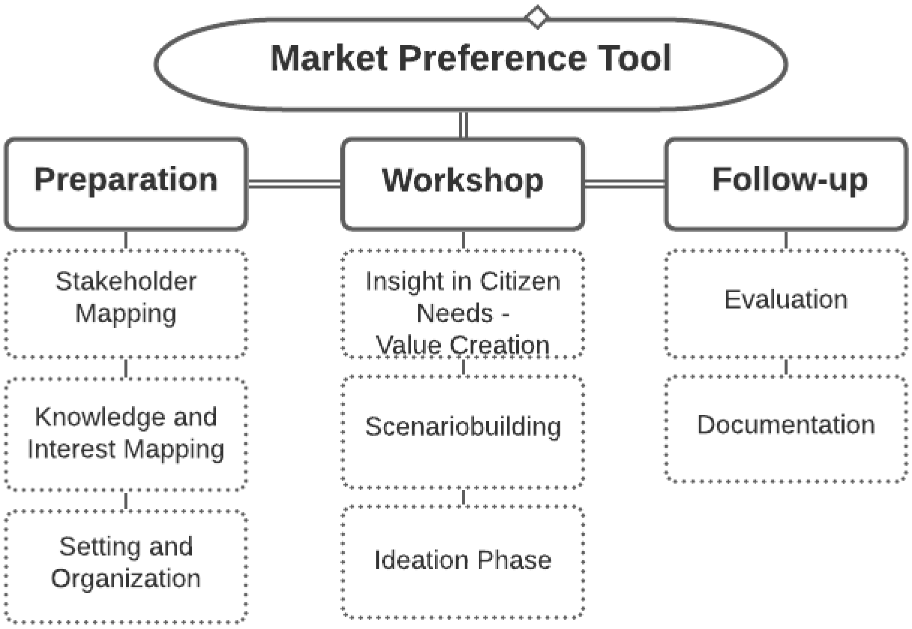

Fig. 2: The MPT tool

5.3.1 Preparation

If not done earlier in the projects timeline, a systematic review of stakeholders through stakeholder analysis is an important first step to identify which stakeholders to invite to the workshop and their status of knowledge. Stakeholder analysis consists therefore of a mapping of stakeholder and their knowledge and interests. In preparation of the workshop and its elements, the stakeholder analysis should include a short description of knowledge and interests of the respective stakeholders. The identified status of knowledge and interest is guiding the need of knowledge to be presented at the workshop.

As the Ydalir project is spanning over several years and new stakeholders or different persons are representing organisations, preparation is an important step in a project with a long timeline for completion. Based on stakeholder mapping, relevant stakeholders were identified and sorted by their relevance to the specific topic of the workshop. Relevant stakeholder groups (six groups) were identified, and they attended the workshop in different numbers: landowners/developers (6), (municipal) administration and project development (7), architects (2), energy sector (2), marketing (2) and complementary financial sector (1). In total 20 participants attended the workshop in addition to five researchers.

The mapping of stakeholders is accompanied by a mapping of existing knowledge of the stakeholders on the project development itself, its history and concepts relevant for the workshop topic. In the case of Ydalir, this mapping was done by the project owner. As relevant knowledge inputs, the status of the neighbourhood development of Ydalir and the results of a former workshop from 2017 on branding were identified. These both were presented by the project owner at the workshop. Additionally, new knowledge inputs as co-benefits of integrative neighbourhood development or best practices for city- and neighbourhood marketing activities were presented by external actors to provide workshop participants a deeper insight in these topics and concepts to enable them to ideate within new knowledge frames.

5.3.2 Workshop

The workshop itself builds on three elements: Firstly, to get insight in citizens' needs, secondly to develop a joint idea of the future neighbourhood in line with citizen needs, and thirdly to ideate concrete action points on further process and marketing activities. Tab. 1 presents the knowledge input from external or internal sides of the project stakeholders involved and the techniques used for learnings and knowledge production during the workshop.

Workshop phases/ Knowledge development	1. Insight in citizen needs	2. Scenariobuilding: Define solutions and benefits of future neighbourhood	3. Ideation Phase
Knowledge input – extern: from the external actors	Elements of wellbeing concept, double-loop learning concept, co-benefits	--	Best practice for city and neighbourhood marketing activities
Knowledge input – intern: from the internal actors	--	Status of Ydalir development, Masterplan of Ydalir, former work on branding and marketing	--
Techniques to gain new knowledge and experience	Role cause analysis/ 5 whys technique, role changing	Scenario-building, role play: tell a friend, double-loop learning	Brainstorming, visualisation, pitching

Table 1: Workshop phases

During the first part of the workshop - insight in citizen needs - we started with a role-change, where participants change role from being a professional person to a private person, and describe elements they like about their home, neighbourhood and city. Building on the descriptions of this "elements of wellbeing", the participants worked with a root cause analysis facilitated by the 5 whys technique to identify needs and values. This task laid the basis for double-loop learning activities facilitated in the second part of the workshop. Additionally, the participants were introduced to the concepts of double-loop learning, elements of wellbeing and co-benefits especially related to technical solutions to give them deeper background insight and enable them to adopt these learning when creating future scenarios of Ydalir in part two.

The second part of the workshop was dedicated to develop a vision of the future neighbourhood of Ydalir in 2030. The starting points were the seven categories of the ZEN neighbourhood definition (see 2.1), and a best-case scenario for Ydalir in 2030 was developed in groupwork in four groups. Each group consisted of participants from the six different stakeholder groups (see 5.3.1) to enable for social learning across sectors and disciplines. The results of the group work were presented in a role play, facilitated as "tell a friend" play, where the participants had to convince a friend to move to Ydalir in the year 2030. Due to covid 19 restrictions, we had to stick to the groups and could not form new groups during the workshop, which would enable for more learning activities a cross the groups and its participants.

While the first two parts of the workshop were dedicated to develop a deeper understanding of citizen needs and values and how a zero emission neighbourhood could respond to them, the last part was dedicated to describe the way forward, the process ahead and marketing activities to be implemented to gain more interest of potential buyers. The workshop itself should ideally be facilitated by a neutral person – in our case the researchers of the ZEN Centre facilitated the workshop. All group and individual work was done with tactile and artistic elements as visualisation on post-its and sheets or role play to facilitate learning.

5.3.3 Follow-up

After the workshop, two elements are important to conduct. An evaluation of the workshop itself to gain insight and feedback on results and effectiveness, potentially missing points and to catch up ideas and thoughts that have been developed by the participants after the workshop. A proper documentation of results and a summary of key results need to be shared with workshop participants and ideally must also be communicated to stakeholders that did not participate in the workshop and to the local community.

In the Ydalir case, we conducted an evaluation of the workshop with help of a web-based questionnaire. The questionnaire had an open research design with qualitative questions regarding the learning and knowledge development of the participants, the workshop design and its organizational implementation. Ten participants (50% of total number) from all stakeholder groups responded to the questionnaire. The answers of the participants shows that the intended knowledge development and learning arose. Participants emphasized that they got new knowledge on the Ydalir project and inspiration from new concepts and best-practice projects. Insight in other participants and citizens mindset and interests, was realised during the workshop as expressed by one participant who represented developers: "Learned a lot about marketing and how those who work with it think". Double-loop learning happened as participants started to reflect on own attitudes and perceptions, as a participant from administrational side expressed: "For me, as I come from marketing, it was completely new knowledge that in such [neighbourhood development] projects it is everyone and not just a specific focus group - and this was completely new to me."

6 ANALYSIS AND DISCUSSION

As we have seen earlier, the MPT tool has 3 elements, namely preparation, workshop, and follow-up. The focus of this paper is on the main element: Workshop.

During the first part of the workshop – where the participants changed their roles from a professional person to a private person, and described elements they like about their home, neighbourhood and city – the participants could get the opportunity to reflect and learn. When they tried to describe likable aspects of their home, city, etc., they could then structure and formulate the likable aspects. Structuring and formulating thoughts, which are often abstract, is itself a learning process, and it can lead to obtain new understanding or perspective.

During the second part, there were, among other things, groupwork and role play. Groupwork that consisted of participants from diverse branches and backgrounds was aimed at facilitating collective reflection and discussion, and hence creating new knowledge and understanding. In other words, social learning took place through interaction with other participants in the workshop. Knowledge is continuously reproduced and potentially transformed during interaction between people (Stacey, 2001). The way people interact – communicate, respond and discuss – with each other plays a key role in creating new knowledge.

This new knowledge could enable the participants to capture a holistic understanding of the discussed matter, think out-of-the-box- and trigger double-loop learning. Varying views expressed in the groupwork and discussions during the role play (convincing a friend to buy a house) could challenge the participants' pre-established understanding and norms, and lead the participants to reflect on questions such as "why do we do what we do?" and "why do we do it the way we do?" These questions can facilitate critical reflection on the existing values and norms, and hence promote double-loop learning. Asking the fundamental and critical questions can be seen in connection with a description that Schön (1998) mentions regarding reflection of a practitioner: "A practitioner’s reflection can serve as a corrective to over-learning. Through reflection, he can surface and criticise the tacit understandings that have grown up around the repetitive experiences of specialised practice and can make new sense of the situation of uncertainty or uniqueness which he may allow himself to experience" (Schön, 1998, p. 61). The description points out the importance of being expose to diverse views and critical reflection in finding new ways to approach and tackle the situation at hand.

From the Ydalir case, we found out that the intended learning is created with the help of the MPT tool. The learning that happened in the workshop is an important part and ingredient of capacity building, which could lead to innovation. This learning can be viewed in connection with three learning traditions that can be applied to collaborative work settings to accomplish a task related to sustainability transitions. The three learning traditions are: Collaborative, organizational and social learning in natural resource management (Mierlo and Beers, 2020).

When discussing collaborative learning, Mierlo and Beers (2020) say that interaction in heterogeneous groups – compared with interaction in homogeneous group – can lead group members to develop more understanding, knowledge, and competence. Different views and understanding that emerge from a heterogeneous collaborative setting can direct group members to reflect upon their own understanding of the reality from different (others') perspectives, develop a holistic picture of the situation and thus make sense of the situation. Application of the MPT tool – especially, the workshop – demonstrates this point. When it comes to organizational learning, the authors discuss the role of single- and double-loop learning in changing practices in organizations. New understanding that arose from communication, reflection and interaction in the workshop suggests that the workshop is conducive to single- and double-loop learning. When describing social learning in natural resource management, the authors point out that "the literature typically views social learning in terms of its inputs and outcomes, with stakeholder diversity (knowledge, interests, values, resources) as input and novel solutions to complex social problems as outcomes" (Mierlo and Beers, 2020, page 262). Diversity of the participants in the workshop (see 5.3.1) and the statements form the participants (see 5.3.3) depict the relevance of social learning. In our view, these three learning traditions seem to overlap each other, at least to some extent.

Mierlo and Beers (2020) also differentiate two major modes of learning in transitions:

- Discursive interaction: This is mainly about exchanging information, knowledge and meanings, and creating a common ground for understanding.
- Reflective action: This primarily deals with searching for viable and applicable solutions, and engaging in an iterative process of action and reflection that involves activities of planning, action and evaluation that can lead to change practices.

According to the authors, discursive interaction is a part of reflective action. The workshop encompasses these two modes of learning in transitions. When it comes to reflective action, it is to be noted that the last part of the workshop was dedicated to describe the way forward, the process ahead and marketing activities to be implemented to gain more interest of potential buyers.

7 CONCLUSION

This paper looks at how professional stakeholders such as developers, landowners, planners, civil servants can gain more insight and knowledge on user needs and values to create solutions within neighbourhood developments that are in line with user needs and thereby foster public value creation. In this regard, application of a tool (the MPT tool) in a case project was presented and discussed with using relevant concepts.

Building on literature study on (social) learning and findings from a case study of a ZEN neighbourhood, we presented a concept for a workshop as a tool to get deeper insight in citizens' needs and how professional stakeholders of a ZEN neighbourhood could respond to those needs. This tool has to be seen as one tool among others and the results should be verified by citizens. This tool is not replacing citizen participation.

This paper aimed at contributing to elaborate on learning within multi-stakeholder settings and focused especially on capacity building among professional stakeholders. Additionally, we provide practical guidance for using a tool that can be seen as a contribution to approaches towards stakeholder participation and for a methodology of local context-based tools for social learning.

Poeck et al. (2020) point out that empirical research on learning in transition initiatives is rare. This paper and the study associated with it can be considered as a contribution to this research field.

About further research:

- As this workshop was facilitated by researchers, we will discuss the setting and factors necessary to implement this workshop by diverse stakeholders in detail at a later point of time.
- The presented study is embedded in an ongoing research project on market preferences for Zero Emission Neighbourhoods. Results from other future workshops (applying the MPT tool) will be studied to find out more about the application of the MPT tool and its effects in diverse settings.

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Integration of Multi-dimensional Rural and Urban Planning Efforts for Achieving SDG 13 – Indian Context

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1 ABSTRACT

Earth's climate is dynamic phenomenon subjected to change through natural cycle and anthropogenic influences. Rapid urbanization and industrialization have accelerated the process of climate change. During last few decades world has become more concerned about changes in climate, popularly known as Global Warming. Every sphere of life is affected through climate change. Prime anthropogenic reason for climate change is accumulation of Green House Gases due to burning of fossil and fuel. As per estimation of World Bank half of the world's population lives in cities, a share that is likely to reach 70 per cent in 2050 (World Bank 2010). Cities utilize as much as 80 per cent of worldwide energy production and account for a roughly equal share of global greenhouse gas emissions. Urban population is expected to be double by 2030 however; the global built-up area is expected to triple during the same period (Angel et al. 2005).

Sustainable Development Goal 13 (SDG13) talks about climate change action plan, it is one of the 17 Sustainable Development Goals established by United National during 2015. SDG13 invites Governments to "take urgent action to combat climate change and its impacts". It emphasizes addressing and minimizing the risks arised due to climate change and is integral to the successful implementation of SDGs. Scope of SDG13 comprises multi-dimensional focus which inter alia includes adaptation and mitigation, mainstreaming climate concerns in development policies and discussing financial mechanisms to meet the targets.

Cities are hubs of opportunities for livelihood, therefore, it attract population for migration. Cities are drivers of global climate change and at the same time it is most affected party. Rapidly growing cities in developing countries and emerging economies with limited infrastructure very often become unsuccessful to provide adequate protection from extreme weather events and changing climatic conditions. The urban poor are particularly most vulnerable towards extreme weather events as they are more exposed to these events. In many cities, unplanned and haphazard urban growth leads to rapid urban sprawl, pollution, and environmental degradation. To meet the demand of urbanization issues related to climate change is largely under estimated. Peri urban areas are the most dynamic space in the process of urbanization, encounter land use change, haphazard development without prefeasibility study. These areas need special attention for mitigation and adaptation for climate change.

Rural ecosystem of India possesses unique physical, social and economic characteristics which make them uniquely vulnerable to the impacts of climate change. Impact of climate change in rural areas involves major questions of detection and attribution. Whilst having potential, there are complications with using traditional knowledge and farmer perceptions to detect climate trends (Rao et al., 2011; in IPCC 2014). Climate Change impact may be categorized into two segments, i.e. first sort involves extreme events, such as floods and storms, as they impact on rural infrastructure and cause direct loss of life and second sort will involve impacts on agriculture or on ecosystems on which rural people depend.

Sustainable development, climate change impacts and disaster risk management are core issues for both rural and urban areas of India. Vulnerability due to climate change is a dynamic concept, varies spatially as well as temporally with sensitivity, exposure and adaptive capacity. In case of urban areas climate change responsive city plan should not be confined within city administrative boundary it should encompass peri-urban areas. Similarly for climate change responsive rural planning efforts may integrate climate change issues with rural employment, infrastructure development, natural resource management, basic need development programme, etc.

Various initiatives like, Smart City Mission, National Urban Information System, Environmental Information System, National Spatial Data Infrastructure, Atal Mission for Rejuvenation and Urban Transmission, Rurban Mission, etc. are implemented by the Government of India toward sustainable rural and urban development. But in these rural and urban planning programmes issues related to climate change are not addressed. Details study of these programmes/ schemes reveals the scope of integration of climate change related issues with exiting planning initiatives. For achievement of SDG13 there is need to integrate

these initiatives along with climate change responsive plan for both rural and urban areas. . In this article an attempt has been made to develop a methodology for preparing cross sectoral and multi-dimensional planning model for climate change responsive planning for rural and urban areas.

Keywords: Rural Planning, Urban Planning, Peri Urban, Vulnerability, Adaptation, Mitigation

2 BACKGROUND

Climate Change is primarily the outcome of accumulation of Green House Gases (GHG) in atmosphere. The global increase in carbon dioxide concentration is basically due to burning of fossil fuel and landuse change, while those of methane and nitrous oxide are primarily due to agriculture activities. 'Global Warming' is a specific example of broader term 'climate change' and refers to observe increase in average temperature of air near earth's surface and oceans in recent decades. It's effect particularly on developing countries is adverse as their capacity and resources to deal with the challenges are limited' (India, Ministry of Environment and Forest, Annual Report, 2012-13:349). Scientific studies have shown that the global atmospheric concentrations of carbon dioxide, methane and nitrous oxide which are the most important Green House Gases, have increased sharply as a result of human activities since 1750 and now far exceed pre-industrial values.

During 1988 Intergovernmental Panel on Climate Change (IPCC) was established for assessing "the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change". Based on the analysis of data and information for several decades IPCC in its Fourth Assessment Report has said that the incident of climate change is evident everywhere on the planet. Its impact is vivid from the depths of the ocean up to troposphere. In this report, Working Group Summary for Policymakers had synthesized current scientific understanding of global warming and also projects future climate change. It says that emissions of heat-trapping gases from human activities have caused "most of the observed increase in global average temperatures since the mid-20th century". Evidences say that human activities are the prime cause of recent climate change and are even stronger than prior assessments.

According to IPCC assessments the degree of climate change in coming decades is directly related to emission scenario. It means, if emissions from various sources like transportation, power plants, landuse, etc., are reduced then some degrees of warming will still continue because past emissions will persist in the atmosphere for decades or more. Another scenario is that, if no action is taken to reduce emission, there will be twice as much warming over the next two decades than efforts taken to stabilize heat-trapping gases and other climate relevant pollutants in the atmosphere at their year 2000 levels.

Sustainable Development Goal 13 (SDG13) is one of the 17 Sustainable Development Goals established by United Nation during 2015. SDG13 invites Governments to "take urgent action to combat climate change and its impacts". It emphasizes addressing and minimizing the risks arise due to climate change and is integral to the successful implementation of SDGs. Scope of SDG13 comprises multi-dimensional focus which inter alia includes adaptation and mitigation, mainstreaming climate concerns in development policies and discussing financial mechanisms to meet the targets. Targets of Goal 13 comprises Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries (13.1), Integrate climate change measures into national policies, strategies and planning (13.2), Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning (13.3), Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible (13.3a), Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities(13.3b). SDG 13 targets emphasize on capacity building , awareness generation along integration of climate measures into national policies, strategies and planning. The successful implementation of the targets demands mainstreaming of climate concerns not only in national policy making process but also at rural and city planning.

3 OBSERVATIONS ON CLIMATE CHANGE EVENTS IN INDIA :

According to India’s Initial National Communication, 2004 (NATCOM) to UN Framework Convention on Climate Change (UNFCC) observations are as follows:

Surface temperature: Over the past century the average surface air temperature has increased by 0.4oC across the country. The subcontinent is withstanding two different trends in change of surface air temperature. A warming trend has been recorded along the west coast, in the central part of the country, peninsular India and in the north-eastern region of country. While cooling trend in the surface air temperature is prevalent in north-west and parts of southern India.

Prakasa Rao et al. (2004) examined the effect of urbanization on the meteorological parameters at fifteen Indian cities and found that radiation values, bright sunshine hours, wind speeds and total cloud amounts have a decreasing tendency during the last 40–50 years, whereas relative humidity and rainfall amounts show increasing tendency in some cities. The impact of climate change may differ from one region to the other, specially for a geographically complex country like India.

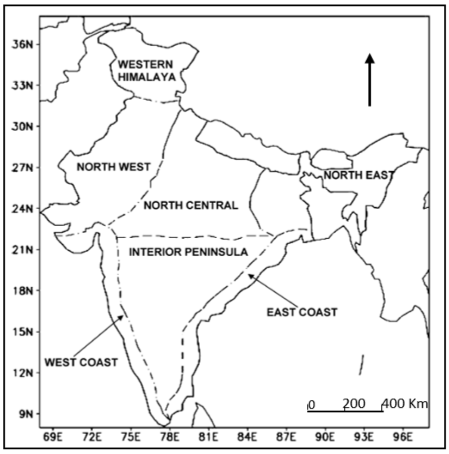

Fig. 1 : Seven homogenous regions of India used for examining temperature trends. Source: IITM.

India has been divided into seven zones as shown in Fig.1.0 to examine the changes in maximum and minimum temperatures over these regions. Seven identified zones are north-west, western Himalaya, north central, north-east, interior peninsula, east coast and west coast. West coast shows maximum increase in its maximum temperature by about 1.2°C followed by 1°C in the north east, 0.9°C in the western Himalaya, 0.8°C in the north central, 0.6°C in the north west, 0.6°C in the east coast and the least amount of 0.5°C in the interior peninsula.

- Rainfall: At the national level monsoon rainfall does not show any significant trend while at the regional level rainfall anomalies have been observed. The areas along the west coast, northern Andhra Pradesh and north-western India have increasing trend of monsoon rainfall (+10 per cent to +12 per cent of the normal over the last 100 years) while eastern part of Madhya Pradesh, north eastern India and some parts of Gujarat and Kerala are receiving less monsoon.
- Extreme weather events: The weather reports of the previous century do not indicate any significant long term trend in the frequencies of large-scale drought and floods. During the last two decades, however, the incident of more frequent droughts followed by less severe droughts become common phenomena. The coastal areas of the country experience increase trend in severe storm at the rate of 0.011 events per year (MoEF&CC).West Bengal and Gujarat have reported increasing trends severe storm while Orissa is experiencing decline trend. The analysis of daily rainfall data set have shown (i) a rising trend in the frequency of heavy rain events, and (ii) a significant decrease in the frequency of moderate events over central India from 1951 to 2000 (Goswami et al 2006).
- Rise in sea level: Based on the records of coastal tide gauges in the North Indian Ocean for more than 40 years Unnikrishnan and Shankar have estimated sea level rise was between 1.06 -1.75 mm per year. These rates are consistent with 1-2 mm per year global sea level rise estimates of IPCC.
- Impacts of Himalayan Glaciers: The Himalayas posses one of the largest resources of snow and ice and its glaciers form a source of water for the perennial rivers namely Indus, Ganga, Brahmaputra,

etc. Glacial melt may impact their long –term lean –season flows, with adverse impacts on the economy in terms water availability and hydropower generation. The monitoring data on the spatial extension of glacier in the Himalayan regions shown recession of some glacier in recent year, the trend is not consistent across the entire mountain chain.

Based on the increase trend in concentration of atmospheric GHG, various studies are undertaken by scientists to project future change in climatic characteristics. Some of the observations are listed below:

- As per IPCC's projection annual mean surface temperature increase will range from 30C to 50C under A2 scenario and 2.50C to 40C under B2 scenario while Indian Institution of Tropical Meteorology (IITM), Pune forecast more pronounced worm in the northern parts of India.
- IITM, Pune indicated that summer monsoon intensity may increase beginning from 2014 and by 2100 under A2 scenario of IPCC.
- Changes in frequency and / or magnitude of extreme temperature and precipitation events. Some results show that fine scale snow albedo influence the response of both hot and cold events and that peak increase in extreme hot events are amplified by surface moisture feedbacks.

3.1 Possible Impact of Projected Climate Change

Impact on water resources: Changes in climatic factors like, temperature, precipitation, humidity will have long term impact on quality and availability of water. The decrease in snow cover in the Himalayan region will affect the availability of water in the rivers systems like Brahmaputra, Ganga, during the lean season. NATCOM has projected a decline in total run-off for all river basins, except Narmada and Tapti. The decline in run-off is also estimated by more than two-thirds for the Sabarmati and Luni basins. Intrusion of sea water due to sea level rise will affect the costal fresh water sources.

Impacts on agriculture and food production: The agricultural yields are subjected to the variation in monsoon rainfall and seasonal temperature change. Studies by Indian Agriculture Research Institute (IARI) and others forecast greater expected loss in Rabi crop. It says 1oC rise in temperature reduces wheat production by 4-5 Million Tonnes. Small changes in temperature and rainfall have significant impact on quality of fruits, vegetables, tea, coffee, aromatic and medicine plants and basmati rice. Other impacts on agriculture and related sectors include lower yield from dairy cattle and decline in fish breeding, migration and harvests. Global reports show a loss of 10-40 per cent in crop production by 2100.

Impact on health: Change in climatic pattern may have also impact on distribution of important vector species and may increase the spread of such diseases to new areas. It is estimated that an increase of 3.8oC in temperature and 7 per cent increase in relative humidity the transmission windows i.e., months during which mosquitoes are active will be open for all 12 months in 9 states in India. The transmission windows in Jammu and Kashmir and in Rajasthan may increase by 3-5 months. However, Orissa and some southern states, a further increase in temperature is likely to shorten the transmission window by 2-3 months.

Impacts on forests: Based on the future climate projections, it is estimated that on an average 70 per cent of the forest areas in the country are likely to experience shift in forest types, followed by changes in forests produce, livelihood etc. outcome of NATCOM projects shows an increase in the areas under xeric scrublands and xeric woodlands in central India at the cost of dry savannah in these regions.

Vulnerability to extreme events: Densely populated regions of coastal areas are exposed to climatic events, such as cyclones, floods and drought and huge declines in cultivable areas in arid and semi-arid regions arise during extreme climatic conditions. Vast areas in Rajasthan, Andhra Pradesh, Maharashtra and Gujarat and relatively small areas in Karnataka, Orissa, Madhya Pradesh, Tamil Nadu, Bihar, West Bengal and Uttar Pradesh are frequently affected by the incidents of drought. It is estimated that about 40 million hectares of land is flood prone, including most of the river basins in the north and north eastern belt, affecting about 30 million people on an average each year.

Impacts on coastal areas: By the mid 21st century the mean Sea level Rise (SLR) projected along the India's coast will be 15 – 38 cm and of 46-59 cm by 2100. India's NATCOM assessed the vulnerability of coastal district based on physical exposure to SLR, social exposures to SLR, social exposure based on population affected and economic impacts. In addition, a projected increase in the intensity of tropical cyclones poses a threat to the heavily populated coastal zones in the country (NATCOM 2008).

3.2 India's Action Plan for Climate Change

India's emissions are estimated as 1331.6 million tonnes of the carbon dioxide equivalent Green House Gas (GHG) emissions in 2007. The emissions indicate an annual growth of 4.2 per cent from the levels in 1994. Whereas India's CO2 emissions are only about 4 per cent of total global CO2 emissions and much less if the historical concentrations are taken into account (India, Ministry of Environment and Forest, Annual Report, 2012-13: 349).

In pursuance of the obligations cast on parties to the United Nations Framework Convention on Climate Change (UNFCCC), India has undertaken to communicate information about the implementation of the Convention, taking into account the common but differentiated responsibilities and respective capabilities and their specific regional and national development priorities, objectives and circumstances. The elements of information provided in the communication include a national inventory of anthropogenic emissions by sources and removals by sinks of all Green House Gases, a general description of steps taken to implement the Convention including an assessment of impacts and vulnerability and any other relevant information. India has submitted the Second National Communication (NATCOM) to the UNFCCC in 2012. The first National Communication was submitted in 2004. As per the Second National Communication submitted by India to the UNFCCC, it is projected that the annual mean surface air temperature rises by the end of the century ranges from 3.5 c to 4.3 c whereas the sea level along the Indian coast has been rising at the rate of about 1.3 mm/year on an average. These climate change projections are likely to impact human health, agriculture, water resources, natural ecosystems, and biodiversity (Economic Survey, 2012-13:257).

India's development is closely knitted with its unique natural resources, the huge demand for economic and social development and poverty eradication and its adherence to its civilization legacy that places a high value on the environment and maintenance of ecological balance. Climate change may alter the distribution, quality and quantity natural resources and it will adversely affect the livelihood of its people. Maintaining a high economic growth rate is essential for increasing living standards of the vast majority of our people and reducing their vulnerability to the impacts of climate change. In order to achieve the sustainable development path along with the economic and environment development objectives, the National Action Plan for Climate Change (NAPCC) is guided by the following principles (MoEF&CC, 2014):

- Protecting the poor and vulnerable section of the society through an inclusive and sustainable development strategy, sensitive to climate change.
- Achieving national growth objectives through a qualitative change in direction that enhances ecological; sustainability, leading to further mitigation of greenhouse gas emission.
- Devising efficient and cost effective strategies for endues Demand Side Management.
- Deploying appropriate technologies for both adaptation and mitigation of greenhouse gases emissions extensively as well as at an accelerated pace.
- Engineering new and innovative forms of market regulatory and voluntary mechanism to promote sustainable development.
- Effecting implementation of programmes through unique linkage, including with civil society and local government institution and through public –private –participation.
- Welcoming international cooperation for research, development, sharing and transfer of technologies enable by additional funding and global IPR regime that facilitates technology transfer to developing countries under the UNFCC.

The National Action Plan focuses on the development and use of new technologies. Eight National Missions namely; National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for sustaining the Himalayan Ecosystem, National Mission for Green India, National Mission for Sustainable Agriculture, National Mission on strategic knowledge for Climate Change are identified. Further Indian Network for Climate Change Assessment (INCCA) has also taken steps at the institutional level for conducting research in climate change related sciences and making necessary assessments. The MoEF&CC has already set up a network, namely the Indian Network for Climate Change Assessment (INCCA) comprising of 127 research institutions tasked with undertaking research on the science of climate change and its impacts on different sectors of economy

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across various regions of India. INCCCA has helped the Ministry to put together its Green House Gas (GHG) Emissions Inventories and in carrying out other scientific assessments at more frequent intervals.

3.0 Impact of Climate Change

3.3 Scenario in Rural India

The word "rural" generally refers to reas of open country, small settlement with primary/ agro – based economic activities. During year 1951 share of urban population in India to total population was 17 percent and it becomes 31.6 per cent during 2011 census. In contrast to this during last 50 years the share of rural population of the country has decreased from 82.0 to 68.9 per cent. The disparity is rate of development, opportunity for livelihood, etc are major reasons for decrease in rural share of population. According to National Sample Survey 64th Round approximately a third of Indians (i.e. some 325 million people, out of a population of 1.14 billion in 2008) are migrants. Employment seems to be the prime force for migration; in rural areas, 55 per cent of the households have migrated for employment related reasons.

Rural ecosystem of India possesses unique physical, social and economic characteristics which make them uniquely vulnerable to the impacts of climate change. Impact of climate change in rural areas involves major questions of detection and attribution. While having potential, there are complications with using traditional knowledge and farmer perceptions to detect climate trends (Rao et al., 2011; in IPCC 2014). Climate Change impact may be categorized into two segments, i.e. first sort involves extreme events, such as floods and storms, as they impact on rural infrastructure and cause direct loss of life and second sort will involve impacts on agriculture or on ecosystems on which rural people depend.

Impacts of climate change on agriculture and related activities are due to rising temperature and changes in rainfall characteristics and seasonality along with extreme events. Changes in temperature and rainfall pattern bring changes in agricultural season. Rural economy is primarily agro based and governed by occurrences of monsoon. According to Central Statistical Organization (CSO) growth in GDP in agriculture and allied sectors in 2014-15 over 2011-12 is -0.1%, share of agriculture and allied sectors in total GDP has reduced by -0.4% .

The reasons for migration in India are usually summarized as push and pull factors. While push factors are mostly convincing reasons which help the migrants to make up their mind for migration. The pull factors offer opportunity and attract migrants towards the place of destination. The push factors include the population pressure, declining yields, institution of marriage, disintegration of joint family system, lack of livelihood opportunities, etc; the pull factors also include better educational, health care facilities, modern means of transport and communications, more employment opportunities and a growing craze for urban life. In addition to these factors, the incidents of climate change is affecting the rural ecosystem in various ways. It is causing flood, drought, sea level rise, etc. These events trigger rural to urban migration. Climate refugees are push migrants , they may be permanent or temporary in nature.

Rural to urban migration is the major reason for urbanization. Rapid growth in urban population is a big challenge to the city administrator to serve housing, infrastructure, environmental quality, etc. to the city dwellers. Rural to urban migration has both positive and negative impacts on urban areas. Due migration of people from rural to urban areas the mushrooming of slums in are around the urban areas/ urban centre takes place. According to the study carried out by economic and social commission for Asia and the Pacific (ESCAP, 1991) "migration from rural to urban areas continues at a rapid pace in many countries of the region, and it was often beyond the capacity of towns, cities and metropolitan areas to cope with the increasing numbers". Increasing inflow of distressed population from rural to urban area results into overcrowding of cities and development of slums. Economically weaker migrants from rural areas come to the urban areas and settle in the slums. It is observed that unskilled marginal farmers or landless labours migrates to the urban areas become unskilled labourers and settle in the slums. The great slums of India are mainly formed because of migration of large numbers of individuals or families to the urban centers in search of their dreams, usually in hunt of better economic prospects/ livelihood (Bandyopadhyay , 2018) .

3.4 Scenario in Urban area

In the recent days a new challenge has been added to urban issues, that is climate change. Its outbreak is in the form of increase in temperature/ occurrence of super storm/flood/drought/ submergence of coastal areas, etc. Coping with climate change remains a daunting challenge. The degree of quandary that cities are facing due to climate change has made the urban sustainability a big question.

The majority of the world's population already lives in urban areas and it will become 66 per cent by 2050. Cities consume up to 80 per cent of total global energy production and account for 71 to 76 per cent of global CO2 emissions (Gerics 2015). They are the drivers of global climate change and at the same time it is most affected party. Rapidly growing cities in developing countries and emerging economies with inadequate infrastructure fails to provide adequate protection from extreme weather events and changing climatic conditions. The urban poors are particularly most vulnerable towards extreme weather events as they are more exposed to these events. In many cities, unplanned and haphazard urban growth leads to rapid urban sprawl, pollution, and environmental degradation. In addition, cities are points of convergence of many risks, which makes them particularly vulnerable to chain reactions and amplify the interconnection between global risks (World Economic forum 2015) such as natural hazards and climate change impacts. The concentration of people, assets, critical infrastructure and economic activities in cities exacerbates the potential of natural hazards (Gerics 2015). Asia, Africa and Latin America have experienced high rates of increase in the incidence of natural disasters over the last three decades, with many urban areas having sustained heavy losses of human lives due to disasters. Total population exposure to cyclones and earthquakes, is projected to rise (Lall & Deichmann, 2009). Many of the world´s cities are situated along the coast, they are exposed to flood from storm surges and sea level rise. The risk of coastal flooding has further increased in cities affected by subsidence. Coastal cities of South America have to face more frequent heavy rainfall and higher temperature which could put thousands of homes in the low-income settlements at risk (United Nation 2011).

The International Council of Local Environmental Initiatives (ICLEI), South Asia, associated with 54 local governments in the South Asian region (including 41 cities from India) to collect city energy consumption and related carbon emissions inventory data of the participating cities (Figure 2.0).

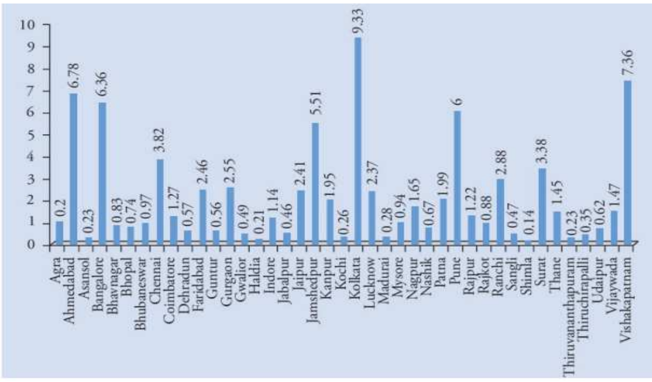

Fig. 2: City-wise energy consumption and related carbon emissions inventory data.

It shows the highest emissions are in Kolkata, followed by Vishakapatnam and Agra. It is found that the average per capita carbon emissions are higher in the metropolitan cities of India (being 1.19 tonnes per capita as compared to only 0.90 tonnes per capita in the non-metropolitan cities) and the national average is 0.93 tonnes per capita (Sridhar, Kala Seetharam, 2011). This is because larger cities have more industries and other polluting activities such as emissions from public and private transport. However, the corporation level emissions as a percentage of city-level emissions are much higher in the non-metropolitan areas than in the metropolitan areas. This is because smaller city corporations lack the adequate technology to minimize their carbon emissions in the provision of various public services such as water supply, sewerage, street lighting, and transportation. Not only cities and urbanization impact climate change, but also, the question of whether climate change has impact on cities India's cities which are characterized by high density of population, housing stock, and poor infrastructure, all these make them more vulnerable to climate change. Given that the most valued infrastructure is usually located in cities, the economic and social costs of climate change will be much higher in cities. For example, cities house valuable communications infrastructure as they do physical infrastructure such as buildings, roads, bridges, and fly-overs. Hence, any climate change impacts in the form of damage will be quite expensive. Revi (2009) highlight the multiple ways in which climate change can impact Indian urban residents through loss of livelihood opportunities (including housing and assets) and income, loss in terms of health or ability to work, loss of community and informal social nets due to forced migration, reduced resilience to future shocks, reduced affordability and access to public

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services, and greater vulnerability to unsustainable debt exposure, that could be necessitated in times of crisis. There is nothing uniquely urban about these phenomena and these channels can work equally in rural areas. Second-order impacts of climate change on Indian cities as occurring via migration, since climate change can accelerate the pace of rural–urban migration, driven by increases in extreme events, greater monsoon variability, drought, flooding, and resource conflict, as well as loss of both livelihood opportunities and informal social nets, especially due to sea-level rise and enhanced flooding in cities by the coasts, leading to changes in the spatial distribution and density of both formal and informal settlements. Degradation of building and infrastructure materials is also projected to occur. As warmer temperatures extend into higher latitudes, diseases that have long been considered eradicated may re-emerge; and new diseases may also be experienced. The health ramifications could be serious. The gap between water supply and demand is also projected to increase as drought-affected areas expand and the episodes of flood intensify.

4 OVERVIEW OF PLANNING INITIATIVES IN INDIA IN CONTEXT OF CLIMATE CHANGE

4.1 Rural Development Initiatives in India

With the objective to improve rural economy, Govt of India has implemented numerous initiatives likes; Community Development Programme, Twenty Point Programme, Drought Prone Areas programme, Desert Development programme, National Fund for Rural Development, Council for Advancement of People's Action and Rural Technology, Har Khet ko Pani, Mahatma Gandhi National Rural Employment Guarantee Scheme, etc.

During 2016 Government of India has launched National Rurban Mission to develop cluster of villages that preserves and nurtures the essence of the rural community life with prime focus on equity and inclusiveness without compromising with the facilities perceived to be basically urban in nature thus creating a cluster of 'Rurban Villages'.

An Integrated Cluster Action Plan (ICAP) for each Rurban cluster would be prepared to guide the development of the village cluster. ICAP is a key document comprising baseline studies of the cluster and the key interventions needed to address these needs and to leverage its potential. The ICAP prepared for the cluster includes: (1) A strategy for the cluster integrating the vision for each Gram Sabha (village level administrative body elected by villagers) identified in the cluster. (2) The desired outcomes for the cluster under the Rurban Mission (3) The resources to be converged under various Central Sector, Centrally Sponsored and State Sector schemes. (4) The Critical Gap Funding (CGF) required for the cluster. (5) Most importantly, the ICAP would delineate the cluster areas to form well planned layouts following the planning norms (as laid down in the State Town and Country Planning Acts/similar Central or State statutes as may be applicable), which would be duly notified by the State/UTs. These plans would be finally integrated with the District Plans/Master Plans as the case may be. ICAP for each cluster will contain two components ; Socio-economic components and infrastructure component and Spatial Planning Components.

4.2 Rural Planning Initiatives in the light of SDG13

Government of India has undertaken numerous initiatives towards infrastructure development, economic up-gradation, increase in agricultural production, spatial area development, socio-economic development, community development, etc. These efforts are disjointed and target based, lack of considering all aspects of rural development .

National Rurban Mission has scope for development of village cluster, it focuses on development of village cluster socially as well as economically. In National Rurban Mission villages clusters are considered as unit of planning. 300 villages clusters are identified for development . The Mission not only focuses on reducing regional disparity but also it focuses on social development . It has scope for development of spatial data , resource map, cluster profile for demography, socio-economy, culture, administrative profiles of the clusters, etc. The Mission has also embedded components like; training for economic activities, developing skills and local entrepreneurship and infrastructure amenities. For each cluster the comprehensive assessment are made on economic profile of the cluster to understand drivers of economic growth of the cluster, assess the basic strengths and weakness of the cluster and identify the opportunities for economic growth of the cluster. This exercise will not be restricted at the cluster level and will include economic assessments at the block and district levels. The cluster level strength and deficiency analysis and identification of needs are integrated with the ongoing schemes of the Government of India. Resources for cluster development would be converged under various ongoing central and state level schemes. For implementation of the mission, bottom to top integration approach is adopted.

Though objective of National Rurban Mission is not directly focusing on climate change related issues but it has scope to accommodate the tasks and targets for achieving SDG 13 Goals.

4.3 City Planning Initiatives in India

Since independence various initiatives are taken by Government of India for city/ urban planning which, inter alia, include National Commission on Urbanization, 74th Constitutional Amendment Act, Urban Development Plan Formulation and Implementation Guidelines, Jawaharlal Nehru National Urban Renewal Mission, National Urban Information System, Rajiv Awas Yojana, National GIS, Smart City, Swachh Bharat, Atal Mission for Rejuvenation and Urban Transformation, etc

Government of India had appointed National Commission on Urbanisation during 1980s under the Chairmanship of Charles Correa to analyze the state of urbanization with reference to the demographic, economic, infrastructural, environmental, physical, shelter, energy, communication, land, poverty, aesthetic and cultural aspects and to identify priority action areas and it had also made projections of future needs and estimated the available resources. On the basis of analysis carried out by the Commission it had prepared basic guidelines for the specific action plan in priority areas along with policy frames and suggestion of basic approaches for the encouragement of manageable urbanization and also the methods of creating networks of interactions as an ongoing process among government, academic and research institutions and citizen groups. The recommendations of the Commission had not been finalized and yet to be implemented as policy.

The Constitution (Seventy Forth Amendment) Act, 1992 has introduced a new part namely, Part IXA in the Constitution, which deals with the issues relating to municipalities. The main provisions introduced by Act are constitution of municipalities, composition of municipalities, composition of ward committee, duration of municipalities, etc. This amendment has provided a constitutional form to the structure and mandate of local bodies. It has made urban local bodies to perform as democratic and self governing institution at grassroot level.

Since 1996, due to rapid growth of population and reasons like globalization and liberalization, the towns and cities have become more dynamic in nature. Urban areas are subjected to challenges in terms of requirements of infrastructure and other basic services and amenities. The Urban Development Plan Formulation and Implementation (UDPFI) Guidelines have been framed to incorporate the provisions of the various legal and policy/ guidelines of the respective Ministries and departments, best practices of the States as examples and the planning system in vogue. An interrelationship between them is proposed for a sustainable urban and regional development.

Jawaharlal Nehru National Urban Renewal Mission (JnNURM) was launched in 2005 to encourage cities to commence steps for bringing phased improvements in their civic service levels. The mission of JnNURM was to development in the context of urban conglomerates focusing to the Indian cities. JnNURM aims at creating ‘economically productive, efficient, equitable and responsive Cities’ by a strategy of upgrading the social and economic infrastructure in cities, provision of Basic Services to Urban Poor and wide-ranging urban sector reforms to strengthen municipal governance in accordance with the 74th Constitutional Amendment Act, 1992.

National Urban Information System (NUIS) initiated by Ministry of Urban Development (MoUD) in 2006 for creation of multi-scale (1:10,000, 1:2000, 1:1000) hierarchical urban geospatial database on thematic content using satellite, aerial and GPR techniques. It generated GIS based maps for preparation of Master Plan for selected cities.

Rajiv Awas Yojana (RAY) was launched in 2009 as a continuation of JnNURM. It envisages a “Slum Free India" with inclusive and equitable cities where every citizen has access to basic civic infrastructure and social amenities and decent shelter.

Ministry of Urban Development during 2015 has launched the Smart city mission transformation with the objective to support cities to enable them to offer core infrastructure and provide a decent quality of life to its citizens along with a clean and sustainable environment and application of ‘Smart’ Solutions. The aim is to achieve sustainable and inclusive development. The mission aims to develop a replicable model which will act like a light house to other aspiring cities.

During 2015 the Ministry of Urban Development has launched Atal Mission for Rejuvenation and Urban Transformation (AMRUT) with the aim to formulate GIS-based Master Plan for selected AMRUT cities. The geospatial technologies is used for formulate a master plan for decision-making, effective land use management and utilization, spatial growth management, enable project planning and urban management.

4.4 City planning initiatives in the light of SDG 13.

Addressing climate change related issues for urban areas emphasize to integrate city planning programmes and climate change indicators as important input for decision support systems for city planning. Thorough review of city planning initiatives reveals that approach of city/master planning exercise is compartmentalized by nature and having prime focus on landuse, infrastructure, industrial, transportation development, etc. To meet day to day demand for urban life the vulnerability of the city arise due to climate change has become underestimated.

Non-consideration of climate change issues in city planning is mainly due to limited knowledge of climate change adaptation mechanisms. The measures identified by the researchers/ stakeholders deal mostly with mitigation (afforestation, sustainable transport, etc.) and not with adaptation initiatives. Knowledge about possible adaptation mechanisms specific to the local context is missing. Another reason is lack of information and mechanism for information exchange. One of the emerging gaps is lack of reliable, accessible data sets. While some data are available with Government and also with a couple of NGOs. The main issue is non-availability of reliable data in public domain. Most of the information available with the Government of India can be accessed through the Right to Information Act. But it remains a project in itself to access and collate the data available in different places, especially, when spatial data is required for planning at a city level. By using spatial data sets available in public domain some of the constraints can be overcome. Lastly, it is attributed to limited planning capacities, restrictive planning processes and institutions. Most of the cities have limited internal capacity to plan beyond the immediate project at hand. Moreover, the planning process itself is protracted and still driven primarily by landuse planning that often fails to incorporate the current risks and resource constraints. The institutions dealing with planning are fragmented, like the municipal corporations, the development authorities and the town planning institutions all have a role to play.

Though protocols of ongoing city planning initiatives like; NUIS, AMRUT, Smart City etc. are not directly addressing climate change related issues of urban areas but within their protocol there is scope to incorporate aspects of climate change responsive planning without hampering the basic structure of the scheme.

5 INTEGRATED MULTIDIMENSIONAL MODEL FOR RURAL AND CITY PLANNING

In previous segments it is understood that impacts of climate change are vivid in both urban and rural lives of India . Climate change is acting as one of the push factors for rural migrants, generating addition burden to urban infrastructure, peri urban growth, haphazard development, poor quality of life, degradation of natural resources , environmental degradation etc. ICAP for rural areas and NUIS, AMRUT, Smart City, etc for urban areas have scope to incorporate targets of SDG 13 in their exiting planning mechanism. There is requirement of integrated multidimensional planning model for rural and urban planning which will knit climate change related issues with exiting planning mechanisms.

The model will be a rational approach to understand and assess the risks of climate change, policy to reduce the impact of climate change and lessen the causes behind climate change at city and rural levels. The components of the integrated multidimensional model will be assessment of risk, policy to reduce the risk, approaches to reduce the impact of the hazard and last not the least to diminish the functions accelerating the process of climate change. Performance of these tasks entails data and information from various aspects of both rural and city life, its environment and factors influencing GHG emission.

The major theoretical challenge involves in implementation of integrated multidimensional planning model is development of multidisciplinary approach that integrates diverse rural and urban themes such as social, economic, cultural, environmental, spatial and physical infrastructure into a unified conceptual framework capable of understanding present state of resiliency of any geographical area and how they should move towards a more resilient state. The integrated multidimensional planning model aims to investigate the phenomenon of present resilience and developing a new multidisciplinary conceptual framework towards more resilient state. It will integrate the climate change responsive plan with mainstream planning.

While developing the indicators for integrated multidimensional planning model the followings aspects are considered:

- to assess a system's resilience for both rural and urban ecosystems.
- to understand dynamics of social–ecological systems in the light of resilience

5.1 Conceptualization of Integrated multidimensional planning model

While working on concept of integrated multidimensional model following aspects are taken into consideration:

- Mapping of multidisciplinary data sources;
- Reviewing the literature and categorizing the selected data;
- Identifying and naming the concepts;
- Integrating the concepts;
- Validating the conceptual framework.

The entire concept of integrated multidimensional model consists of basic four components:

(A) Vulnerability Assessment Index (VAI): It is a dynamic concept, significant to assess degree of present resilience of an area and to forecast future risks and vulnerabilities. The index analyzes and identifies characteristics of climate change hazards, its intensity, scope and impact on demography, infrastructure and other aspects of urban ecology. This concept deals with the affects of hazards, risks and uncertainties influencing various rural and urban population. VAI matrix is composed of three components, namely, demographic vulnerability, urban space informality and spatial dimension vulnerability. Urban space informality is applicable to urban areas only.

(B) Planning Initiatives: Any rural or urban area becomes more resilient when its governance is capable to promptly restore basic services and recommence social, institutional and economic activity after any hazard events. A common believe is that a more resilient State undertakes decision making processes in the realm of planning, open dialog, accountability, and collaboration. In this process rural and urban dwellers, local stakeholders, various social groups, communities, civil society, grassroots organizations, etc. participate. While weak governance lacks the capacity and capability to include participatory planning and decision making and generally fails to meet the challenges of resilience as well as increase the vulnerability of the urban population.

The role of governance in resiliency is very crucial, related to measures of quality of life, environmental well being, economic vitality and implementation of policies. Local authorities have important role in mitigation and adaption of climate change. According to this concept in order to cope with uncertainties, risks and hazards that cities and their communities may face, and make them more resilient, there needs a shift in governance. This shift will make governance more integrative, deliberative, and socially and eco-economically sound. This concept is comprises the components like implementation, monitoring and management.

(C) Plan for Prevention: In order to move towards greater resiliency and less vulnerability, rural and urban areas are required to prevent environmental hazards and climate change impacts. There are three main components that aim to prevent future catastrophes. These components assess mitigation policies to reduce hazards, include the spatial restructuring as a preventive measure for future environmental disaster, and search for alternative clean energy.

(D) Plan to Address Uncertainty: According to this concept the planning exercise should be uncertainty oriented rather than adapting the conventional planning approaches. There is a need to rethink and revise current planning methods which leads to address uncertainties, challenge the concepts, procedures, and scope of traditional planning approaches. Planning efforts should be towards controlling uncertainty either by taking action now to secure the future or by arranging actions to be taken in case an event occurs any time in future. In this concept there are three interrelated components, adaptation , spatial planning and sustainable urban design (for city planning only).

6 CONCLUSION

Climate change is no longer a distant possibility but a current reality (Work Bank -2009). There is no scope to disagree with the fact that the global climate change is an outcome of human-induced GHG emissions. Increased levels of heat trapped in the atmosphere have accelerate the process of modifying weather patterns, which in turn alter temperatures, sea levels, storm frequencies, etc. These will impact both urban and rural areas especially those are in geographically sensitive areas.

Sustainable development, climate change impacts and disaster risk management issues are core concerns for each and every nation. The action plan to reduce the impact of climate change starts with reducing emission of GHG. But reducing GHG emissions is not the sole solution to combat climate change. Management of urban areas, their growth and spatial planning requires the consideration of disaster risk management and the climate change agenda as essential components of urban development plan. Expectations from rural planning encompasses plan for extreme events , such as storms , flood and plan to secure agricultural productivity.

Scope of SDG13 includes multi-dimensional focus for adaptation and mitigation, mainstreaming climate concerns in development policies and discussing financial mechanisms to meet the targets. The proposed integrated multidimensional model for climate change responsive planning is multidimensional in nature, it comprises components like vulnerability assessment, plan for prevention , plan for uncertainty and planning initiatives for successful implementation of model. The Model has ample scope to achieve targets SDG13.

While comparing outcome of each component of integrated multidimensional model with targets of SDG 13 it appears that targets of SGD 13.1, 13.3, 13.3b are directly addressed by components like ; Vulnerability assessment index, Plan for prevention and Plan to address uncertainty, while SDG 13.2 and 13.3a targets can be achieved through meaningful planning initiatives.

Vulnerability of any geographical location is not static rather it is a function of exposure, sensitivity and adaptive capacity. The proposed model is a dynamic concept varies with geographical location, nature of impact of climate change , level of exposure, sensitivity and adaptive capacity . Plan for combating climate change may not be considered as stand-alone effort it should be embedded with exiting city and rural planning programmes, schemes. The proposed integrated multidimensional planning model for climate change responsive planning can be easily merged with the exiting rural and city planning schemes of India for achieving targets of SDG 13.

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Integrierte Betrachtung einer nachhaltigen Wärme- und Kältebewirtschaftung von Stadtquartieren

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1 ABSTRACT

Der Kampf gegen den Klimawandel wird zunehmend zu einer Aufgabe der Stadtplanung. Klimaneutrale Gebäude reichen nicht aus – die Klimaneutralität muss ebenso auf der Ebene des Stadtquartiers erreicht werden. Dafür sind Stadtentwicklungskonzepte mit Energiekonzepten zu kombinieren, mit Aussagen zur dezentralen Gewinnung sowie zur Verteilung und Speicherung von erneuerbaren Energien. Der Fokus dieses Papers liegt auf der Wärmeversorgung von Stadtquartieren; die Mobilität sowie die Stromversorgung werden nicht betrachtet.

Die ökologische und technische Effizienz von wärmeeffizienten urbanen Systemen erfordert eine kompakte und dichte städtebauliche Struktur. Dabei sind die vielseitigen Zusammenhänge und Wechselwirkungen zwischen Nutzern, Gebäuden, technischer Infrastruktur und der Umwelt zu berücksichtigen. Mit dem Prozess der „Energieleitplanung“ kann diese enge interdisziplinäre Zusammenarbeit gesteuert werden. Dieses Vorgehen gewährleistet, dass neue oder optimierte technische Systeme frühzeitig im Planungsprozess berücksichtigt werden. In der Energieleitplanung müssen inhaltliche Ziele und Indikatoren formuliert werden, wie die energetischen Vorgaben mit den Instrumenten der Stadtplanung umgesetzt werden können. Die Stadtplanung übernimmt dabei eine Koordinationsfunktion für andere Disziplinen,um die energetisch optimierte Planung in einem iterativen Prozess zu steuern.

Im Rahmen des Forschungsprojeks „Integrative Betrachtung einer nachhaltigen Wärmebewirtschaftung von Stadtquartieren im Stadtentwicklungsprozess“ (IWAES), gefördert vom Bundesministerium für Bildung und Forschung (BMBF), wird analysiert, wie ein ausgeglichener Wärme- und Kältehaushalt auf Quartiersebene hergestellt werden kann. Dies soll anhand der „Sowieso-Infrastruktur“ erreicht werden, hier mit einem thermisch aktivierten Hybridkanal. Neben seiner primären Funktion der Abwasserentsorgung soll der Kanal auch Abwärme und Abkälte im Stadtquartier transportieren. Hierfür muss der thermisch aktivierte Hybridkanal im Verteilungs-, Entzugs- und Einspeichermodus operieren können. Restbedarfe sollen durch im Quartier generierte erneuerbare Energien gedeckt werden, z.B. Solar- und Geothermie oder Photovoltaik.

Als Untersuchungsgebiet dient das Bahnkonversionsprojekt Rosenstein in Stuttgart (ehemals „Stuttgart 21“). Das städtebauliche Konzept der Stadt Stuttgart ist hinsichtlich der „Wärmedichte“, die sich unter anderem aus der baulichen Dichte und Kompaktheit ergibt, zu überprüfen und ggf. anzupassen.Stadtplaner, Bauingenieure und Energieingenieure arbeiten im Projekt eng mit kommunalen Vertretern sowie privatwirtschaftlichen Unternehmen zusammen. Neben den technischen Details des Hybridkanals und des Verteilsystems werden somit auch Schnittstellen zwischen den Disziplinen definiert, um den Prozess der Energieleitplanung weiterzuentwickeln.

Keywords: Wärme- und Kältenetz, Abwärmenutzung, Energiegerechte Stadtentwicklung, Energieleitplanung, thermisch aktivierter Hybridkanal

2 EINLEITUNG

In Deutschland gibt es insgesamt rund 21,7 Mio. Gebäude (dena 2019: 6), davon sind 19 Mio. Wohngebäude (dena 2019: 10), etwa 15,75 Mio von den Wohngebäuden sind Ein- und Zweifamilienhäuser (ebd.). 2,7 Mio. Gebäude sind Nichtwohngebäude, ihr Anteil am Gebäudeendenergieverbrauch beträgt aber überproportional 36 % (dena 2019: 14).64 % des Gebäudeenergieverbrauchsentfallen auf Wohngebäude (dena 2019: 10).

Für Ein-und Zweifamilienhäuser existieren bereits viele Konzepte zur autarken Energieversorgung, sowohl für Neubau als auch für Bestandsgebäude. Diese umfassen in der Regel die Nutzung von Umgebungsluft oder Solarthermie, Photovoltaik und Geothermie, in Verbindung mit Energiespeicherlösungen sowie Dämmungen etc. „Ein-und Zweifamilienhäuser […] haben im Vergleich zu Mehrfamilienhäusern […] große Wohnflächen je Wohneinheit und hohe quadratmeterbezogene Energieverbräuche.“ (dena 2019:10). Zugleich ist die Fläche, die zur Energiegewinnung zur Verfügung steht,im Verhältnis zumEnergieverbrauch gut. Hier gilt es,vor allem die jährliche Sanierungsrate von derzeit 1% zu erhöhen (dena 2019: 7).

Die Herausforderung besteht aber darin, integrierte Konzepte für Stadtquartiere mit hohen Bau- und Bevölkerungsdichten zu entwickeln. Hier stehtin der Regel wenig Dach- und Freifläche pro Bewohner zur Verfügung, um erneuerbare Energien zu gewinnen. Erschwert werden die Bestrebungen zusätzlich durchdiverse Nutzungskonflikte, z.B. hinsichtlich Verschattung, Dachbegrünungen, Blendung und Spiegelung, Brandschutz etc.

In diesem Beitrag wird aufgezeigt,wieWärmeenergiegewinnung und -versorgung auf Stadtquartiersebene durch dieEnergieleitplanunggesteuert werden können. Dazu gehören die interdisziplinäre Zusammenarbeit, die Integration unterschiedlicherPlanungsinstrumente sowie ein System zur technischen Umsetzung.

3 INTEGRIERTER PLANUNGSANSATZ FÜR DIE QUARTIERS-WÄRMEVERSORGUNG

Gebaute Strukturen sind beständig, eine nachträgliche Änderung der Baustruktur oder Versorgungsinfrastruktur ist sehr kostspielig und schwer umsetzbar.Der integrierte Planungsansatz dient dazu, frühzeitig alle relevanten Belange bei der Planung zu berücksichtigen.Dennoch können technische Systeme sehr anpassungsfähig sein, die Stadt- und Gebäudetechnik wird kontinuierlich erneuert. Anpassungsfähigkeit und Technologieoffenheit sind somit zentrale Kriterien im Städtebau.

Die Erforderlichkeit von Klimaschutzkonzepten ergibt sich auch aus der BauGB-Novelle 2011, in der gemäß § 1 Abs. 5 und 6 Nr. 7a BauGB die Abwägungsbelange bezüglich des Klimaschutzes definiert werden. Es gibt bislang aber wenige Reglungen, wie entsprechende Konzepte zu gestalten sind, und wie die verschiedenen Disziplinien bei der Planung der Wärmeversorgung von Stadtquartieren kooperieren können. In der Stadtplanung sind „[b]ei der Aufstellung der Bauleitpläne […] die öffentlichen und privaten Belange gegeneinander und untereinander gerecht abzuwägen.“ (§ 1 Abs. 7 BauGB).Zusätzlich wird durch die Vorschriften zur Beteiligung bei der Planung nach §§ 3 und 4 BauGB sichergestellt, dass die Öffentlichkeit, Behörden und sonstige Träger öffentlicher Belange frühzeitig in die Planung einbezogen werden.Andere Fachdisziplinen werden nicht explizit genannt.

Außerdem sollen für jede Stadt und jeden Stadterneuerungsschwerpunkt integrierte Stadtentwicklungskonzepte erstellt werden. Die Rahmenbedingungen für die nachhaltige Stadtentwicklung sind in der Leipzig Charta und in der Nationalen Stadtentwicklungspolitik definiert: gemeinwohlorientiert, kompakt, nutzungsgemischt, sozial ausgeglichen und autoarm. Stadtentwicklungskonzepte bieten die Möglichkeit, vor der formellen Bauleitplanung Zukunftsstrategien zu erarbeiten, mit einem sehr partizipativen und integrierten Ansatz. Hier können bereits frühzeitig Ziele zum Klimaschutz berücksichtigt werden, in dem z. B. künftige Reduktionsziele für die Stadtentwicklung mit kalkuliert werden. Gemäß Baugesetzbuch sind "[…] sonstige städtebauliche Planungen[…]" (§ 1 Abs. 6 Nr. 11 BauGB) als abwägungsrelevante Grundlage in den Planungsprozess einzubeziehen. Diese Konzepte sollten als Teil einer gesamtstädtischen Stadtentwicklungsplanung einen räumlich-funktionellen Bezug aufweisen und durch die Gemeinde förmlich beschlossen werden.

In den Bauleitplänen (Flächennutzungsplan/Bebauungsplan)wird die Gestaltung und Nutzung von Stadtquartieren festgelegt. Die energierelevanten Steuerungsmöglichkeiten werden in Abschnitt 5 dargestellt.

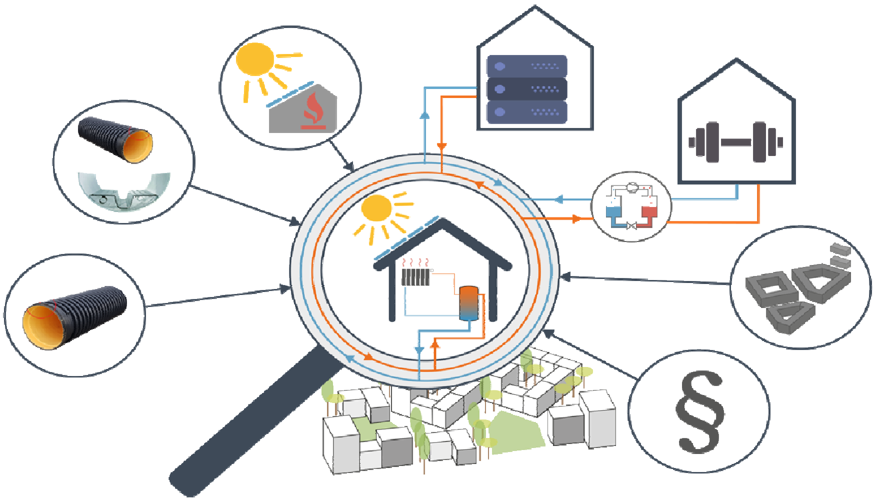

Fig. 1: Integration verschiedener Komponenten bei der Wärmeversorgung von Stadtquartieren.

Bei der Wärmeversorgung von Stadtquartieren variieren die zu beteiligenden Disziplinen,abhängig vom Versorgungssystem. Die unterschiedlichen Systeme müssen frühzeitig anhand der spezifischen Rahmenbedingungen jedes Quartiers ermittelt werden. Hierfür ist es unerlässlich, alle potenziell relevanten Akteure einzubinden. Neben der Stadtplanung sind das unter anderem Energieingenieure, Bauingenieure und Architekten.

In der Regel beginnen diese Disziplinien ihre Arbeit erst auf Grundlage der bestehendenstädtebaulichen Planung,sie müssen die Vorgaben aus der Bauleitplanungumsetzen. Im Städtebau wurden bereits teilweise Zwangspunkte geschaffen, die ggf. energetisch suboptimal sind.Die Fachdisziplinen sollten deshalb früher in den Planungsprozess einbezogen werden, damit Quartiere in einem iterativen Prozess durch Abstimmungen verschiedener Kriterien energieoptimiert geplant werden können. Dieser Prozess ist durch die Stadtplanung zu koordineren, da auch die energetischen Belange in die Abwägung nach § 1 Abs. 7 BauGB eingestellt werden müssen.

4 UNTERSCHIEDLICHE HANDLUNGSANSÄTZE BEI ENERGIEKONZEPTEN

Für die interdisziplinäre Zusammenarbeit auf der Verwaltungs-, Planungs- und Umsetzungsebene sind ein einheitliches Begriffsverständnis und ein gemeinsames Planungsinstrumentarium erforderlich.Bei der nachhaltigen Energieversorgung auf Quartiersebene gibt es unterschiedliche Herangehensweisen, die oft nicht einheitlich definiert sind. Hierzu zählen z. B. (kommunale/integrierte) Energiekonzepte, Energieleitplanung, Energienutzungsplanung, Energieplanung oder Energiepläne, kommunale Energieversorgungskonzepte, energetische Quartierskonzepte und andere. Auf sektoraler Ebene kommen weitere Instrumente hinzu. Im Baugesetzbuch werden zu dieser Thematik keineBezeichnungenangewendet.

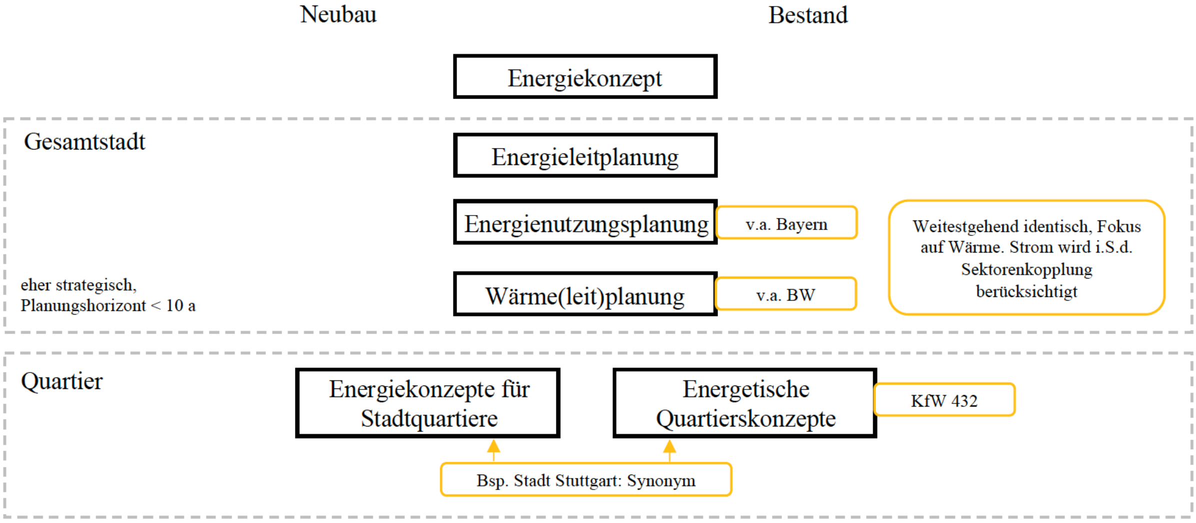

Fig. 2: Auswahl von Instrumenten der energetischen Planung

Häufig werden die Begriffe als Synonyme ohne klare Abgrenzung zueinander verwendet. Teilweise werden weder die Bezugsebenen noch die Akteursstrukturen oder Planungsvorgänge unterschieden. Auch die Inhalte, die die einzelnen Instrumente umfassen, sind oft nicht direkt nachvollziehbar. Sie unterscheiden sich hauptsächlich in ihrer räumlichen Maßstabsebene, ihrer Bindungswirkung, ihrem inhaltlichen Bezug (Energie, Strom und/oder Wärme), den Zielgruppen, dem Detaillierungsgrad und der Datenbasis.

Beeinflusst wird der Prozess darüber hinaus durch vielseitige Faktoren wie beispielsweise Bestandsplanung oder Neubau, die Versorgungsstrukturen, die Eigentümerstrukturen und dieAnzahl und Motivation der Bauherren, sofern diese bereits bekannt sind. Auch die finanzielle Ausstattung sowie die Innovationsaffinität der Kommunen sind bestimmende Faktoren.

Mit diesen Instrumenten wird das Ziel verfolgt, die Trias Energieerzeugung, -verteilung und -verbrauch zu analysieren und zu optimieren. Die unterschiedlichen Herangehensweisen sorgen jedoch für Missverständnisse zwischen den Beteiligten. Die interdisziplinäre Zusammenarbeit zwischen Stadtplanern, Architekten, Bauingenieuren, Energieingenieuren, Facility Managern und vielen anderen ist jedoch die Grundlage für eine optimale Energieversorgung auf Quartiersebene und auch für die Gesamtstadt.

Wir begreifen das Modell der Energieleitplanung als einen prozesshaften Ansatz. Bislang aufgestellte Energieleitpläne sind informeller Natur, ebenso die Energienutzungspläne. Für ein neues, eigenständiges formelles Instrument im Sinne eines„Energieleitplans“ gibt es bislang keine rechtliche Grundlage, aber diverse Förderprogramme. Auch sind die Wechselwirkungen mit weiteren Ressourcen zu berücksichtigen. Der Instrumentenkasten der Stadtplanung bietet bereits zahlreiche Möglichkeiten, die Energieleitplanung zu implementieren. Diese Möglichkeiten werden in Abschnitt 5 aufgezeigt.

Die verschiedenen Quartiere innerhalb einer Gesamtstadt unterscheiden sich häufig deutlich,unter anderem bezüglich der Bauweise bzw. Kompaktheit, Baustoffe, Sanierungszustand, Anzahl und Charakteristika der Bewohner, der Flächengröße und -effizienz sowie der vorhandenen Nutzungen. Von daher sollte die Analyse des Ist-Zustands sowie die Erstellung eines Energieleitplans auf Quartiersebene durchgeführt werden, immer in Verbindung mit Stadtteilkonzepten.

5 STEUERUNGSINSTRUMENTE DER ENERGIELEITPLANUNG

Das deutsche Planungssystem folgt der Normenhierarchie und wird stufenweise auf verschiedenen Ebenen gegliedert. Auf Bundesebene werden z.B. im Raumordnungsgesetz grundsätzliche Entscheidungen getroffen und Leitlinien formuliert. Viele der energierelevanten rechtlichen Vorgaben auf Bundesebene resultieren aus der Implementierung europäischer Vorgaben in nationales Recht.

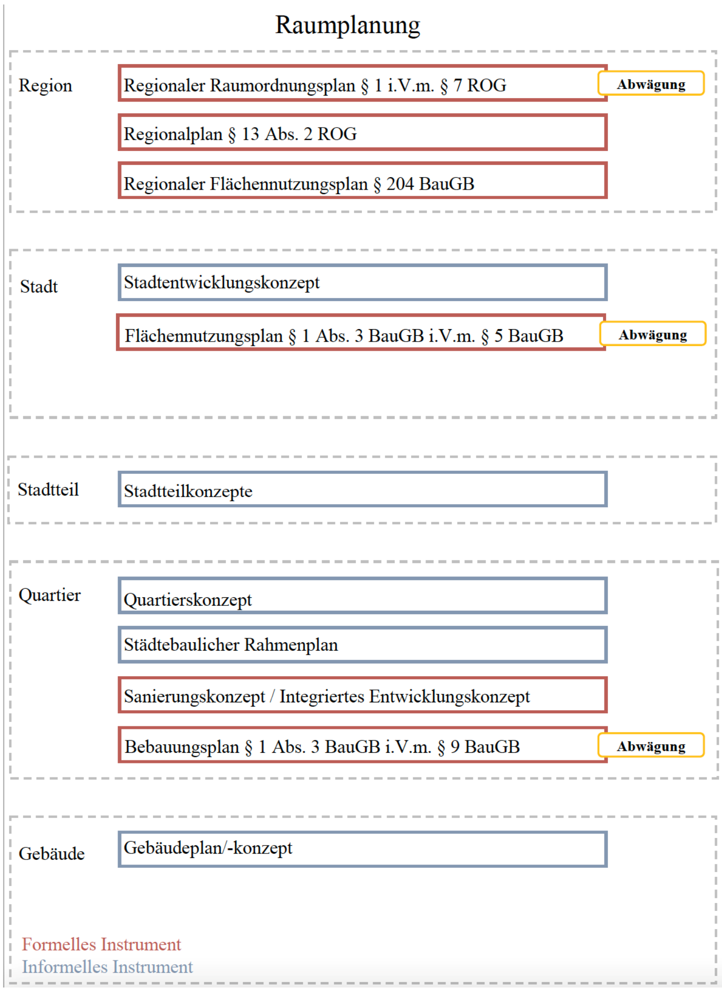

Fig. 3:Steuerungsinstrumente der Raumplanung

5.1 Raumordnungsplanung

Gemäß § 1 Abs. 1 und 3 ROG ist es die Aufgabe der Raumordnung, den Gesamtraum der BRD und ihrer Teilräume durch raumordnerische Zusammenarbeit zu entwickeln, zu ordnen und zu sichern. Gemäß § 2 Abs. 2 Nr. 6 ROG ist „[d]en räumlichen Erfordernissen des Klimaschutzes […] Rechnung zu tragen“. Energetisch sinnvolle Abgrenzungen von Räumen entsprechen u.U. keinen administrativen, geographischen oder anders gegliederten Gebieten. Von daher muss die Regionalplanung über die Grenzen hinaus agieren.

Diesem Umstand trägt § 1 Abs. 1 S. 1 ROG Rechnung: „Der Gesamtraum der Bundesrepublik Deutschland und seine Teilräume sind durch Raumordnungspläne, durch raumordnerische Zusammenarbeit und durch Abstimmung raumbedeutsamer Planungen und Maßnahmen zu entwickeln, zu ordnen und zu sichern."

Auf Ebene der Länder sind sowohl ein Raumordnungsplan für das Landesgebiet (landesweiter Raumordnungsplan) und Raumordnungspläne für Teilräume der Länder (Regionalpläne) aufzustellen (§ 13 Abs. 1 ROG). Die in Regional- oder Landesentwicklungsplänen enthaltenen Aussagen sind in der Regel generalisiert, enthalten aber wichtige Aussagen unter anderem zur Siedlungsentwicklung, Freiraumstruktur und Infrastruktur, und somit auch zu großflächigen Anlagen für die Strom- und Wärmeerzeugung. Der Energiebedarf kann meist nicht auf Quartiersebeneoder auf Stadtebene gedeckt werden. Durch Windenergieanlagen, Wasserkraft oder auch großflächige Geothermie-, Agrothermie- oder Photovoltaikanlagen im Umland kann der Restbedarf potenziell gedeckt werden. „Bei der Aufstellung der Raumordnungspläne sind die öffentlichen und privaten Belange […] gegeneinander und untereinander abzuwägen" (§ 7 Abs. 2 ROG), um die Nutzungen bereits frühzeitig optimal zu steuern.

5.2 Bauleitplanung

Nach § 1 Abs. 4 BauGB sind „[d]ie Bauleitpläne […] den Zielen der Raumordnung anzupassen." So wird sichergestellt, dass die Ergebnisse der Raumordnungsplanung in der weiteren Planung konkretisiert und umgesetzt werden. „[D]ie Nutzung erneuerbarer Energien sowie die sparsame und effiziente Nutzung von Energie" sind bei der Aufstellung von Bauleitplänen besonders zu berücksichtigen (§ 1 Abs. 6 Nr. 7 lit. f BauGB). Zusätzlich soll „[…] den Erfordernissen des Klimaschutzes […] durch Maßnahmen, die dem Klimawandel entgegenwirken […] Rechnung getragen werden." (§ 1 Abs. 4 BauGB)

Bei der Ausweisung der zukünftig bebaubaren Flächen im Flächennutzungsplan können bereits energetisch optimierte Bedingungen berücksichtigt werden. Bei einer ausgeprägten Topographie kann z.B. die natürliche Verschattung genutzt werden, um den Kühlbedarf im Sommer zu reduzieren. Darüber hinaus können Nutzungen nach § 1 Abs. 1 BauNVO so miteinander verknüpft werden, dass Synergien entstehen.

Durch § 5 Abs. 2 Nr. 2 lit. b BauGB wird die Darstellung der Ausstattung des Gemeindegebiets von „[…] Anlagen, Einrichtungen und sonstigen Maßnahmen [des Gemeindegebiets], die dem Klimawandel entgegenwirken," ermöglicht. Die Art der Anlagen werden nicht präzisiert (Battis u.a. 2019 Rn 17b). „Erfasst werden alle Anlagen, Einrichtungen und sonstigen Maßnahmen des Energiefachrechts, insbesondere des EEWärmeG sowie des KWKG." (ebd.)

Durch Festlegungsmöglichkeiten i.S.d. § 5 Abs. 2 BauGB i.V.m. § 16 Abs. 1 BauNVO können im Flächennutzungsplan darüber hinaus bereits die Geschossflächenzahl, die Baumassenzahl und die Höhe der baulichen Anlagen bestimmt werden.Diese Parameter haben wiederum Einfluss auf energierelevante Kriterien wie z.B. die Verschattung oder beheizte Nettogeschossfläche.

Aus Flächennutzungsplänen werden Bebauungspläne entwickelt (§ 8 Abs. 2 BauGB).Die Kommunen treffen nach den in § 9 Abs. 1 BauGB i.V.m. den in der BauNVO aufgezeigten Möglichkeiten rechtsverbindliche Festsetzungen für die städtebauliche Ordnung. Der Energiebedarf bzw. die Energieeffizienz im Quartier können über Festsetzungen hinsichtlich der Art und dem Maß der baulichen Nutzung (§ 9 Abs. 1 Nr. 1 BauGB) und der Bauweise, der überbaubaren und nicht überbaubaren Grundstücksflächen sowie der Stellung der baulichen Anlagen (§ 9 Abs. 1 Nr. 2 BauGB) gesteuert werden.

Nach § 16 Abs. 2 Nr. 1 bis 4 BauNVO kann das Maß der baulichen Nutzung „[…] durch Festsetzung der Grundflächenzahl oder der Größe der Grundflächen der baulichen Anlagen, der Geschossflächenzahl oder der Größe der Geschossflächen, der Baumassenzahl oder der Baumasse, der Zahl der Vollgeschosse, der höhe baulicher Anlagen" bestimmt werden.Diesbezügliche Festsetzungen wirken sich auf energetisch relevante Indikatoren wie Versiegelungsgrad, Verschattung, bauliche Dichte, Kompaktheit und das A/V-Verhältnis aus.

Zusätzlich sind die Regelungsmöglichkeiten des § 16 Abs. 4 BauNVO zentral für die Energieeffizienz von Neubauquartieren. Durch die Festlegung eines Mindestmaßes der „[…] Geschossflächenzahl oder [der] Größe der Geschossfläche, [der] Zahl der Vollgeschosse und [der] höhe baulicher Anlagen […]" (§ 16 Abs. 4 S. 1 BauNVO) kann die städtebauliche Dichte sowie die Kompaktheit der Gebäude gesteuert werden. Außerdem kann hierdurch ein schonender Umgang mit Grund und Boden gesteuert werden. Dies kann die Erhitzung von Stadtquartieren im Sommer reduzieren, was wiederum den Kühlbedarf der baulichen Anlagen

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reduziert. Zudem wird dem in § 1a Abs. 3 S. 1 BauGB verankerten Grundsatz „[m]it Grund und Boden […] sparsam und schonend […]“ umzugehen, Rechnung getragen.

Außerdem kanndurch Bestimmungen zu Bauweise, Baugrenzen und Bautiefen unter anderem die Stellung der Baukörper gesteuert werden. Gemäß § 22 Abs. 1 BauNVO kann im Bebauungsplan „[…] die Bauweise als offene oder geschlossene Bauweise festgesetzt werden.“ Eine geschlossene Bauweise weist im Vergleich in der Regel einen geringeren Energieverlust auf.Zu berücksichtigen ist aber auch das A/V-Verhältnis, also die Kompaktheit der Baukörper, das zur Energieeffizienz beiträgt.

Durch Anwendung der § 9 Abs. 1 Nr. 12, 13 und 21 BauGB können Festsetzungen bezüglich Versorgungsflächen, -anlagen und -leitungen sowie den entsprechenden Geh-, Fahr- und Leitungsrechten getroffen werden.§ 9 Abs. 1 Nr. 23 lit. b BauGB regelt die Möglichkeiten zur Festlegung von Gebieten, in denen „[…] bei der Errichtung von Gebäuden oder bestimmten sonstigen baulichen Anlagen bestimmte bauliche und sonstige technische Maßnahmen für die Erzeugung, Nutzung oder Speicherung von Strom, Wärme oder Kälte aus erneuerbaren Energien oder Kraft-Wärme-Kopplung getroffen werden müssen“.

5.3 Weitere Instrumente

Zusätzlich zu den oben aufgeführten Regelungen kann die Gemeinde weitere Regelungen durch städtebauliche Verträge i.S.d. § 11 BauGB treffen. Städtebauliche Verträge werden eingesetzt, um Regelungen zwischen Privaten (z.B. Investoren) und der öffentlichen Hand abzuschließen. Es gibt verschiedene Arten der städtebaulichen Verträge wie z.B. Durchführungs- oder Kostenübernahmeverträge. § 11 Abs. 1 BauGB führt die Gegenstände an, die insbesondere Inhalt städtebaulicher Verträge sein können.

Gemäß § 11 Abs. 1 Nr. 4 BauGB kann die klimabezogene Infrastruktur (EZBK/Krautzberger 2020 Rn. 165), insbesondere „[…] die Errichtung und Nutzung von Anlagen und Einrichtungen zur dezentralen und zentralen Erzeugung, Verteilung, Nutzung oder Speicherung von Strom, Wärme oder Kälte aus erneuerbaren Energien oder Kraft-Wärme-Kopplung […]“ entsprechend den mit den städtebaulichen Planungen und Maßnahmen verfolgten Zielen und Zwecken Gegenstand eines städtebaulichen Vertrags sein.

Auf Grundlage der jeweiligen Gemeindeordnung kann auch ein Anschluss- und Benutzungszwang festgesetzt werden. Gemäß § 11 GemO BW kann die Gemeinde „[…] bei öffentlichem Bedürfnis durch Satzung für die Grundstücke ihres Gebiets den Anschluss an […] die Versorgung mit Nah- und Fernwärme […] vorschreiben.Wurden Regelungen bezüglich eines Anschluss- und Benutzungszwangs getroffen, bleiben diese von den in den städtebaulichen Verträgen getroffenen Vereinbarungen unberührt (EZBK/Krautzberger 2020 Rn. 165).

Nach § 11 Abs. 1 Nr. 5 BauGB können städtebauliche Verträge insbesondere Anforderungen an die energetische Qualität zum Gegenstand haben. Wie auch die städtebaulichen Verträge über o.g. klimabezogene Infrastruktur müssen die in den nach § 11 Abs. 1 Nr. 5 BauGB festgelegten Anforderungen den Zielen und Zwecken der städtebaulichen Planung und Maßnahmen entsprechen (§ 11 Abs. 1 Nr. 5 BauGB).

§ 12 BauGB regelt den Vorhaben- und Erschließungsplan (der Bestandteil des vorhabenbezogenen Bebauungsplans wird), der über die Vorgaben des § 9 BauGB hinaus Möglichkeiten bietet, Festsetzungen zum Klimaschutz bei städtebaulichen Planungen zu treffen. Der Vorhabenträger erstellt den Plan und stimmt ihn im Anschluss mit der Gemeinde ab. Der Durchführungsvertrag stellt die Grundlage der Durchführung des Bauleitplans dar (§ 12 Abs. 1 S. 1 BauGB). Auch Kaufverträge können einzelne klimaschutz- oder energierelevanten Aspekte beinhalten. Da bei Kaufverträgen unter anderem die Koppelungsverbote nicht greifen, können die hier vereinbarten Regelungen umfassender sein als die Regelungen in öffentlich-rechtlichen Verträgen.

Bei der integrierten Betrachtung einer nachhaltigen Wärme- und Kältebewirtschaftung sollten die Instrumente der verschiedenen Disziplinen auf allen Ebenen miteinander verknüpft werden. Zusätzlich ergänzen sich formelle und informelle Planungsinstrumente.

Im Schaubild "Energieleitplanung" werden die unterschiedlichen Handlungsebenen von der Region über die Gesamtstadt, den Stadtteil und das Quartier bis hin zur Gebäudeebene sowohl für die Planungsinstrumente als auch für die Energieversorgungskonzepte verdeutlicht. Die Planungsebenen der Stadtentwicklungsplanung und Bauleitplanung nach BauGB sollten mit denen der energetischen Fachpläne korrespondieren. So kann auf der Gesamtstadtebene der Wärmebedarf über standardisierte Gebietstypologien abgeschätzt werden, darauf aufbauend können detailliertere Energieversorgungskonzepte und Gebäudemodernisierungspotentiale formuliert werden. Diese Ergebnisse des Energieleitplans stellen dann die Grundlage für Darstellungen im Flächennutzungsplan dar, und sie können somit eine verwaltungsinterne Verbindlichkeit für die folgenden Stadtteilkonzepte und Bebauungspläne entfalten.

Die Energieleitpläne auf Quartiersebene enthalten Teilschritte von der Analyse über die Zielformulierung bis hin zu einem Maßnahmenkatalog und einer Umsetzungsstrategie. In ihnen können die gebietstypologischen Wärmebedarfe und Umbaupotenziale auf einer konkreteren Datenbasis als für die Gesamtstadt ermittelt werden. Sie sollten z.B. Aussagen zur Energieversorgung enthalten (Nah- oder Fernwärme, Photovoltaik- oder Solarthermieanlagen), zur energetischen Gebäudesanierung, aber auch zu städtebaulichen Aspekten wie Nachverdichtung, Wohnungsanpassung und zum Verkehr. Die Ergebnisse sollten dann in die Sanierungskonzepte oder ggf. Bebauungspläne implementiert werden.

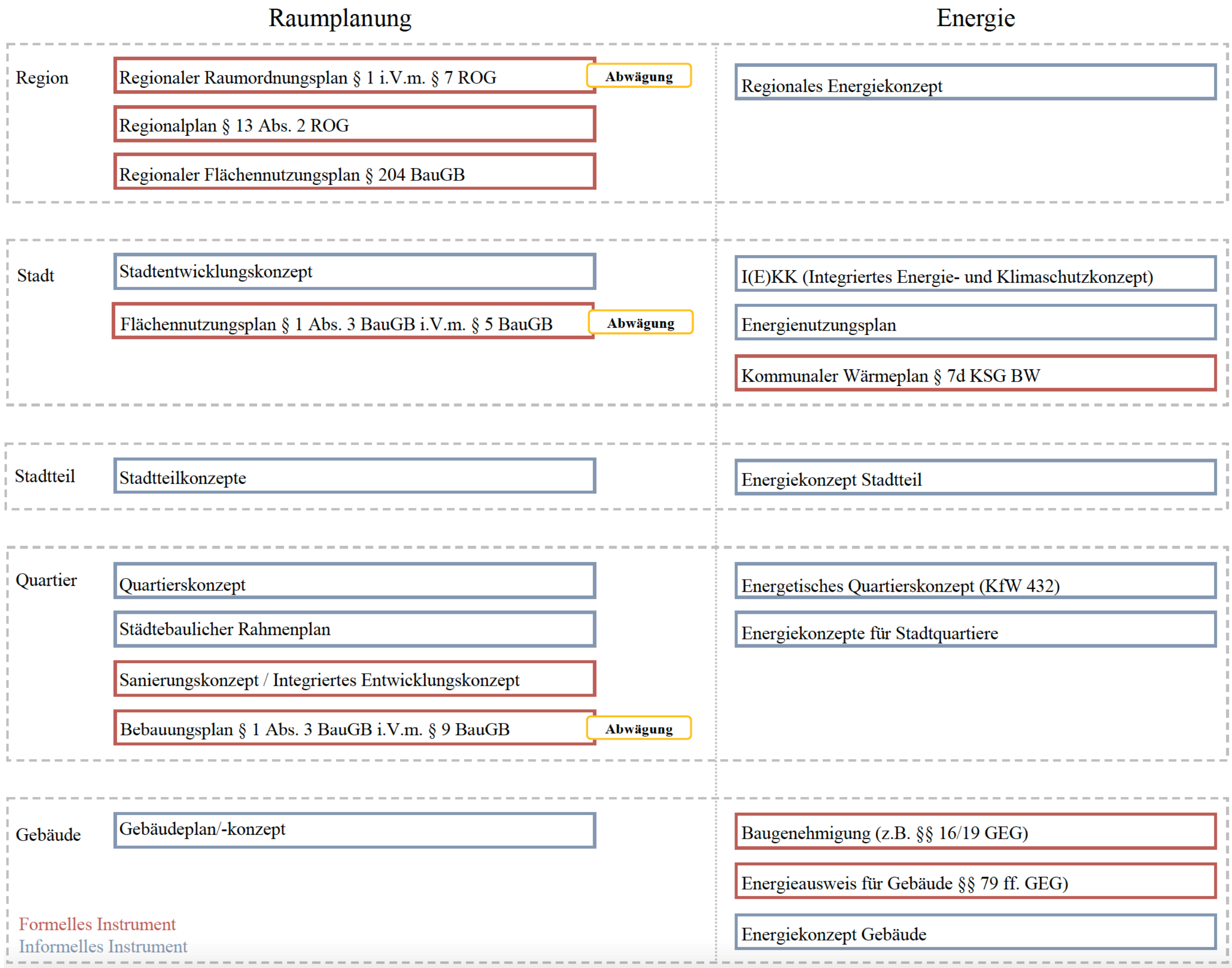

Fig. 4: Modell der Energieleitplanung

6 BEISPIELHAFTES WÄRMEVERSORGUNGSSYSTEM AUF QUARTIERSEBENE

Wie kann ein ganzjährlich ausgeglichener Wärme- und Kältehaushalt auf Quartiersebene hergestellt werden? Dieser Frage widmet sich das Forschungsprojekt am Beispiel des Rosensteinquartiers der Stadt Stuttgart. Das Versorgungssystem basiert auf Abwärme- und Abkältenutzung in nutzungsgemischten Quartieren. Die überschüssige Abwärme, die beispielsweise durch die Nutzung technischer Geräte wie Kühl- oder Gefrierschränken entsteht, kann der Luft entzogen und mithilfe eines Wärmetauschers an anderer Stelle im Quartier zu Kühlzwecken zur Verfügung gestellt werden.

Der Siegerentwurf des städtebaulichen Wettbewerbs von asp Architekten GmbH dient als Grundlage für die Entwicklung des Versorgungssystems.

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Fig. 5: Siegerentwurf, Internationaler Wettbewerb Rosensteinquartier Stuttgart

Fig.5 verdeutlicht, dass demäß dem städtebaulichen Entwurf ein durchgrüntes Stadtquartier entstehen soll. Entsprechend den Forderungen der Leipzig Charta soll ein durchmischtes, möglichst autofreies Quartier mit einer qualitätvollen Dichte und ansprechenden öffentlichen Räumen entstehen. Quartiershubs dienen dazu, diverse Infrastruktureinrichtungen zu bündeln.

Die Abwärme und Abkälte soll mithife der „Sowieso-Infrastruktur", in diesem Fall einem thermisch aktivierten Hybridkanal, im Quartier transportiert werden. Zusätzlich fungiert er als Energiesenke. Durch die Mehrfachnutzung einer Infrastruktur können Synergien geschaffen und der Ressourcenverbrauch reduziert werden. Das System setzt eine noch zu bestimmende Wärmedichte voraus, um einen hohen Wirkungsgrad zu erreichen. Der thermische Ausgleich im Untersuchungsgebiet soll stufenweise erfolgen (siehe Fig. 6).

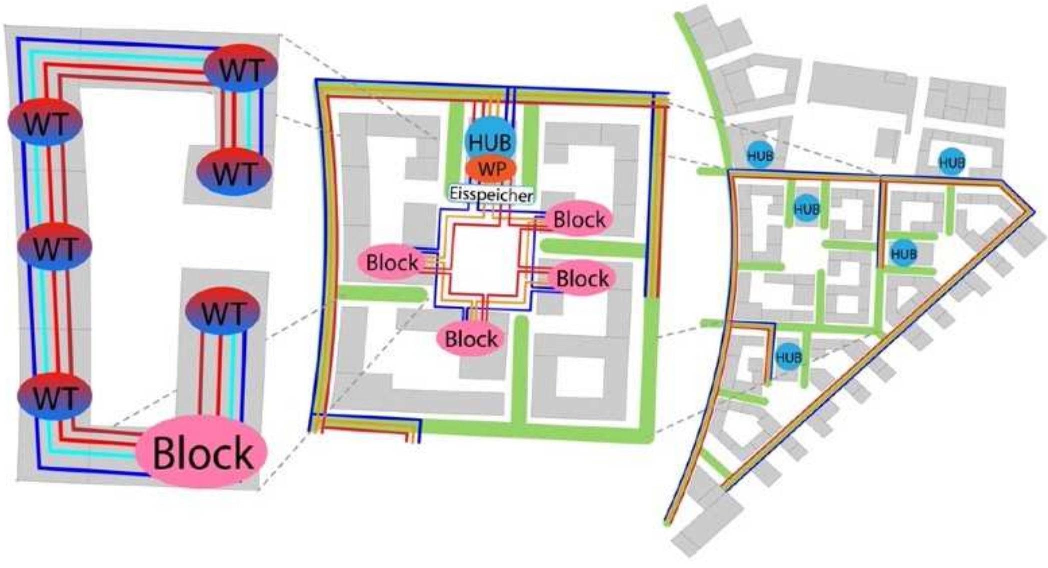

Fig. 6: Dreistufiger Ausgleich des Wärmebedarfs auf Quartiersebene mithilfe eines thermischen Hybridkanals

Zuerst werden die Bedarfe innerhalb eines Gebäudes bzw. Gebäudeblocks ausgeglichen, die Gebäude(blocks) werden mit Wärmetauschern ausgestattet. Im nächsten Schritt wird der Bedarf in einem sogenannten „Hub-Areal" ausgeglichen. Hier werden die Gebäude durch einen Hub ergänzt, der neben

Quartiersgaragen undweiteren Infrastruktureinrichtungen auch Flächen für die Energieversorgung vorsieht. Hier können Energiespeicher sowie Wärmepumpen untergebracht werden. Die letzte Ausgleichsebene stellt das gesamte Quartier dar.(Weitere Informationen zum Forschungsprojekt: www.iwaes.de)

In diesem System werden die Stadtplanung und die Energieplanung durch die Disziplin der Siedlungswasserwirtschaft ergänzt, es werden also Instrumente der Entwässerung mit denen der Stadtplanung verknüpft.

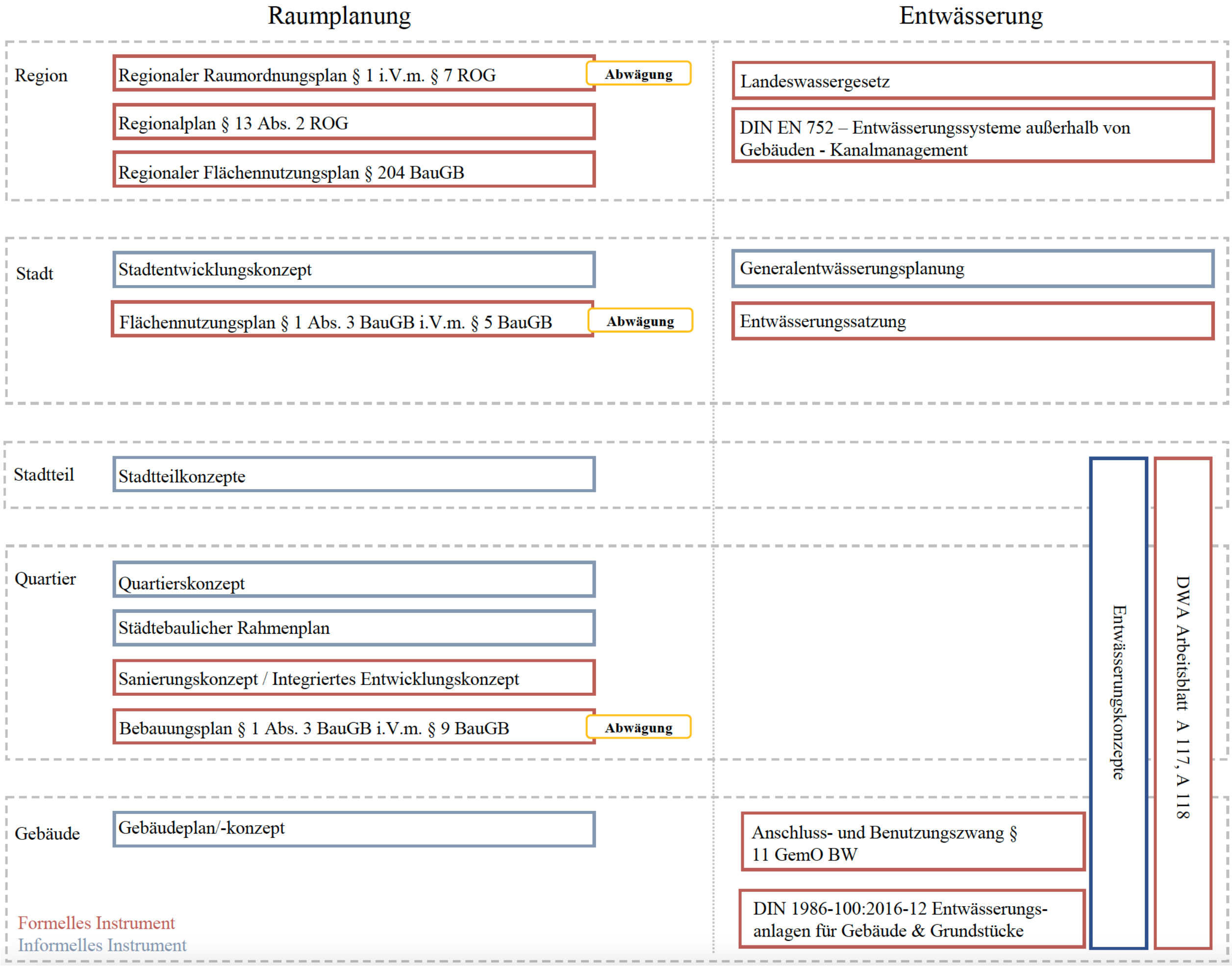

Fig. 7: Erweitertes Modell der Energieleitplanung

Andere Versorgungssysteme setzen voraus, dass Instrumente weiterer Disziplinen mit dem Instrumentenkasten der Stadtplanung verknüpft werden. Nur so kann sichergestellt werden, dass alle Belange in die Abwägung eingestellt werden können.

7 FAZIT

Die Wärmeversorgung bietet ein enormes Einsparpotenzial von Treibhausgasen. Um die Klimaziele zu erreichen, muss der Klimaschutz einen noch höheren Stellenwert bei der Planung einnehmen, insbesondere auf Quartiersebene. Das Planungsrecht umfasst bereits viele Instrumente, um die energiegerechte Planung zu gewährleisten. Der bestehende Instrumentenkasten könnte durch ergänzende Vorgaben optimiert werden.

Im Bereich der energetischen Planung gibt es sehr unterschiedliche Herangehensweisen und Begriffverständnisse. Für die interdisziplinäre Zusammenarbeit ist ein einheitliches, koordiniertes Planungsinstrument erforderlich. Das Forschungsprojekt möchteeinen Beitrag dazu leisten, Begriffsdefinitionen in Leitfäden oder Normen zu typisieren bzw. standardisieren.

Die Energieleitplanung ist vor allem als Modell und Prozessansatz zu betrachten. Die Energiewende bringt immer wieder technische Neuerungen mit sich, die eine veränderte, integrative Zusammenarbeit vieler Disziplinen erfordert. Das im Forschungsprojekt IWAES entwickelte Versorgungssystem veranschaulicht die Potenziale, die sich durch eine neue Kombination bestehender Technik ergeben. Die Energieleitplanung

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muss immer wieder flexibel aufdie individuellen Gegebenheiten in den unterschiedlichen Quartieren und den Akteurskonstellationenreagieren. Die hier vorgestellte entwickelte Methodik legt einen Grundstein für die interdisziplinären Zusammenarbeit und die Integration der Wärmeversorgung in das Planungsrecht. Ausgehend von der Planungssystematik der Stadtentwicklung kann die Methode bedarfsgerecht weiterentwickelt werden.

Aufgrund des sehr komplexen deutschen Planungsrechts kann die Methode nicht ohne Weiteres auf die Planungssysteme anderer Länder angewendet werden. Da die Disziplinen Raumplanung, Energie und Wasserbau die Infrastrukturplanung weltweit beeinflussen, lässt sie sich jedoch individuell auf diverse Planungssysteme anpassen.

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Introduction of Key Nexus Indicators to Assess the Urban Food-Water-Energy Nexus within the SUNEX Project

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1 ABSTRACT

Within the SUGI initiative addressing the challenges of sustainable urban food, water and energy nexus (FWE-Nexus) the ongoing project SUNEX -funded by JPI Urban Europe in collaboration with the Belmont forum- is developing an integrated interdisciplinary approach to analyse the intersection between FWE-systems. It aims at supporting cities' decision-making process in formulating inclusive and sustainable urban FWE–strategies. The project has established an integrated modelling framework to model FWE demand and supply and assess their key intersections through a nexus approach that endorses sustainable and efficient solutions to cover cities FWE-demand. The modelling framework is being applied in 4 case studies for the cities Berlin, Bristol, Doha and Vienna. The applied Nexus-approach relies on profound urban FWE-data and consistent socio-economic and technological development scenarios constructed within a co-creation process supported by cities' stakeholder dialogue (Hainoun and Loibl, 2019). To address the complex interlinkages between the three systems and capture their key synergies, SUNEX has developed a novel concept called "Key Nexus Indicators (KINs)" that helps to quantify and monitor the key nexus-effects of urban FWE systems. The introduced KNIs are classified into two categories, addressing either dual effects (FW, FE, EW) or triple effects referring jointly to the 3 FWE systems. Altogether 6 triple KNIs and 22 dual KNIs of FWE-Nexus effects have been specified. The introduced KNIs are quantified based on the results of the developed future FWE demand-supply scenarios formulated using the established SUNEX-modelling framework. The scenario results are monitored and evaluated to specify the strength of coupling effects (nexus-grade) using the introduced KNIs.

Keywords: sustainable urban development, food-water-energy-nexus, Key nexus indicator, city decision making , SUNEX project

2 METHODOLOGY

The urban FWE-Nexus approach applied within SUNEX project focuses on analysing the intersection between the three systems along the supply chain of the considered urban area. For this purpose, an integrated demand-supply analysis of the FWE systems has been conducted using the newly established SUNEX-IMFA (Integrated Modelling Framework). In these Analyses sustainable FWE strategies for the considered demo cities has been formulated following expected future socio-economic and technological development aligned to the official cities' future visons (like SCWFS for Vienna) (Hainoun and Loibl, 2021). Due to the central role of the energy demand for the FWE-Nexus detailed modelling of the city's energy demand by sector and energy form (within SUNEX-IMFA) has been conducted using the end-use, bottom-up approach of the sub-module MAED-City. MAED-City concept disaggregates the urban energy demand by sector of consumption comprising building (household and service), agriculture, construction, manufacturing industry and transportation (passenger and freight). The future development by sector and fuel is projected following a sustainable, efficient and low-carbon transformation path. The employed drivers of the conceived transformation comprise energy efficiency improvement, switching to clean fuel, digitalisation and electrification. Considering the decarbonisation of electricity through increased renewable energy shares, the electrification accounts for increased penetration of electricity in the end-use of all consumption sectors like EV and H2 for passenger and freight transport, electrisation of building heat demand via heat pumps for space and water heating, etc. The energy supply accounts also for the increased need of flexibilization like P2H and P2G. However, the impact of sector coupling related to V2X is not considered within SUNEX-project. This is part of follow-up activities and other running projects. More detailed elaboration on the supply strategy for the case of Vienna city can be found by Horak and Hainoun (Horak et al., 2021).

Following an integrated demand-supply analysis an interdisciplinary approach is being applied aiming to quantify and optimise existing synergies between the three systems and thus supporting the desired sustainable urban transformation towards efficient, sustainable and low-carbon economy. Form the conceptual viewpoint the FWE-interlinkage is obvious, and the main related Nexus-Effects can be reasonably well defined. However, the quantitative analysis is challenging, in particularly for cities and urban areas with their strict geographic boundaries at which the considered FWE are balanced. Hence, many of the supply related effects lie fully or partially outside the boundaries of the cities on which the urban decision has no direct influence, e.g., the production and transport of food from long distances. However, cities -with their concentrated social and economic activities and intensive resources use- have their role to play in enabling the desired CC mitigation with focus on ensuring sustainable production and consumption pattern and working towards sustainable, resource-efficient and low-carbon economy where the expected growth is driven by the interaction between rapid technological innovation, sustainable infrastructure investment, and increased resource productivity (NCE, 2018). Moreover, the desired sustainable development needs to be balanced and inclusive resulting in efficient, liveable cities characterised by low-carbon, smart and resilient infrastructure. In this context the FWE-Nexus can provide a valuable contribution by harnessing existing synergies and making the intersection between the three systems impactful through innovative socio-economic and technological measures that focus on resource efficient practices like reducing food wastes and switching to renewable energy sources.

To quantify and monitor these interlinkages of FWE-systems, SUNEX has introduce the concept of “Key Nexus Indicators (KINs)”. Two categories are identified addressing either dual effects among the three systems (FW, FE, EW) or triple effects where the three systems jointly interact with each other (Figure 1). Altogether 6 triple KNIs and 22 dual KNIs of FWE-Nexus effects have been specified.

As depicted in Figure 2 the multidisciplinary FWE systems are described following the associated demand and supply activities and then interrelated via the expected nexus-effects. The endorsed KNIs followed these effects and quantify the resulting impact associated with them. The total city energy demand is being specified by sector of consumptions with specific focus on energy needed for food and water provision, like energy for urban farming in agricultural sector, energy for food industry and energy for freight transport (including food and water), energy for cooking, etc (Hainoun and Loibl, 2021). The same applies for water being needed for irrigation, catering and beverage, household cooking, etc. The approach accounts only for the energy and water related to services and commodities provided within the city boundary. Energy and water embodied within the import food products are not considered. However, with focus on the different food supply routes (national, international) estimation are given for the transport distances to estimate the energy of food transport.

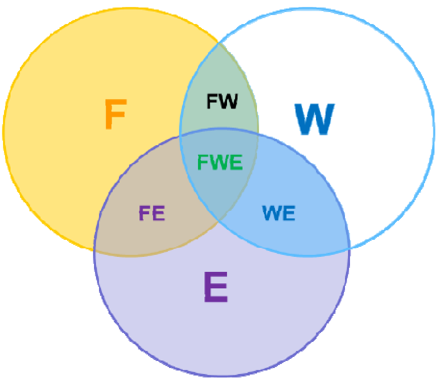

Figure 1: intersection of FWE systems and resulting KNIs

The established KNIs-concept is being integrated within the newly developed SUNEX-modelling framework focussing of formulating long-term future FWE-development scenarios (Hainoun and Loibl, 2021), (Doernberg et al, 2019). The scenario results are monitored and evaluated to specify the strength of coupling effects (nexus-grade) using the introduced KNIs.

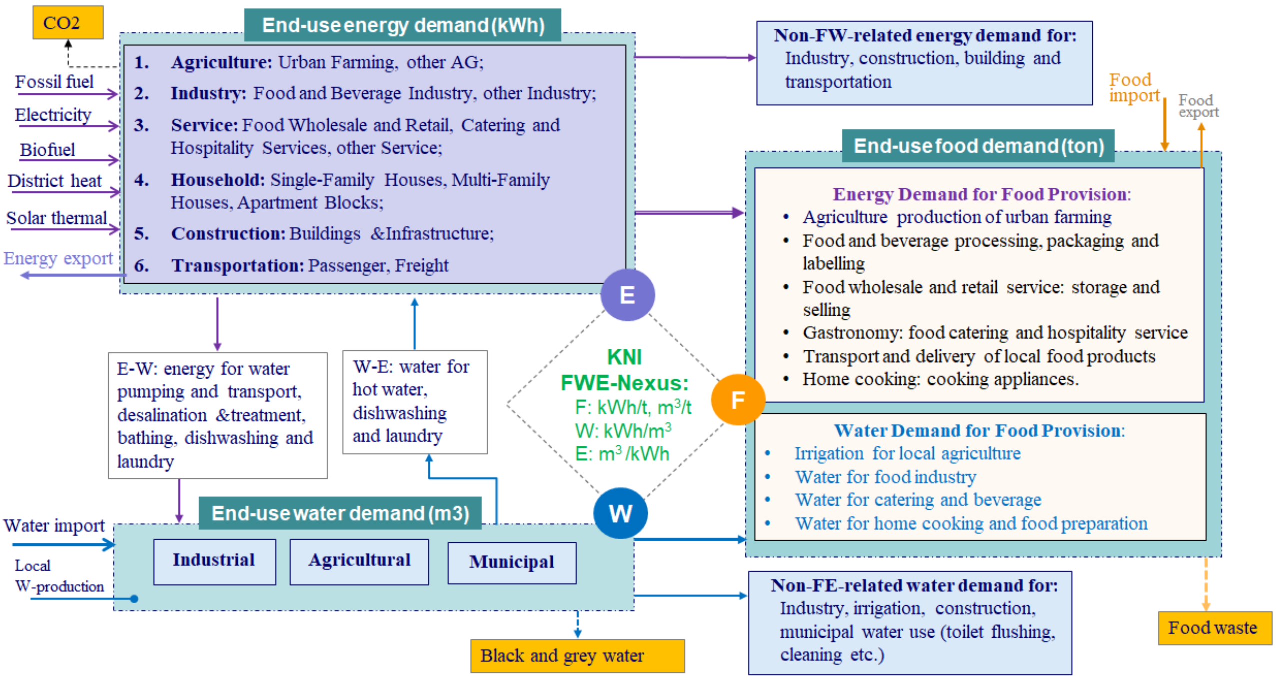

Figure 2: SUNEX-concept of the key nexus indicators (KNIs) to assess urban FEW-nexus.

3 APPLICATION

Tracing the main intersections along the FWE-supply chains 22 dual KNIs and 6 triple KNIs have been identified. Table 1 presents exemplary a selection among the identified KNIs. Permutation effects can play a roly if they are referring to different effects, like energy for water pumping and water for energy production (power plan cooling).

Considering the intersection of FWE-systems, the food perspectiveprovides the most interesting full FWE-Nexus-effects -along the food supply chains-, i.e. effects where the three systems are jointly interacting. These effects refer to the energy and water intensity in terms of energy and water amounts needed to generate one-unit of food. The resulting set of tripple KNIs are then associated to:

- Agricultural production of urban farming,
- Food and beverage processing,
- Packaging and labelling industry,
- Food wholesale and retail service (storage and selling)
- Household cooking and food provision in gastronomy (food catering and hospitality service within the service sector).

Besides, the mentioned steps along the food supply chain are associated with energy demand for food transportation (a dual KNI effect of energy for food).

With the set relation about the intensities -E(kWh)/F(ton), W(m3)/F(ton)- any future change in the amount or structure of food demand affects both energy and water demand via the specified KNIs that correlate with the existing nexus-effects. For example, the shift of demand per capita from meet to vegetable will reduce the energy and water demand due to the lower intensity of vegetable provision. From a holistic system perspective, this leads to reducing the CO2 emission per unit of food. However, within the city boundary, any increase of local production would increase the local energy and water demand (and land-use) which might feature a new challenge for the city given its limited energy, water and resources. The answer for the city-decision making is to choose the optimal balance between food import and local production considering the prevailing limits and constraints of the considered city. With focus on future city vision this challenge is exaggerating in relation with the set cities' goals in the EU to become carbon neutral latest by 2050.

Accordingly, the FWE Nexus-approach provides an interesting basis for a multisectoral decision making for a sustainable FWE strategy in respect to the city's long-term development goals (Ludlow et al, 2019).

	Affected Systems	Activity	Reference unit	Key Indicator
	FWE	Cooking (in household and HH): (all cooking appliances)	Per dwelling	E and W per F (kWh/t, m^3/t)
	FWE	Dishwashing (HH)	Per dwelling	E and W per F (kWh/t, m^3/t)
	FWE	Gastronomy (Ser): food catering and hospitality service	Per ton of food or related (GDP-VA)	E and W per F (kWh/t, m^3/t)
	FWE	Food and beverage processing, packaging and labelling	Per ton of food or related (GDP-VA)	E and W per F (kWh/t, m^3/t)
	FWE	Agricultural production of urban farming	Per ton of food or related (GDP-VA)	E and W per F (kWh/t, m^3/t)
	FWE	Food waste treatment	Per ton of food	E and W per F (kWh/t, m3/t)
	EF	Transport and delivery of local food products	Per ton or (GDP-VA)	E per F (kWh/t) or (kWh/$)
	EF	Refrigeration (in household)	Per dwelling	E per F (kWh/t)
	EW	Hot water (in household): (for bathing and showering)	Per capita	E per W (m3/kWh)
	EW	Laundry (in household)	Per dwelling	E per W (m3/kWh)
	EW	Irrigation: urban farming, private garden, public parks	Per m^2 of irrigated area	E and W per m^2 (kWh/m^2) (m3/ m^2)

Table 1: selection of main KNIs specified along the urban FWE-supply chain (FEW: intersection of Food-water-energy systems; EF intersection of Food and energy systems, EW: intersection of energy and water systems)

4 CONCLUSION

The introduced KNIs to monitor and evaluate the FWE-Nexus prove to be a valuable approach in supporting the development of sustainable urban FWE-strategies. The KNIs-concept has been realised within the integrated SUNEX-Modelling frame being under development. It has been successfully applied to cover the urban food supply chain covering (within the city boundary) form the agricultural production of urban farming up to the food provision in the household or gastronomy. Currently the concept is being applied to track and monitor the results of long-term sustainable FWE strategy for the cities of Vienna, Berlin, Bristol and Doha.

5 ACKNOWLEDGEMENT

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🏆 *reviewed paper*

Investigation of the State of Spatial Transformation Policy and Practice: Lessons from the City of Johannesburg

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1 ABSTRACT

country's spatial legacy. This planned segregation system left many South African cities with a spatial legacy that cannot support the ever-rising urban population, particularly the black African population that is ever migrating from rural to urban areas. The elements of concern include informal settlements, undesirable spatial configuration, single land use development, improper transportation and different forms of infrastructure. This paper aims to assess the level of spatial transformation across the city of Johannesburg. The paper adopts a case study research design and applies a mixed methods approach. Data was collected through interviews, a literature review on the spatial planning policies, and direct observations of the city's infrastructure. When the country gained its democracy in the year 1994, many policies and legislative frameworks were introduced, all of them having one primary objective: to transform South Africa spatially, mainly the cities. Since then, several policies and legislative frameworks have been implemented with the same vision of transforming the spatial configuration of the urban areas in the country. However, the spatial issues have remained the same for many if not all South African cities. Spaces in these cities remain divided along racial lines. The results revealed an improvement in the level of transformation across the municipality and an improvement in the policies and practice of spatial transformation. Developmental projects such as transit-oriented development have led to income elasticities for properties along the corridors of freedom. Overall, the paper recommends collaborative planning as a tool for assessing the performance of spatial transformation.

Keywords: Sustainable frameworks, collaborative planning, transit-oriented development, spatial transformation, Johannesburg

2 INTRODUCTION

The draconian planning system of the apartheid regime in South Africa played a huge role in shaping the country's spatial legacy. This planned segregation system left many South African cities with a spatial legacy that cannot support the ever-rising urban population, particularly the black African population that is ever migrating from rural to urban areas. Since the country gained its democracy in 1994, the government made it its mandate to introduce policies and legislative framework to address the challenges that were as a result of the apartheid system of spatial planning. All if not most of these policies and legislative frameworks had one primary objective which was to transform South Africa spatially, mainly the cities. Since then, many policies and legislative frameworks keep on being implemented, with the same vision as the ones before them, to transform the configuration of the country's urban areas spatially (South African City Network, 2016). However, the spatial issues have remained the same for many if not all South African cities. Spaces in these cities remain divided along racial lines (Ndhlovu, 2019).

With the noticeable undesired spatial legacy that the country inherited, spatial transformation is seen as the way forward to address socio-economic inequalities, racially divided spaces and transformation of the cities to provide equal opportunities and sustainable means of living for all citizens (Meerow & Miller, 2019). As Nkoane (2019) stated, South Africa needs spatial transformation not only to address the configuration of the urban areas, but also 'to embrace new spatial practices in respect of sustainability, liveability, resilience and facilitating technological innovation and economic structural change'. South Africa is noted as the most unequal society in the world; thus it is not surprising that South African spaces of cities reflect high inequality (Schensul & Heller, 2010). Johannesburg not being an exception adopted the spatial transformation approach to address the challenges such as inequality, injustices, and the social alienation that the city faces (Noyoo, 2019). Even with the implementation of many various policies, legislatives frameworks and projects across the city, the spatial configuration of the city is still highly fragmented. The efforts by the city mostly do not cater for the urban poor and as a result, the majority of the poor households continue to live in peripheral, poorly located areas with insufficient access to opportunities (Kruger, 2014). There is widespread poverty, criminality and a growing inequality which are the result of high unemployment rates that are unacceptably high; on the other side, the city's infrastructure is inadequate and not coping due to high migration. These aspects only highlight the reality which is that the city is not functioning properly spatially. This paper aims at assessing the level of spatial transformation across the city of Johannesburg with a focus on spatial planning policies, legislative framework and the practice of spatial transformation.

3 CONCEPTUAL FRAMEWORK

Transformation can be seen as 'a spatially defined, socially embedded process; with an interrelated series of materially driven practices, whereby the form, substance and overall dimensions of urban space are purposefully changed to reflect the principles of a more equitable social order' (Williams, 2000: 169). Williams (2000) continued to describe transformation as a 'programmatic, plan oriented, project directed effort to change the unequal access to and occupation/ownership of socio-politically differentiated space in South Africa. It is a multi-dimensional open-ended, fluid process of change, organically linked to the past, present and future' (Williams, 2000: 169).

It is increasingly acknowledged that 'spatial transformation' is required to address the injustices of the past. However, it is a concept with rather abstract and fluid meanings. The term has been used to refer to 'major urban change or restructuring', with very loose application in public policy, academic research and popular writing (Turok, 2014: 74). Spatial transformation is sometimes used interchangeably with the concept of urban restructuring, which can also refer to actions that reform while retaining the underlying power structures in order to minimise disruption and turmoil instead of pursuing fundamental change (Oranje, 2014).

Over the past two years, the understanding of the government's role in shaping and transforming cities and towns in South Africa has changed. The transformation of space is fundamentally linked to other key structural transformations: of institutions, capacity building, and the reconfiguration of power and influence (Williams, 2000). Fundamentally, the transformation of space can be equated to the living experience of urban dwellers. An inclusive, productive, sustainable and well-governed city is one in which residents experience a high quality of life, and both benefit from what the city offers and contributes towards making and shaping the city. It is important to understand that certain pathologies manifest in the urban environment when people are not able to determine, influence and ultimately access opportunities (Max-Neef, 1992).

4 STUDY AREA

Spatial transformation is critical for the growth of cities in South Africa as it addresses the challenges such as injustice and undesirable spatial configuration of the cities, making it an indispensable factor for the development in the cities. However, the current policies and legislative framework seem to be missing certain aspects to make the implementation of spatial transformation successful. Thus, there needs to be continuous improvements in strategies, procedures and elements that inform spatial transformation of the country. The Gauteng province is also affected by this challenge, and this being the economic hub of the country, it affects the development prospects of the ountry as a whole, both economically and socially.

The City of Johannesburg is faced with a mounting pressure of growing demand of infrastructure and services delivery.This is clearly visible from the protests that happen almost every year. The increase in population of the city and the demand for services and infrastructure is not being met by the investment in infrastructure and this is partially as a result of the current spatial planning policies and practices in the city. This has resulted in increased inequality, unaligned and uncoordinated development, continued inefficient spatial development, decaying urban infrastructure, locational disadvantage in projects aimed at assisting the urban poor, built environment investment not resulting in inclusive economic development and spatial fragmentation (SACN, 2016: 50-58). The scope of this study focuses on the city of Johannesburg, which is in Gauteng Province of South Africa as shown on the figure below (figure 1).

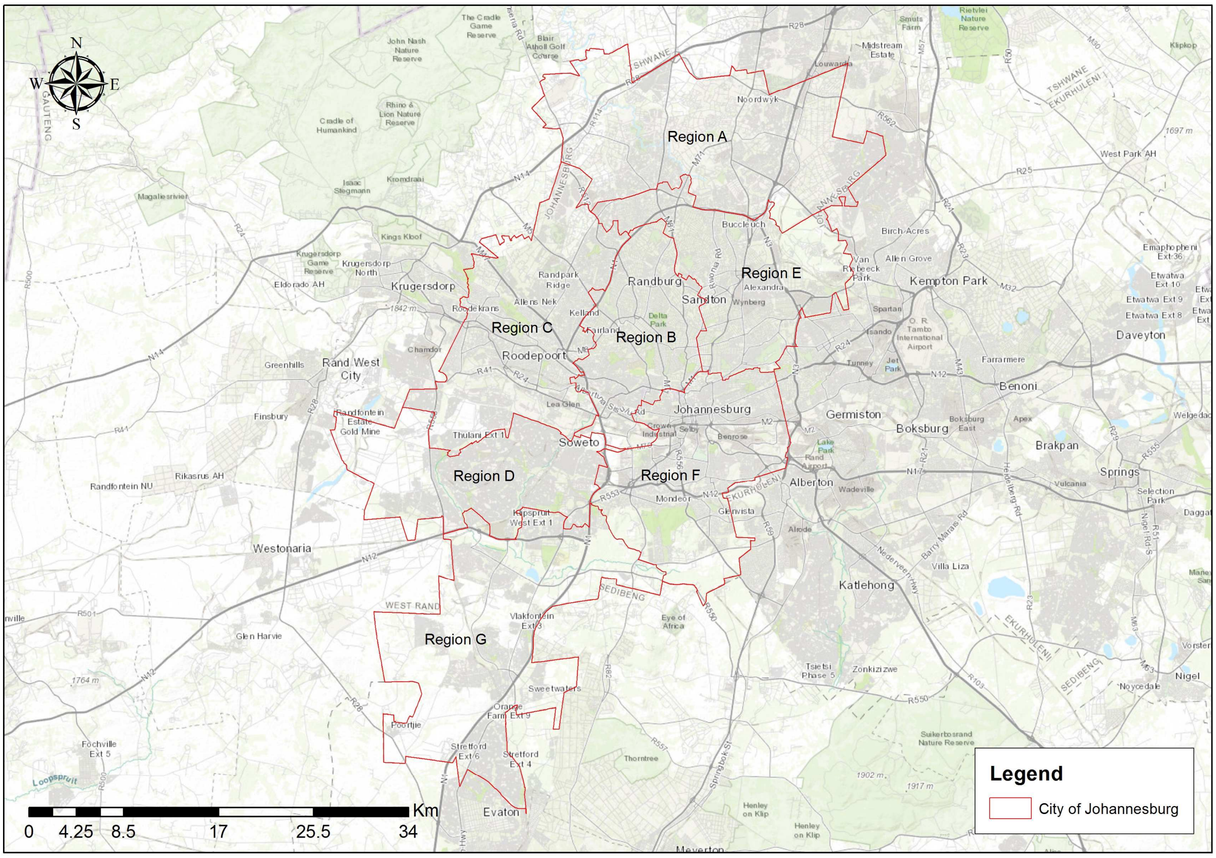

Figure 1: City of Johannesburg

5 METHODOLOGY

This study adopted the mixed method approach to fully explore the research question: 'What is the current state of policy and practice of spatial transformation in the City of Johannesburg?'. A case study design was chosen to extract meaning from the experiences of residents living in the city of Johannesburg Metropolitan Municipality. Located in the Gauteng Province of South Africa, the City of Johannesburg is one of the three metropolitan municipalities in this province. It shares the borders with the MetropolitanCity of Tshwane to the North, the Metropolitan City of Ekurhuleni to the East, Sedibeng District to the South and West Rand District to the West.

This study relied heavily on interviews and observations of the situation in the city of Johannesburg. Interviews were conducted with 30 respondents, in which 7 of them were from the city's planning department, 7 were private developers within the city's jurisdiction and 16 were people who reside in the city. Interviews with the municipal officials were unstructured and the ones conducted with residents were structured. Due to Covid-19 lockdowns in South Africa, the interviews were conducted via Zoom and Microsoft Teams. Observations and literature were also used to support the information gathered using interviews. For the literature review on spatial planning policies, a desktop study was used as the primary means of obtaining data. Text analysis was applied to qualitative data from interviews. Town planning professionals, private developers and community residents all provide their unique experience which were all used as the basis of analysing the current state of spatial transformation and spatial planning within Johannesburg.

6 FINDINGS

6.1 Policy and Legislative framework for spatial planning and transformation

The section of the interviews focused on the policy and legislative framework of the city. Only policies and legislative frameworks that relate to spatial planning and spatial transformation were reviewed and assessed in order to determine how they help in enforcing spatial transformation in the city of Johannesburg. The

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policies and legislations that were reviewed included SPLUMA, GDS, IDP, SDF and Corridors of Freedom Initiatives.

The Spatial Planning and Land Use Management Act (SPLUMA) is South Africa's national legislation governing all spatial planning. It was enacted in 2013 and came into effect in July 2015. "In its mandate to spatially transform the country, SPLUMA introduces a new spatial planning system which now places the local municipality at the centre of spatial planning and decision making related to land use management. SPLUMA basically reinforces the vision set out by the NDP (National Development Plan) to deal with the serious socio-economic issues crippling South Africa through spatial transformation" (Spatial Transformation Conference Report, 2014). SPLUMA aims at closing the gap on the racial divide spatially and the transformation of the country's settlement patterns. It also seeks to address the legacy of inefficient, discriminatory, and costly special patterns that are a burden on the country's public resources (Spatial Transformation Conference Report, 2014). The act also plays an important role in the restructuring of South African cities (SPLUMA, 2013). SPLUMA principles are content focused which translates into the spatial transformation issues that the country is seeking to address through spatial planning. In Johannesburg, SPLUMA was found to be contributing greatly to the spatial transformation of the city. This was possible because it enforces intergovernmental cooperation. The cooperation of the three spheres of government contributed to the strategic spatial planning of the city which then translated to spatial transformation of Johannesburg. The proper implementation of SPLUMA is noted to be benefiting in terms of transforming space within Johannesburg, however, there are challenges with regards to the implementation of this legislation within Johannesburg. The key challenges are as follows: (1) Some principles are not clearly explained (vagueness); (2) there is no target specification, the legislation does not show which principle should be prioritised; (3) Co-ordination is complex in the sense that there is an "absence of a hierarchical relationship between the spheres of government" (Spatial Transformation Conference Report, 2014).

The SDFs)Spatial Development Frameworks) are also noted as important for spatial change or transformation of the city, mainly because the SDFs indicate the spatial vision for the city and the means of implementation (CoJ SDF, 2016). The breaking down of the SDF into eight Regional Spatial Development Frameworks meant that the city could give more detail into the plans and the implementation for each of the city's region. The SDF has been successful to some extent in dealing with some of the major issues in Johannesburg's spatial and social landscape which are increasing pressure on the natural environment; spatial inequalities and the job-housing mismatch; exclusion and disconnection; and inefficient residential densities and land use diversity.

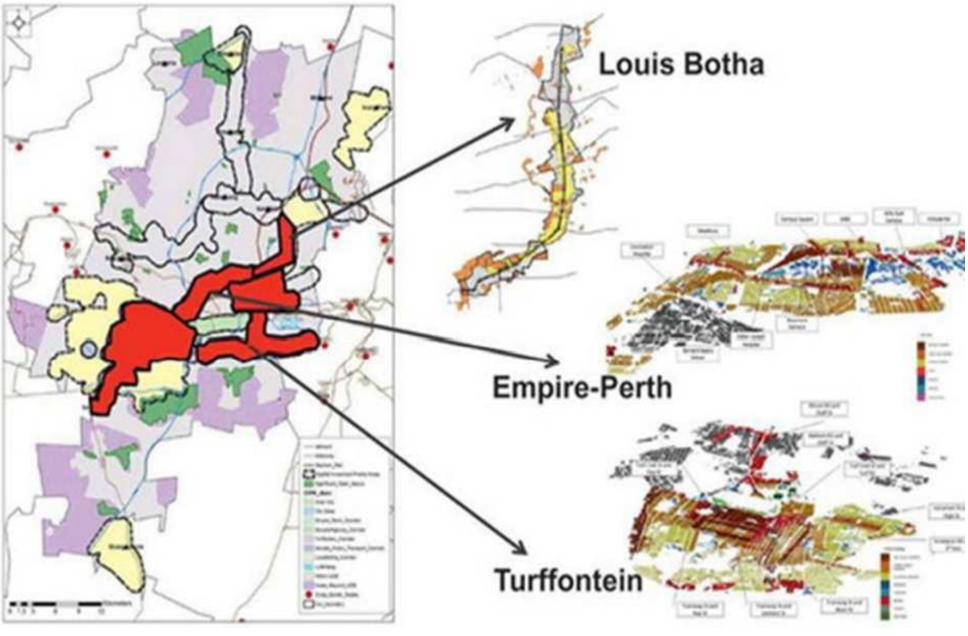

Figure 2: Corridors of Freedom in Johannesburg (City of Johannesburg, 2013).

The City of Johannesburg aimed at achieving "well-planned transport arteries linked to interchanges where the focus will be on mixed-use development of high-density accommodation, supported by office buildings, retail development and opportunities for leisure and recreation" (COJ, 2013, pp. 2, 4). The city had planned to use the Corridors of Freedom to achieve this. The Corridors of Freedom transformed the entrenched settlement patterns by bringing access to economic opportunities and access to jobs and growth. Through the Corridors of Freedom Johannesburg was able to make a decisive turn towards a low-carbon future with an eco-efficient infrastructure that underpins a sustainable environment. Overall, the Corridors of freedom played a significant role in the urban and spatial planning of Johannesburg; however, the initiative does not have far reaching impacts across the city. Only a few areas in the city benefit from these types of development. The City of Johannesburg has already implemented three of these Corridors of Freedom, making it ahead of its counterpart municipalities in the pursuit of achieving spatial transformation the three areas: Louis Botha, Empire-Perth and Turffontein as shown on the figure below (figure 2).

6.2 Strategies, procedures and elements that necessitated and informed spatial planning and transformation

When the study was being carried out it was noted that for sa patial transformation vision to be achieved, there needed to be a transformation of institutions and intergovernmental relations. Effective intergovernmental relations play an important part in the spatial transformation of a city. These intergovernmental relations assist in recognising the role played by the local government. “The scope and pace of change in South Africa are also influenced/determined by the extent to which public institutions adjust to and comply with the current directives of transformative planning” (Williams, 2000: 170).

As one of the municipal officials interviewed notes, “one of the challenges we face is that there is a lack of integration within the departments in the city, thus information doesn’t smoothly move across all 15 departments of the City of Johannesburg”. There clearly is a need for the municipal departments and the municipality as a whole to move from this traditional silo approach in which each department aims to use the resources to fulfil their mandate or their own targets. The local level is the best place to achieve spatial transformation, and this cannot be achieved through a ‘fragmented approach’; however it requires an ‘institutional arrangement’ that is able to respond to the coordination, integration and nuance that may be required. As the COGTA (2016) notes, there is a need for the intergovernmental and interdepartmental relations to be strengthened so as “to drive the agreed policy, fiscal and regulatory changes, and to steer the priorities of the urban agenda” (COGTA, 2016: 101).

There is a need to transform politics and power. Williams (2000) argued that the “radical change needed to disrupt the power imbalances that exist within South Africa’s urban spaces would not be an easy or smooth process”. Mainly because there are still numerous vested interests in keeping Johannesburg the way it is and not equalising the power relations amongst black and white communities. Amongst the community members interviewed for this study, most still feel that white people are the ones that drive development in the city, mainly because they have the means (capital) and because they pull the strings of municipal officials behind the scene. Black communities feel that they are not being involved in the development processes as much as white people. They feel that they are excluded. According to Williams (2000), “People-driven development” helps in terms of the transformation of “social relations of power which give rise to the patterns of uneven development in South African society” (Williams, 2000: 172). To date, two decades later, the argument by Williams is still very valid. The City of Johannesburg is faced with political power-brokering, corruption, nepotism and inefficiency amongst some of the officials which all pose a great challenge to the city achieving its desired spatial transformation. The private sector and individuals (especially from the private sector) who power over decisions or even challenge decisions that are made which, in turn, slows down progress of spatial change as well as social integration. This is clearly visible in most suburbs for the middle income class and the high-income class. One classic example was when the Rosebank community objected to the construction of the BRT route through the area (RMD, 2011)/ However, the construction of this BRT was aimed at integration and sustainable transport to accommodate all social classes. This power display dynamics needs to be changed for spatial transformation to take place properly and with ease.

Transit Oriented Developments (TOD) refer to the “utilisation of an age-old phenomenon of urban development in terms of which more intensive non-residential and higher-density residential development concentrates at public transport (notably train and later on light-rail) stations” (Boarnet and Crane, 1997; Peters and Novy, 2012). In Johannesburg, these are done in a form of corridors of development. The City currently has three of those which are: (1) Louis Botha; (2) Empire-Perth; and (3) Turffontein. In Johannesburg’s perspective, these play an important role in the spatial transformation of the city because they are the ones that connect most townships to the central business district (CBD). They increase densities along the transport routes which are mostly low densities, and are “physically and tangibly restructuring the highly inefficient sprawled-out city” (Oranje, 1999). In the city, the Transit Oriented Development (TOD) in its purest form is still limited, although if these kinds of developments were increased, it would be a right direction towards achieving the desired spatial transformation.

State-led Urban Renewal Projects aim to upgrade neighbourhoods and suburbs that are in a state of distress or decay. These projects would address the decaying urban areas and tackle challenges, such as poor physical infrastructure, dull urban areas, poor community services and deteriorating inner city housing. Currently the Johannesburg urban renewal projects are undertaken by the private sector. One example of this is the Maboneng Precinct. The end results of these projects being run by the private sector is that the developments do not intend to cater for the urban poor. Once properties are re-developed, the rents become so high that most people cannot afford them anymore, forcing them to relocate to other parts of the city. Urban renewal projects in Johannesburg should be undertaken by the municipality. It should form part of its broader projects of expanding the economy of the city as well as housing projects. In that sense, the city can achieve spatial transformation at the address the spatial justice issue by ensuring access and inclusion to the previously disadvantaged communities. In Seoul the state-led urban renewal proved to be effective, “this new form of high-density housing proved to have provided a longer term, (more) lasting answer to addressing the needs of a growing economy and expanding middle class” (Kyung, 2011: 10). However, the external stakeholders do not believe that this can work on Johannesburg. They feel that if state-led urban renewal projects are implemented, they will not work. They base their claims on the fact that most state led developments are mostly not properly maintained and they run down easily, thus coming to a conclusion that the urban renewal projects should be left to the private sector or that there should be a public-private partnership to make housing affordable.

6.2.1 Transformation of management and capacity

Numerous changes have occurred over the past two decades across the built environment, requiring a fundamental shift in the skills and capacity needed to transform and deal with spatial transformation and spatial planning issues. For instance, the skills needed to deliver housing products in the human settlements sector are now different from the ones that are needed to carry out ‘sustainable human settlements’, thus these two require co-production and cross-sectoral cooperation. This also applies to the transport sector. Achieving better transport systems needs a better integration between the modes of transport in the city. All this can be achieved through building capacity and skills of officials with the involvement of the communities, “so that they have the knowledge and are empowered to influence and determine city form and function effectively” (Williams, 2000). The current skills set of many officials is ‘silo’, their skilla are related to a specific node. However, they need to be able to integrate different aspects of planning to achieve spatial transformation.

6.2.2 Intensified human settlements

Johannesburg, like most of South African cities, is characterised mainly by “low-density urban sprawl and higher densities on the outskirts of cities, not the inner cities” (SACN, 2016). This is mainly due to the apartheid planning that placed the majority black population on the outskirt of the city, and it is also as a result of the development of the low-cost housing on the outskirts of the city because land is cheaper. An example of this is the historical Sowetan Townships.

As shown in figure 4.8, Soweto is a low-density settlement in the outskirts of the Johannesburg CBD. According to the Census 2011, the population of Soweto is at 1,271,628 with a population density of 6,357.29 inhabitants per square kilometre (16,465.3/sq mi). “Better located and integrated development is critical to reducing urban sprawl and spatial economic transformation of cities” (Bertoldi, 2015). The land located in close proximity with the city is usually expensive, thus it becomes important to make the best use of this land. This land can be used for high rise buildings to accommodate greater population density, and this could contribute to ‘enhanced efficiency in the city space economy’ (Bertoldi, 2015). Currently, the government’s emphasis has shifted from delivering mass housing to delivering sustainable human settlements. Johannesburg in particular has acknowledged that there is a need for locating housing in ‘well-located urban neighbourhoods. However, “political and private developer vested interests have so far trumped concerns for better located, more compact and integrated housing alternatives”.

Figure 3: Soweto Township (Source: Mason, 2017)

6.2.3 Improved mobility and access to public transport

Johannesburg commuters face a daily challenge of security concerns, overcrowding, high cost of travel and long commuting times and this is most apparent in low-income groups who live in the outskirts of the city and work in the CBD. Thus, providing a public transport system that is affordable and reliable would definitely go a long way, and would help in reducing the traffic congestion that the city CBD encounters in the early morning hours and late afternoon when people come back from work. Reducing the cost of public transport and travel time enhances urban spatial connectivity and inclusiveness and enhances urban resilience. Consolidating city-level public transport presents the greatest opportunity to reshape the spatial patterns of Johannesburg.

6.3 Spatial Transformation Policy and Practice Outcome in Johannesburg

Since 1994, the spatial planning policy and practice have undergone some serious changes in Johannesburg and South Africa as whole. There have been some positive outcomes of the spatial planning policy and practice in transforming Johannesburg. However, the effectiveness of the spatial planning policy and practice on restructuring City of Johannesburg is being questioned as there is little evidence showing that this being achieved.

Dimension	Yes	No
Clear horizontal coordination with spatial plans of adjacent region	3	4
Clear horizontal coordination with spatial plans of adjacent municipalities	7	-
Explicit vertical alignment with provincial spatial plans and strategies	7	-
Clear consideration of national spatial development plans and perspective	6	1

Table 1: Institutional coordination and alignment of Regions in City of Johannesburg (Source, Author, 2020).

6.3.1 Improved Institutional Coordination and Alignment

There has been improved management of urban growth and improved governance. There has been quite a noticeable alignment between various departments within the municipality. “Spatial plans with other sector planning activities within municipalities and with the planning of neighbouring municipalities are aligned” one of the officials said during the interview. The regional SDFs of various regions within the municipality have their plans aligned which improves institutional coordination, but this is not the case for all the regions. Some regions still need to improve their coordination and alignment. Through literature review of various SDFs, the author came up with the following table that shows the level of alignment of the Regional SDFs with the other SDFs that are applicable to the city. The table below shows the alignment of the Johannesburg Regions SDFs with the Overall City’s SDF, Provincial SDF and the National SDF.

6.3.2 Increased Physical and Socio-economic Integration

"It has been argued that spatial governance in places characterised by existing levels of social inequality and racial polarisation will continue to be ineffective" (Robins, 2002). Johannesburg has shown much effort in combating the social inequalities. There are projects that are aimed at unification of the urban fabric and densification of human settlements, but the city is still facing problems in combating challenges of physical and socio-economic integration. There are projects within the city that are aiming at the 'integration of the various aspects of land development' (social, economic, institutional and physical), the integration of land development in rural and urban areas in mutual support and the integration of residential and employment opportunities in close proximity to each other. This is important because integration is an integral part of spatial planning policies, right from the local plans all the way to the National Development Plan 2030, which "contains as many as individual references to the concept of integration" (National Planning Commission, 2012). As contained in the NDP, each municipality is meant to have "explicit spatial restructuring strategy including identified priority precincts for spatial restructuring" and "critical interventions to redress past social segregation" (National Planning Commission 2012, p. 286). As much as this is noted as an important aspect by the municipality, they still have a long way to achieve a socio-economic integration.

6.3.3 The city's Space Economy

"One of the key tension points in spatial planning in South Africa is the interplay and associated trade-offs between the need for economic growth and competitiveness on the one hand, and for socio-economic redress on the other" (Jenkins and Wilkinson, 2002). In this sense, cities have to compete globally with other cities in order to improve their financial position as well as developing the local skill set. Johannesburg competes with the world, and is currently ranked as the economic hub of South Africa. As such it contributes 17% of the total output of the South Africa and enabled the spatial planning policies and practices within the city. Johannesburg does not only hail as the financial capital of South Africa, but it is also ranked the first of the richest cities in the African continent.

6.3.4 Infrastructure Development and Capital Investment

"Infrastructure provision is one of the most powerful forces shaping urban areas" (Doxiadis, 1970). It cannot be denied that the infrastructure in Johannesburg is amongst the most advanced in the country and in Africa. The critical role of infrastructure and investment in achieving spatial planning objectives was confirmed by Healey (2004, p.46) by describing spatial planning as "self-conscious collective efforts to reimagine a city, urban region or wider territory and translate the results into priorities for area investment, conservation measures, strategic investment in infrastructure, and land use principles". Todes (2008, p. 11) further emphasises this view, stating that "infrastructure planning with its own spatial logic was more effective than spatial planning in shaping the spatial structure of cities." The NUDF also identified improved urban infrastructure and service delivery systems as one of the strategic outcomes for urban areas in South Africa (Republic of South Africa, 2009). There are specific issues in Johannesburg that adversely affect the integration of infrastructure development and capital investment. The problem involves the fact that spatial planning is the only dominant influence of low-income public sector-driven housing projects funded by the Department of Human Settlements, the shaping of cities through commercial and residential development in the private market sector, and the emphasis on 'mega-projects' disjointed from spatial planning. As one of the municipal officials notes, there is a need for planners to "call for the replacement of the traditional piecemeal pursuit of capital projects with a more coherent long-term view focused on selected areas and policy themes".

Informal economy in the urban environment can stretch to different dimensions, like the development of infrastructure, land and housing, and processes of decision-making (Roy, 2005). Within Johannesburg's context, the notion of urban informality is linked to the activities of the informal economic sector and to informal housing and services, both of which often involve some measure of illegality. Johannesburg has an informal economy that is vibrant and growing. The analysis of the Johannesburg SDFs clearly demonstrates that in spatial planning, informality remains largely unrecognised. Only two of the plans reviewed contained explicit strategies relating to the informal sector, with an additional six reflecting certain strategies that at least imply consideration of certain aspects of the informal sector. Those plans, which included informal sector strategies, were almost exclusively concerned with upgrading informal housing settlements and with broad strategies for managing and controlling informal trading areas.

6.4 The proposed strategies for improving the state of spatial transformation

The city should use economic bridging plans. Spatial strategies should be highlighted by the nodes and corridors system of local economic development which is an economic bridging plan. Nodes of economic activity should be developed in central parts of townships and linked to other parts of the city using corridors based on existing transportation networks. The underlying concept of the nodes and corridors strategy should be that while people continued to live apart, economic activity could be spurred that bridged racial residential lines.

There should be an increase in economic density. To support its economic transformation and move up the industrial value chains, Johannesburg needs to significantly increase its economic density to reap productivity gains derived from agglomeration. A project which has good potential as an example is the Corridors of freedom developments across the city, if planned well, it could accommodate a significant amount of the region's projected growth and potentially become a new engine of growth for the city.

7 CONCLUSION

The paper sought to assess the level of spatial transformation across the city of Johannesburg. The paper went on to assess policies and legislative framework on the city's spatial transformation; the strategies that the city uses to promote and enable transformation and inclusivity within the city; and lastly focused on the current outcomes of spatial planning policies and practice within the city. The results revealed an improvement in the level of transformation across the municipality and an improvement in the policies and practice of spatial transformation. Developmental projects such as transit-oriented development have led to income elasticities for properties along the corridors of freedom. Overall, the paper recommends collaborative planning as a tool for assessing the performance of spatial transformation.

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🏆 *reviewed paper*

Ist der Onlinehandel Wettbewerbstreiber oder gar "Rettungsanker" für unsere Städte? Eine modellgestützte Analyse der Determinanten des Einkaufsverhaltens im Multi- und Cross-Channel-Kontext

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1 ABSTRACT

Multi- und Cross-Channel-Retailing gewinnen stetig an Bedeutung, weshalb ein gesteigertes Interesse an der Erklärung des (räumlichen) Einkaufsverhaltens im Multi-Channel-Kontext besteht. Die Standorttheorie des Einzelhandels liefert hier, ebenso wie bisherige Modelle der Einkaufsstättenwahl, keine Antworten, da in beiden Fällen "nur" der stationäre Einzelhandel berücksichtigt wird. Die Forschung zum Multi-Channel-Einkaufsverhalten beschäftigt sich zwar mit den Einflussgrößen der Kanalwahl, berücksichtigt aber weder die vorhandene räumliche Angebotsstruktur des stationären Handels noch die Möglichkeit von Cross-Channel-Einkäufen. Weitere Forschungslücken liegen in der seltenen Verbindung der Erklärungsansätze des Einkaufsverhaltens sowie in methodischen Problemen (z.B. hinsichtlich Repräsentativität von Befragungen). Der vorliegende Beitrag beschreibt die wichtigsten Eckpunkte eines laufenden Forschungsprojektes, in dem die genannten Aspekte aufgegriffen werden. Anhand mehrerer Einzelhandelsbranchen werden die Determinanten der Einkaufsstättenwahl im Multi-Channel-Kontext untersucht, d.h. unter den Bedingungen, dass sowohl stationäre als auch Online-Anbieter zur Verfügung stehen und außerdem viele Anbieter Cross-Channel-Shopping ermöglichen. Die empirische Grundlage der Untersuchung ist eine schriftlich-postalische Befragung zum Einkaufsverhalten in zwei deutschen Untersuchungsgebieten. Die Analyse individueller Einkaufsentscheidungen und -ausgaben erfolgt mit Hilfe eines mikroökonometrischen Modells zur Einkaufsstättenwahl, das eine deutliche Erweiterung bestehender Modellansätze darstellt. Im Ergebnis zeigt sich u.a., dass die Kanalpräferenz (stationär oder online) weniger von demographischen Faktoren abhängt, sondern von individuellen Einstellungen und dem Wohnort. Die Einkaufsstättenwahl wird vorrangig durch anbieterabhängige Transaktionskosten (z.B. Fahrtzeit, Liefergebühren) und deren Charakteristika erklärt. Es zeigt sich z.B. die Relevanz der Cross-Channel-Integration von Handelsbetrieben, wenngleich der „click and collect"-Service tendenziell überschätzt wird. Der Modellansatz und die Ergebnisse des Projektes haben praktische Relevanz, u.a. für die Raumordnung, betriebliche Standortplanung sowie das Citymarketing.

Keywords: Cross-channel retailing, Modell der Einkaufsstättenwahl, Einkaufsverhalten, Onlinehandel, Ökonometrie

2 HINTERGRUND DES PROJEKTES

Die Relevanz des Onlinehandels steigt stetig, was die Standorte des stationären Einzelhandels (Innenstädte, Stadtteilzentren) einem erheblichen Wettbewerbsdruck aussetzt (BBSR, 2017; Stepper, 2016). Gleichzeitig werden Multi- und Cross-Channel-retailing – zumindest für vertikal integrierte Handelsunternehmen – immer selbstverständlicher; die Digitalisierung des Einzelhandels kann demnach auch förderliche Effekte für bestehende Handelsstandorte haben (Battermann/Neiberger, 2018; Heinemann, 2015; Rumscheidt, 2016; Wieland et al., 2020). Von großem Interesse ist daher das Konsumentenverhalten im Multi-Channel-Kontext, das bisher – grob zusammengefasst – anhand folgender Forschungsstränge untersucht wurde:

- Transaktionskosten des Einkaufs, z.B. Erreichbarkeit (des stationären Handels), Lieferkosten und
- -zeit (im Onlinehandel) (z.B. Chintagunta et al., 2012; Hsiao, 2009; Schmid/Axhausen, 2019)
- Räumliche und andere situative Erklärungsgrößen, z.B. Verfügbarkeit von stationärem Handel, Wohnort der Konsumenten (Innovations-Diffusions-Hypothese vs. Effizienz-Hypothese), sozio-demographische Faktoren der Konsumenten wie Alter, Geschlecht etc. (z.B. Beckers et al., 2018; Cao et al., 2013; Clarke et al., 2015; Zhen et al., 2018; Wiegandt et al., 2018)
- Einstellungen zum Onlinehandel im Sinne einer „Online-Affinität" bzw. Abneigung dem Onlinehandel gegenüber (z.B. Bezes, 2016; Schmid/Axhausen, 2019; Zaharia/Hackstetter, 2017)
- Der bisherige Forschungsstand weist v.a. drei erhebliche Defizite auf:

- Die Studien beziehen sich meist nur auf einen der genannten Aspekte (Ausnahmen z.B. Schmid/Axhausen, 2019; Wiegandt et al., 2018); eine gleichgewichtige Berücksichtigung aller genannten Aspekte wurde bisher nicht erreicht.
- Es zeigen sich Defizite hinsichtlich der Repräsentativität bzw. Verallgemeinerbarkeit der Ergebnisse: Bisherige Arbeiten stützen sich häufig auf Online-Befragungen und/oder schließen bewusst nur Multi-Channel-Kunden ein (z.B. Beckers et al., 2018; Cao et al., 2013; Zaharia/Hackstetter, 2017). Dies schließt Kunden aus, die über keinen Internetanschluss verfügen oder sich dem Onlinehandel verweigern. Zudem sind i.d.R. Minderjährige, die noch keinen eigenen Haushalt führen, von den Befragungen ausgeschlossen. Einige Studien beziehen sich nur auf Kunden einzelner Unternehmen (z.B. Bezes, 2016; Chintagunta et al., 2012). Studien mit Repräsentativitätsanspruch bezüglich der Gesamtbevölkerung sind selten (z.B. Schmid/Axhausen, 2019; Wiegandt, et al. 2018; zur Repräsentativität bei Befragungen in der Geographischen Handelsforschung siehe Rauh/Hoffmann, 2020). Wesentliche Ergebnisse basieren zudem auf Befragungsexperimenten (z.B. Hsiao, 2009; Schmid/Axhausen, 2019) und wurden bisher nicht anhand von realem Einkaufsverhalten überprüft.
- Die Analyse/Modellierung erfolgt in fast allen bisherigen Arbeiten mit Kanalwahlmodellen, wobei entweder die Wahrscheinlichkeit oder die Häufigkeit von Onlinekäufen untersucht wird (z.B. Beckers et al., 2018; Cao et al., 2013; Clarke et al., 2015; Hsiao, 2009; Schmid/Axhausen, 2019). In einigen Fällen erfolgt die Auswertung auch bivariat (z.B. Wiegandt et al., 2018). Bis auf wenige Spezialfälle fehlt die Integration des Onlinehandels in ein Modell der Einkaufsstättenwahl, wie es in der (geographischen) Handelsforschung seit Jahrzehnten eingesetzt wird (Suel/Polak, 2018; Überblick zu Modellen der Einkaufsstättenwahl z.B. Wieland, 2015). Die geographische Handelsforschung beschäftigt sich maßgeblich mit der Einkaufsstättenwahl, der theoretischen Erklärung ihrer Determinanten und ihrer Modellierung; räumliches Einkaufsverhalten ist ein zentraler Gegenstand der Standorttheorie des Einzelhandels, bezieht sich jedoch ausschließlich auf stationäre Handelsbetriebe bzw. Angebotsstandorte (z.B. Huff, 1962; Überblick z.B. Brown, 1993).

3 UNTERSUCHUNGSKONZEPT UND METHODIK

3.1 Ziele und Fragestellungen, Forschungsansatz

Ausgehend von den o.g. Forschungslücken verfolgt das Projekt u.a. folgende Ziele:

- Integration der o.g. Ansätze zur Erklärung des Einkaufsverhaltens in eine Untersuchung
- Empirische Erfassung von realem Einkaufsverhalten unter der Bedingung von Repräsentativität im Hinblick auf alle Konsumententypen (inkl. Nicht-Onlinekäufer)
- Annähernde Abbildung der räumlichen Heterogenität des Untersuchungslandes (Deutschland)
- Integration des Onlinehandels bzw. genauer: des Multi-Channel-Shoppings sowie der Option des Cross-Channel-Shoppings in ein Modell der Einkaufsstättenwahl

Das Projekt geht u.a. den folgenden Forschungsfragen nach:

- Wie wirken sich die Transaktionskosten auf die Einkaufsstättenwahl zwischen den zur Verfügung stehenden (Online-/Offline-)Einkaufsalternativen aus?
- Wie wirkt sich das stationäre Handelsangebot vor Ort auf die Einkaufsstättenwahl aus?
- Wie wirken sich die „Online-Affinität“ der Konsumenten sowie deren sozio-demographische Eigenschaften auf die Kanal-/Einkaufsstättenwahl aus?
- Wie wirkt sich die Cross-Channel-Integration von Anbietern auf die Einkaufsstättenwahl aus?

Um die obengenannten Fragen zu beantworten, wird das Konsumentenverhalten im Multi-Channel-Kontext mit einem Revealed-Preference-Approach untersucht, d.h. dass auf die Präferenzen der Konsumenten auf der Grundlage realer (Einkaufs-)Entscheidungen der Vergangenheit geschlossen wird (Train, 2009). Die Analyse erfolgt mit einem quantitativen Modell der Einkaufsstättenwahl; diese Modellfamilie erklärt räumliches Einkaufsverhalten auf der Basis von Nutzenfunktionen, die sich aus angebotsseitigen (d.h. Eigenschaften der Einkaufsalternativen) und nachfrageseitigen Attributen (d.h. Konsumenteneigenschaften) zusammensetzen. Ökonometrische Einkaufsstättenwahlmodelle gehen dabei von Nutzenmaximierung der Konsumenten aus, wobei stets nur ein Teil dieses Nutzens durch das Modell erklärt werden kann. Das Wahlverhalten wird als probabilistisch angenommen, d.h. in Form von Auswahlwahrscheinlichkeiten, wobei die Alternative mit dem größten Nutzen die höchste Wahrscheinlichkeit hat (Wieland, 2015). Da im vorliegenden Fall individuelle Eigenschaften der Konsumenten berücksichtigt werden, ist ein mikroökonometrisches Modell erforderlich.

Berücksichtigt werden vier Einzelhandelsbranchen aller drei Zentralitätsstufen mit unterschiedlichen Online-Marktanteilen (HDE, 2019), nämlich Lebensmittel, Bekleidung, Elektronikartikel und Möbel. Für die Analyse ist sowohl die Erfassung der Angebotssituation (d.h. der Einkaufsalternativen des stationären und Onlinehandels) als auch des Konsumentenverhaltens (d.h. getätigte Einkäufe) sowie weiterer Attribute der Konsumenten (u.a. Einstellung zum Onlinehandel) in Form einer Konsumentenbefragung notwendig.

3.2 Untersuchungsgebiete

Es wurden zwei siedlungsstrukturell unterschiedliche Verflechtungsräume, die in der Raumordnung als zusammengehörige Regionen definiert sind, als Untersuchungsgebiete ausgewählt; ein Wahlkriterium war hierbei, dass die Untersuchungsgebiete alle Kreis- und Gemeindetypen des BBSR beinhalten, um Großstädte, deren suburbanes Umland, Kleinstädte sowie ländliche Gemeinden abzudecken. Ein weiterer Grund für die Auswahl waren pragmatische Erwägungen im Sinne von Arbeitseinsparungen durch bereits bestehende Vorarbeiten in diesen Gebieten. Ausgewählt wurden 1) der (ehemalige) Regionalverband Südniedersachsen und 2) der Regionalverband Mittlerer Oberrhein (Überblick siehe Tab. 1 und Abb. 1).

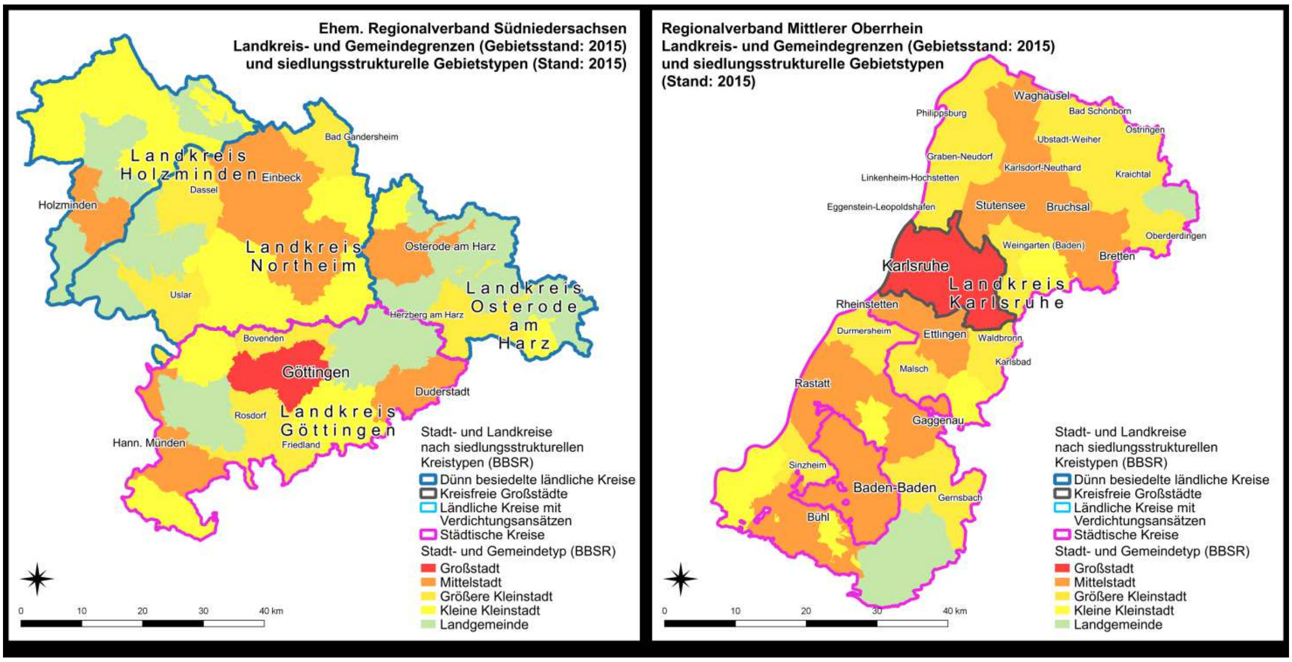

Abb. 1: Siedlungsstruktur der Untersuchungsgebiete.

	1 – (Ehem.) Regionalverband Südniedersachsen	2 – Regionalverband Mittlerer Oberrhein (= IHK-Bezirk Karlsruhe)
Bundesland	Niedersachsen	Baden-Württemberg
Einwohnerzahl 2018 [Anzahl]	531.814	1.043.465
Anteil Einwohner 65 u. älter 2018 [%; BRD: 21,5]	23,7	20,6
Bevölkerungsdichte 2018 [EW/km2]	143,22	488,20
Arbeitslosenquote 2018 [%; BRD: 5,2] *	5,7	3,2
Einzelhandelskaufkraft (MB Research) 2019/2020, [Index; BRD = 100] *	95,3	103,9
Raumstruktur (Kreis- und Gemeindetypen)	1 Großstadt + überw. dünn besiedelte ländliche Kreise mit Kleinstädten u. Landgemeinden	1 Großstadt + städtische Kreise mit überw. Klein- und Mittelstädten
Datengrundlagen: Regionaldatenbank der Statistischen Ämter des Bundes und der Länder, Tab. 12411-02-03-4 (Abruf 15.04.2020), BBSR, IHK Hannover, IHK Karlsruhe, eig. Berechnungen. * Bevölkerungsgewichteter Mittelwert der jeweiligen Landkreise und kreisfreien Städte im Untersuchungsgebiet.		

Tab. 1: Eckdaten der Untersuchungsgebiete.

3.3 Konsumentenbefragung

Für die Befragung wurde eine schriftlich-postalische Kontaktaufnahme gewählt, um die Verzerrungsrisiken anderer Befragungsformen zu umgehen. Um den Teilnahmeanreiz für Jüngere zu erhöhen, wurde den Befragten die Möglichkeit eröffnet, den Fragebogen stattdessen online auszufüllen. Die Adressen für die

Befragung wurden von den kommunalen Meldebehörden beschafft. Hierbei wurde eine Zufallsstichprobe aus allen Einwohnern des jeweiligen Gebietes ab einem Alter von 15 Jahren (=Grundgesamtheit) gezogen. Die Befragung fand von März bis Juni 2019 statt.

Der Fragebogen beinhaltete folgende Bereiche:

- Abfrage der letzten drei Einkäufe in den vier betrachteten Sortimentsbereichen (Lebensmittel, Bekleidung, Elektroartikel, Möbel) inkl. der zugehörigen Ausgaben bei jedem dieser Einkäufe. Diese Frageform lehnt sich an vorherige Studien an und dient einer möglichst unverzerrten Abfrage des realen Einkaufsverhaltens (Steiger, 2017; Wieland, 2015; 2019a).
- 15 Einstellungs-Items zur Ableitung der „Online-Affinität" (u.a. Risikoaversion beim Onlinekauf, ethisch-moralische sowie datenschutzbezogene Aspekte des Onlinehandels). Von diesen Items sind neun einem Stated-choice-Befragungsexperiment zur Kanalwahl von Schmid/Axhausen (2019) entlehnt. Diese Untersuchung bildete eines der Vorbilder für die hiesige Studie. Ein weiteres Item bezog sich auf die Informationsbeschaffung über das Internet und zwei auf ethisch-moralische Fragen des Onlinekaufs, die auf aktuelle mediale/gesellschaftliche Diskussionen abzielen, nämlich Umweltbelastung (durch Lieferverkehr) und schlechtere Arbeitsbedingungen (insb. Logistiksektor) durch den Onlinehandel. Drei weitere Items beschäftigten sich mit dem Vertrauen gegenüber dem Internet bezüglich des Datenschutzes und sind aus einer Befragung zu diesem Thema (Sinus 2018) übernommen worden. Dieser Teilbereich wurde aufgenommen, da dem Thema Datenschutz im Zuge des Inkrafttretens der DSGVO (2018) eine erhöhte mediale Aufmerksamkeit gewidmet wurde und die Ergebnisse der genannten Sinus-Studie eine erhöhte diesbezügliche Sensibilität aufzeigen.
- Sozio-demographische Angaben (Alterskategorie, Geschlecht, Berufstätigkeit usw.)

Insgesamt (Ersterhebung und Nachfassung) gingen von 9.120 kontaktierten Personen 1.375 Antworten ein (Südniedersachsen: 297, Mittlerer Oberrhein: 1.078). Dies entspricht einer Rücklaufquote von 15,7 % bzw. einem Promille (0,1 %) der Grundgesamtheit. Von den befragten Personen haben sich rd. 10,2 % für die Online-Ausfüllung des Fragebogens entschieden.

3.4 Erfassung/Kartierung des Einzelhandelsangebotes

Die untersuchungsrelevanten Anbieter umfassen 1) sämtliche stationären Einzelhandelsbetriebe in beiden Untersuchungsgebieten, die zu den vier untersuchten Branchen gehören und bestimmte Kriterien der branchenspezifischen Vergleichbarkeit erfüllen und 2) sämtliche Online-Anbieter, auf die dieselben Kriterien zutreffen. Bei den stationären Betrieben wurden u.a. der Standort (Adresse) und die Verkaufsfläche erfasst. Bei den Onlineanbietern wurden u.a. die Lieferbedingungen (Versandkosten, Versanddauer) erhoben. In jedem Fall wurde recherchiert und erfasst, ob eine Cross-Channel-Einbindung des einzelnen Betriebs bzw. der Kette vorliegt. Hierbei wurde erhoben, ob ein integrierter Onlineshop betrieben wird und ob die „click and collect"-Option angeboten wird. Als "integrierter Onlineshop" wurde definiert, dass auf der dem Betrieb zugehörigen Website 1) das Sortiment des Onlineshops und der einzelnen Filialen und 2) die Verfügbarkeit einzelner Produkte in den Filialen und 3) die Filial- und Onlinepreise sowie weitere Produktinformationen abrufbar sind. Die Informationen wurden über die jeweiligen Unternehmens-Websites (Filialsuche) recherchiert. Verkaufsflächenangaben wurden i.d.R. über Anfragen bei den Handelsunternehmen erfragt; in einigen Fällen erfolgte eine manuelle Erfassung vor Ort. Für das zweite Untersuchungsgebiet wurden durch den Regionalverband Mittlerer Oberrhein Rohdaten einer Einzelhandelsvollerfassung zur Verfügung gestellt. Diese Daten wurden aktualisiert (v.a. durch Recherche von Neueröffnungen und Schließungen).

Weiterhin wurde die Artikelzahl der Onlineshops und, soweit möglich, der einzelnen Standorte bzw. Filialen erfasst. In den Fällen, in denen integrierte Onlineshops bestehen, konnte dies durch selbst programmierte Funktionen und Skripte zum automatischen Auslesen von Websites („web scraping") erfolgen, wofür das Paket httr (Wickham, 2019) in R (R Core Team, 2019) genutzt wurde. Da dies jedoch in Ermangelung integrierter Onlineshops nicht bei allen Verkaufsstellen möglich war, wurden fehlende Werte der Artikelzahl mit Hilfe von Regressionsmodellen interpoliert (z.B. bei Elektrofachmärkten und Möbelmärkten), wobei u.a. die (erfasste) Verkaufsflächengröße als Prädiktor genutzt wurde. Im Fall der Lebensmittelmärkte lagen Einzelangaben zu Artikelzahlen für Super- und Verbrauchermärkte vor, aus denen ein kettenspezifischer Durchschnittswert (Artikel pro qm Verkaufsfläche) gebildet und mit diesem die fehlenden Werte der anderen Vollsortimenter geschätzt wurde. Für LM-Discounter lagen Daten zur durchschnittlichen Verkaufsfläche und

Artikelzahl vor, aus denen der o.g. Indikator berechnet und, darauf aufbauend, deren Artikelzahl geschätzt wurde. Die Artikelzahlen der Onlineshops wurde über deren Website ermittelt.

Die Erfassung des Einzelhandelsangebotes erfolgte im Februar/März 2019 und wurde nach Beendingung der Konsumentenbefragung (ab Juni/Juli 2019) erweitert (z.B. um einzelne Anbieter, die außerhalb der Untersuchungsgebiete lokalisiert sind, jedoch aufgrund ihrer Relevanz berücksichtigt werden müssen). In beiden Untersuchungsgebieten in allen vier Branchen wurden 1.141 stationäre Einzelhandelsanbieter und 115 Onlineanbieter erfasst, wobei nicht alle dieser Anbieter untersuchungsrelevant sind.

3.5 Datenweiterverarbeitung

Da die Modellanalyse auf Individualdaten basiert (Konsument, Anbieter), wurden sowohl die Wohnstandorte der Befragten als auch die Standorte der stationären Handelsbetriebe geocodiert. Aus den Rohdaten wurden Interaktionsmatrizen für alle Kombinationen aus den befragten Personen und den berücksichtigten Anbietern erstellt (Wieland, 2015); diese beinhalten die Einkäufe und Ausgaben der befragten Konsumenten bei allen stationären und Online-Anbietern sowie die erklärenden Variablen (s.u.). Eine wichtige Variable in der Modellanalyse, auf die sich auch mehrere Fragestellungen beziehen, ist die Fahrtzeit zwischen den Wohnorten der Kunden und den stationären Anbietern. Diese wurde für alle o.g. Kombinationen mit Hilfe von Abfragen bei der Open Source Routing Machine (OSRM) erfasst und der Interaktionsmatrix angehängt. Als Indikator wurde hierbei die schnellste Route, gemessen als PKW-Fahrtzeit, zu Grunde gelegt. Diese Arbeitsschritte erfolgten in R (R Core Team, 2019) mit dem Paket MCI2 (Wieland, 2019b), das wiederum über die Pakete tmaptools (Tennekes, 2018) und osrm (Giraud, 2019) auf OpenStreetMap-Daten zugreift.

3.6 Modellanalyse des Einkaufsverhaltens

Die statistische Datenanalyse bzw. Modellierung erfolgte mit einem Hurdle-Modell (Mullahy, 1986), einem mikroökonometrischen Modellkonzept, das zu den Zähldatenmodellen gehört und aus zwei Komponenten besteht: Die erste (participation equation) analysiert, ob etwas Bestimmtes getan wird (hier: ob bei einem bestimmten Anbieter eingekauft wird). In der zweiten Komponente (intensity equation) wird untersucht, wie etwas Bestimmtes getan wird, vorausgesetzt, dass bereits entschieden wurde, dies zu tun (hier: Ausgaben bei den Anbietern, die für einen Einkauf ausgesucht wurden). Das Modell wurde konzipiert, um stark schief verteilte abhängige Variablen mit einem hohen Anteil von Null-Werten statistisch korrekt zu analysieren; allerdings steht dahinter auch die implizite Verhaltensannahme eines zweistufigen Entscheidungsprozesses. Das Modell wird mit Hilfe mit der Maximum-Likelihood-Schätzung (ML) parametrisiert (Cameron/Triverdi, 2005; Zeileis et al. 2008). Die Anwendung des Hurdle-Modells zur Modellierung des räumlichen Einkaufsverhaltens lässt sich wie folgt zusammenfassen (Wieland, 2019a):

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

Der repräsentative Nutzen ist eine lineare Funktion mit erklärenden Variablen (Teilnutzen):

$$V_{ij} = \boldsymbol{x_{ij}}'\boldsymbol{\beta}$$

Das Hurdle-Modell besteht aus zwei Gleichungen, wobei die erste (participation equation; hier: binäres Logit-Modell) die eigentliche Wahlentscheidung modelliert (Kunde *i* kauft bei Anbieter *j* oder nicht). Deren Zielgröße ist die Wahrscheinlichkeit, dass Kunde *i* Anbieter *j* aufsucht (p_{ij}), d.h. dass die Zahl der empirisch erfassten Einkaufssummen, S_{ij}, größer als null ist; sie wird durch den repräsentativen Nutzen erklärt:

$$p_{ij} = Pr\left[S_{ij} > 0|V_{ij}\right] = \frac{e^{V_{ij}}}{1 + e^{V_{ij}}}$$

Eine lineare Interpretation des repräsentativen Nutzens ergibt sich durch die Betrachtung der Logits (Logarithmiertes Verhältnis der Wahrscheinlichkeiten des Eintretens und des Nichteintretens):

$$\ln \frac{p_{ij}}{1 - p_{ij}} = V_{ij}$$

Der zweite Teil des Modells (intensity equation) beinhaltet alle Werte von S_{ij} größer null. Hierfür wird ein linkstrunkiertes Poisson-Modell verwendet; der Poisson-Parameter λ_{ij} entspricht dem Mittelwert von S_{ij}:

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$$E\left(S_{ij}, S_{ij} > 0 \middle| V_{ij}\right) = \frac{\lambda_{ij}}{1 - e^{-\lambda_{ij}}}$$

Die Linkfunktion des Poisson-Parameters λ_{ij} stellt durch eine loglineare Form einen linearen Zusammenhang mit dem repräsentativen Nutzen her:

$$\ln \lambda_{ij} = V_{ij}$$

Der Erwartungswert des Hürdenmodells ist das Produkt aus der Auswahlwahrscheinlichkeit der participation equation und dem Erwartungswert der intensity equation:

$$E\left(S_{ij} \middle| V_{ij}\right) = \left(Pr\left[S_{ij} > 0 \middle| V_{ij}\right]\right)\left(E\left[S_{ij}, S_{ij} > 0 \middle| V_{ij}\right]\right)$$

Durch die Aufspaltung in eine „ob“- und eine „wie“-Entscheidung ist es möglich, Einflüsse auf die Auswahlwahrscheinlichkeit eines Einzelhandelsanbieters (stationär oder online) getrennt von den dort getätigten Ausgaben zu betrachten. Im vorliegenden Fall werden konsumentenspezifische Eigenschaften zur Erklärung der Kanalwahl (stationär vs. online) herangezogen, zur Erklärung der Einkaufsstättenwahl (d.h. welcher Anbieter) hingegen Anbieterattribute und Transaktionskosten der Einkaufsalternativen. Die Nutzenfunktionen enthalten – je nach berücksichtigter Branche leicht unterschiedlich – folgende erklärende Variablen, die sich v.a. auf kanal- bzw. anbieterspezifische Transaktionskosten sowie psychographische und sozio-demographische Konsumenteneigenschaften beziehen:

- Sortiment: Artikelzahl der einzelnen Anbieter; Anzahl (siehe Kap. 3.4)
- Fahrtzeit (zu stationären Anbietern; bei Online-Anbietern: null); Minuten (siehe Kap. 3.5)
- Liefergebühr und Lieferzeit (bei Online-Anbietern; bei stationären Anbietern: null); EUR bzw. Tage (siehe Kap. 3.4)
- Cross-Channel-Integration: Vorhandensein eines integrierten Online-Shops, Verfügbarkeit des „click and collect“-Services; Dummy-Variablen (siehe Kap. 3.4)
- Konkurrenznähe: Räumliche Nähe (distanzgewichtet) zu konkurrierenden Anbietern; Indikator auf der Grundlage der Hansen-Erreichbarkeit
- „Online-Affinität“ der Konsumenten: Latente Variable, abgeleitet mittels Faktorenanalyse aus 15 Einstellungs-Items, die in der Befragung erfasst wurden (siehe Kap. 3.3)
- Sozio-demographische Eigenschaften der Konsumenten: Altersgruppe, Erwerbstätigkeit, Geschlecht, Wohnort in einer Großstadt; Dummy-Variablen, in der Befragung erfasst (siehe Kap. 3.3)
- Dummy-Variablen für die berücksichtigten Filialunternehmen (z.B. Aldi, Media Markt, IKEA)

Eine Differenzierung zwischen Kanal- und Einkaufsstättenwahl wurde bei den Modellen mit Hilfe einer Dummy-Variable operationalisiert, die anzeigt, ob Anbieter j ein Onlineshop (1) oder ein stationärer Anbieter (0) ist; für diese Dummy-Variable wurden Interaktionsterme mit den Variablen gebildet, die Konsumenteneigenschaften beschreiben (z.B. wohnhaft in Großstadt, Online-Affinität) und deren Koeffizienten interpretiert. Die Kanalwahl wurde nur im ersten Modellteil (Auswahlwahrscheinlichkeit) berücksichtigt. Die erklärenden Variablen zur Beschreibung der Einkaufsalternativen gingen hingegen sowohl in die participation equation als auch die intensity equation ein. Die Berechnung des Hürdenmodells erfolgte in R (R Core Team, 2019) mit dem Paket pscl (Zeileis et al., 2008).

4 AUSGEWÄHLTE ERGEBNISSE

4.1 Marktanteile und Durchschnittsausgaben (Deskriptive Darstellung)

Tabelle 3 zeigt eine deskriptive Darstellung der in der Befragung erfassten Einkäufe für drei Branchen (Lebensmittel, Elektronikartikel, Möbel). Die jeweiligen Anteile des Onlinehandels spiegeln durchaus die existierenden Marktforschungsdaten wieder (z.B. HDE, 2019). Erwartungsgemäß ist der Anteil sowohl der Einkäufe als auch der Ausgaben bei Elektronikartikeln am höchsten (Südniedersachsen: 41,9 bzw. 31,8%; Mittlerer Oberrhein: 43,3 bzw. 38,0%). Es zeigt sich, dass bei Gütern des mittel- und langfristigen Bedarfs die Ausgabenanteile mitunter deutlich unter den Einkaufsanteilen liegen, was sich auch an den geringeren Durchschnittsausgaben zeigt. Dies kann durch Preisunterschiede zwischen Online- und Offline-Anbietern erklärt werden, jedoch auch dadurch, dass der Onlinekanal tendenziell für geringwertigere Anschaffungen genutzt wird. In jedem Fall zeigt sich daran, wie sinnvoll die Anwendung des Hurdle-Modells (siehe Kap. 3.6 bzw. 4.3) ist, da so zwischen Einkaufsentscheidungen und Ausgaben – die bei deskriptiver und aggregierter Betrachtung deutlich unterschiedliche Anteile haben – differenziert werden kann.

Auffällig ist weiterhin, dass sowohl der Einkaufs- als auch der Ausgabenanteil von Online-Anbietern im zweiten Untersuchungsgebiet höher ist als im ersten, was auf regionale Unterschiede in der Online-Affinität hindeutet. Dies ist möglicherweise auch durch demographische Unterschiede zwischen den Gebieten erklärbar. Daran zeigt sich wiederum die Sinnhaftigkeit eines mikroökonometrischen Modellansatzes, der es ermöglicht, individuelle Charakteristika der Konsumenten zu integrieren.

Branche/ Betriebsform	USG 1 – Südniedersachsen			USG 2 – Mittlerer Oberrhein		
	Einkäufe	Ausgaben [EUR]		Einkäufe	Ausgaben [EUR]	
	%	%	MW	%	%	MW
Lebensmittel						
Supermärkte (< 1.000qm)	10,5	6,4	31,57	13,6	11,8	48,79
Verbrauchermärkte klein (1.000-2.500 qm)	35,2	32,3	41,95	26,3	26,8	56,68
Verbrauchermärkte groß (> 2.500 qm)	21,5	25,5	52,80	19,4	25,5	72,60
Discounter	32,8	35,8	47,73	39,8	35,0	45,42
LM-Abteilung Warenhaus	-	-	-	0,4	0,3	51,71
Online-Anbieter	-	-	-	0,6	0,5	65,78
Elektronikartikel						
Elektrofachgeschäft	5,7	15,9	609,42	3,7	8,6	570,26
Elektrofachmarkt	48,2	49,9	224,41	49,3	50,9	250,31
EL-Abteilung (SB-) Warenhaus	4,3	2,4	124,79	3,7	2,5	164,66
Online-Anbieter	41,9	31,8	161,70	43,3	38,0	210,70
Möbel						
Möbelmärkte	82,4	94,6	1.303,89	85,1	94,4	1.201,05
Online-Anbieter	17,6	5,4	334,78	14,6	5,7	376,41

Tab. 3: Erfasste Einkaufs- und Ausgabenanteile nach Branche, Betriebsform und Untersuchungsgebiet

4.2 Online-Affinität der Konsumenten

Da psychographische Merkmale – konkret: die „Online-Affinität" – eine wichtige Rolle in dieser Studie spielen, ist es sinnvoll, sich die Verteilung der einzelnen Einstellungs-Items anzuschauen (siehe Abb. 2). Das erste Item, das sich auf eine Selbsteinschätzung der Häufigkeit der Nutzung des Onlinehandels bezieht („Ich bestelle häufig Produkte auf dem Internet"), ist in den vier Ausprägungen der Likert-Skala nahezu gleich verteilt („trifft zu": 24,4%; „trifft eher zu": 20,4%; „trifft eher nicht zu": 27,1%, „trifft nicht zu": 25,7%). Sehr auffällig ist die hohe Zustimmung zu zwei Items, die sich auf die Rolle des Internets bei der Informationsbeschaffung im Kaufprozess beziehen (Items 6 und 8): 84,3% der Befragten stimmen der Aussage „Das Einkaufen im Internet erleichtert den Vergleich von Preisen und Produkten" vollständig (54,3%) oder eher (30,0%) zu. Allerdings ist dies offenbar nicht auf das Internet als Kaufkanal beschränkt, denn etwa zwei Drittel der Befragten (66,5%) stimmen der Aussage „Egal ob ich im Internet oder im Geschäft kaufe: Vor dem Kauf informiere ich häufig im Internet über die Produkte vergleiche Preise" entweder voll (38,4%) oder eher (28,1%) zu. Diese Relevanz als Informationskanal ist auch vor dem Hintergrund interessant, dass in der Modellanalyse (siehe Kap. 4.3) auch der Effekt der Cross-Channel-Integration von Händlern untersucht wird; denn ein integrierter Onlineshop ermöglicht das Einholen von Vorinformationen, unabhängig davon, ob im jeweiligen Onlineshop oder stationär eingekauft wird. Mehrere Items, die sich entweder auf Datenschutzaspekte (13-15) oder auf ethische Fragen des Onlinehandels beziehen (8 und 9), legen nahe, dass negativen Aspekten des Onlinehandels zumindest bei bekundeten Einstellungen ein großes Gewicht beigemessen wird.

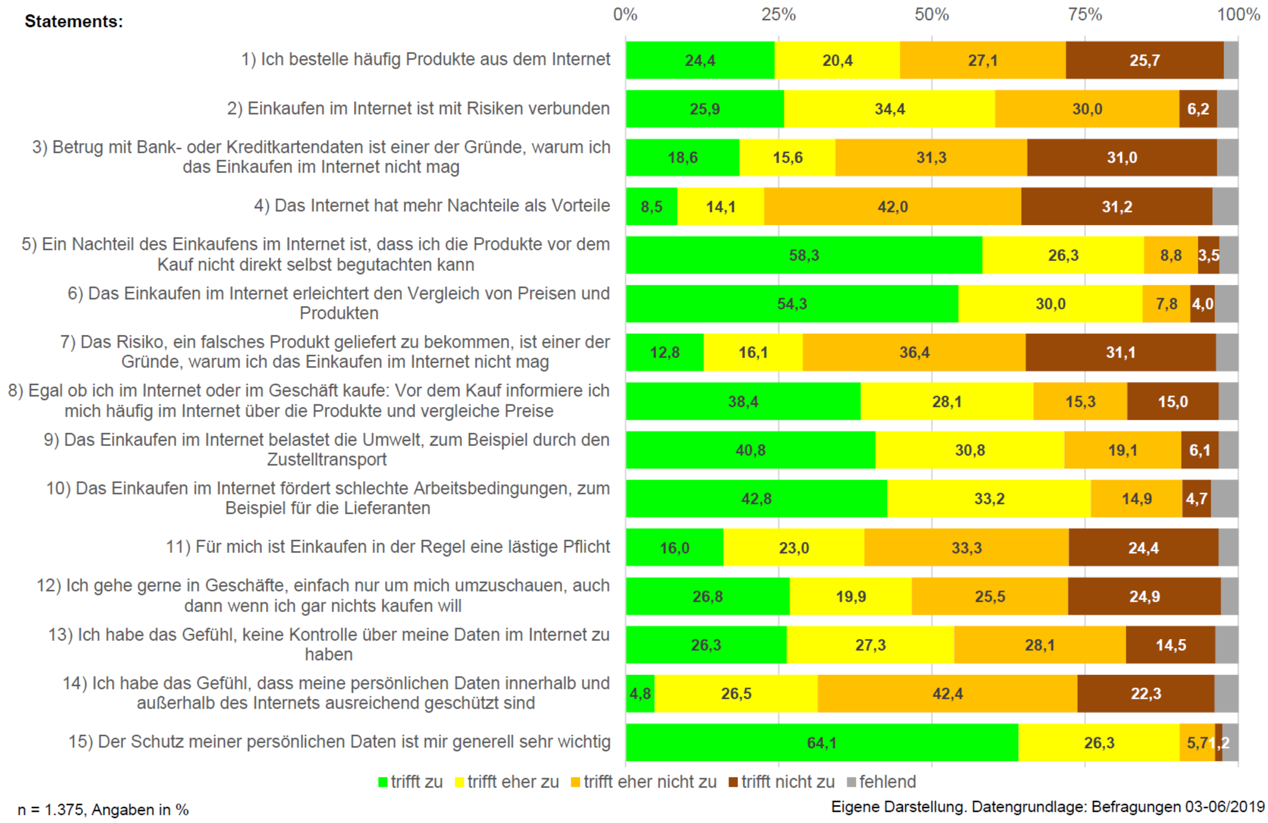

Abb. 2: Relative Häufigkeiten der 15 Items (Quelle: Eigene Erhebungen und Berechnungen).

Die Extraktion von zwei latenten Variablen aus diesen 15 Einstellungs-Items mittels explorativer Faktorenanalyse (Hauptkomponentenanalyse) bestätigt im Wesentlichen die Ergebnisse aus dem Stated-Choice-Befragungsexperiment von Schmid/Axhausen (2019): Die Items 2-5, 7, 9-10 und 13-15 laden in plausibler Weise auf einen Faktor, der im Folgenden als „Online-Affinität" bezeichnet wird (z.B. Item 3 zu Bank-/Kreditkartenbetrug im Internet: Je geringer die Zustimmung, desto „online-affiner"; Item 14 zum Datenschutz: Je geringer die Zustimmung, desto weniger „online-affin"). Eine Reliabilitätsprüfung dieses Konstruktes mit Hilfe des Cronbach's-Alpha-Indikators ergibt einen Wert von $\alpha = 0{,}80$, was einer mindestens akzeptablen, eher guten Reliabilität entspricht. Die zwei extrahierten Faktoren haben einen Anteil der Gesamtvarianz in den 15 Variablen von 37,9%.

4.3 Überblick zu Modellergebnissen

Abbildung 3 zeigt eine schematische Zusammenstellung der wichtigsten Ergebnisse der Modellanalyse für die Branchen Lebensmittel, Elektroartikel und Möbel. Die jeweils ersten beiden Spalten („Kanalwahl: Online" und „Einkaufsstättenwahl") sind die Komponenten der participation equation, sind hier allerdings nach Sinnzusammenhängen getrennt. Ein positiver (grünes Plus) bzw. negativer Effekt (rotes Minus) in der ersten Spalte bedeutet hierbei, dass durch die jeweilige Variable die Wahrscheinlichkeit erhöht bzw. gesenkt wird, online zu kaufen. In der dritten Spalte „Einkaufsausgaben" sind die Ergebnisse der intensity equation zusammengefasst. Nicht in jedem Fall konnten identische Variablen verwendet werden; beispielsweise wurden für Möbelanbieter die Aspekte „integrierter Onlineshop" und „click and collect" zusammengefasst, da faktisch jeder Anbieter mit integriertem Onlineshop auch den zweitgenannten Service anbietet. Die Darstellung differenziert nur in eine (signifikant) positive bzw. (signifikant) negative Wirkung bzw. das Ausbleiben des Nachweises eines signifikanten Effektes. Die Ergebnisse sind nicht in jedem Fall für beide Untersuchungsgebiete identisch und werden in Fällen von Nicht-Übereinstimmung getrennt ausgewiesen.

Im Hinblick auf die Kanalwahl bestätigt sich zunächst, dass eine positive Einstellung dem Onlinehandel gegenüber („Online-Affinität") auch die Wahrscheinlichkeit erhöht, online einzukaufen. Das ist keineswegs so selbstverständlich, wie es zunächst erscheinen mag; denn bekundete Präferenzen sind nicht notwendigerweise kongruent mit tatsächlichem Verhalten (Soziale Erwünschtheit in Befragungssituationen). Ferner basierte die Studie von Schmid/Axhausen (2019), an die das hier gezeigte Vorgehen angelehnt ist, wie viele Kanalwahlstudien, auf einer fiktiven Auswahlsituation; es war somit keinesfalls a priori klar, dass dieses Ergebnis hier anhand von realem Kaufverhalten bestätigt werden würde.

Im Fall der Elektronik- und Möbelkäufe wurde auch der Wohnort der Befragten als erklärende Variable überprüft. Hierbei zeigt sich – überraschenderweise – immer noch dasselbe Muster, wie es in älteren Studien bezüglich der Kanalwahl gefunden wurde, nämlich, dass Großstadtbewohner, alle anderen Bedingungen konstant gelassen, eine höhere Wahrscheinlichkeit des Onlinekaufs haben. Dieses Ergebnis ist deswegen überraschend, weil die höhere Online-Neigung in Großstädten ursprünglich mit der Innovations-Diffusions-Hypothese begründet wurde (siehe Kap. 2); dass Online-Shopping aktuell immer noch eine „Innovation" darstellt, erscheint fragwürdig. Mögliche Erklärungen könnten beispielsweise regionale Disparitäten in der Breitband-Ausstattung oder der Qualität des Mobilfunknetzes (M-Commerce), aber auch eine geringere PKW-Dichte in Großstädten sein; ersteres würde vorranging die Vorinformation und den Einkauf selbst, zweiteres die Erreichbarkeit des stationären Angebotes und den Transport der erworbenen Güter (z.B. Möbel) betreffen. Sozio-demographische Eigenschaften der Konsumenten spielen hingegen nur eine recht geringe Rolle; recht eindeutig (und den Erwartungen entsprechend) ist aber, dass die Online-Wahrscheinlichkeit für Konsumenten ab 65 Jahren geringer ist als für jüngere Altersgruppen.

Branche	**Lebensmittel**			**Elektroartikel**			**Möbel**		
Erklärende Variablen	Kanalwahl: Online	Einkaufs-stättenwahl	Einkaufs-ausgaben	Kanalwahl: Online	Einkaufs-stättenwahl	Einkaufs-ausgaben	Kanalwahl: Online	Einkaufs-stättenwahl	Einkaufs-ausgaben
Sortiment [Anzahl Artikel]		+	+		+	+ / −		+	−
Fahrtzeit [Minuten]		−	−		−	+		−	+ / −
Konkurenz-nähe [Index]		◎	−		+ / −	+ / −		◎	−
Integrierter Onlineshop [1/0]					+	+		+	+
Click and collect [1/0]		◎	−		− / ◎	− / ◎			
Lieferzeit [Tage]					−	−			
Liefergebühr [€]		−	◎		− / ◎	+ / −		◎	−
Online-Affinität [LV]	+			+			+		
Großstadt [1/0]				+			+		
Alter < 25 [1/0]				◎			+ / −		
Alter >= 65 [1/0]	◎			−			−		
Geschlecht: männlich [1/0]	◎			◎			◎		
Erwerbstätig [1/0]				◎			◎		
Einfluss Ketten		ja	ja		ja	ja		ja	ja

+ = Positiver Effekt, − = Negativer Effekt, ◎ = kein signifikanter Effekt, Zelle nicht ausgefüllt = nicht überprüft

Abb. 3: Schematische Zusammenfassung von Modellergebnissen nach Branchen (Quelle: Eigene Erhebungen und Berechnungen).

Im Hinblick auf die Einkaufsstättenwahl bestätigen sich zwei Annahmen des klassischen Huff-Modells, hier allerdings unter der Berücksichtigung von stationären und Online-Anbietern: Das Sortiment erhöht die Auswahlwahrscheinlichkeit, während die Fahrtzeit (zu stationären Betrieben) nutzenmindernd wirkt. Dieser Effekt findet sich jedoch nicht in jedem Fall für die Einkaufsausgaben, zumindest nicht bei Gütern des mittel- und langfristigen Bedarfs. Der Sortimentseffekt wurde auch nach Online- und Offline-Anbietern differenziert (hier nicht dargestellt), wobei sich zeigte, dass er bei Onlineshops wesentlich geringer ist; dies lässt sich dadurch erklären, dass Onlineshops i.d.R. ein um ein Vielfaches größeres Sortiment anbieten, was natürlich die Such- und Entscheidungskosten der Konsumenten erhöht. Ein positiver Effekt der Konkurrenzanziehung bei stationären Anbietern (im Sinne von „cumulative attraction") konnte im Regelfall nicht identifiziert werden; im Fall der Einkaufsausgaben zeigt sich eher die Tendenz, dass die räumliche Nähe zu Mitbewerbern die vor Ort getätigten Ausgaben senkt, was auf eine Überlagerung möglicher Agglomerationseffekte durch verstärkten Wettbewerb hindeutet.

Erwartungsgemäß senken steigende Lieferzeiten bzw. -gebühren – aus der Transaktionskosten-Perspektive die Äquivalente zur Fahrtzeit bei stationären Anbietern – die Auswahlwahrscheinlichkeit eines (Online-)

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Anbieters tendenziell; dieses Ergebnis bestätigt ebenso Erkenntnisse aus experimentellen Kanalwahlstudien oder Studien zu einzelnen Multi-Channel-Händlern. Erstmals kann weiterhin nachgewiesen werden, dass die Cross-Channel-Integration von Handelsbetrieben einen positiven Effekt auf ihren Kundenzufluss hat; dies trifft – wie etwa am Elektrofachhandel zu erkennen, bei dem die Cross-Channel-Einbindung auf zwei Variablen aufgeteilt wurde – vorranging auf das Vorhandensein eines integrierten Onlineshops zu; dieses Ergebnis deckt sich mit der in der Befragung festgestellten hohen Relevanz des Internets als Informationsmedium (siehe Kap. 4.2). Der „click and collect“-Service als solcher erweist sich hingegen – zumindest beim Lebensmittel- und Elektrofachhandel – nicht als signifikant nutzensteigernd; dies ist kongruent mit der Erkenntnis aus einer Standortanalyse für Elektrofachmärkte, dass dieses Angebot auch die Umsatzzuflüsse in den reinen Onlinehandel nicht kompensiert (Wieland, 2019c). Der Vollständigkeit halber muss erwähnt werden, dass auch bei Dummy-Variablen, die einzelne Ketten repräsentieren, häufig signifikante Effekte gefunden wurden; dies lässt auf unterschiedliche intrinsische Nutzen bestimmter Marken bzw. Vertriebslinien schließen, liegt jedoch außerhalb der Betrachtung der Studie.

5 SCHLUSSBEMERKUNGEN UND AUSBLICK

Im Zuge des Projektes, das aktuell verlängert bzw. erweitert wird, konnte bislang gezeigt werden, dass es möglich und auch sinnvoll ist, Multi- und Cross-Channel-Einkäufe in ein Modell der Einkaufsstättenwahl zu integrieren, obwohl diese Modellfamilie ursprünglich nur für den stationären Einzelhandel konzipiert war. Weiterhin konnten wesentliche Erklärungsvariablen des Kanal- bzw. Einkaufsstättenwahlverhaltens empirisch identifiziert werden; hierzu zählen insb. anbieter- bzw. kanalspezifische Transaktionskosten sowie objektive und subjektive Konsumenteneigenschaften. Die Ergebnisse demonstrieren, dass die Logik der Standorttheorie des Einzelhandels sowie der früheren Einkaufsstättenwahlmodelle grundsätzlich auf Multi-Channel-Wettbewerbssituationen übertragbar ist; stationäre und Online-Anbieter können – obwohl sie sich in zentralen Aspekten völlig voneinander unterscheiden (insb. durch den physischen Standort, der stets eine zentrale Erklärungsgröße in der Geographischen Handelsforschung ist) – so „vergleichbar gemacht“, ihr Wettbewerbsverhältnis quantitativ abgebildet werden.

Doch auch für die Praxis ergeben sich Implikationen: Modelle der Einkaufsstättenwahl werden seit Jahrzehnten in der betrieblichen Standortplanung und in der Raumordnung eingesetzt, um den Einfluss neuer Angebotsstandorte auf räumliche Kaufkraftströme abzuschätzen (Müller-Hagedorn, 2021); diese Modelle können in ihrem Erklärungsgehalt von der Berücksichtigung des Onlinehandels profitieren und so die Auswirkungen zukünftiger Planungen (z.B. Eröffnungen, Erweiterungen, Verlagerungen) bezüglich Einzelhandelsgroßprojekten zuverlässiger abschätzen. Ein weiterer für die Praxis wichtiger Aspekt ist die Erkenntnis der hohen Relevanz des Internets als Informationsmedium: Die Ergebnisse legen nahe, dass Händler von einer Cross-Channel-Integration in Form höherer Kundenzuflüsse profitieren. Somit zeigt sich Cross-Channel-Vertrieb durchaus als Aspekt der Stärkung bestehender Einzelhandelsstandorte. Da dieser bisher im inhabergeführten stationären Einzelhandel (ISEH) noch vergleichsweise wenig verbreitet ist (Wieland et al., 2020), könnte hier das Citymarketing lokale ISEH-Betreiber beim Aufbau eines solchen Vertriebs unterstützen. Einzelne Initiativen hierzu bestehen bereits, z.B. als Teilprogramm der „Mittelstand 4.0“-Initiative des deutschen Bundeswirtschaftsministeriums.

Es ist jedoch zu berücksichtigen, dass das gesamte Projekt – inklusive der Datenerhebungen, die 2019 stattfanden – die Corona-Pandemiesituation und die damit verbundenen Eindämmungsmaßnahmen („Lockdowns“ usw.) nicht berücksichtigen konnte. Effektiv hat es in den ersten Monaten der Pandemie, teilweise bedingt durch die verordneten Betriebsschließungen, aber auch durch freiwillige Anpassungen des (Einkaufs-)Verhaltens – deutliche Verschiebungen der Marktanteile zu Gunsten des Onlinehandels gegeben (bevh, 2020; Bitkom, 2020). Diesen Aspekten wird in der Fortsetzung des Projektes besondere Beachtung geschenkt, wobei u.a. vergleichende Analysen der Angebots- und Nachfragesituation sowie eine Abfrage von pandemiebedingten Verhaltensänderungen angedacht sind.

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KI-gestützter Wordcloud-Generator für Beteiligungsprozesse

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1 ABSTRACT

Es liegt auf der Hand, dass eine digitale Unterstützung von Planungs- und Beteiligungsverfahren in vielfacher Hinsicht enorme Vorteile bietet. So können mittels moderner, digitaler Partizpationsplattformen Prozessbeteiligte orts- und zeitunabhängig an städtebaulichen Ideenfindungs- und Bewertungsverfahren teilnehmen und ihre Gedanken, Meinungen und Vorschläge mit anderen teilen und diskutieren. Seit einigen Jahren stehen hierfür eine Reihe adaptierbarer Softwareprodukte zur Verfügung, z. B. Consul, ein community-basiertes Opensource-Projekt der Consul Democracy Foundation auf GitHub, die proprietäre Software citizenLab des gleichnamigen belgischen Unternehmens, oder dem neuseeländischen Pendant Loomio der Loomio Cooperative Ltd. und viele weitere. Der webbasierte Zugang ermöglicht dabei nicht nur eine potenzielle Reichweitensteigerung an Teilnehmenden und die schnelle Verlinkung zu anderen digitalen Inhalten bzw. Medien, sondern erleichtert auch die statistische Informationsauswertung und die mediale wie inhaltliche Dokumentation des Gesamtprozesses. Aktuelle Softwarelösungen sind dabei als anwenderfreundliches Baukastensystem konzipiert, das je nach Anwendungsfall individuell, modular und ohne Programmierkenntnisse zusammengesetzt werden kann. Die zuschaltbaren Module reichen von einfachen Formularmasken über interaktive Karten-Tools, MindMaps und Umfragen bis hin zu integrierten Video-Chat-Funktionen und kollaborativen Whiteboards.

Zukünftig ist davon auszugehen, dass die modulare Struktur und die enorm vielfältigen Einsatzgebiete dieser Softwarelösungen zunehmend auch KI-gestützte Funktionen als neue Features enthalten werden bzw. im Baukasten bestehende Module optimieren oder ablösen werden. Die Gründe hierfür liegen größtenteils im disruptiven Fortschritt der Softwarentwicklung. Andererseits darf aber auch erwogen werden, ob nicht doch häufig beobachtete Hemmnisse oder Probleme bisheriger Partizipationsverfahren ggf. durch den unterstützenden Einsatz von KI auch abgebaut oder verringert werden könnten.

Beide Perspektiven stellen für sich genommen schon sehr breite Grundlagenforschungsfelder dar, die insbesondere durch die noch hinzukommenden Aspekte der Technologieakzeptanz enorm komplex werden können. Da aber die technologische Hürde zur Umsetzung einfacher Software-Prototypen durch die Vielzahl zur Verfügung stehender Opensource-Tools sehr niedrig ist, entwickelte der Forschungsschwerpunkt nextPlace der Technischen Hochschule Ostwestfalen-Lippe zunächst eine allererste, prototypische Hardware-Software-Applikation, um - im Sinne eines Proof-of-Concept – die Relevanz und Aufwände tiefergehender Forschungs- und Entwicklungsarbeiten abschätzen zu können. Folglich stellen die nachfolgenden Ausführungen einen technischen Erfahrungsbericht der ersten Entwicklungsschritte dar, um einen einfachen, kostengünstigen und experimentellen Zugang in dieses noch recht junge Forschungsfeld nachvollziehbar zu machen.

Keywords: Data Visualisation, Participation, Speech Recognition, Artificial Intelligence, Internet of Things

2 HINTERGRUND UND MOTIVATION

Wordclouds sind ein bekanntes Werkzeug der Informationsvisualisierung. Sie bieten den Vorteil, dass sich Textinhalte prägnant und zusammenfassend schnell und visuell erfassen lassen. In der Regel begegnet man Wordclouds am Anfang oder Ende von Folien-Präsentationen, um die inhaltliche Bandbreite grafisch darzustellen, die wichtigsten Aspekte der enthaltenen Information hervorzuheben oder einfach als gestalterisches Element in jeglichen Publikationsformen. Ein derartiger Nutzen kann aber auch für, in Präsenz oder digital stattfindenden Workshops oder Besprechungen von Vorteil sein, um aktuelle Diskussionsinhalte für Teilnehmerinnen, Teilnehmer und Außenstehende strukturiert und medial publizierbar widerzuspiegeln. Hierfür wäre es dann allerdings von Vorteil, wenn die Wordcloud einerseits dem Stand der Diskussion in Echtzeit folgen und auch vorhergehende Diskussionstände archivieren könnte, um inhaltliche Redundanzen aufzuzeigen oder ggf. auch Vergleiche zwischen unterschiedlichen Diskussionen herstellen zu können. Damit dies möglich wird, gilt es, die Diskussionsinhalte mehrerer Teilnehmerinnen und Teilnehmer als Tonaufnahme mitzuschneiden und daraus mittels KI-gestützter

Spracherkennung automatisch, in Echtzeit, die wichtigsten Begriffe zu extrahieren und in Form einer digitalen Schlagwortwolke grafisch aufzubereiten.

Technisch gesehen, sind auf der Eingabeseite hierfür einfache Textformate, z. B. Begriffslisten, notwendig, die üblicherweise am häufigsten vorkommenden Schlagwörter vereinen. Neben dem hier beschriebenen Testeinsatz der Spracherkennungs-KI im Rahmen zweier Veranstaltungen gehen die denkbaren Verwendungsmöglichkeiten der Texvisualisierung aber weit darüber hinaus. So unterstützen die Schlagwörter nicht nur externe zugeschaltete oder verspätet eintreffende Teilnehmer beim schnellen Auffassen des aktuellen Diskussionsstands oder der begleitenden Dokumentation, sondern ermöglichen auch zeitliche Veränderungen des Gesprächsablaufs oder temporäre Änderungen der inhaltlichen Prioritäten objektiv messbar zu machen.

In Verbindung mit einer dazu verknüpften, semantischen Netzwerkstruktur ließe sich so, mittels Machine-Learning-Algorithmen, eine koninuierliche Informations- & Wissensstruktur aufbauen, die einerseits durch fortwährende Diskussionsbeiträge wächst und andererseits auch redundante Disksussionsphasen erkennt oder an geeigneter Stelle neue inhaltliche Verknüpfungen oder Inspirationen aus anderen Beteiligungsprozessen einbringen kann. Als allererster Schritt in dieses mächtige Anwendungsfeld wurde in diesem Technologieprojekt zunächst auf experimentelle Weise mit der Verknüpfung einfacher Hardware- und offen verfügbarer Softwarekomponenten begonnen, wobei einschränkend hinzugefügt werden muss, dass eine weitreichende Erprobung und qualitative Bewertung allerdings noch ausstehen.

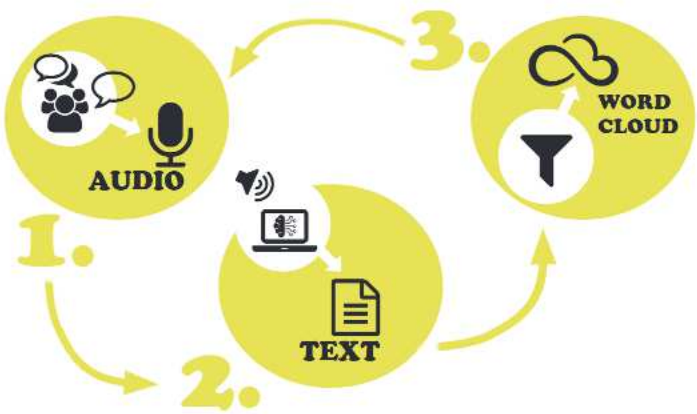

Abb. 1: Grundprinzip der Applikation [Jacobi 2020]

2.1 Stand der technischen Forschung

Erste technisch vergleichbare Konzepte wurden schon vor einigen Jahren u.a. von Haubold (2004) oder auch Flamary et al. (2011) beschrieben. Verwandte Konzepte aus jüngster Zeit finden sich u.a. bei Padmanandam et al. (2021) oder Wu et al. (2020). Bestehende Software-Unternehmen wie IBM, Google oder auch Facebook bieten bereits niederschwellige Zugänge zu intelligenten Spracherkenungssystemen und kombinierbaren Textanalyse-Tools. Das vermutlich prominenteste Beispiel ist die KI-Plattform Watson von IBM, in der die Spracherkennungsfunktionen online als Software-as-a-Service prozessiert werden. Neben diesen proprietären Diensten bietet aber z.B. auch die Mozilla Foundation ein opensource-basiertes Ökosystem zur Spracherkennung und Sprachsynthese mittels diverser Deep-Learning Algorithmen an (vgl. Ardila et al. 2019). Das Projekt ist in sofern von besonderem Interesse, da es im Rahmen der Mozilla-CommonVoice-Kampagne, die Community anregt, ihre eigenen Sprachaufnahmen an ein offenes Repository zu spenden, um die Spracherkenungsbibliotheken fortwährend trainieren zu können.

Prinzipiell ist der Nutzen von Speech-to-Text-Services schon vielfach beschrieben worden und grundsätzlich seit langem erprobt. Der Einsatz im Rahmen von Gruppengesprächen oder Workshops benötigt aber wesentlich performantere Serverkapazitäten, die erst in jüngster Zeit einer breiten Anwenderschicht zur Verfügung stehen. Neuere Konzepte zum Einsatz von Echtzeit-Spracherkennung finden sich daher vornehmlich im Bildungskontext, zur ergänzenden Verständnisunterstützung Beeinträchtigter, wie Google´s Project Euphonia oder auch als Dokumentationsfunktion, gekoppelt an Videokonferenzsysteme, wie beispielsweise innerhalb der Software Zoom.

In Hinblick auf den Einsatz KI-gestützter Verfahren innerhalb öffentlicher Beteiligungsprozesse, lieferte in jüngster Zeit insbesondere auch das Verbundprojekt Civitas Digitalis, der Universitäten Hamburg und Kassel mit der Fortiss GmbH und Stadt Kassel wichtige Erkenntnisse (Balta et al. 2019). Insbesondere konnten hier interessante Grundlagen zur Nutzerakzeptanz digitaler Beteiligungsformate und daraus abgeleitete Handlungsempfehlungen zusammengestellt werden. Allerdings wurde in diesem Projekt durch die Verwendung eines textbasierten Chat-Bots ein verwandter aber etwas anderer technologischer KI-Ansatz gewählt.

3 UMSETZUNG

Im hier beschriebenen Projekt lag der Fokus vor allen Dingen auf einer einfachen Do-It-Yourself-Technologie, möglichst geringem Kostenaufwand und darauf, mittels OpenSource-basierter Software eine erste Schnittstelle zur Nutzbarmachung weiterführender KI-Bausteine herzustellen. Auf technischer Seite wurde ein kostengünstiger Einplatinen-Computer (Rasperry-Pi) verwendet, der die gesprochenen Workshop-Inhalte mittels einer zusätzlich notwendigen Sensorplatine aus acht Mikrofonen (MatrixCreator-Shield) über die GPIO-Schnittstelle (general purpose input/output) aufnimmt. Dies ermöglicht Aufnahmen mit bis zu acht Kanälen. Zu beachten ist allerdings, dass Nebengeräusche und Lärmquellen die Qualität der Aufnahme erheblich reduzieren können. Die Programmierung dieses DIY-Aufnahmegeräts erfolgte durch eigene Skripte auf Basis passender Python-Bibliotheken. Zur Umwandlung der Sprachaufnahmen in Text kam die Open-Source- Spracherkennungsbibliothek Kaldi (Povey et al. 2011) zum Einsatz. Diese Bibliothek bietet umfangreiche Softwarewerkzeuge zur Spracherkennung und Signalverarbeitung.

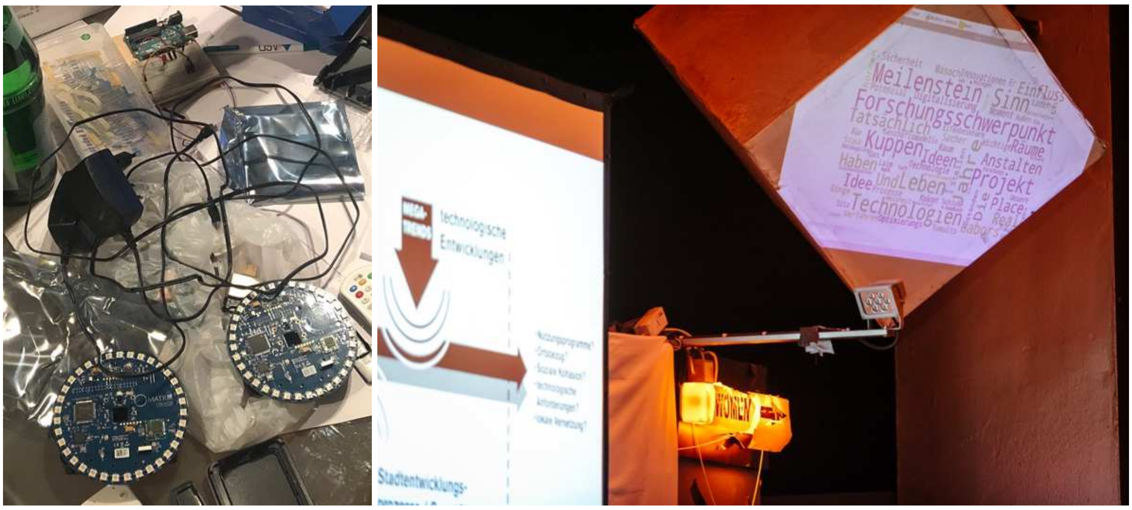

Abb. 2: Bauelemente des DIY-Aufnahmegeräts und Einsatz im Rahmen der Workshop-Veranstaltung 02/2020

Kaldi selbst ist zwar in C++ geschrieben, jedoch ist eine Einbindung in Python durch eine Wrapperbibliothek problemlos möglich. Da es sich bei Kaldi um freie Software handelt, kann diese ohne weitere Kosten auf einem eigenen Server aufgesetzt werden. Dies ist insbesondere datenschutzrechtlich von Vorteil, da auf diesem Wege nicht die Notwendigkeit besteht, Serverinfrastrukturen im Ausland zu verwenden, wie es bei den Cloudtechnologien von Microsoft (Azure) oder IBM (Watson) der Fall wäre. Da die Rechenleistung des Raspberry Pis nicht ausreichend ist für eine zeitnahe Spracherkennung, wird die Spracherkennungssoftware Kaldi unter einem eigens für das Projekt aufgesetzten Linux-Cloudserver betrieben.

Aufgrund beschränkter Performanceressourcen werden die Audioaufnahmen derzeit nicht in unmittelbarer Echtzeit, verarbeitet. Sondern Aufnahmen von 20 Sekunden Länge werden vom Raspberry Pi packetweise an den Kaldi-Server geschickt. Vor der eigentlichen Spracherkennung müssen die Daten noch vorprozessiert werden. Genauer gesagt gilt es, die Audioaufnahmen auf die von Kaldi verwendete Frequenz von 16 kHz herunterzusampeln und die Audiokanäle auf ein Mono-Format zusammenzufassen. Im Anschluss werden die Sprachaufnahmen durch Kaldi prozessiert und die Sprache in Text umgewandelt.

Eine wichtige Limitierung bei diesem Prozess stellt das Sprachmodell dar, dessen Qualität einen hohen Einfluss auf das Ergebnis der Spracherkennung hat. Da es nur sehr wenige, frei verfügbare Modelle für die deutsche Sprache gibt, wurde ein Opensource-Sprachmodell des Fachbereichs Informatik der Universität Hamburg verwendet (Milde, Köhn 2018). Prinzipiell wäre auch die Erzeugung eines eigenen Modells denkbar, allerdings würden hierfür, neben den sehr zeitraubenden Trainingsdurchläufen (viele Tage bis Wochen) auch mehrere hundert Stunden an Basis-Trainingsdaten benötigt werden.

3.1 Schlagwortidentifizierung

Nach erfolgreicher Datenumwandlung in Text besteht jedes Prozesspaket aus mehr oder weniger vollständigen Sätzen, die sich insbesondere durch eine besondere Häufung von nicht-brauchbaren Wortelementen, wie Artikel, Pronomen, Präpositionen, etc. auszeichnen. Mittels eines einfachen Textparsers in Python wurde diese Teile aus den Textdaten eliminiert, um im Anschluss die wichtigsten Hauptwörter abfragen und in das Skript zur Erstellung der WordCloud implementieren und dort nach Häufigkeit gewichten zu können. Im Abstand von 20 Sekunden erzeugte das Skript folglich eine neue, dem letzten Sprachverlauf folgende Wordcloud, die ihrerseits wieder durch Beamerprojektion in den Veranstaltungsraum zuückgespiegelt wurde.

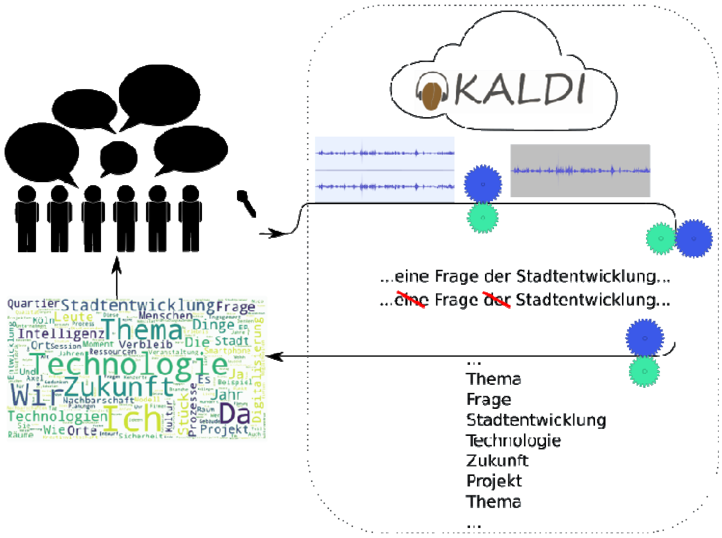

Abb. 3: Schematische Darstellung der Schlagwortidentifizierung und Resultat als Beamerprojektion (eigene Darstellung)

Gleichermaßen wurde in erster rudimentärer Form während Probedurchläufen versucht, thematisch unpassende Begriffe ebenfalls auszusortieren, um die visuelle Informationsdichte der WordCloud möglichst nah am themtischen Schwerpunkt des Veranstaltungsthemas zu halten. Allerdings wurde genau an dieser Stelle relativ schnell klar, dass exakt hier entweder die Grenzen im nutzbringenden Einsatz der Technologie oder die Potenziale zur inhaltlichen Weiterentwicklung liegen. Hierauf soll im Kap.4 noch weiter eingegangen werden.

3.2 Bislang beobachtete Hemmnisse

Während unserer Testworkshops wurden mit der hier beschrieben Konfiguration gleichzeitig die Diskussionen von zwei räumlich getrennten Workshopgruppen aufgezeichnet, um diese später inhaltlich und zeitlich analysieren zu können. Leider stellte sich im Anschluss der Diskussionen heraus, dass die Aufnahmequalität der Sprachaufnahmen mit der Matrix Creator Shield für die weitere Analyse zu schlecht waren und in Folge zu einer sehr geringen Worterkennung resultieren. Folglich eignet sich das hier besprochene Setting für eine einfache Raumaufnahme ohne individuelle Mikrofone nur bedingt.

Für einen weiteren Veranstaltungstermin mit größerer Besucherzahl wurde an dem Raspberry Pi eine externe Soundkarte per USB angeschlossen, die direkt mit dem Mischpult für eingesetzte Funkmikrofone zur Audioaufnahme verbunden wurde. Die direkte Verbindung der Soundkarte mit dem Audiosignal aus dem Veranstaltungsmischpult ermöglichte es, Nebengeräusche weitestgehend zu eliminieren, was wiederum in einer weitaus höheren Worterkennung resultierte.

Derzeit wird die Wordcloud noch auf dem Raspberry Pi generiert. Eine Generierung auf dem Server, der bereits die Spracherkennung durchführt, würde den Raspberry Pi weiter entlasten. Weiterhin wäre es möglich, die Spracherkennung online durchzuführen, d.h. die Audioaufnahmen werden nicht in Paketen mit einer Aufnahmelänge von 20 Sekunden an den Server geschickt, sondern direkt, ohne diese zwischenzuspeichern, an den Server weitergeleitet. Dies würde gewährleisten, dass Wörter während der

Aufnahme nicht auseinandergeschnitten werden und so von der Spracherkennungssoftware nicht korrekt erkannt werden würden.

4 KONTEXTERWEITERUNG

Wie unter 2.1 und 3.1. bereits angedeutet, stellt zwar die reine Spiegelung des kurzfristig Gesagten ein interessantes und kurzweiliges Ergänzungsfeature klassischer Veranstaltungsformate dar. Allerdings muss auch attestiert werden, um mittels Echtzeit-Spracherkennung der Veranstaltung eine neue und inhaltlich weiterführende Informationsebene anzudienen, reicht die rein nach Häufigkeit gewichtete Textanalyse nicht aus. Wesentlich interessanter wäre es, wenn die besprochenen Inhalte in ihrem Kontext automatisch interpretiert bzw. bestimmten (stadtentwicklungs-)methodischen Analyseebenen zugeordnet werden könnten. Folglich muss der bislang reine Textdatensatz um eine gewisse Semantik ergänzt oder in diese eingebettet werden, um in der Lage zu sein, aus den Häufigkeiten bestimmte Bedeutungsattribute abzuleiten und folglich auch wiederkehrende Verknüpfungen in der Diskussion oder Argumentation zu erkennen. Auch wären hierdurch besonders interessante Vergleichsanalysen zwischen verschiedenen Beteiligungsprozessen oder auch unterschiedlichen Stadtentwicklungsdiskussionen denkbar.

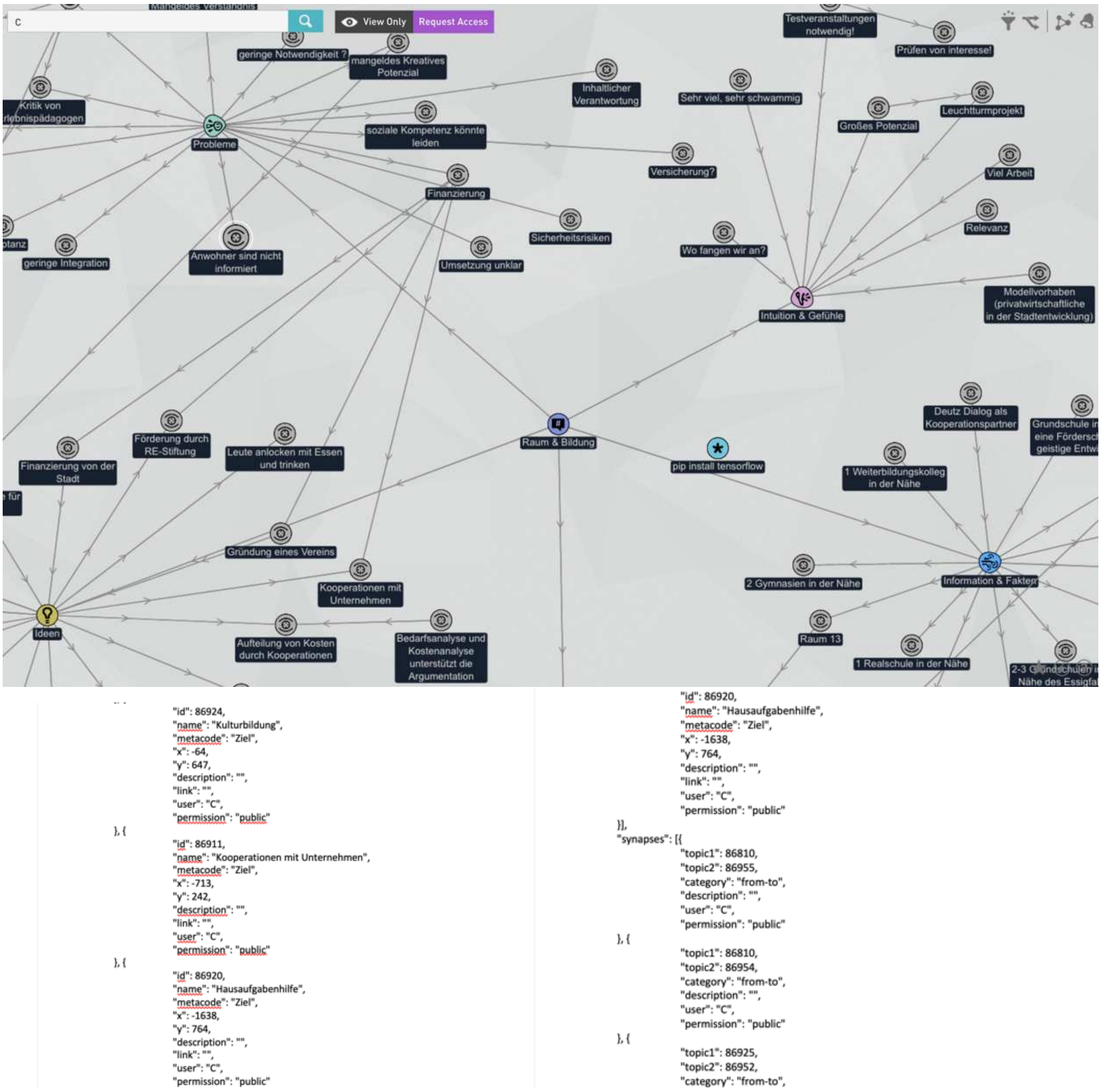

Abb. 4: Visualisierung der interaktiven MindMap und Auszug des Exports im JSON-Format (eigene Darstellung)

Um sich diesem, doch komplexen Thema in einem ersten Schritt nähern zu können, wurden in den gleichen Workshopveranstaltungen, in denen die Sprachaufnahmen als Speech-to-Wordcloud prozessiert wurden, zunächst interaktiv digitale MindMaps erzeugt, die relevante Begriffe quasi „per Hand“ einer

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Kontextkategorie zugeordnet haben. Ausgangspunkt dieses sehr rudimentären Kontextmodells bildete das Koordinatensystem der bewährten SWOT-Analyse aus Stärken, Schwächen, Potenzialen und Hemnissen. Um das inhaltliche Interpretationsspektrum des Kontextmodells noch zu erweitern, ergänzten wir die vier Bedeutungskategorien um weitere Kontextrubriken, wie z.B. Idee, Problem, Fakt, gesetzliche Vorgabe, Location, Ressource, Partner, etc.. Zur digital-interaktiven Erstellung der MindMaps kam die freie Software MetaMaps zum Einsatz, mit der sich eine klassifizierte Verknüpfung der diskutierten Inhalte kollaborativ und web-basiert erzeugen lässt. Diese Softwarebibliothek wurde auch deshalb gewählt, da die erstellten MindMaps als JSON-Datei exportiert werden können und damit folglich die Grundlage für ein maschinenlesbares und routingfähiges Knoten-Kanten-Modell darstellen. Dieses wird als Basis für das noch zu erstellende, semantische Netz dienen, mit dem die Sprachinhalte später weiter ausgewertet sollen.

Da sich viele Gesprächsinhalte auch mit konkreten Orten im diskutierten Stadtgebiet beschäftigten, wurde eine zweite, räumlich orientierte Kontextebene als kartografische Verknüpfung relevanter Orte hinzugefügt. Auf einem großen TouchTable wurde die kollaborative, auf den Softwareframeworks Django und Leaflet basierende Python/JavaScript-Bibliothek uMap, die eine einfache, der MindMap-ähnliche, aber georeferenzierte Zeichnung von Verbindungslinien zwischen relevanten Kartenpositionen ermöglicht. Die so erzeugten Geodaten können ebenfalls mit zusätzlichen Attributen verknüpft werden und wiederum im JSON-Format abgespeichert und exportiert werden.

Abb. 5: Diskussion der räumlichen Wechselwirkungen via WebMapping-Tool auf dem Touchscreen

Im weiteren Verlauf gilt es nun die beiden JSON-Datensätze durch ein geeinetes Feature-Schema inhaltlich und datentechnisch so zu verknüpfen, dass damit ein routing-fähiges Knoten-Kanten-Netz aus relevanten, wiederkehrend Bedeutungskategorien, einschließlich einer ersten Verbindungsstruktur erzeugt werden kann. Diese Arbeiten, einschließlich der Generierung des semantischen bis neuronalen Netzwerks und der automatisierten Abfrage der Begriffe aus der Spracherkennung sind allerdings noch gänzlich zu erbringen.

5 AUSBLICK

Der hier beschriebene Prototyp bildet ein Teilprojekt eines mehrjährigen EFRE-Forschungsvorhabens zur Erforschung KI- & AR-gestützter Technologien in Stadtentwicklungsprozessen. Zum aktuellen Zeitpunkt liegen die Komponenten des hier beschriebenen KI-Konzepts nur in prototypischer Form und als unverknüpfte Softwareskripte vor. Im weiteren Verlauf ist vorgesehen, die jeweils analysierten

Schlagworteinhalte so in die künftige Semantik zu implementieren, dass diskutierte Chancen und Risiken verglichen, statistisch analysiert und qualitativ bewertet werden können. Ziel ist es, diskutierte Wechselwirkungen und Verflechtungen städtebaulicher Potenziale und Hemmnisse zu dokumentieren, zu untersuchen und ggf. Scheinargumente oder Self-fulfilling Prophecies frühzeitig durch lernende Vergleichsanalysen erkennen zu können.

Neben den beschriebenen softwaretechnischen Aufgaben sind aber darüber hinaus auch noch wichtige datenschutzrechtliche Rahmenbedingungnen abzuklären und generell der individuelle Umgang von Projektbeteiligten mit der KI oder auch die daran geknüpften Erwartungen zu studieren.

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Machine Learning for Land Use Scenarios and Urban Design

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1 ABSTRACT

Geographic Information Systems (GIS) are becoming a more common tool in the practice of urbanism and urban design. Usually, GIS is used to visualize geo-located data to gain inside into the urban fabric, to either plan interventions within it, restructure it, or extend it. One problem for a data-driven planning process with GIS is how to turn the gained data into knowledge to drive a project.

This paper discusses the use of super- and unsupervised machine learning to develop land-use scenarios for a vacant site within the city parameters of Berlin. Unsupervised learning is used to find cluster which shares certain characteristics. This interpretation of the data helps to make more informed decisions.

As an example, for supervised learning, a neural network was trained to develop land-use scenarios fully autonomously. Autonomously generated land-use scenarios are an essential step to bridge the gap between the analysis and the design phase of urban development and enable the use of artificial intelligence in the planning process.

Keywords: Land-Use Scenarios, Urban Design, Neurnal Networks, Machine Learning, GIS

2 INTRODUCTION

The topic of "Big Data" or the handling of a multitude of digital resources in urban planning is a long-standing discussion that first emerged in the course of the "Smart City" movements (Batty 2012a; Batty et al. 2012b). The interaction of different disciplines such as planning but also computer science is essential for this phenomenon. On the other hand, the application of these new technologies also scares off many "old-established" planners, the entry hurdle in the application of these new methods was and is partly very high, administrations were not technologically prepared for this trend. The discussion about who has power over the data and who can and may process it has not stopped at urban planning (Streich 2018). Holistic data collection approaches in the smart city context have always relied on the collection of GIS datasets (Exner 2014). 3D city models, on the other hand, attempted to represent the topology of the city in its three-dimensionality (Döllner et al. 2006) and provided the first platforms for simulations in a three-dimensional urban context (Zeile 2010; Mach and Petschek 2006). With the approach of digital twins - coming from product development, transferred to urban planning (Batty 2018), simulation in the urban context is experiencing a renaissance (Dembski et al. 2019).

Using the possibility of parametric design, form-finding processes can be quickly integrated into urban situations. In König et al. (Koenig et al. 2017), "cognitive design" also uses contextual data such as GIS repositories to create and verify designs. In combination with methods of "artificial intelligence" or the "machine learning" assigned to the domain, various international research groups are trying to enrich novel, design methods with "intelligent" algorithms to make faster (and more transparent) statements about (urban) designs like relational urbanism in their approach for the Baishizhou Shanghai study (Ilaria Di Carlo 2016; Llabres and Rico 2016; Cantrell and Mekies 2018). While others generated the land use pattern with cellular automata such as KPF UI (KPF UI 2019, 2018). But some issues have still not been resolved:

How can the data be interpreted correctly in an urban context? Can planners and programmers go beyond the visual feedback of the single layer and analyse them?

In this contribution, we propose 1) a new method for organising land use plans (semi-)automatically out of urban land use datasets and 2) additionally give an outlook on how typological AI can be used to integrate the implementation of different land-use scenarios into generative urban planning processes.

3 MACHINE LEARNING FOR LAND-USE SCENARIOS

In this section we introduce the notion of "land use" used for us in the context of machine learning - it is solely about how we can use a meaningful approach to classify “use” / “land-use” on an urban district level. Land use represents the link between the land cover and the actions people take in their environment (Di

Gregorio 2005). Therefore in planning, the challenge is to find a suitable link between those two, so that the land is suitable for the actions people take and vice versa. While land use is relevant in different scales like the regional, city, district or quarter and parcel or building scale (Curdes 1995), in the following we will focus on the district scale.

In the following, we consider the search for suitable land use as a classification problem, while classification is assigning objects to a group based on several observed attributes. (Sathya and Abraham 2013)

If we use this logic to identify a suitable land use for a specific area, the object becomes a certain area of land which can be assigned to a group of potential land uses, based on its attributes. Following this approach implies that not merely the intention of the planner – but the characteristic of the land itself becomes the driver for the pursued use. Whereas the use can become the driver of the design itself.

The case study for the use of machine learning for land use scenarios was conducted and discussed for the Berlin Pankower Tor site, a flat conversion area of a former freight station. Both super-supervised and unsupervised machine learning were used to interpret geodata.

3.1 Methodology: Land-Use – from Vector to Grid Cell

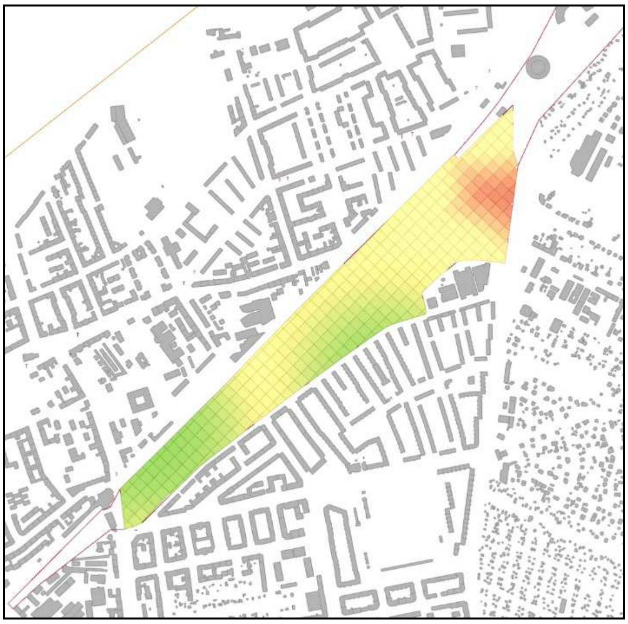
With the help of machine learning algorithms, we aim to go beyond the representation of geospatial data to a (semi-) automated or first interpretation of it. To apply the algorithms, we first have to prepare the geospatial data for it.

Within GIS the form of raster GIS and vector GIS or the mixture of both are commonly used to represent geospatial data (Winter 1998). To link areas as "objects" for classification with geospatial data, the objects need to be geometrically defined. Therefore, we chose a region-based grid GIS approach, in which we divided the site into grid cells.

Afterwards, we scaled the data to make them relatively comparable to each other. So instead of focusing on absolute values, we interpreted the interplay of relative values of certain data categories with the help of two different machine learning algorithms. Thereby we achieved with the unsupervised learning method we achieved different clusters of areas of a site based on the characteristics whereas with the help of a supervised learning method we assigned land use to specific grid cells based on the characteristics of the cell.

3.2 Data

Various data can be linked to the grid cells of the raster GIS. For example, they could be structured according to the order of the city structure in categories like the constructive spatial structure, land use structure, infrastructure, social and economic structures (Streich 2011).



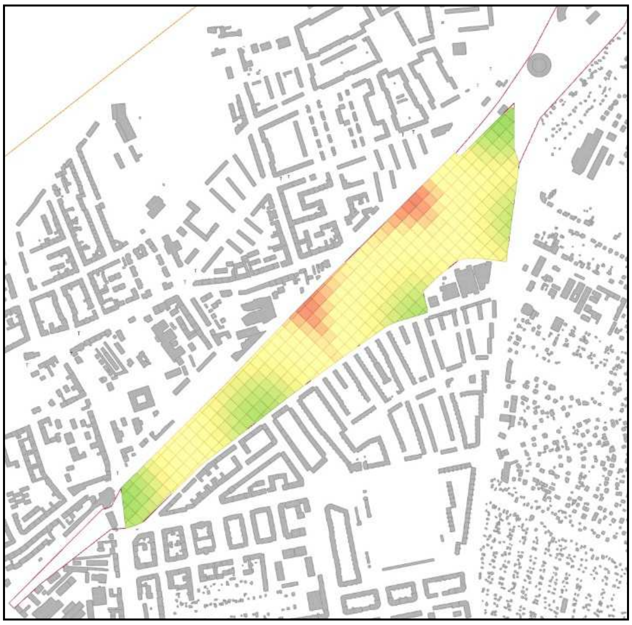


Fig. 1 (left): relative proximity to schools (green high proximity to red low proximity). Fig. 2 (right): relative proximity to public transportation (green high proximity to red low proximity)

The way we implemented geospatial data was by distinguishing distance-based data from environmental and morphological data. If this method would be implemented for analysis of an urban district, other categories such as performance, cadastral and socio-demographic data would matter as well. Distance-based data includes social, cultural or other amenities, local supplies, communal uses, transportation especially public transportation etc. measured in either the shortest or street network distance to the related cell. Environmental data focuses on aspects such as sun exposure, noise pollution ventilation and wind comfort, soil conditions and similar. Less relevant for the case study site as an even and cleared site was morphological data which would include the topology, landscape and existing build structures. Also performance data such as walkability, cadastral data and socio-demographic data didn't play a role in this case. We set a residential mix-use as a specific desire for land use. Therefore, qualitative measures of which land use is best for the site is less relevant. But relative measures like which areas on the site are better for land use x compared to other areas help to place a suitable use. In other words comparing the values of all categories between all cells.

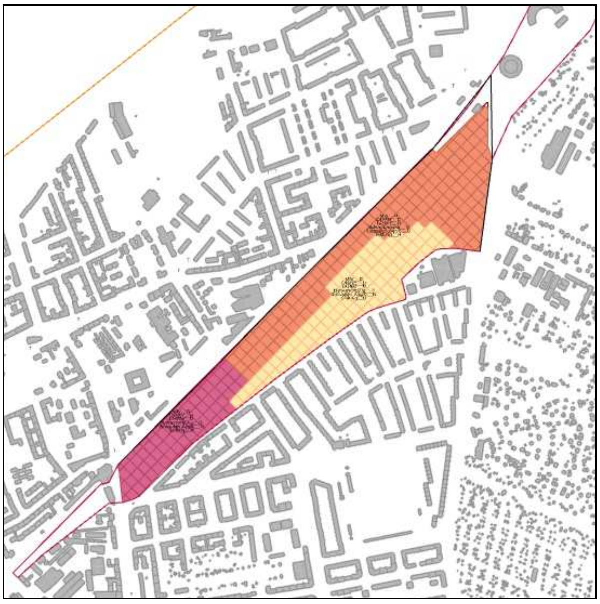
For the task presented in the case study, distance-based and environmental data were the most relevant decision criteria. As an example of distance-based data, we implemented educational facilities (see figure 1), public transport (see figure 2), general accessibility of the site, local amenities, as well as commercial uses based on agglomeration advantages. In the area of environmental data, information on relative noise pollution was used. Therefore we used geospatial data provided by OpenStreetMap (OpenStreetMap Contributors 2020) and the city of Berlin (Senatsverwaltung Berlin 2017).

3.3 Unsupervised and supervised machine learning

To explore the potential of machine learning for land use in the realm of classification, we tested different approaches within machine learning, namely supervised and unsupervised learning.

3.3.1 Unsupervised machine learning for land-use scenarios

As an example, for unsupervised learning, we implemented a k-means clustering algorithm in python with the help of the sklearn library.



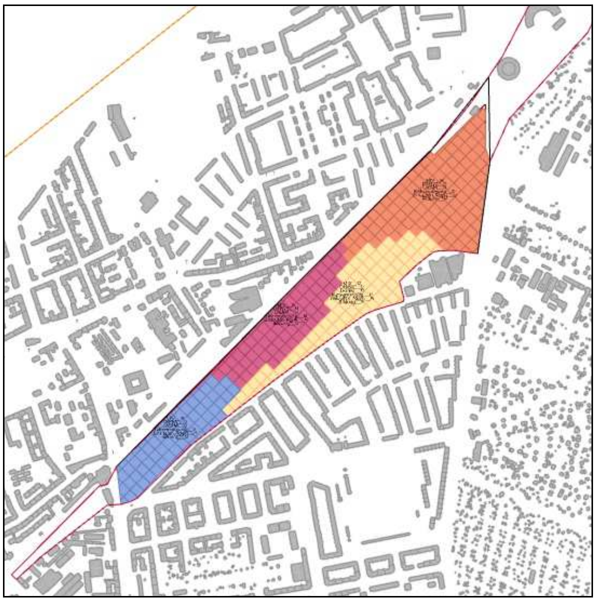
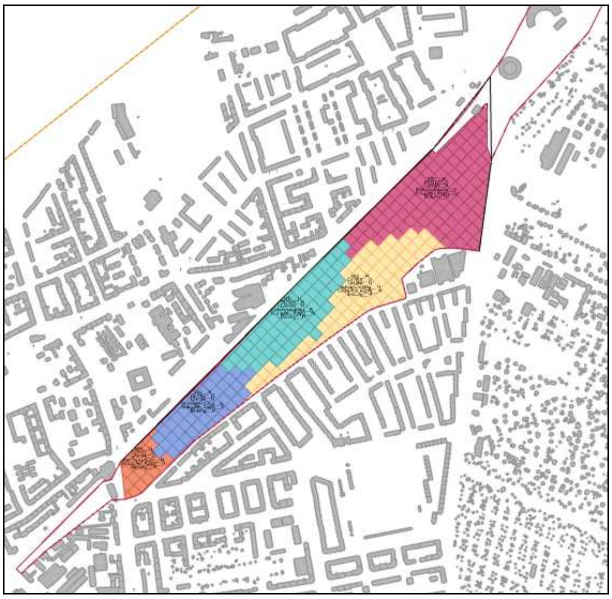


Fig. 3 (left): Clustering with three cluster. Fig. 4 (right): Clustering with four cluster.

orange	Education demand: high; motorized private transport: high; public transport: average; noise pollution: high; local amenities demand; low; shopping demand:low
red	Education demand: average; motorized private transport: low; public transport: high; noise pollution: average; local amenities demand; average; shopping demand:high
yellow	Education demand: average; motorized private transport: average; public transport: average; noise pollution: low; local amenities demand; high; shopping demand:low

orange	Education demand: high; motorized private transport: high; public transport: average; noise pollution: average; local amenities demand; average; shopping demand:average
red	Education demand: average; motorized private transport: average; public transport: low; noise pollution: high; local amenities demand; low; shopping demand:low
yellow	Education demand: low; motorized private transport: average; public transport: average; noise pollution: low; local amenities demand; high; shopping demand:low
blue	Education demand: low; motorized private transport: low; public transport: average; noise pollution: average; local amenities demand; average; shopping demand:high

Clustering aims to find subsets or clusters within the dataset that are related in terms of their data. The k-means clustering algorithm clusters the data by relating the data points to k sets of clustering centroids (James et al. 2017). This method is best compared to the planner overlaying different analysis layers to search for a pattern that may emerge from it. With the use of the k-means algorithm, this task is automated. The algorithm returns descriptive characteristics for certain clusters of the site. For instance, the description for the yellow cluster in fig. 3 is average values for access to education, motorized private transport, and public transport; low values for noise pollution and high demand for local amenities including a grocery store, while providing relatively low values for shopping. Clustering, therefore, allows to go beyond the visual feedback of a single layer and shows how clusters with similar characteristics emerge on the site. Looking at a different number of clusters helps to get a better grasp of how the site can be organized by relating the values of each cell to one another. This can help the planner make informed decisions while assigning land use. Determining the optimal number of clusters into which the data may be clustered is the popular elbow method (James et al. 2017). In this case, the elbow method suggests five clusters (see fig. 5).



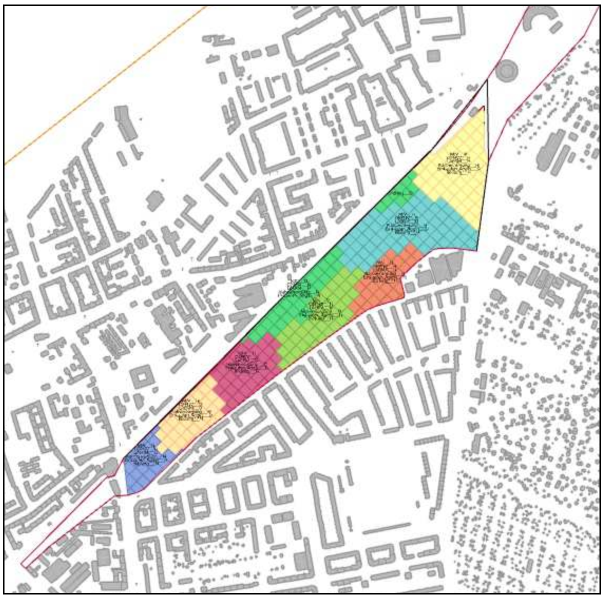


Fig. 5 (left): Clustering with five cluster (optimal acc. to elbow). Fig. 6 (right): Clustering with eight cluster.

orange	Education demand: low; motorized private transport: low; public transport: high; noise pollution: average; local amenities demand; low; shopping demand: high
red	Education demand: high; motorized private transport: high; public transport: average; noise pollution: average; local amenities demand; average; shopping demand: average
yellow	Education demand: low; motorized private transport: high; public transport: average; noise pollution: low; local amenities demand; high; shopping demand: low
blue	Education demand: low; motorized private transport: low; public transport: average; noise pollution: average; local amenities demand; high; shopping demand: average
light blue	Education demand: average; motorized private transport: average; public transport: low; noise pollution: high; local amenities demand; low; shopping demand: low

orange	Education demand: low; motorized private transport: high; public transport: high; noise pollution: low; local amenities demand; high; shopping demand: low
red	Education demand: average; motorized private transport: low; public transport: high; noise pollution: average; local amenities demand; average; shopping demand: average
yellow	Education demand: low; motorized private transport: low; public transport: average; noise pollution: average; local amenities demand; high; shopping demand: low
blue	Education demand: low; motorized private transport: low; public transport: average; noise pollution: average; local amenities demand: low; shopping demand: high
light blue	Education demand: high; motorized private transport: high; public transport: low; noise pollution: average; local amenities demand: high; shopping demand: low
green	Education demand: average; motorized private transport: average; public transport: low; noise pollution: high; local amenities demand: low; shopping demand: low
light green	Education demand: low; motorized private transport: average; public transport: low; noise pollution: low; local amenities demand: average; shopping demand: low
light yellow	Education demand: high; motorized private transport: high; public transport: high; noise pollution: high; local amenities demand; low; shopping demand: low

Since the planner still has to transfer the cluster to meaningful land use himself, this algorithm could be used as a semiautomatic approach, helping the planner to make more informed decisions.

3.3.2 Supervised machine learning for land-use scenarios

The aim of supervised learning differs from the one of unsupervised learning we discussed before. Instead of trying to find clusters on how the site could be organized based on the underlying characteristics, supervised learning relates a specific pre-defined land use to each cell based on how it learned to interpret its data.

So supervised learning depends on a training source with labelled data to train on and to classify the test data accordingly. We used an Artificial Neural Network (ANN) as an example for supervised learning. An ANN uses error signals to adjust its interconnection with weight combinations and thereby learns how to classify cells according to the training data (Sathya and Abraham 2013). We implemented the ANN with the sklearn and tensorflow python library.

Fig. 7 (left): Suggested land use by ANN for the ground floor: 0 – local amenities, grocery, 1 – no specific ground floor use, 2 – commercial (work), 3 – educational amenities, 4 – commercial (retail). Fig. 8 (right): Suggested land use by ANN for upper floors: 0 – residential, 1 – commercial.

As a training set, we generated a pseudo database of land use relating to the categories we use. Therefore, we described each land use how it relates to the categories. For example, a site for a grocery store is described as follows: rather good access to road infrastructure, for better coverage of local supplies a rather high distance to other grocery stores, a medium to high proximity to public transport, proximity to other stores is preferred but not required, proximity to educational facilities, noise pollution or other environmental factors are rather irrelevant. Commonly land use is classified into types such as residential, commercial, industrial, recreational, institutional, various types of green and open space, infrastructural and transportation land use (Reicher 2017). While the method introduced here can be used to assist a classification in such a way, we focused on the usage related to the following planning steps namely educational amenities, local supplies, commercial and residential land use. We differentiated between the use of the ground floor and the upper floors.

Green spaces and infrastructure were considered in a later step. Green spaces and infrastructure were then to the morphology of the urban design rather than to the characteristics of the site itself, even though in a different context, especially green spaces might be more related to the site characteristics and context influences.

In the training process of the ANN, we followed a conventional approach (Hastie et al. 2017). After we trained the ANN and filterd the results, we gained slightly related land-use scenarios for the site which could serve as a base for generating various urban design schemes. In a later stage, we double-checked the average shortest walking distance from each parcel to the amenities in various generated street networks to get feedback on whether it is well-positioned regarding walking distances. The amenities were mostly in their ideal location regarding their walking distance or only off by a parcel.

4 TYPOLOGICAL AI: IMPLEMENTATION OF LANDUSE SCENARIOS FOR GENERATIVE URBAN DESIGN

For a better understanding of what typological AI is and what approaches have been used in the context of urban planning, we start this paragraph by introducing similar approaches.

In addition to the more familiar approaches in architecture, parametric design and generative design have also found their way into urban planning (Fusero et al. 2013). Parametric models, applied for example by Zaha Hadid Architects (Rico 2011; Schumacher 2008) or relational urbanism (Cantrell and Mekies 2018; Ilaria Di Carlo 2016; Llabres and Rico 2016), are used for form-finding, scenario development and optimization of certain aspects of a design (Fusero et al. 2013). Generative approaches like from Nagy et al. represent more or less fully automated design generation to optimize development for profit and solar energy (Nagy et al. 2018). More recently, Design Space Exploration started to be used for multi-criteria and stakeholder optimization in urban design like suggested by Wilson et al. (Wilson et al. 2019, KPF UI 2019;) and implemented also by sidewalk labs and others (Ikhena 2020; Margrave 2020). The proposed method enables the generation of design variants via procedural geometry generation and statistical analysis of the variants. This allows a systematic search for designs based on performance criteria to find reasonably good trade-offs for multiple criteria and multiple stakeholders.

But how can the design space be generated to represent a rather extensive field of possibilities? And how can a generated design relate to its surrounding?

4.1 Methodology: land use to typological design generation

The already discussed ANN land-use scenarios require as input contextual, environmental and other influences as well as desired land-uses. Those land-use scenarios serve as a base for the procedural design generation of variants. The generation of the design variants is built up as follows: first, the structure of the district is generated based on the district typology, based on the construction fields of the district typology building typologies are generated and complete the urban design.

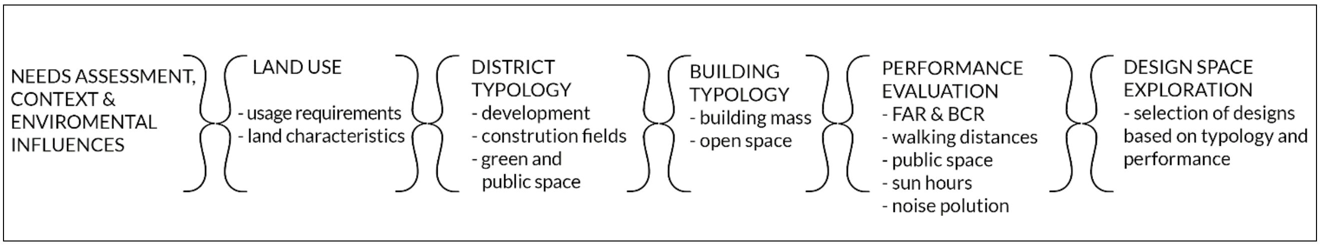


Fig. 9: Proposed workflow

The design versions are evaluated for floor area ratio (FAR) and building coverage ratio (BCR), real walking distances to key amenities, quantities of land usage, sun hours and noise pollution. After the design versions are exported including their performance data, they are imported into a design space explorer (DSE) to make them easily selectable based on their performance values and morphological criteria like the district typology, the building typology and the average building height.

4.1.1 District Typologies

There had been various approaches on how to generate urban design variants. A common way is to start with the street network and then to implement other morphological elements like green spaces and buildings (Schumacher 2008; Rico 2011; Cantrell and Mekies 2018; Fink and Koenig 2019; Wilson et al. 2019). In urban design also other approaches had been discussed, for example, to start with the green and public spaces and then to develop all other aspects according to it (Bott et al. 2014; Sheppard 2015). One of the key benefits of working with DSE is the ability to make different design approaches comparable and include them in the design space in which the planner and stakeholder can search for a suitable design scheme. To offer a design space that incorporates different approaches, we developed typologies for urban districts in the German context. Like building typologies also district typologies can benefit from the "inherent knowledge" (Curdes 1995) of the typology due to the "shared formula" derived from repetitive construction (Luna et al.

2010). The district typology incorporates the street network, construction fields, as well as the public and green space system. Following typologies had been developed, described algorithmically and were implemented in the generative process: the grid district, the irregular grid district, the fluent district, the cluster district, the central district and hybrid forms with the free shaped public space, overriding open spaces and various exceptions.

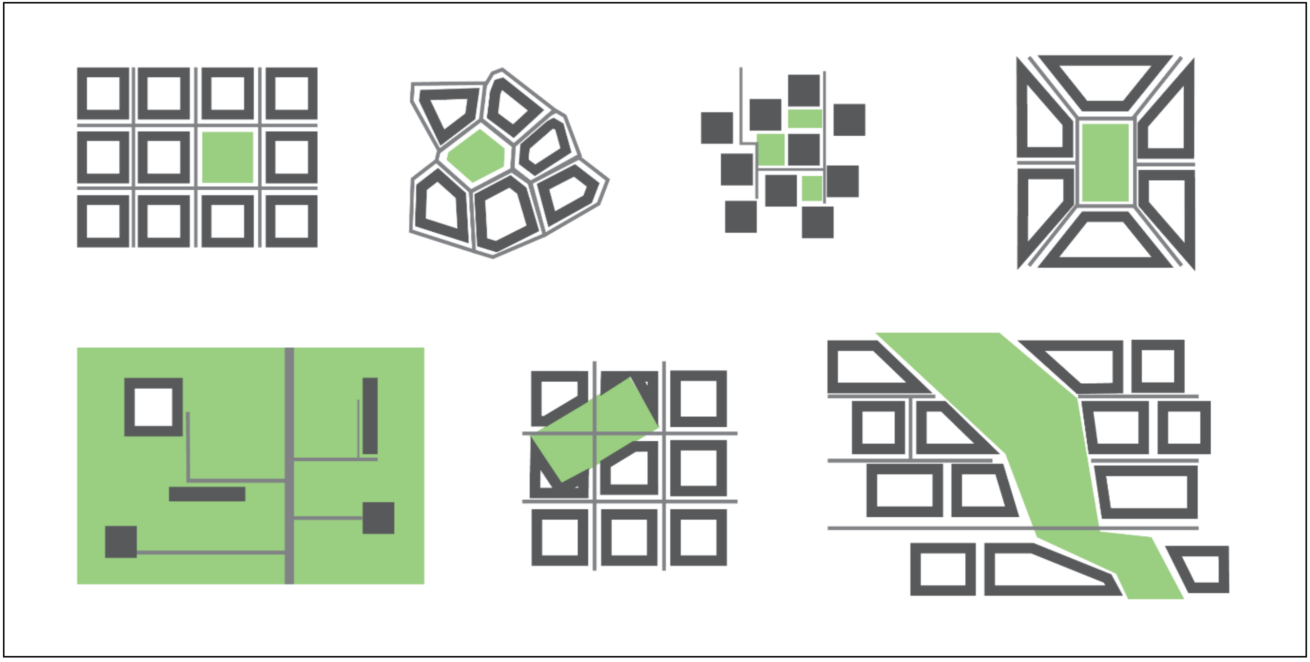


Fig. 10: District typologies: grid district, irregular grid district, cluster district, central district, fluent district, free shaped public space, overriding open spaces.

4.1.2 Building Typologies

Based on the construction fields and the land use, the construction fields are further divided into parcels suiting the land use. Based on the parcels and the land use, different building typologies are generated.

There are various suggestions for typologies on the building level (Bürcklin and Peterek 2016; Reicher 2017; Korda 2005). In this context, we implemented the perimeter block, the dissolved perimeter, linear buildings, detached houses including multifamily, the box and hybrid typologies.

4.1.3 Performance Evaluation and Design Space Exploration

After an urban massing is generated, it is evaluated on different performance criteria. Following the process of geometry generation like shown in figure 11, preliminary urban designs were generated based on the land-use scenarios derived from the Artificial Neural Network, district typologies and building typologies. At the point of the analysis (Fig. 11, 8) over a thousand variants were generated. For each land use scenario (figure 11, 3), the different district typologies (figure 11, 4-5) were applied in certain variants of the typologies, like different orientations or grid sizes etc. Based on the district typologies different building typologies (figure 11, 6-7) were applied again enriching the solution space. These generate urban massings are now calculated in quantities, like area usage of public versus private areas, FAR, BCR etc. and performance characteristics. We implemented a sunlight analysis (Ladybug 2013), real walking distances with a*search algorithm and noise exposure. Many other evaluations could be applied, like cost estimates etc.. But with each evaluation the time required for the computation increases. Based on these criteria, the choice of various typologies and their comparability with help of DSE makes them selectable for various interest groups like investors, cyclist activists, environmental activists, administration and others. We also found with a small study group, that the way the design variants are selectable with the DSE can be used to help also non-professionals to express their desires and priorities for the site based on a preliminary design. This could make this workflow interesting for more interactive participation methods like the Charette (Nanz and Fritsche 2012).

With this heuristic approach based on land use scenarios urban designs could be found, that outperformed an urban design study for the site in all areas (Christ et al. 2017). This means, that versions were found, that

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provided more open space as well as more build square meters, shorter real walking distances to all key amenities, more sun hours per façade square meter and less noise pollution.

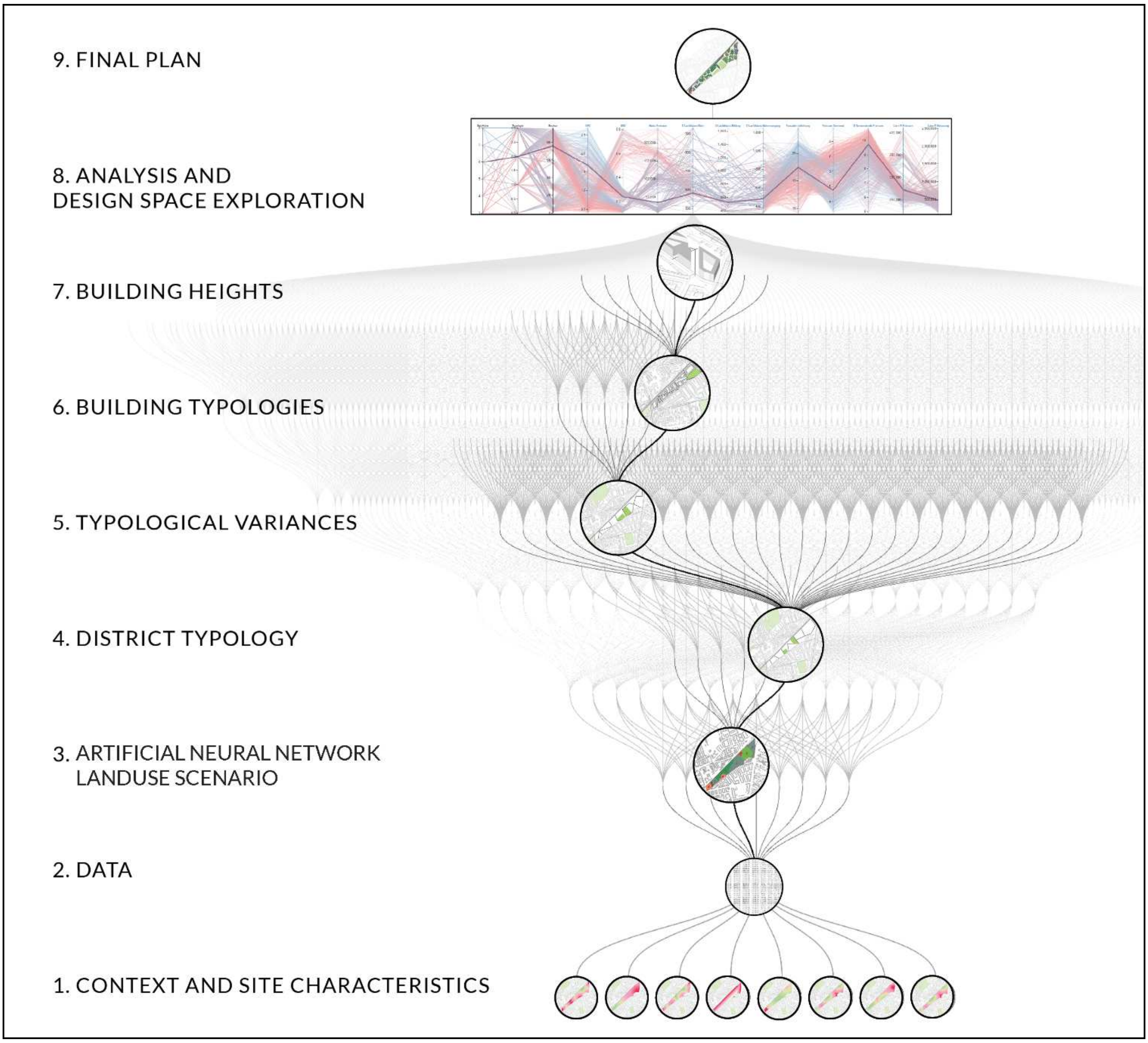

Fig. 11: Integration of the land-use scenarios in a generative typological approach

5 CONCLUSION

While both machine learning algorithms - supervised and unsupervised - aim to find hidden patterns in geospatial data referred to a site the way they do this differs. The fundamental difference between those two classes of machine learning is the existence of labelled training data (Wah and Berry 2020; Alloghani et al. 2020).

In supervised learning, with the existence of labelled training data, the data pattern or characteristics of a grid cell as data are directly transferred to a specific label from the training set in this case a land use. Whereas in unsupervised learning, the hidden pattern in the analysed geospatial data is related to each other as clusters. While the cluster emerge from the characteristics of the geospatial data of each grid cell. This makes each approach suitable for different use scenarios.

The supervised learning method, which was discussed with the example of an Artificial Neural Network for classification, is suitable for directly generating land-use scenarios and use these as a design basis for generative urban design. It comes with the upside of directly performing a task for the planner of placing the land use in a way that suits the labelled training set. This makes supervised learning suitable to at least partially automate the task to develop land-use scenarios.

But the training of the Artificial Neural Network and the description for the land use for generating the training data is a relatively time-consuming matter - especially if the requirements for the land-use change. Also, the ability to control the quantity in which each land use is assigned is rather limited.

Unsupervised learning on the other side does not directly transfer the information of the geospatial data to pre-defined land use or label. It rather provides an analysis of the relationship of the geospatial data, or the analysed characteristics of each cell, to each other. Therefore, it can be used as a helpful tool for analysis to show the planner patterns or better clusters which emerge from different combinations of geospatial data.

This approach is rather flexible and relatively easy to implement and can give the planner a first overview and inform the decision of where to place which use. The performance evaluation of the generated preliminary design based on the land-use scenarios shows that this method can help to find high-performance designs (s. 4.1.3) and especially DSE makes these design variants comparable and selectable based on structural or performance criteria.

In general, the presented AI mechanisms in combination with the design space exploration fits very well in the context of urban workshops, initial brainstorming, starting discussions and the first approaches with quantitative data to an area and the spatial grasping of the proposed uses and dimensions. It is intended to be a useful addition to the planning process at a very early stage - in the so-called preliminary draft, in which important urban planning parameters are set and checked for their effect. The tool still needs to be tested in real life situations to further evaluate the effectiveness for planning and participation.

The proposed concept is not intended to replace the actual planning work in the sense of plan elaboration and plan realization; rather, we see it as a useful addition to be able to "explore" variants more quickly, better and more transparently and to be able to better grasp not only qualitative design work but also quantitative urban development designs. Used sensibly, it helps to be able to quickly examine variants at an early stage. Artificial intelligence is not intended to replace the planner's profession, but to better prepare the basis for decision-making.

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Methods for Regrouping Economic Activities into Meaningful Clusters

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1 ABSTRACT

“The Flemish territory is characterized by a large urban sprawl […]. Even last years, an additional 6 hectares of undeveloped space is being built on daily. As a consequence open space is highly fragmented in Flanders“ (Pennincx, De Maeyer, Leroy, & De Mulder, 2021). As a strategic objective, the Flemish spatial government aims at a transition towards a net zero landtake daily by 2040. In this context, our spatial economy research group takes the choices and behaviour of individual companies and their use of space as a starting point. The main goal of the research is informing policy and supporting decision making by discerning spatial patterns, related to economic locations, and more precisely by focusing on the spatial environment of these locations.

Over the years, we developed a the business-oriented approach for local spatial-economic policy and location advice for companies (Giaretta, Zaman, Pennincx, & De Mulder, 2019; Zaman, Pennincx, & De Mulder, 2020). For this, we need the exact location of the activity and the exact activity of every economic site. However,this information is difficult to gather from the only area-wide economic administrative database for the whole territory of Flanders (VKBO) (Gruijthuijsen et al., 2018). This area-covering database is used for major spatial-economic analyses, but it falls short in precision at the detail level needed for our work. We have carried out quite a lot of research in recent years to get to know the terrain situation by creating a field inventory. A key element of the research is the search for the right spatial synthesis of the data collected at the level of the parcel: through economic ecotopes and market segments we sought to combine the (economic) parcels into meaningful groups with similar characteristics. We described this step in previous papers (Giaretta et al., 2019; Zaman et al., 2020).

Although the past research is interesting for the local policy makers of the mapped area’s, we still need to find a way to also make meaningful statements on spatial economic patterns for other areas in Flanders that have not been mapped. Producing this area-covering map for Flanders is rather important, as it will enable us to translate the analyses and the knowlegde we have gathered to (regional) policy. Although being thourough and rather precise, the visual inventory method has some drawbacks: it is time consuming and at this point, it cannot be easily applied to the entire area of Flanders. We therefore opt to first assess if we can extract useful statements regarding economic patterns from administrative databases.

The main research question is whether the synthesis of the mapping data into the economic ecosystems or economic segments can be reproduced with the administrative database. Obviously, the results from the administrative database and the inventory will not be 100% alike. However, we believe it is possible come to spatial economic meaningful groups, even using the administrative database. The purpose of this grouping remains the same as with the inventory work and economic ecotopes and segments: being able to inform policy choices related to economic locations.

In a first step, we examined whether and how the area synthesis (starting from the inventory and resulting into economic ecotopes and segments), that was carried out with manual work, field knowledge and expert opinion can be reproduced through automated methods, specifically through (1) statistical approach and/or machine learning and (2) a spatial predefined spatial clustering. The automated grouping results are reviewed and spatially analysed by spatial planners with territory knowledge. Only in a second step, when the grouping results on basis of the inventory are satisfying, we will rerun the method with the administrative data of the VKBO. In this paper we will discuss the first few steps of the grouping methods, in particular the distance and the activities clustering. We will outline the next steps, using the VKBO-data, assessing if we can come to meaningful economic clusters.

Keywords: machine learning, clustering, Spatial economic patterns, Business Perspective, Flanders

2 RESEARCH ISSUE/INTRODUCTION

In a more general way, we aim at informing policy choices regarding economic locations and the spatial environment of these locations. We therefore chose to investigate the microscale first, in order to then arrive at the mesoscale. Next, we are looking for ways to extend the mesoscale to similar areas in Flanders. To this end, we have two main sources of information: a visual field inventory, covering 3% of the entire Flemish area, and an economic administrative database that covers the entire Flemish area.

The first steps of micro- and mesoscale has been to focus on the organisation of economic activities and spatial patterns in Flanders. One part is the categorisation of economic units and parcels, that were observed in the field, into economic ecotopes and market segments of economic spaces. This categorisation is meant to advise companies and policies of the right location for economic activities: is the type of economic ecotope the one that is best suited to the companies' needs, located in that economic ecotope? Which territorial policies can close the gap between the companies' needs and current economic ecotope? (Zaman et al., 2020)

As the current administrative database for the registration of economic activities (VKBO), was mainly designed for legal purposes (and not spacial identification purposes), the exact location of the activity and the exact activity (many businesses register as many activities as possible) is difficult to extract from the database. A visual check between the exact registered location in VKBO and the reality on the field shows us a dicrepancy, that varies according the type of environment (Gruijthuijsen et al., 2018). Therefore, we have been visually recording economic activities on the field since 2017, trying to understand the spatial-economic patterns (for the method see (Giaretta, Pennincx, De Mulder, & Zaman, 2018; Giaretta & Zaman, 2017; Giaretta et al., 2019; Zaman et al., 2020). In november 2019, we had mapped an area of almost 38.000 ha in Flanders and Brussels including almost 45.000 economic activities on 34.000 parcels. This led us to the creation of 16 types of economic ecotopes (Zaman et al., 2020). These are economic environments, taking into account the mix of economic activity and the distance between economic activities.

Although the past research is interesting for the local policy makers of the mapped area's, we still need to find a way to also make meaningful statements for other areas in Flanders that have not been mapped. A considerable area was inventoried with a big difference in types of spaces. However, we want to be able to extrapolate the findings to the whole Flemish territory. Producing this area-covering map for Flanders is rather important, as it will enable us to translate the analyses and the knowlegde we have gathered to (regional) policy. Last, but not least, as researchers in the Flemish government we want to generate research that is consistent for the whole territory. For the time being, there are two possibilities to make this switch to the Flemish scale level: an area-wide inventory of the economic use of the parcels or resorting to the administrative data sources. Although being thourough and rather precise, the visual inventory method has some drawbacks: it is time consuming and should ideally be done once a year to capture changes, as companies come and go, move to another location, expand (or decrease) their activities and so on. The first field work dates from 2016 and it is very likely that it is outdated for some economic locations. At this point, a field inventory of the entirel Flemish area cannot be easily applied: according to the distribution of competences of the different administrations, the source data of economic information for the entire Flemish territory fall under economic administrations, not under those of spatial planning and environment. Before resorting to a field inventory of the entire Flemish area, we want to asses if we can get any useful results from the administrative database: what type of statements regarding the spatial economic patterns can we extract?

The aim is to create spacial meaningful groups of economic activities, that can be reproduced later on, with each new release of the administrative databases. Of course, the results of this automated grouping will not be exactly equal to the 16 types of economic ecotopes, as the visual and automatic methods are too different. However, both start from the visual inventory of economic activities.

3 THE SEMI-AUTOMATED APPROACH TO OVERCOME AN EXPERT-BIAS

In the visual construction of the area types (starting from the inventory of economic parcels into 16 types of economic area's/ecotopes), the researcher used a semi-automatic approach (Giaretta & Zaman, 2017). The previous attempts, made by experts to group the economic parcels, were based on a purely visual interpretation and revealed a considerable expert bias (Gruijthuijsen et al., 2018). A first pitfall was splitting the mapped territory into traditional spatial entities such as "industrial park", "city centre", "main road",…, whereas the mapping of economic activities clearly did not stop at the pre-defined borders. The inventory showed for instance quite an amount of productive activities in the mixed fabric of certain areas, which went against the expectations of experts, who tend to see mixed environments only suitable for retail and offices, and industrial parks as the exclusive location for productive and wholesale activities. As a consequence, productive and wholesale activities were not taken into account or acknowledged in mixed environments, according to the expert-based economic area types. In order to overcome these biases, we objectified the occurrence of economic activities into groups, and later interpreted them again.

This method consists of three main steps. First of all, the parcels with economic activities are divided into classes based on distance from each other (0m, 20m, 50m, 90 m) (ArcGIS near tool). Each parcel with an economic use gets an additional attribute field containing the distance to the nearest other parcel with an economic use. This produces a map of parcels with an economic use, grouped by distance. The second step of the operation was to use this map as an indication for drawing polygons based on the key paterns, e.g. distance, density, local field characteristics, grouping the different polygons into three new types. A first group, concerned the merging the neighbouring polygons with a continuous occurrence of economic activities. The second new group consisted of the nearby polygons with less continuous economic activities and even including small clusters of continuous economic activities. The third new area category regrouped the rest of the mapped area, in which economic activities are spread out and fragmented. It is important to note that in this fase of manual drawing, the researcher ¬–who was a spatial expert– applied his knowledge of physical spatial boundaries such as recognising main streets and entrances to back streets, streets with different width, zones for loading and unloading, etc... or spatial appearance such as building typology, presence of greenery or pavements, etc. In the third and last step, in order to define homogeneous areas of similar economic composition, these areas were again subdivided using the presence of different economic activities. A continuous economic area (e.g. along a main road) where one section is mainly retail, and another section has also productive activities would be split in two, to create two distinct, more homogenous types. In this step, the parcel map was initially interpreted visually. In our 2020 paper we explored the types more in depth (Zaman et al., 2020). Again, terrain characteristics were taken into account by the researcher-expert.

The method resulted into a classification of 16 types of economic ecotopes) (Zaman et al., 2020). These are economic environments, taking into account the mix of economic activities and the distance between them.

4 AUTOMATED CLUSTERING (USING THE INVENTORY OF PARCELS WITH ECONOMIC USE)

Although much of the additional field characteristics and implicit knowlegde used by the planner in the semi-automated method could in theory be available digitally, these data are difficult to identify, interpret and to collect for the research areas and the entire Flemish territory. The automation must therefore replace the expert knowledge with something else that also results in a usable spatial economic classification.

Taking aside the extra information the planner used in order to define the final economic types, the semi-automated method consisted of two 'objectifiable' steps: firstly, clustering the parcels with economic activities into categories based on distance between the parcels with economic use and secondly, when this distance clustering gives a stable and accountable result, analysing what types of activities are collected in the clusters. Finally, this leads to a new homogenous groups, that are relevant from a spatial economic point of view.

The goal of the economic classification is a map, showing spatial economic relevant results, that covers the entire Flemish territory. Eventually it will be based on data available in administrative (economic) datasets (VKBO). We therefore first tested several methods on distance and activities clustering within the mapped area that contains the data of the terrain inventory. Next, we tried to reproduce the methods with the administrative datasets. This will be discussed in point 5. Every automated step was reviewed by spatial planners with terrain knowledge.

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4.1 Distance clustering

We used several methods in order to reproduce these two steps. For the distance clustering we used four different methods: (1) DBSCAN on distance between centroids of parcels, (2) ST_ClusterWithin (3) DBSCAN on GPS routing distance between access points of parcels and (4) Predefined building blocks.

The DBSCAN algorithm is an intuitively quite easy to understand clustering technique. Starting from a random data point, we find out which other data points are within a defined distance (Method 1: 20m, 50, 100, 500, 5000 m and Method 3: ranging from 25 to 250m walking distance between the access points in steps of 25m). For each new data point we then check which other data points are not yet assigned to the cluster and are also within that distance. We repeat this process until there are no more data points in that cluster. Although the method is interesting because it clusters only data points, regardless of the context (cf. biased view of experts in section 3), and because it clusters on both sides of a same road, the randomness of the method has its drawbacks. The algorithm uses both the distance and a minimum number of points to define the core of a cluster. Points that are only reachable from one core point (and not meeting the minimum number of points critirium), are border points. In our data, there are many border points that can be part of different cores, but in reality belong together in one cluster. (Schubert et al., 2017) The DBSCAN clustering seems to jump sometimes to other points, and to forget the continuity of the cluster in other directions. This 'border' condition results in some 'missed' points, that end up in other clusters (See Figure 1). Another problem with DBSCAN is the size of certain parcels. E.g. when we set DBSCAN variable to 25m, as we want to cluster the parcels where the walking distance between access points is 25m or less, neighbouring parcels end up in a different cluster just because they are larger than 25m. However, using a larger walking distance between the access points, such as 100m, tends to smoothen out all differences: everything is put together in one big cluster. Interesting differentiation is then lost (Figure 1, left image). Variants of DBSCAN such as HDBSCAN* work hierarchical and deterministic (McInnes et al., 2017), and will overcome the randomness of the border points, but it remains uncertain whether it will result in accountable spatial clusters.

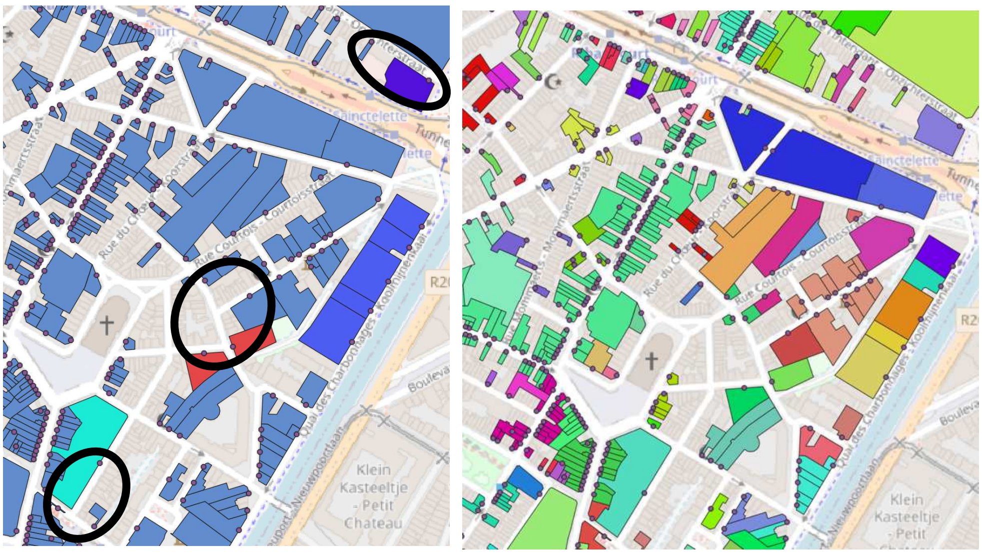

Figure 1 : Distance clusters with DSCAN at 100m (access points) in Brussels centre. Left: some accesses are closer to each other than 100m and yet, are not taken in the same cluster. Right: Distance clusters with DSCAN at 25m (access points): because the parcels are too large, they end up in different clusters, although they are neighbouring. (Background layer: Open Street Map)

The difficulty of dealing with large parcels is mainly due to the reduction of a polygon to a point (centroid or access point). In PostGIS the ST_ClusterWithin function is an aggregate function that returns an array of geometry collections. Each geometry collection represents a set of geometries that are separated by no more than the specified distance (in our case 0,1m, 20m, 90m, 500m). Although this method actually clusters parcels according to a certain distance without randomness, the results show that there are a lot of small clusters, that form a spatial economic point of view should belong together. Next to this, back and front streets are not differentiated.

The fourth method consists of predefining building blocks according to their distance to certain types of roads in OSM[1] (Pedestrian = 25m, Tertiary = 50m in Flanders and 25m in Brussels, Secondary = 70m in Flanders and 50m for Brussels area, Primary = 70m). Only parcels that are within the settlement area are taken into account (Poelmans, Janssen, & Hambsch, 2021), and are categorised according to their distance to pedestrian, tertairy, secondary and primary road.

Figure 2: Distance clusters with ST_Cluster_Within at 0,1m (full colour polygons), 20m (striped polygons) and 100m (dotted polygons). Left: Inner city with primary and secundary shopping street in Roeselare, Flanders: At 0,1m distance, it is logical that roads slice groups that should be together. However, from an spatial economic perspective this does not make sense. Right: A main shopping street in Brussels outer city centre is sliced into several groups. (Background layer: Open Street Map)

After this, parcels are dissolved into building blocks or parts of building blocks. Figure 3 (left) shows the Flemish city of Hasselt that is characterised by two circumferantial roads. The bigger circumferantial one is the main ring road, a primary road, functioning on a regional level (turquoise colour). The smaller one is a secondary road, connecting the regional and local function (blue colour). It surrounds the medieval city centre, that is now mainly a pedestrian area (pink colour). The two ring roads are linked by several secondary roads. The other building blocks that are not within a certain distance from pedestrian, tertairy, secondary and primary roads are the „rest“ category (green colour). The roads around these building blocks have mainly a local function, e.g. connecting residential area's or some parts of business/industrial parks.

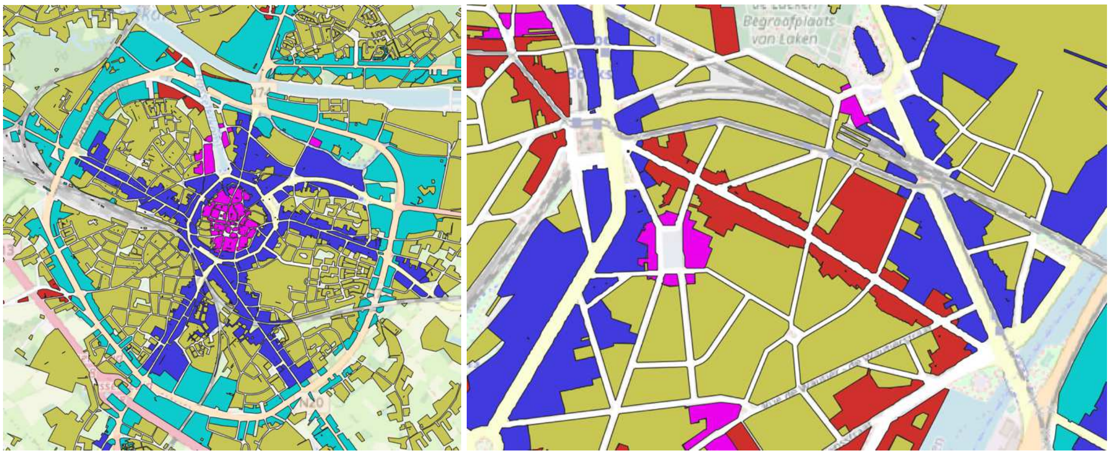

Figure 3: Distance clusters according to predefined building blocks linked to OSM types of roads. Left: the Flemish city of Hasselt and surroundings show that a categorised road network is clearly visible. Right: in the building blocks in the main shopping street in Brussels outer city centre, we distinguish now clearly the main shopping street, as well as the slicing of building blocks, according to back and front streets. (Background layer: Open Street Map)

On the right part of Figure 3, the main shopping street outside the city centre of Brussels, is now clearly defined around a tertiary road (red colour). Because of the predifined distances, the building blocks are as well cut into two parts: a front part, adjacent to the relevant road type, and a back part, that does not have the

1 Open Street Map in Belgium categorises roads into Pedestrian, Motorway, Trunk, Primary, Secondary, Tertiary, Residential, Unclassified, Track, Path, Footway. For our project we assessed that the types Pedestrian, Primary, Secondary and Tertiary were the best suited, as they relate economic locations to accessibility.

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same access and visibility as the front part. The advantage is that we have a spatial clustering that is independent of the presence of economic activities, that has additional attributes linking it to a street name or a street type, and is small. The small size of each cluster combined with the street attributes can allow to merge clusters with the same characteristics in a later stage. It can also prove to be very usefull when we need to add other data (on housing, green, inhabitants,…) to get a better understanding of the differences between types for sit location choice.

4.2 Forming (new) groups through clustering activities

After having a distance clustering, the second general step is to regroup the distance clusters into new groups based on activity mix. The activity combinations in these groups should be internally more or less homogenous, but comparing the groups between each other, they should show enough difference. We used again three methods: (1) Factor analysis (FA), (2) Principal Component Analysis (PCA) and (3) hierarchical manually determined thresholds. A FA is an exploratory data analysis method used to find influential underlying factors or latent variables based on a set of observed variables. It assists in data interpretation by reducing the number of variables. It extracts the maximum common variance from all variables and places them in a common score. The FA was done in promax rotation and 16 factors could be determined. Although quite similar to FA, the PCA is a more robust method and is for instance used in Numerical Ecology (Legendre & Legendre, 2013). PCA is common in exploratory data analysis and predictive modelling. It usually helps reducing dimensionality by projecting each data point only on the first few principal components to obtain low-dimensional data, while preserving as much of the variation of the data as possible. The PCA revealed that certain activities such as Health Care; Education; Vehicle cars/trucks; Arts, Culture, Leisure and Sports; and Vacant are clearly distinguishable from each other. The PCA resulted in 9 groups, where for example Vehicle related activities are mainly in factor 9 (F9), Arts, Culture, Leisure and Sports in F7, and so on.

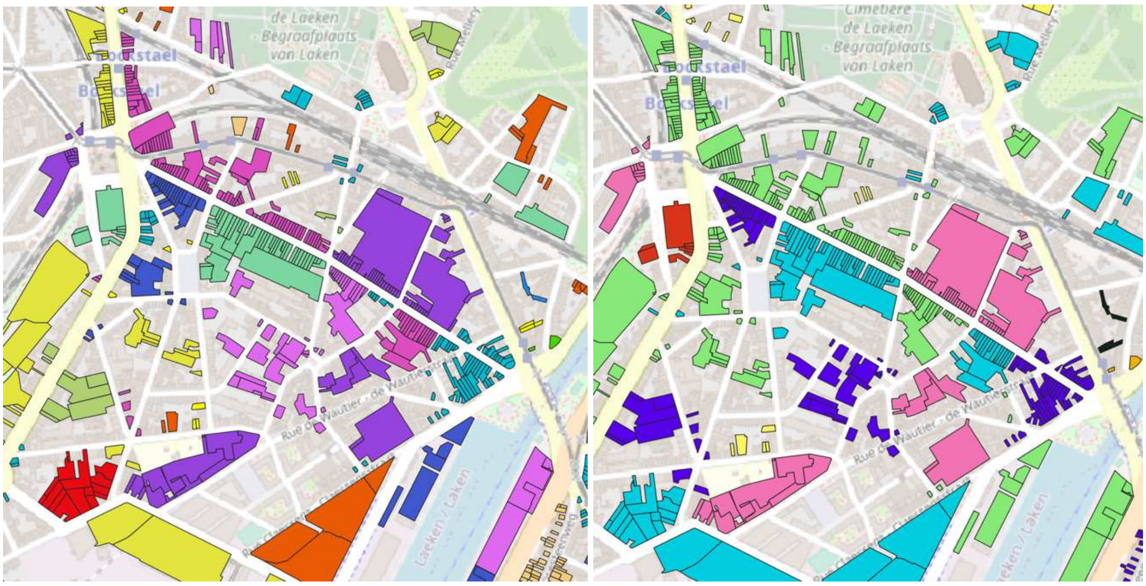

Figure 4: A main shopping street in Brussels outer city centre. Right: Activities clustering with FA – 16 factors. Each colour is another factor. Left: Activities clustering with PCA in 9 factors. The results of both methods are, when compared to terrain knowledge, quite difficult to interpret. (Background layer: Open Street Map)

However, the new formed groups provided by the two activities clustering methods, FA and PCA proved when reviewing and comparing them with in depth terrain knowledge, to be quite difficult to interpret and explain. On one hand, it is not always clear why a type of activity ends up in a certain factor/group, meaning that the differentiation between factors is not clear. On the other hand, there is not always enough differentiation. For example in the PCA, factor 1 (F1) contains more than 50% of all the economic parcels, and is the most mixed factor. It is not clear why a group of parcels belongs to F1, instead of a more „specialised" factor. It contains for instance Vehicle related activities, whereas these activities could also be in F9. In the PCA, activities related to Arts, Culture, Leisure and Sports (ASC) should be grouped in the more „specialised" F7. However, Figure 5 shows this activity is as well in F6. It would make more sense to have these two groups of F6 in either F7 because of the ASC, or in the same factor 1 as the rest of the street, which is the factor with most mixed activities.

The third method of activities clustering has a less statistical background, and is based on defining certain tresholds within the building blocks, in order to come to a spatial economic relevant result. We used the economic typology maps as touchstone and guide.

The categorisation of the building blocks is based on three aspects: (1) using a count of the total parcels in the building block, the propotion of parcels with economic use versus the parcels without economic use, (2) the average distance between the parcels with economic use and (3) using a count of the parcels with economic use, the proportion of the type of economic activities (e.g. services, industry & production, restaurants & bars,…). The first two aspects are quite similar to the semi-automated approach where the parcels with economic use were divided into continuous, close, discontinous and solitary categories. As we start from the fourth method for distance clustering, there are no economic data connected to the clusters. Each distance cluster is joined to the data of the individual parcels with economic uses (type of activity, nearest parcel with economic activity, distance). These are used to calculate density and intensity of economic activities in each cluster. Thresholds are manually set to resemble the results from the semi-automated approach. From the count of economic activities and the proportion of each category of economic activities, the type is further developed with conditional statements. When a certain condition is met (e.g. more than 50% retail) the type is defined regardless of the other values, if not the next condition will be checked. The resulting map of types of economic ecotopes ressembles the manually produced map, but in this case based on a SQL statement.

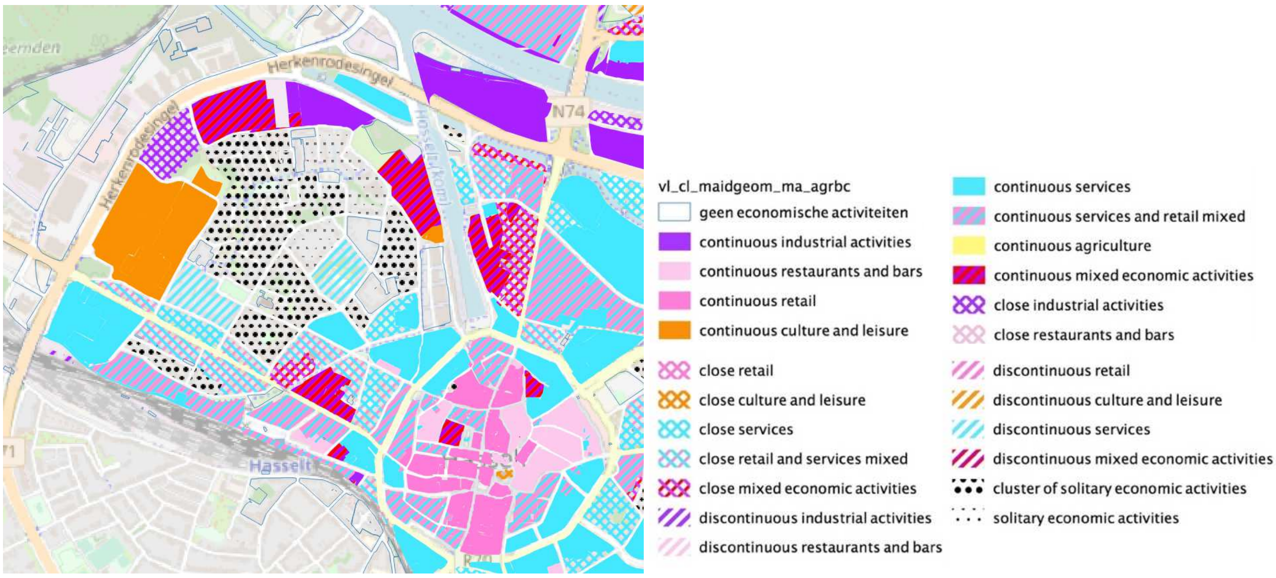

Figure 5: Activities clustering within the predifined building blocks, in the Flemish city of Hasselt. (Background layer: Open Street Map)

Figure 5 shows the results of the clustering in the Flemish city of Hasselt. The economic dense inner medieval centre contains a lot of continuous retail, restaurants and bars, with closer to the small inner circumferential road more continuous services. There are more mixed economy and industrial activities in the vicinity of the bigger circumferential road, which seems logical as there are a couple of regional industrial parks. The secondary road connecting the inner to the outer ring road structures some continuous and close economic activities. The more residential area's accomodate more isolated economic activities. Overall, this description corresponds well to the observations we made in the field. However, the method has as well some disadvantages: (1) it is not certain the results can make sense from a statistical point of view; (2) the thresholds are defined in a way to show relevant differences, based on an expert opinion, and can be biased; (3) it might be that the results cannot be reproduced with machine learning or other forms of artificial intelligence, making it difficult to obtain an extrapolated map for the whole territory of Flanders.

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Methods		Distance clustering	Activities clustering	Results +	Results -	How to improve?
		First clustering	Second, new clustering			
1	DBSCAN + Factor analysis	DBSCAN: parcels with economic use clustered as points (20m, 50, 100, 500, 5000 m)	Factor analysis: 2 groups	Distance clustering: unbiased look in clustering method	Distance clustering: Because of the random function in DBSCAN, some points are overlooked (**Fehler! Verweisquelle konnte nicht gefunden werden.**) Activities clustering: Only 2 factor gives not much differentiation.	Trying another algoritm for distance clustering
2a	Cluster-Within + Factor analysis and PCA	Cluster Within: Parcels with economic use grouped as polygons (0,1m, 20m, 90m, 500m)	Factor analysis: 16 groups	Distance clustering: ClusterWithin groups economic parcels in more are less meaningful groups, based on distance.	Distance clustering: Some groups should be together. Width of (broad) roads slices clusters into smaller groups (**Fehler! Verweisquelle konnte nicht gefunden werden.**) Activities clustering: -Not all categories seem to be spatially relevant	Trying another distance clustering in order to capture different groups in one group, so that both sides on the same street are in one group
2b			PCA: 9 groups	Activities clustering: PCA method is more robust, used in Numerical Ecology (Legendre & Legendre, 2013)	Activities clustering: -Not all categories seem to be spatially relevant -Clusters are either too big or too small. The size of the parcels matters (**Fehler! Verweisquelle konnte nicht gefunden werden.**)	
3	DBSCAN	DBSCAN: parcels with economic use clustered as main access points /front entrances (distances ranges from 25 to 250m)	N/A	Distance clustering: Overbridging the distance of small roads, so that the two sides of the roads are in one group is sucessful	Distance clustering: Because of the random function in DBScan, distance points are overlooked (**Fehler! Verweisquelle konnte nicht gefunden werden.**) -Defining main entrances difficult at corner parcels and asymetrical polygons -Clusters are either too big or too small. The size of the parcels matter (**Fehler! Verweisquelle konnte nicht gefunden werden.**)	Trying another algoritm for distance clustering
4	Predefined building blocks	Based on predefined distance between building blocks (includes all parcels of the settlement area, not just economic use parcels) and the roads. (25m, 50m, 70m)	Activities added to building blocks. Used of predefined tresholds to categorise the blocks into 23 categories	Distance clustering: -Differentiation is successful, regardless if the parcels are big or small (**Fehler! Verweisquelle konnte nicht gefunden werden.**) -Type of road is a defining factor for economic activities (e.g. one end of building block is at a main road; other end at a back road) Activities clustering: -Monitoring changes in building blocks is easier, as they stay always the same -All parcels in settlement area are included, which makes it easier to add more characteristics that are non-economic	-It is not sure the results make statistically sense -hierarchical system, we might be biased (e.g. defining tresholds)	Do some statistical analysis

Table 1: Summary of the used methods to make distance clusters and then regroup them into activities clusters

5 FIRST RESULTS OF USING THE SEVERAL METHODS WITH ADMINISTRATIVE DATABASES

As mentioned before, the administrative database (VKBO) that contains information about the location and the type of economic activities shows discrepansies with the data collected on the field (Gruijthuijsen et al., 2018). Next to this, each record in the VKBO contains a lot of NACE-codes. Choosing one activity, is not an easy task. Comparing the administrative database with the field observations, there are a lot more records in the VKBO. On average, the number of economic locations visible on the field accounts for only 48% of the number of businesses registered in the VKBO data. In certain residential area's there could be three times as much activities in de administrative database. There is definitely some extra research to do in order to determine for which categories of economic activity the discrepancy is large and for which the information from VKBO does give a good picture of the actual activity.

Nonetheless, some first tests with the VKBO, using the previous distance and activities methods, have been done, trying to replicate: (1) the PCA results via machine learning (ML) algoritms and (2) the predifined building blocks. The test with ML consisted of two steps. First of all, the results of the PCA within the mapped area of the inventory of the parcels with economic use are scored on accuracy according to ML algortims K-Neighbours Classifier and Random Forest Classifier. This resulted into high accuracies varying between 0,93 and 0,95. The next step is to label the geografically obtained distance clusters with the activities (NACE-codes) on the parcels as available in the VKBO. Afterwards, a model is again trained through ML algorithms to find, this time on the basis of the NACE activities, the obtained activities clusters. This approach gave results around 0,59 and 0,57 accuracy.

The last test consisted of using all available NACE-codes and linking them to the predefined buildings blocks of the distance clustering. New thresholds had to be developped, as the non-visible businesses are also included in the data. Considering the dominance of service activities, most of the parameters were set rather low. Figure 6 illustrates the first results for the Flemish city of Hasselt.

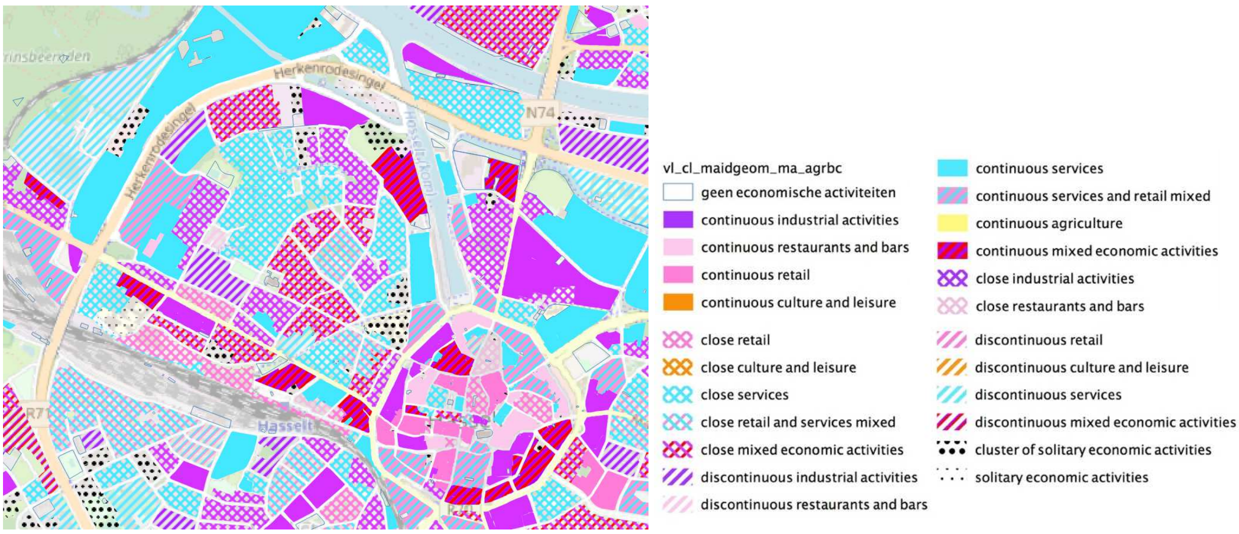

Figure 6: Activities clustering within the predifined building blocks, based on all available NACE-codes, in the Flemish city of Hasselt. (Background layer: Open Street Map)

6 CONCLUSION

Our recent work focussed on comparing potential methods for creating a map of economic ecotopes for Flanders, based on the experience from mapping economic a small part of our territory. We produced different methods to get to an automated or scripted result, based on an inventory of economic activities. This shows that (1) clusters of economic activities exists and (2) that types are statistically different, as the PCA and FA show. However, spatially interpreting these clusters proved to be more difficult. So far, adding some spatial information to the characteristics seems to be necessary. Therefore,we also created (3) a hierarchical, conditional method (based on the building blocks) to obtain similar results to drawing the types manually, and (4) proved that this can also be done using the registry of companies database. It is not yet known if this clustering method with the building blocks makes sense from a statistical point of view or if it can be reproduced for the entire area of Flanders. In conclusion,, for each of these methods, many difficulties need to be solved from the point of view of spatial interpretation, statistics and choice of treshholds,and more exploring of different ways of doing this will be needed. We consider it a big advantage to be able to compare this variety of approaches as we assume it will help us make an educated and informed choice on how to represent the map of types of economic ecotopes in Flanders, and to use it to provide policy advice.

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The next steps will include the development of both a statistical and an hierarchical method to produce this map. We will also try to understand what makes the key differences between the field inventory of visible economic activities and the location of companies in the registry (VKBO). Regarding the DBSCAN and ST_ClusterWithin, we think that a more in depht knowledge of how the algorithm (and its derivatives e.g. HDBSCAN, GDBSCAN) works with our type of data will be needed.

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Mobilitätswende in den Köpfen – interdisziplinäre Analyse zur Einleitung von Transformationsprozessen im Verkehrssystem

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1 ABSTRACT

Die Erreichung der Klimaziele und eine menschengerechte Gestaltung unserer Städte sind in hohem Maße von einer Reorganisation des Verkehrssektors auf allen Ebenen abhängig. Die Initiierung eines Paradigmenwechsels muss dabei als Strukturveränderung verstanden werden. In einem interdisziplinären Ansatz beleuchten wir das Thema aus Sicht der Ingenieur- und Planungswissenschaften, Soziologie sowie Politikwissenschaft. Anhand der Multi-Level-Perspektive beschreiben wir Rollen, Abhängigkeiten und den Einfluss von Akteurinnen und Akteuren sowie strukturelle Barrieren der Mobilitätswende und weisen auf mögliche Lösungen hin. Die Ergebnisse zeigen, dass dringend auch eine „Mobilitätswende in den Köpfen" der Verantwortlichen in Politik, Planung, Verwaltung und Wissenschaft erforderlich ist, da sie Rahmenbedingungen vorgeben oder beeinflussen, Entscheidungsgrundlagen schaffen und/oder unterstützen und Maßnahmen definieren und umsetzen (sollen).

Keywords: Governance, Transoformation, Verkehr, Mobilität, Multi-Level-Perspektive

2 EINLEITUNG

Speziell in Bezug auf die voranschreitende Klimakrise ist Veränderung im Verkehrssektor überfällig. Die globalen CO2-Emissionen im Verkehrssektor sind zwischen 1970 und 2010 um 250% gestiegen, wobei der Straßenverkehr dabei den Großteil ausmacht (Sims et al., 2014). In vielen europäischen Staaten steigen die Verkehrsemissionen weiterhin an. Österreich verzeichnet seit 2014 wieder einen kontinuierlichen Anstieg. Zwischen 1990 und 2017 erhöhten sich die nationalen Verkehrsemissionen um 71,8% und machten damit Einsparungen in anderen Sektoren wieder zunichte (Umweltbundesamt, 2019).

Immer mehr Berechnungen und Simulationen zur Ressourcennutzung kommen unter Berücksichtigung der planetaren Grenzen (Klimawandel, Biodiversität, verfügbare Ressourcen) zu dem Ergebnis, dass Nachhaltigkeitsziele nur dann erreicht werden können, wenn es im Verkehrssektor zu einer radikalen Wende kommt, die über eine reine Antriebswende - wie etwa der Umstieg auf Elektromotoren – und die Einführung neuer Technologien hinausgeht. Jüngste Publikationen zeigen dies für globale Analysen (de Blas et al., 2020, Millward-Hopkins et al., 2020). Auf österreichischer Ebene wurde dies im „Sachstandsbericht Mobilität" des Umweltbundesamts (Heinfellner et al., 2018) quantifiziert. Zusätzlich zur Umstellung auf nicht-fossile Antriebe ist eine drastische Senkung der Fahrleistung im motorisierten Individualverkehr (MIV) notwendig.

Wir benötigen also eine Mobilitätswende, die nicht nur eine Verhaltensänderung bei der Verkehrsmittelwahl („Verkehrswende") bedeutet, sondern Mobilität ganzheitlich betrachtet, unter Berücksichtigung weiterer Aspekte wie beispielsweise der Raumplanung und sozioökonomischer Rahmenbedingungen und Wirkungen.

Das Mobilitätsverhalten hängt von einer Vielzahl an Einflussfaktoren ab, wie der Siedlungs- und Verkehrsinfrastruktur als Voraussetzung für Verhaltensalternativen, dem Wegetyp sowie Geld-, Zeit- und Bequemlichkeitskosten, als auch persönlichen Einstellungs- und Wertemustern (vgl. Haselsteiner et al. 2020; Neugebauer, 2004; Seebauer 2011). Diese verschiedenen Faktoren führen dazu, dass sich bestimmte Gewohnheiten im Mobilitätsverhalten herausbilden. Für einen umfassenden Verhaltenswandel ist es nun Ziel und Schwierigkeit zugleich, diese Gewohnheiten aufzubrechen und so Raum für Verhaltensalternativen zu schaffen. Da die Verfügbarkeit und Attraktivität der unterschiedlichen Verkehrsmittel Grundlage für das Verhalten sind, müssen die Strukturen (baulich, rechtlich, finanziell, organisatorisch), die diese bedingen, verändert werden. Es ist also ein umfassender systemischer Wandel notwendig, eine Transformation des bestehenden sozio-technischen Verkehrssystems.

Es gibt eine große Kluft zwischen dem, was notwendig wäre, um Klima- und Nachhaltigkeitsziele zu erreichen und dem, was in der Praxis umgesetzt, beziehungsweise dem, was in der Politik diskutiert wird.

Manche sprechen gar von Tabus, sogenannten „transport taboos“ (Gössling and Cohen, 2014): für den Großteil der Akteurinnen und Akteure undenkbare Maßnahmen, die vom etablierten Regime daher entweder nicht adressiert oder als zu „radikal“ oder politisch nicht umsetzbar disqualifiziert werden. Beispiele hierfür finden sich zur Genüge, etwa das Herabsetzen von Tempolimits, den Rückbau von Straßeninfrastruktur oder die Einführung einer CO2-Steuer in solch einer Höhe, die einen tatsächlichen Lenkungseffekt herbeiführen würde.

Verkehrspolitische Entscheidungen basieren nach wie vor vielfach auf nicht kritisch hinterfragten Theorien und Kernprinzipien. Sie sind Grundlage zur Verteidigungshaltung des Status-quo und Aufrechterhaltung einer zum Teil auch in Normen und Gesetzen festgelegten Wertehierarchie. Dogmen wie „Erreichbarkeit“, „maßgebliche Geschwindigkeit“ oder die – meist monomodal diskutierte ¬ „Beseitigung von Kapazitätsengpässen“ werden im Rahmen der Stabilisierungsstrategie um „jeden Preis verteidigt“. Es wird technische Objektivität vorgegeben, wobei die zu Grunde liegenden Annahmen nicht explizit ausgesprochen werden und oft nicht öffentlich sind. Veränderte Annahmen, die den Status Quo in Frage stellen, werden nicht anerkannt.

3 SYSTEMTHEORIE, REGIMES UND NACHHALTIGKEITS-TRANSFORMATION

3.1 Menschliche Bedürfnisse und „Provisioning“-Systeme

Das von Mattioli (2016) vorgestelltee und durch Brand-Correa, et al. (2020) weiterentwickelte Modell zur Verknüpfung von menschlichen Bedürfnissen und „provisioning“ (Bereitstellungs-)Systemen zeigt Angriffspunkte zur Intervention im Verkehrssystem auf. Die Basis bilden dabei Stufen der Bedürfnisbefriedigung, die mit dem privaten Pkw als Beispiel veranschaulicht werden. Menschen haben Grundbedürfnisse, die sie mithilfe von „Befriedigern“ („need satisfiers“) erfüllen. Während die Nutzung eines Pkws selbst kein Bedürfnis ist, fungiert der Pkw als Befriediger von Bedürfnissen höherer Stufen. Ein Beispiel ist das Bedürfnis des Lebensunterhalts. Menschen müssen Geld verdienen, um ihren Lebensunterhalt zu bestreiten. Dafür müssen sie von ihrem Zuhause zu ihrem Arbeitsort gelangen. Befriediger erster Stufe sind sozio-technische „provisioning“ Systeme wie Infrastruktur (z.B. eine Straße, die den Wohnort mit dem Arbeitsplatz verbindet). Auf der zweiten Stufe sind Aktivitäten, auf der dritten Dienstleistungen und auf der vierten spezifische Produkte, wie etwa der Pkw.

Interventionen auf der ersten Stude sind zwar die effektivsten, jedoch gleichzeitig jene, wo Veränderung am schwierigsten durchzusetzen ist. Das kann mit einer Zahnrad-Metapher visualisiert werden (vgl. Brand-Correa, et al., 2020), oder als Hebelpunkte (siehe Abb. 1). Eine Intervention auf der ersten Stufe, um eine Abkehr vom Pkw-orientierten System zu schaffen, müsste einen Wandel in der Bereitstellung von nicht-Pkw-Infrastruktur, verbesserter und integrierter ÖV-Systeme und Veränderungen in Stadtplanung, inklusive der Verlagerung von Arbeitsplätzen an besser erreichbarere Gebiete beinhalten (Brand-Correa, et al., 2020) – also eine Veränderung der Systemstrukturen. Eine Maßnahme auf vierter Stufe wäre hingegen zum Beispiel der Umstieg auf Pkws, die mit Biokraftstoff angetrieben werden (Veränderung eines einzelnen Parameters). Dies stellt zwar eine wesentlich einfachere Aufgabe dar, die jedoch nicht annährend effektive Klimawirkungen erzielen kann. Sozio-technische „provisioning“ Systeme bestehen aber nicht nur aus der gebauten Infrastruktur, sondern auch aus Institutionen, ökonoischen und politischen Logiken – letzten Ende also Denkweisen und Paradigmen. Diese zu adressieren mag wie eine unmögliche Herausforderung erscheinen und Akteurinnen und Akteure im Verkehrssektor könnten dies als Rechtfertigung sehen nicht zu handeln. Im Umfang dieser Studie ist es zwar nicht möglich, die fundamentalen wirtschaftlichen und politischen Logiken, welche auch die Basis für die Rahmenbedingungen im Verkehr bilden, im Detail zu analysieren, es ist dennoch notwendig, auch den Verkehrssektor zu adressieren. In diesem Artikel fokussieren wir dabei auf gebaute Infrastrukturen sowie rechtliche und administrative Prozesse zur Infrastrukturplanung.

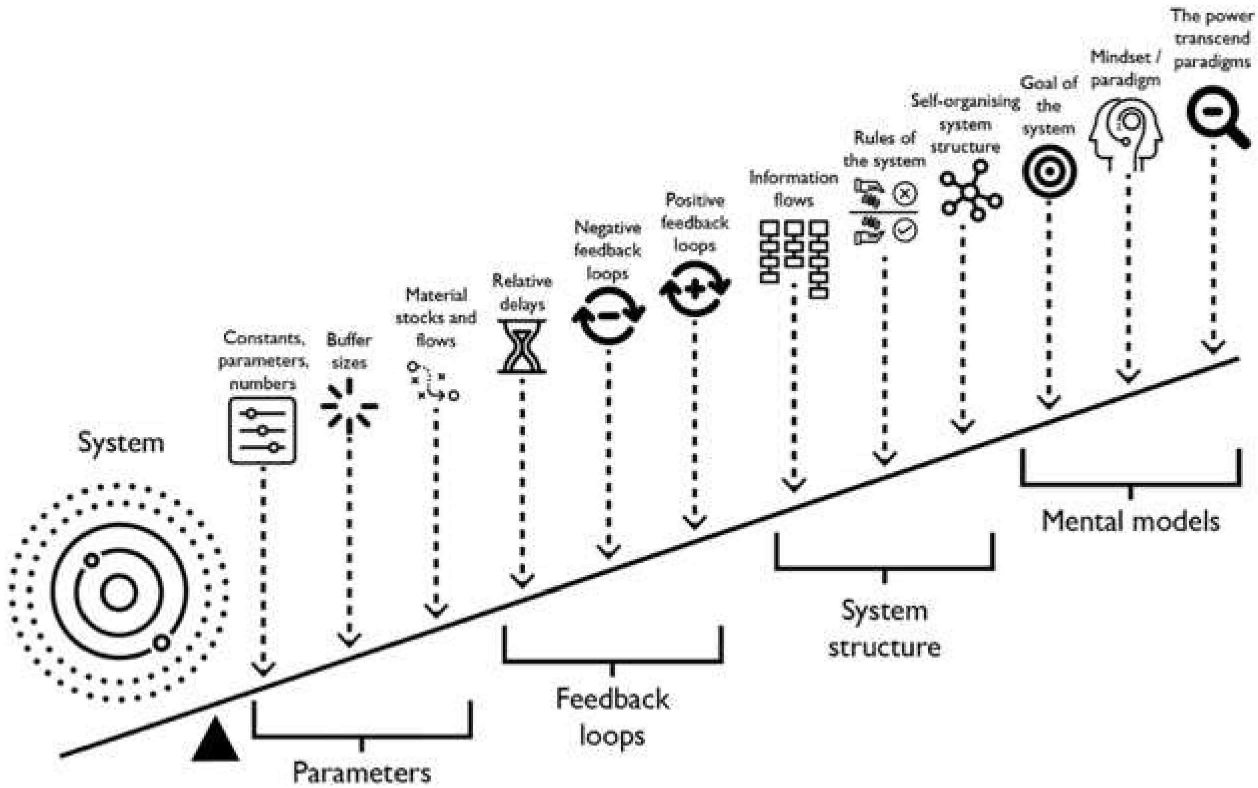

Abb. 1: Hebelpunkte im System mit nach rechts steigender Hebelwirkung, Grafik von (Angheloiu and Tennant, 2020) basierend auf (Meadows, 1999)

3.2 Multi-Level-Perspektive als Transformationstheorie

Ein relativ junges wissenschaftliches Feld beschäftigt sich mit der Nachhaltigkeitstransition, also der Frage, wie bestehende sozio-technische Systeme, die nicht nachhaltig sind, zu nachhaltigen Systemen verändert werden können. Markard et al. (2012) beschreiben die Entstehung dieses neuen Forschungsfeldes und seine Notwendigkeit. In einigen Sektoren, wie der Energieversorgung, Landwirtschaft und eben auch dem Verkehrssektor zeichnen sich zunehmend ökologische, soziale und ökonomische Probleme ab. Im Verkehrssektor zeigen sich die Probleme beispielsweise in lokaler Luftverschmutzung, der Erschöpfung fossiler Brennstoffe, CO2-Emissionen und Unfallrisiken. Aufgrund von Entwicklungen in der Vergangenheit (so genannter Pfadabhängigkeiten) und „Lock-In"-Effekten verändern sich die etablierten Systeme nur inkrementell und nicht radikal. Diese inkrementellen Veränderungen werden jedoch nicht ausreichen, um den drohenden Herausforderungen der Nachhaltigkeit rechtzeitig gerecht zu werden. Daher beschäftigt sich die Forschung der Nachhaltigkeitstransition mit der Frage, wie die notwendige radikale Veränderung dieser etablierten Systeme gefördert werden kann.

Die Multi- Level Perspektive (MLP) nach Geels and Schot (2007) hat sich dabei als anschaulichste Theorie zur Beschreibung der notwendigen Veränderungen und bestehender Barrieren im Verkehrssystem herauskristallisiert. Die MLP unterscheidet drei Ebenen: (exogene) Rahmenbedingungen, Regime und Nischen (siehe Abb. 2). Das zentrale Regime beinhaltet die dynamisch stabilen, etablierten und hegemonialen Praktiken, Diskurse, Institutionen und Artefakte (Vogel, 2015). Rip and Kemp (1998) definieren ein Regime als „den zusammenhängenden Komplex aus Wissen, Technik, Produktionsprozessen, Produktcharakteristiken, Fähigkeiten und Prozessen, Nutzerbedürfnissen, gesetzlichen Anforderungen, Institutionen und Infrastruktur". Innerhalb des Regimes können drei Dimensionen unterschieden werden: (1) materielle Technologien wie Artefakte, Infrastruktur und Geräte; (2) Akteurinnen, Akteure und soziale Gruppen, die Technologien entwickeln, nutzen und regulieren; und (3) Regeln (formale und informelle), welche die Wahrnehmung und Handlungen der Akteurinnen, Akteure und Gruppen leiten (Geels, 2007). Eine Transition im Sinne der MLP ist definiert als der Übergang von einem Regime zu einem anderen Regime. Nischen und Rahmenbedingungen werden in Relation zu dem Regime definiert.

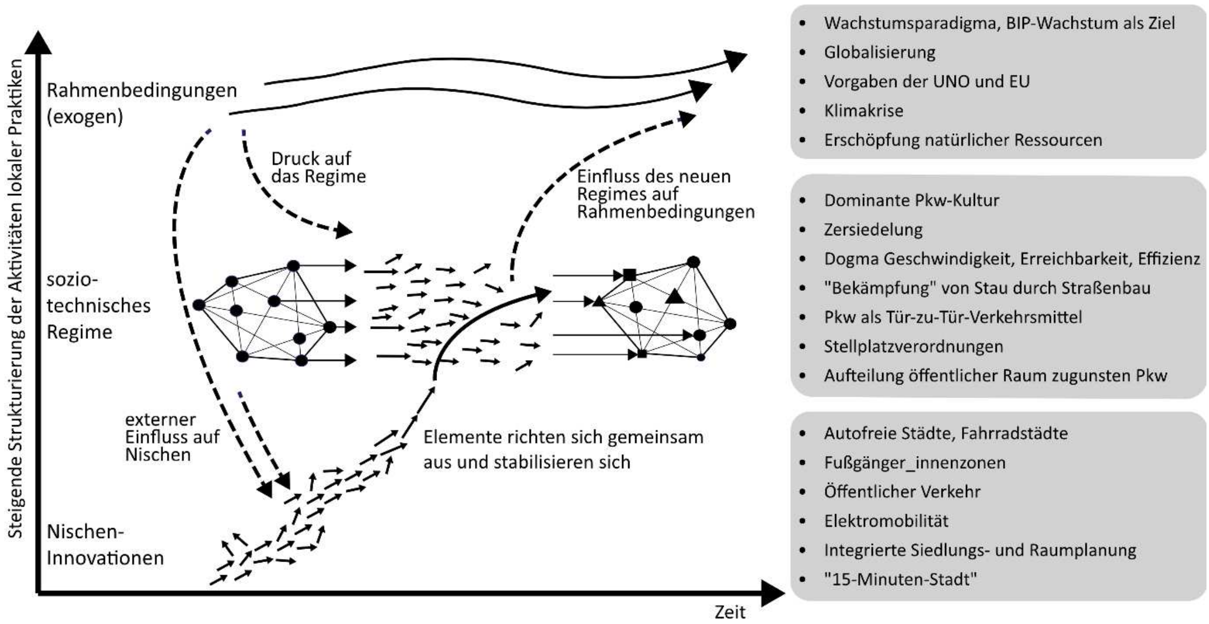

Abb. 2: Multi-Level-Perspektive, adaptierte Illustration von Haselsteiner et al. (2020), basierend auf Geels and Schot (2007)

Die übergeordneten Rahmenbedingungen stellen exogene Faktoren dar, die auf das Regime wirken, in der Betrachtung aber nicht direkt Teil des Regimes sind. Die Abgrenzung zwischen Regime und den übergeordneten Rahmenbedingungen wird in der Literatur zwar intensiv diskutiert, aber nicht klar definiert (Vogel, 2015). Daher ist die Abgrenzung stark vom analysierten System und der Sicht der analysierenden Person abhängig. Gemäß dieser Theorie können die Rahmenbedingungen Druck auf das Regime ausüben. Durch den Druck verändern sich die Verbindungen im Regime, die etablierte Ordnung wird aufgebrochen. Dieser destabilisierte Zustand des Regimes kennzeichnet ein „window of opportunity“, stellt also ein „Möglichkeitsfenster“ dar, während dem es möglich ist, eine neue Konfiguration des Regimes herzustellen und Nischenentwicklungen darin aufzunehmen. Nischen sind definiert als Technologien oder Praktiken, die substanziell vom existierenden Regime abweichen. Sie können das Regime unterstützen oder als Gegnerin gesehen werden. Auf dieser Ebene agieren unterschiedliche Akteurinnen und Akteure in unkoordinierter Weise. Durch gemeinsame Ausrichtung können sich die Entwicklungen zu einer dominanten Form stabilisieren, die bei einem Möglichkeitsfenster den „Sprung“ in das Regime schaffen. So hat sich beispielsweise auch der private Pkw in der Vergangenheit vom Nischen- zum Massenprodukt entwickelt.

3.3 Das „Car-Regime“

Bezogen auf den Verkehrssektor in Österreich heutzutage – wie in allen Ländern des globalen Nordens – lässt sich das etablierte System als „Car-Regime“, also Pkw-Regime beschreiben (Zijlstra and Avelino, 2012, Marletto, 2011). Durch das vorherrschende System wird der private Pkw als Verkehrsmittel vielfach bevorzugt und Strukturen an ihm ausgerichtet. Das hemmt die Implementierung von klimawirksamen Maßnahmen und sorgt dafür, dass auch heute noch Infrastrukturen geplant und finanziert werden, welche nachweislich zu einer drastischen und kontinuierlichen Steigerung der CO2-Emissionen sowohl direkt als auch indirekt durch ihre verursachten Folgewirkungen und Rebound-Effekte führen.

Mattioli et al. (2020) beschreiben die derzeitige Pkw-Abhängigkeit (im System) in detaillierter Form anhand von sechs Teilsystemen: der Bereitstellung von Infrastruktur, der Pkw-Industrie, Flächennutzungs-Mustern, der Vernachlässigung des öffentlichen Verkehrs und der Pkw-Kultur. Diese Teilsysteme sind miteinander verbunden und wirken zusammen als positiver Regelkreis, der sich selbst verstärkt. Hier sei als Beispiel nur die Bereitstellung von Infrastruktur herausgegriffen: die öffentliche Hand plant und finanziert Infrastrukturen wie Straßen, Parkplätze und Institutionen, welche die Pkw-Nutzung unterstützen. Straßen und Parkplätze können entweder durch die Vereinnahmung bestehender Infrastrukturen, wie etwa bei innerstädtischen Flächen oder durch die Bereitstellung neuer Infrastruktur, wie beispielsweise durch zusätzliche Straßen geschehen. Im ersten Fall werden Flächen genutzt, die zuvor als öffentlicher Raum primär allen Menschen zur Verfügung standen. Durch entsprechende Gesetze wie der Straßenverkehrsordnung und Stellplatzverpflichtungen wird der neue Vorrang für Pkw auch formal geregelt. Dadurch werden gleichzeitig der ÖV benachteiligt und die Bedingungen für aktive Mobilität verschlechtert. Die Bereitstellung von Infrastruktur bildet die Basis für Flächennutzungs-Muster die auf Pkw-Nutzung angewiesen sind, wie etwa zersiedelte Strukturen. Diese Entwicklungen sind im Sinne der Industrie, da dies mit einem erhöhten Bedarf an Pkw einhergeht. Die Fahrzeughersteller und Zulieferbetriebe sind zu einem der Haupt-Industriesektoren herangewachsen. Sie produzieren in sehr großen Skalen und haben eine hohe wirtschaftliche Bedeutung, wodurch Regierungen von den Arbeitsplätzen und Staatseinnahmen durch die Unternehmen in gewisser Weise abhängig sind. Außerdem entstehen durch Pkw-orientierte Strukturen Praktiken und Gewohnheiten, die zur Verfestigung einer „Pkw-Kultur“ beitragen und somit wiederum zu Entscheidungen für weitere Pkw-Infrastrukturen führen. Aus diesem Teufelskreis gilt es auszubrechen.

3.4 Die Rolle der Akteurinnen und Akteure

Akteurinnen und Akteurein diesem „Car-regime“ umfassen Politikerinnen und Politiker, die planende und administrative Verwaltung (Stadt, Land, Bund), Vertreterinnen und Vertreter der Behörden, externe Planerinnen und Planer, Bürgerinnen und Bürger, Interessenvertretungen und Medien (vgl. (Kloss, 2009). Sie alle sind in Strukturen eingebettet, die ihnen unterschiedliche Freiheitsgrade und Handlungsspielräume ermöglichen. Innerhalb des Regimes verbinden institutionelle Strukturen die technischen Artefakte, Regeln und Akteurinnen und Akteure miteinander. Diese können ihre Handlungen nur so weit bestimmen, wie es die Freiheitsgrade durch die vorgegebenen Strukturen erlauben. Basierend auf Gidden’s Strukturationstheorie (Giddens, 1984) haben ihre Handlungen jedoch auch Einfluss auf die anderen Regime-Elemente und verändern diese, so entsteht eine Wechselwirkung mit spiralförmigem Verlauf über die Zeit.

In den letzten Jahrzehnten hat sich die Rolle des Staates in seinen Beziehungen zu Wirtschaft, Wissenschaft und Zivilgesellschaft zusehends verändert. Die wirtschaftliche Entgrenzung der 1980er Jahre führte zudem zur Globalisierung und zum internationalen ökonomischen Wettbewerb und zu einer stärkeren Einbeziehung der Wirtschaft in politische Prozesse. Die immer stärkere Einbeziehung wissenschaftlicher Expertinnen und Experten in Entscheidungsfindungsprozesse wurde durch die angeführten Entwicklungen, besonders aber die Globalisierung politischer Probleme, beschleunigt. Diese Veränderungen in der Art und Weise der Beziehungen zwischen Staat, Wirtschaft, Wissenschaft und Zivilgesellschaft werden auch häufig mit dem Schlagwort „von Government zu Governance“ charakterisiert.

Die spezifischen Anforderungsprozesse im Verkehrsbereich drücken sich durch die hohe Diversität an Interessensgruppen aus, was einen hohen Aufwand an Planung und Kompromissbereitschaft voraussetzt. In diese politischen Prozesse werden immer mehr institutionalisierte Gruppen involviert, die eine faktenbasierte Entscheidungsgrundlage schaffen sollen, wie zum Beispiel Wissenschaftlerinnen, Wissenschaftler, Expertinnen und Experten. Diese Einbindung führt jedoch nicht immer zu den gewünschten Ergebnissen, da die von Expertinnen und Expertenvorgeschlagenen Maßnahmen häufig keine Umsetzung finden und der Prozess also teilweise einen symbolischen Charakter annimmt, um die politischen Prozesse zu legitimieren (vgl. Bandelow and Kundolf (2011).

In der Verkehrsplanung zeigen sich die unterschiedlichen Interessenslagen der Akteurinnen und Akteure auch durch unterschiedliche Auswirkungen von Verkehrsinfrastrukturen, die sich auf lokaler, regionaler und überregionaler Ebene ergeben. Oft stehen überregionale wirtschaftliche Überlegungen den lokalen Auswirkungen entgegen. Dabei werden von den handelnden Akteurinnen und Akteuren kurzfristige ökonomische Aspekte für wichtiger erachtet als eine ökologische Nachhaltigkeit und Ressourcenschonung. Lange Zeitverzögerungen zwischen Handlungen und Wirkungen reduzieren die Bereitschaft zur Aktivierung wirklicher Transformationsprozesse (vgl. Brezina und Fernandez, 2017).. Strukturelle Rahmenbedingungen eines auf langsame Veränderungen ausgerichteten politischen Systems erschweren weitreichende Reformen.

Individuelle und vorurteilsspezifische Interpretationen, Wertehaltungen, Ausbildung, rechtliche Grundlagen (Regelwerke) und Indikatoren bestimmen die wahrgenommene Realität und was als Problem definiert wird. Ein beharrliches Verfolgen der „falschen“ Ziele (hohe Geschwindigkeit, permanente Kapazitätserweiterungen, etc.) führt zu zunehmender Abhängigkeit dieses “Regelhandelns” (“Lock-In”). Die erforderlichen Maßnahmen zur Dekarbonisierung des Verkehrssystems sind bekannt. Einzelne Maßnahmen reichen nicht aus um eine Trendwende zu verwirklichen, es braucht vielmehr abgestimmte Maßnahmenbündel, die unterschiedliche Faktoren adressieren, wie Preissignale, Angebotsverbesserungen und eine zusätzliche Veränderung des Bewusstseins (vgl. Haselsteiner et al., 2020). Dabei wird deutlich, dass derzeit nicht nur enorme Defizite in der Bereitschaft, dem politischen Willen und der Organisationsmacht zur

Umsetzung existieren, sondern, dass auch eine realistische Einschätzung über die notwendige Maßnahmenintensität fehlt, um nur annähernd die Klimaziele im Verkehrssektor zu erreichen. Bereits quantifizierte Maßnahmen (wie etwa im Sachstandsbericht Mobilität) sollten rasch umgesetzt werden. Darüber hinaus sind jedoch weitere, auf Prozessstrukturen fokussierte Maßnahmen zu forcieren um eine tatsächliche Transformation zu initiieren (vgl. Haselsteiner et al., 2020).

3.5 „Best“ Practice bisher nur in Nischen

Es gibt einzelne gute Ansätze, Prozesse in der Verkehrsplanung und -politik so zu gestalten, dass Maßnahmen unterstützt werden, welche zur Mobilitätswende beitragen („Best“-Practice Beispiele). Diese Ansätze sind aber nach wie vor als Nischenentwicklungen zu kategorisieren, wenn sie, z. B. eingebettet in weiterhin nicht nachhaltige Entwicklungen einer Metropolregion, in der Stadt alleine nicht die erforderlichen Wirkungen zur tatsächlichen Einleitung einer Mobilitätswende entfalten können.

Dieses Nischendasein wird am Beispiel Kopenhagens ersichtlich. Die dänische Hauptstadt gilt als Vorreiterin der Radverkehrsplanung, nach der sogar ein Index zur Beurteilung der Fahrradfreundlichkeit einer Stadt benannt ist („Copenhagenize Index“). Der sogenannte „Fingerplan“ ist die eigentliche Basis der integrierten Stadtentwicklungs- und Verkehrsplanung der Metropolregion, demzufolge Siedlungen entlang von fingerartigen ÖV-Achsen angelegt werden sollen. Trotzdem verzeichnete das Umland mit 82% den höchsten MIV-Anteil einer europäischen Metropolregion (Driscoll, 2014). Driscoll (2014) zeigt in seiner Analyse, dass diese am ÖV orientierte Planung durch ringförmige Straßenbauprojekte unterminiert wird. Pfadabhängigkeiten, wie die Konstruktion des Fehmarnbelts und steigende Diskrepanzen zwischen Wohnortpräferenzen und Beschäftigungsmöglichkeiten, haben zu einem „Carbon Lock-In“ geführt. Dadurch werden trotz Protesten der lokalen Bevölkerung Straßenbauprojekte immer noch weiterverfolgt und der Autoverkehr dominiert weiterhin das Verkehrssystem.

4 LÖSUNGSANSÄTZE UND INTERVENTIONSSTRATEGIEN

Um Nischen in das Regime zu hieven, müssen unterschiedliche Ebenen der MLP adressiert werden. Individuen sind beispielsweise Teil des Systems auf allen Ebenen. Sie können mit ihrer Weltsicht und ihren Einstellungen auch die Visionen und Paradigmen der Rahmenbedingungen auf dem Makro-Level beeinflussen (Göpel, 2016). Eine Interventionsstrategie kann daher die Aufklärung über das Thema sein, um so auf individueller Ebene neue Sichtweisen aufzuzeigen, die das gemeinsame Paradigma verändern können.

Ein derartiges Vorgehen könnte unter anderem durch bildungspolitische Weichenstellungen unterstützt werden, innerhalb derer sich tertiäre Bildungsinstitutionen und Forschungseinrichtungen stärker in den Dienst der Lösung gesellschaftlicher Problemstellungen stellen. Damit würden Bildung und Wissenschaft politischen Entwicklungen Folge leisten, als Teil derer in den letzten Jahrzehnten aus den Politikfeldern Forschungs- und Technologiepolitik sowie aus sektoralen Politikfeldern wie beispielsweise Teilen der Verkehrspolitik zusehends eine integrale Innovationspolitik wird (Biegelbauer 2013). Jüngste Beispiele sind die Missionen im Rahmen des EU Rahmenprogramms Horizon Europe, die sich der Lösung gesellschaftlicher Problemstellungen vor dem expliziten Hintergrund von Nachhaltigkeitszielen verschrieben haben und jeweils von den sektorspezifischen Generaldirektionen geleitet werden.

Eine weitere Interventionsstrategie im Sinne der Nachhaltigkeitstransition ist die Stärkung von Nischen durch Allianzen. Schließen sich Akteurinnen und Akteure zusammen, können Emergenzen ermöglicht werden und so gemeinsam mehr bewirkt werden als durch individuelle Bestrebungen. Diese Allianzen können auch innerhalb der bestehenden Institutionen gefördert werden. Die Bildung einer derartigen Allianz könnte beispielsweise durch die international gut erprobte Möglichkeit unterstützt werden, Akteurinnen und Akteure mit sehr unterschiedlichen Hintergründen, Zielsetzungen, Interessenslagen und weltanschaulichen Positionen zu einem Annäherungsprozess zu bewegen: durch einen partizipativen Foresight (Dinges et al, 2018). In einem derartigen Prozess werden in der Gruppe in einer ersten Phase Visionen und grundlegende Vorstellungen von einer mittel- oder langfristigen Zukunft ermittelt. Dabei werden bewusst Methoden eingesetzt, die es erleichtern aus dem Alltag herauszutreten, unterschiedliche Positionen zuzulassen und auch selbst die eingespielten Muster hinter sich zu lassen. Unterschiedliche Faktoren, welche die Zukunft beeinflussen können, werden herausgearbeitet und in der Gruppe beurteilt. In einem weiteren Schritt werden aus diesen Visionen von einer Zukunft (beispielsweise für das Jahr 2050) Ziele abgeleitet, die wiederum gemeinschaftlich diskutiert werden. Nach der Verfestigung dieser Ziele werden im Rahmen eines Back-Casting Prozesses Ziele bis zur nahen Zukunft abgeleitet (Wilhelmer und Nagel, 2013).

Die Wirkung der angeführten Maßnahmen ließe sich auch in einen größeren Zusammenhang einbetten, wenn etwa die Nachhaltigkeit als Ziel der Politik eindeutiger als bisher festgeschrieben und im Sinne eines übergeordneten Staatszieles in der Verfassung verankert werden würde. Eine derartige Maßnahme hat einerseits - auch durch die im Zuge der Inkraftsetzung entstehende gesellschaftliche Debatte - einen symbolischen Charakter, indem sie auf die Wichtigkeit einer nachhaltigen Entwicklung verweist. Andererseits sind Staatsziele aber durchaus rechtlich verbindlich, wie etwa im Verfassungsgesetz zur immerwährenden Neutralität Österreichs, dem Verbot nationalsozialistischer Wiederbetätigung oder der Gleichstellung zwischen Mann und Frau als Teil der Rechtsordnung jeweils festgehalten. Dadurch sind derartige Zielsetzungen beim Beschluss neuer Gesetze sowie deren Auslegung im Bereich von Verwaltung und Rechtsprechung verbindlich einzuhalten und können auch eingeklagt werden.

5 SCHLUSSFOLGERUNGEN

Die Initiierung von politischen Maßnahmen für eine ökologische Transformation im Verkehrssystem wäre die Aufgabe von Staat und Politik. Deren Abhängigkeit von globalisierten Konzernen und Märkten einerseits und einer demokratischen Legitimation andererseits, führen zur zulässigen Frage, ob der Staat überhaupt ernsthaft den Willen hat, das Verkehrssystem zeitkritisch zu verändern und einen radikalen Strukturwandel zu etablieren. Vergleicht man die bisherigen Entwicklungen wie z. B. jener der CO2-Emissionen im Verkehrssektor, dem Flächenverbrauch durch Verkehrsinfrastrukturen oder der stetigen Zunahme des Verkehrsaufwandes, kann diese Frage eindeutig verneint werden. Es braucht eine Neuausrichtung aller Prozesse und Strukturen sowie Transparenz der Entscheidungsprozesse (Personen, Strukturen, Prozesse, Gremien, etc.). Ebenso eine neue Wertehierarchie in den Richtlinien, Vorschriften und Gesetzen und daher eine Änderung des Mindsets der Entscheiderinnen und Entscheider (Mobilitätswende „in den Köpfen“). Die Abschätzung von Wirkungen (ökologisch, sozial) infolge von regulatorischen Maßnahmen und Infrastrukturbauten sollten als Basis der Entscheidungen fungieren.

Die Analyse der Transformationsprozesse für eine Mobilitätswende zeigt jedenfalls das Erfordernis der transdisziplinären Betrachtung. Für die Einleitung eines Paradigmenwechsels reichen das Wissen und die Werkzeuge der Verkehrsplanung und –technik nicht aus. Nur im Zuge von transdisziplinärer Forschung, Zusammenarbeit und transsektoraler Planung lässt sich herausfinden, wie es möglich sein wird, die bekannten Maßnahmen im Verkehrssektor in einer Form umzusetzen, die sozial und politisch akzeptiert wird und einen tatsächlichen Transformationsprozess einleitet.

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Mobility in Metropolitan and Peripheral Regions – an Educational Simulation Game

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1 ABSTRACT

Metropolitan regions worldwide face the same problems: air pollution, congestion, urban sprawl. Decades of interventions by policy makers and planners did not change this fact. The methods of System Dynamics reveal that one of the main causes is a lack of understanding of the complex interactions between urban, peri-urban and peripheral regions. Therefore, it is essential to improve systems thinking skills of policy makers, planners and the public. Educational games promote the development of cognitive, spatial and motor skills and can be used to teach facts (e.g. knowledge, retrieval, memorization, retention of knowledge), principles (e.g. cause-and-effect relationships) and complex problem solving. Hence, educational games and simulations are powerful tools to improve systems thinking skills – even for very young age groups.

The objective of the nationally funded project Systemcheck (2019-2020) was to make use of the abovementioned capabilities. An interactive, digital teaching and learning game based on simulations of social and ecological effects of mobility and transport in metropolitan and peripheral regions was developed and tested in classrooms. The game specifically addresses topics of the Austrian 6th grade syllabus for the subject geography and economics. The game, on the one hand, enables students to learn and practise geography subject matters and on the other hand to develop systemic thinking skills. The basic framework of the multi-level game is the vita of a person from primary school through to adulthood. Players have to solve different tasks related to mobility and the characteristics of urban and peripheral regions to collect points and reach the next level. The game is a mixture of quizzes, identification of the player with a role and simulations. Based on teachers' suggestions, the game was subdivided into two parts to allow the game to be played in portions of one or two teaching units. In accordance with the Citizen Science approach two phases of in-class workshops with feedback from students and teachers were conducted.

The first part starts with the player in the role of a schoolchild living in a small village. The village has a primary school and a small shop. A supermarket and a cinema are located in the district town, about ten kilometres away. The player has to answer (quiz) questions regarding topics like periphery, basic needs, accessibility, urban sprawl, etc. to reach the next level. In following levels, the player commutes to secondary school, moves to the capital to study, starts working and moves back to the countryside when founding a family. At this level, the player engages in local politics to stop the greenfield development of a shopping centre. In the final level of part one the player runs for mayor's office. Feedback on a prototype was obtained from teachers and students of three secondary schools. A total of 91 pupils in four classes tested the prototype in classrooms. The overall feedback was very positive. On a scale from 1 = very bad to 5 = very good the average overall rating was 4.2. The majority saw the game as not too difficult, exciting and useful for learning. About two thirds wanted to play the game again.

In the second part the political career of the player continues. Decisions on municipal level have to be made. Cooperation and compromises with neighbouring municipalities, the federal state and the national government are necessary to achieve environmental and social goals. Simple simulation models are used to mimic real world effects of the player's decisions. Simulation models were programmed using the free, web-based software InsightMaker. The player has to use the simulation models to solve tasks like meeting CO2 reduction goals while keeping the municipal budget balanced. A beta version of the second part was tested in March 2020. Due to the pandemic testing in classrooms was replaced by web-based feedback. Collected feedback shows evidence that the simulation model based part was rather difficult for the target group and not user friendly enough. This can be partly explained by the missing possibility of physical presence and briefing in classrooms. In consequence, teaching material for future classroom application was developed. Nevertheless, the overall rating was still positive and the concept was successful. The game is publicly available for free, in both English and German language: https://ive.boku.ac.at/systemcheck/welcome

Keywords: metropolitan and peripheral regions, system dynamics, educational simulation game, children, mobility

2 BACKGROUND AND MOTIVATION

2.1 Systems thinking and System dynamics

Systems thinking should be a key skill for students as they deal with the complex interrelationships between human actions and natural processes. In Austria as well as in many other European countries, the school education system is characterized by separate subjects. Thus, children mainly learn sectoral expertise. After school, however, children are released into a "real" world that is not characterized by its individual parts, but by complex problems and interrelationships. In order to be able to understand the "real" world, to find one's way and also sustainable solutions for problems and challenges, the ability to think in terms of systems, which is still intuitively given at kindergarten age, must be developed. For this it is essential to be able not only to identify individual elements of a system, but to be able to view a system as a whole (Schnürzler, 2017).

System Dynamics is a method for improving learning in complex systems (Sterman, 2000). It can be used to understand, amongst others, dynamic linkages, identify the causes of policy resistance, and formulate more effective policies. Cause-effect diagrams (causal loop diagrams) as a qualitative method and stock flow modelling as a quantitative method can be used as System Dynamics tools (Arndt, 2016). Cause-effect diagrams can be developed, for example, to qualitatively describe and analyse dynamic systems, such as a core city and its surrounding areas, in a simple way. Stock-flow models can be used to simulate the effects of political decisions or technological changes and thus also to investigate them quantitatively.

There are many topics such as climate change, energy, population development, urbanisation, urban sprawl and resource use which benefit from a systems-based approach. In this context, the holistic analysis of mobility in metropolitan areas and peripheries and its effects is a particularly exciting field of application, since a direct link to students' own experiences and observable processes in their direct environment can be established.

2.2 The problem of urban sprawl and congestion

The term urban sprawl or suburban sprawl refers to "low-density automobile-oriented settlement patterns with little comprehensive public planning" (Bruegmann, 2015). In contrast to a compact settlement development, the phenomenon of "urban sprawl" is associated with numerous negative effects. This refers to negative ecological effects, transport related effects as well as social and health effects (Siedentop, 2005).

Lower property prices and the promise of a calm and green living environment in mono functional suburban regions cause people to move out of the city although most of the jobs and higher educational facilities stay located there, resulting in longer commuting distances. If the public transport supply is low, this promotes car dependent life styles and with increasing car mileage also congestion (and related negative effects such as increased travel time, cost, and pollution).

Overall, the interaction between a core city and its peripheral regions, or respectively transport (accessibility) and space, are very complex issues. In more detail, the causes and effects of population distribution (e.g., migration, traffic impacts, environmental effects) are very difficult to understand and to assess. In addition to this, also the effects of transportation and land use planning measures to limit sprawl and environmental impacts are hard to predict and it usually takes a long time until changes come into effect. Furthermore, dealing with the issue of urban sprawl requires the consideration of many different relevant actors. This clearly shows that, as a result, it is difficult to adequately convey this topic to children and young adolescents in order to foster their understanding of these general processes as well as of their own choices with regard to transport and place of residence.

In the past, scientists made use of the methods of systems thinking and System Dynamics to analyse, visualise and communicate complex interrelations between the transport and the land use system. Causal loop diagrams have been used to qualitatively analyse phenomena like congestion, urban sprawl and the concentration of shopping centres in the periphery of functional urban regions (Pfaffenbichler, 2001a, 2001b, 2011). System Dynamics-based simulation models have been developed for quantitative prediction of the effects of transportation and land use planning policies (Pfaffenbichler et al. 2010, Shepherd, 2014). While for non-experts these models are too complex and not user-friendly enough, simplified versions could be part of educational games and support the understanding of complex system behaviour.

On this basis, the aim of the new teaching and learning tool is to arouse the learners' interest in systems thinking through a playful approach to the topics of mobility and transport, conurbation and periphery, environment, resources and politics. By using the final product, the learners should acquire competences in the field of systems thinking and at the same time learn about central topics of the subject geography and economics about life in urban areas, the interactions between urban areas and their periphery and how people shape their living space.

3 THE SYSTEMCHECK EDUCATIONAL GAME

Educational games promote the development of cognitive, spatial and motor skills and can be used to teach facts (e.g. knowledge, retrieval, memorization, retention of knowledge), principles (e.g. cause-and-effect relationships) and complex problem solving (Felicia, 2009; Boyle et al., 2016).

Systemcheck was developed in 2019-2020 as an interactive, digital teaching and learning game based on simulations of social and ecological effects of mobility and transport in metropolitan and peripheral regions. It was developed and tested in classrooms in close cooperation with two secondary schools in the city of Vienna. For the evaluation, other schools were involved as well. The game specifically addresses topics of the Austrian 6th grade syllabus for the subject geography and economics. The main objective of the game was, on the one hand, to enable students to learn and practise geography subject matters and on the other hand to develop systemic thinking skills. The game should (i) build on children’s everyday life experiences, (ii) cover different topics across school subjects and (iii) be motivating and fun as well.

The basic framework of the multi-level game is the vita of a person, starting in primary school and going through to adulthood. Players of the game have to solve different tasks related to the mobility of people of different age cohorts living in urban and peripheral regions. Points are collected in each level if tasks are solved correctly. The game is a mixture of quizzes, identification of the player with a role and simulations. Based on teachers’ suggestions, the game was subdivided into two parts to allow it to be played in portions of one or two teaching units. The first part covers the time span from childhood to early adulthood ending with the player becoming mayor of a medium sized town. This part consists of different types of quizzes. The second part deals with the political career of the player and is made up by simulations. The game is publicly available for free in both English and German language via the following link: https://ive.boku.ac.at/systemcheck/welcome

3.1 First part of the game

At the very beginning, the player has to decide whether to choose a female or male character for the game. Then the game starts with the player in the role of a schoolchild living in a small village. The village has a primary school and a small shop. A supermarket and a cinema are located in the district town, about ten kilometres away. The player has to answer (quiz) questions regarding topics like periphery, basic needs, accessibility, urban sprawl, etc. to reach the next level. In following levels, the player commutes to secondary school, moves to the capital to study, starts working and finally moves back to the countryside when founding a family. At this level, the player engages in local politics to stop the greenfield development of a shopping centre. In the final level of part one the player runs for mayor’s office.

Figure 1 shows a screenshot of the introduction into the level “Work in the Big City”. Each level is introduced with a colourful cartoon symbolising the life stage and living environment of the player and some explanatory text. The introduction is followed by a series of quiz questions. Figure 2 shows a screenshot of such a question. Selecting the correct answer at the first attempt is granted with four points. If the answer is not correct players have the option to modify their choice. Finding the correct answer with the second attempt is granted two points. If the answer is still incorrect, the correct answer is displayed together with a text that provides an explanation, why certain answers are correct and others are not. The answers then are randomly mixed and the player has to find the correct answers again, in order to encourage that the explanation is read and to promote learning. No points are awarded for correct answers once the solution has been displayed. This evaluation scheme should avoid a trial and error strategy by the children. In addition, multiple answers are possible and given answers are randomly mixed.

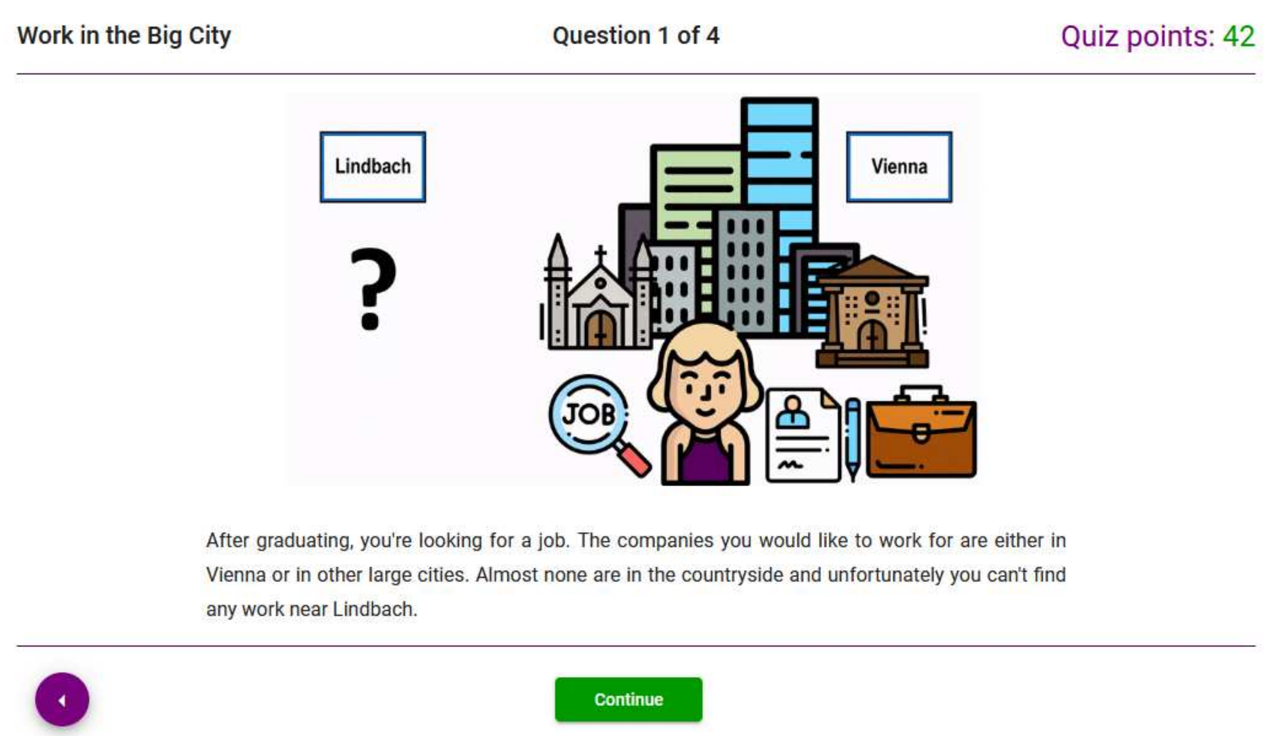

Fig. 1: Screenshot of the level "Work in the Big City" of part 1 of the educational game Systemcheck

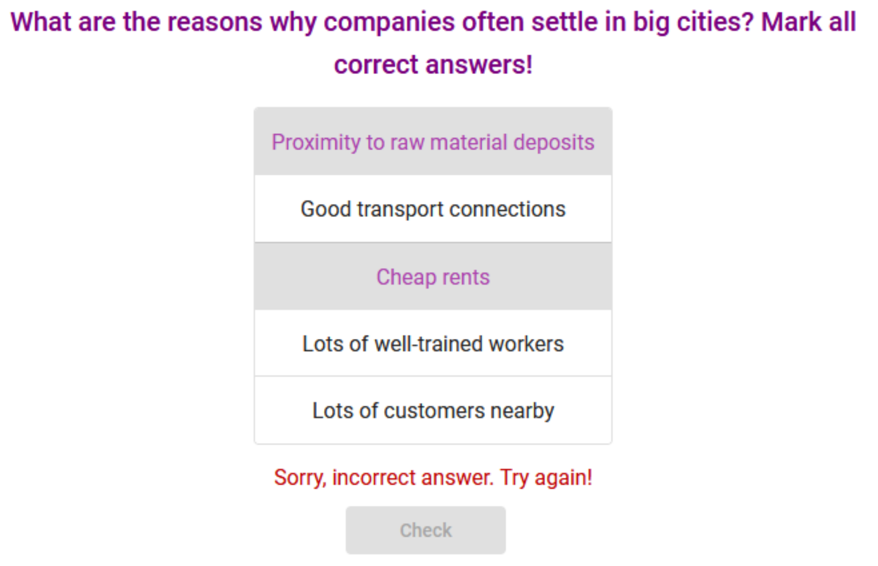

Fig. 2: Screenshot of the 1st quiz question of the level "Work in the BigCity" of part 1 of the educational game Systemcheck

3.2 Second part of the game

In the second part the political career of the player continues. Decisions on municipal level have to be made. Cooperation and compromises with neighbouring municipalities, the federal state and the national government are necessary to achieve environmental and social goals. Simple simulation models are used to mimic real world effects of the player's decisions. Simulation models were programmed using the free, web-based software InsightMaker (www.insightmaker.com). The player has to use the simulation models to solve tasks like meeting CO2 reduction goals while keeping the municipal budget balanced. The models are white box models, so the players could take a look at the parameters and equations behind them, even though without further instruction by teachers this is unlikely the case. Players can experiment with the models as often as they like before submitting an answer. A playful trial and error strategy is encouraged in this part of the game.

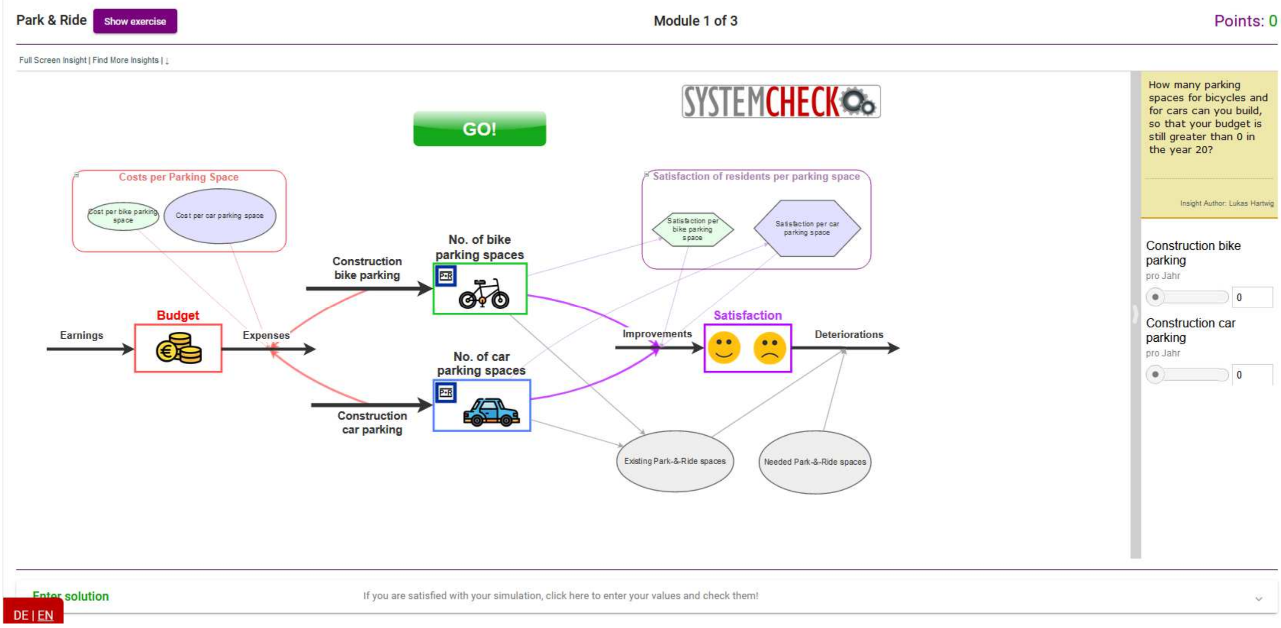

Fig. 3: Screenshot Insightmaker simulation “Park & Ride” of part 2 of the educational game Systemcheck

4 TESTING THE GAME

In accordance with the Citizen Science approach, several feedback loops were conducted to involve students as well as teachers in the development of the game.

In a first phase, feedback on a prototype of the first quiz-based part of the game was obtained in 2019 from teachers and students of the two project partner schools and a third secondary school. The feedback was collected in open feedback rounds in class (teachers, students), observations (of students while playing the game), and with the help of written questionnaires (students). A total of 91 pupils in four classes tested the prototype in classrooms. Ideas for improvements were collected and implemented as far as possible. For example, definitions are given as mouse-over text for important core terms of the game. In addition, explanations are given as feedback in case that incorrect quiz answers were given by the students to promote the learning effect. The beta version of the complete game including the second simulation-based part was tested in March 2020. Due to the pandemic, further testing in classrooms had to be replaced by feedback via a web-based questionnaire. In total 128 persons tested the quiz-based part only and 101 people tested both parts of the game.

The overall feedback was very positive. On a five-point-scale from 1 = very bad to 5 = very good the average overall rating was 4.2. The majority saw the game as not too difficult, exciting and useful for learning. About two thirds wanted to play the game again. The possibility to get into a character and go through the different stages of life was highlighted by the students in the workshops as an interesting feature. Nevertheless, there is a significant difference in the overall rating of people who played only the first part and people who played both parts (Figure 4). About 86% of the people playing only the first part rated the game as good or very good. In the group playing both parts this share is reduced to about 63%. This gives first evidence that the second, simulation-based part might be too difficult or not user-friendly enough. A detailed analysis of the collected feedback supports this finding. Figure 5 shows the feedback on the question about the difficulty of the game of the sample playing both parts of the game. While 27% of respondents say that the difficulty of the first part is appropriate, only 21% think the same for the second part. The percentage of those who think the game is easy drops from 35% to 6%. On the other hand, the share of those who think the game is difficult increases from 11% to 45%. The share of those who think the game is very difficult even increases from 3% to 25%. Hence, we have to conclude that the simulation part was rather difficult, especially for the target group, and not user-friendly enough. The low rating might partly be explained by the missing possibility of physical presence and briefing in classrooms. Nevertheless, there is a strong need for improvement of the simulation-based model part. But, the overall rating was still positive and the proof of concept was therefore successful.

Due to limited resources, further revision of the simulation-based part or the development of a simulation tutorial was not possible within the project. As a temporary fix, extensive teaching material was developed that can be used for briefing before and de-briefing after the game is played. Teaching experience with other learning games in an university context highlights the importance of collective reflection in a de-briefing session for the players' learning effect.

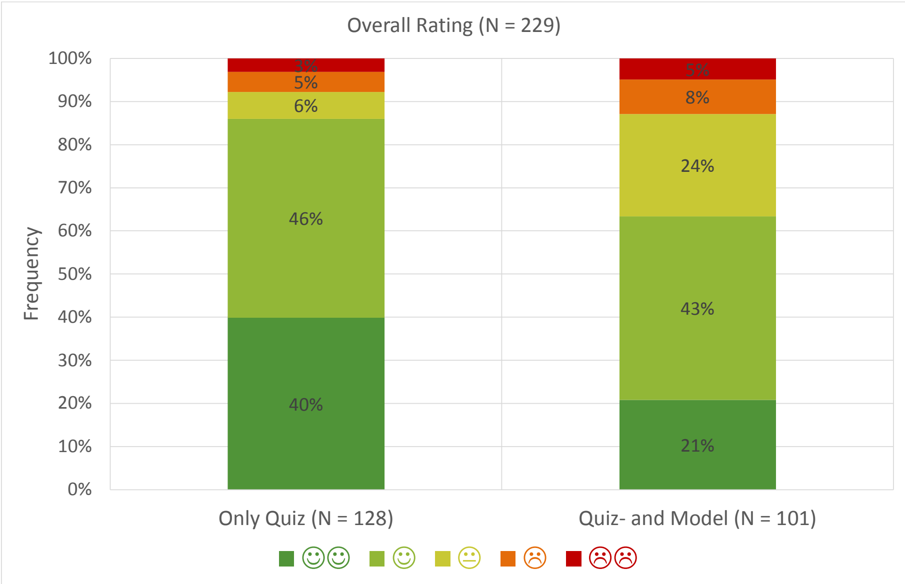

Fig. 4: Overall rating of the educational game Systemcheck

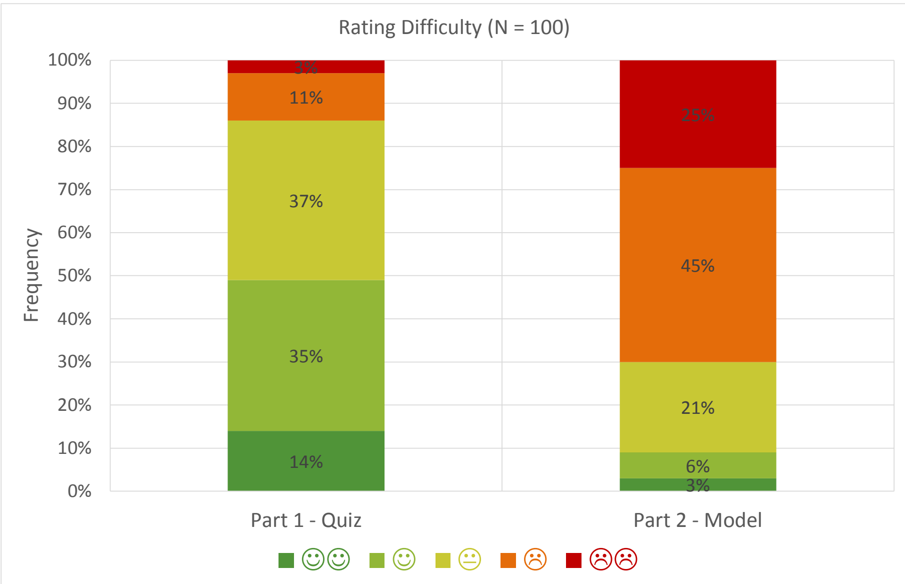

Fig. 5: Rating of the difficulty of the two parts of the educational game Systemcheck

5 CONCLUSION AND OUTLOOK

The multi-step approach of involving teachers and students of different schools to test and develop the digital game proved to be very successful. Due to the pandemic and related measures it was, unfortunately, not possible to conduct more feedback loops and evaluations with the cooperating schools. However, the overall feedback was very positive both from teaching staff and from students. The students thought it was good to get into character and go through the different stages of life. There is, however, strong evidence that the simulation model-based part was too difficult and not user-friendly enough. This can be attributed to several reasons: For example, programming required higher efforts than expected. Hence, resources had to be shifted and were not available for the simulation model design. In addition, the incorporation of InsightMaker into the game could not be realised as seamlessly as intended, so design options were limited. There was also the requirement to keep the game short and concise, so that it each part could be played in one teaching unit. This meant that we decided against tutorials and lengthy introductions. As a result, the simulation games were not as intuitively understandable as planned. More effort on this issue is needed for revised future versions of the game.

There are still many ideas for future adaptations and endless possibilities of extending the digital learning game. Further fields of application are seen in the education of university students; new target groups require further adaptations. Based on the German version of the game, an English version was developed with the help of the prize money (BOKU Sustainability Award 2020 in the category "Education for Sustainable Development”) and is also freely available. An evaluation of the effect of improving system thinking among different target groups would be an interesting future challenge. Regardless of the challenge of further adaptations, authors are enthusiastic about the potential of the gaming approach and very keen to continue the work on educational games and are looking for co-operation partners!

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Mobility Inequality in a Small Town in Central Poland. The Case Study of Zgierz

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1 ABSTRACT

Over the past decades, the number of cars has been increasing around the world rapidly. In effect, the demand for road space and space for parking has also been growing. At the same time, especially in town centres, space is limited, which leads to many urban conflicts.

Our cities are automobile-dependent, which means that transportation and land use patterns favour car users and at the same time create less accessible circumstances for other means of transport, particularly for pedestrians and cyclists. It excludes vulnerable and marginalised groups and harms the majority of inhabitants.

There is a need for a different distribution of the forms of mobility, in particular in terms of sustainable development and climate change mitigation.

It finds confirmation in many European agreements. The European Union has been dealing with sustainable development and mobility for several years. The results of it are the Green and White Papers. The newest documents like the European Green Deal and the New Leipzig Charter focus on sustainable transformation, which leads to climate neutrality. The main aim is to make cities inclusive, safe, resilient, and sustainable. It also concerns the topic of urban mobility.

In Poland, transport problems began to increase in the second half of the 20th century. The transition to a market economy led to the decapitalization of transport networks. As a result, differences between regions increased and the accessibility of many areas in the national and European systems deteriorated. The problem concerns especially small towns, where the resignation from public transport is common. and leads to exclusion.

Zgierz is a town located in central Poland, in the vicinity of Lodz, the third-largest city in the country. Due to the collapse of the textile and chemical industries, Zgierz faced the need to transform its economic profile, which it has not dealt with yet. Moreover, the negative impact of transportation compounds the effect of the degradation. The problem is the most visible in the centre area due to the radial layout of streets and the lack of ring roads.

This study examines the negative impact of transport and mobility inequality in a small town in Poland. Using the case study method it identifies diverse aspects in which users of different means of transport are not treated equally. It analyses traffic congestion, demand for space, barriers in public spaces, road safety and air pollution. It also compares the results of analyses with European guidelines and offers some key recommendations.

Keywords: sustainable development, mobility inequality, urban mobility, climate change, small town

2 INTRODUCTION

The need for inclusive, safe, resilient, and sustainable cities is emphasised in the 2030 Agenda for Sustainable Development. Overcoming mobility inequalities is connected to at least 4 of 17 set goals – good health and well-being (SDG 3), gender equality (SDG 5), reduced inequalities (SDG 10) and sustainable cities and communities (SDG 11). It also finds confirmation in many other documents, such as the New Urban Agenda, the Paris Agreement, the European Commission's Green Deal and the New Leipzig Charter. In order to achieve the set goals, the need for a better understanding of mobility inequality is one of the critical elements.

In Poland, transport problems began to increase in the second half of the 20th century. The transition to a market economy led to the decapitalization of transport networks. As a result, differences between regions increased and the accessibility to many areas in the national and European systems deteriorated. Also, due to the technical condition of regional roads and tracks, the accessibility to public services worsened. The problem particularly concerns small towns, where the resignation from public transport is common and leads to exclusion (Koncepcja Przestrzennego Zagospodarowania Kraju, 2012).

Despite the collapse in the early 1990s and the lack of investment, the mobility and transport of goods increased. As a result, the environment and road infrastructure suffered and the number of accidents increased. The more environmentally-friendly railway has also lost its position. It is no longer a competition for road transport. Moreover, the independent development of individual forms of transport led to the lack of connections between them (Koncepcja Przestrzennego Zagospodarowania Kraju, 2012).

Year	2000	2005	2010	2015
The average daily annual traffic of motor vehicles	7009	8244	9888	11178

Table 1: The average daily annual traffic of motor vehicles on national and voivodeship roads. Source: own table based on Generalny Pomiar Ruchu.

Based on the data collected by the General Directorate for National Roads and Motorways, during the General Traffic Measurement carried out every five years, it is possible to observe the traffic intensity on national and voivodeship roads. In 2015, the average daily annual traffic of motor vehicles was 11,178 vehicles/day, 13% higher than in 2010. The most significant increase in traffic was among trucks with trailers (18%), passenger cars (17%) and motorcycles (15%). In 2010-2015, there was an increase in traffic on national roads in all voivodeships. However, the highest was recorded in the Lodzkie Voivodship, by 26%. These changes were caused not only by the actual increase in traffic but also due to the construction of new road sections such as the A1, A2 motorways or the S8 expressway (Generalny Pomiar Ruchu, 2016).

3 METHODOLOGY

Case study research helps to understand reality, which is nuanced and based in a concrete context. Some processes, especially connected to human behaviour, cannot be described as predictive theories and universals (Flyvbjerg, 2006). The most considerable value of this method is giving special attention to what has actually happened in a given setting and how. This method has a practical value for practitioners, providing data and understanding complex urban processes and relations (Duminy, 2015).

This study adopts a case study method approach to investigate and better understand processes connected to transport patterns leading to mobility inequalities in a small town in central Poland against the backdrop of international documents mentioned above. The first part of the research describes specific conditions in Zgierz, such as spatial structure and road layout. After that, considerations on the consequences of the current situation and the associated nuisances contributing to mobility inequality were discussed. Direct factors such as congestion, land consumption, spatial barriers, safety and air pollution were considered. Based on the available materials related to the conditions in the town, such as reports, databases and thematic maps, and observations and field inventory results, an assessment was made of the impact of transport on mobility inequality in Zgierz. The final part of this study includes conclusions of the findings and some key recommendations.

4 CASE STUDY

4.1 About Zgierz

Zgierz is a town located in central Poland, in the neighbourhood of Lodz, the third-largest city in the country. Due to the collapse of the textile and chemical industries, Zgierz faced the need to transform its economic profile, which it has not dealt with yet. As a result, many post-industrial areas located in the centre are currently unused and contribute to decreased attractiveness. Besides, the negative impact of transportation compounds the effect of the degradation. The problem is mostly visible in the centre area due to the radial layout of streets and the lack of ring roads. The cars' domination in urban space contributes to the aggravation of negative phenomena and prevents the proper functioning of the centre of Zgierz, leading to its collapse.

4.1.1 The road system

The road system in Zgierz is the result of historical connections with neighbouring cities. They form a radial network, the meeting point of which is the town centre (Figure 1). The lack of ring roads and the radial layout makes it necessary to drive through the centre each time, regardless of the destination. It leads to the accumulation of negative impact of transport in the historical part of the town and puts pressure on the environment.

One of the main problems of the transport system in Zgierz is that main national roads run through the town and cross each other in the centre. At the same time, they are one of the most congested roads in Poland. The possibilities of transformation are limited due to external factors, such as road parameters regulations, as well as internal ones, such as the historic urban layout and the current investment. Furthermore, rebuilding these roads would not significantly improve their functioning or eliminate their negative impact (Studium, 2015).

The construction of the bypass system is seen as a solution to a conflict situation. The already completed A1 motorway and the planned S-14 expressway could successfully transfer transit traffic currently running along national roads through the town centre. This situation would allow to adjust the rank and class to the current parameters and adapt to the streets' character in the town centre (Studium, 2015).

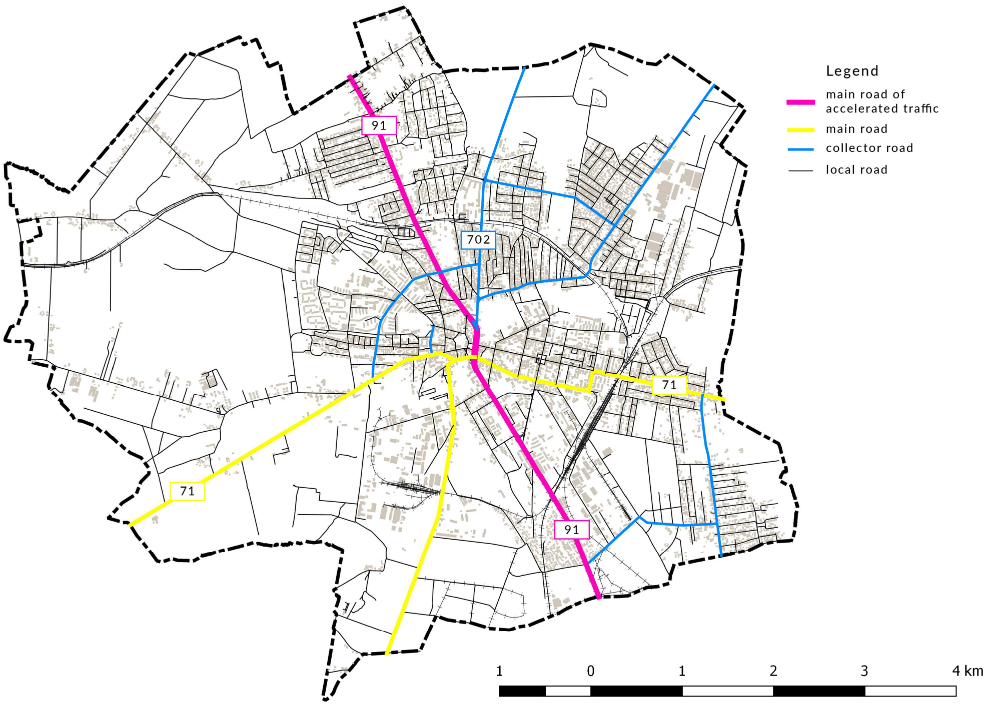

Fig. 1: Road classes in Zgierz. Source: (Olczak, 2019) based on (Studium, 2015) and (Geoportal Województwa Łódzkiego).

In Zgierz, the General Traffic Measurement is the only current source of information about the number of vehicles on the road. Due to the fact that both national roads as well as the only voivodeship road run and intersect in the very centre of town, this gives a certain picture of the traffic intensity.

Measuring point	Road number	Number of vehicles			
		2000	2005	2010	2015
1	91	19213	18684	19980	18114
2	91	24725	26185	25551	27641
3	71	-	11229	11430	11093
4	71	3176	3998	5617	7977
5	702	-	-	17447	16751

Table 2: Average daily annual traffic at measuring points on national and voivodeship roads running through Zgierz in 2000-2015. Source: own table based on Generalny Pomiar Ruchu.

The above data (Table 2) shows that the national road No. 91 has been the most heavily burdened by traffic for many years. Additionally, the traffic on this route has been constantly increasing. Moreover, on the route from Aleksandrów Łódzki (national road No. 71), the number of vehicles has increased by 42% in 2010-2015. In other cases, the traffic was reduced by a few percent. Far more vehicles travel north-south on national road No. 91 than east-west on national road No. 71.

The dominant means of transport on all the routes studied were passenger cars (Table 3), which accounted for over 80% of all vehicles. A significant group on the route to Aleksandrów Łódzki (measuring point 4) were lorries with trailers, their share at the level of over 17%. A comparable value was also recorded on the national road No. 91 at the measuring point 1 – over¬ 10%. In the remaining cases, both lorries with and

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without trailers accounted for a few percent of the share (about 1-6%). Light trucks (delivery vans) constituted a significant group of a few percent share (about 5-10%). Among the other means of transport, a small share, less than a percentage, was recorded.

Measuring point (Road number)		1 (91)		2 (91)		3 (71)		4 (71)		5 (702)	
Motorcycles		64	0,35%	128	0,46%	48	0,43%	21	0,26%	117	0,70%
Passenger cars		14540	80,27%	23203	83,94%	8945	80,64%	5496	68,90%	14272	85,20%
Light trucks		1268	7,00%	1712	6,19%	1024	9,23%	652	8,17%	938	5,60%
Lorries	Without trailer	291	1,61%	911	3,30%	442	3,98%	376	4,71%	268	1,60%
	With trailer	1859	10,26%	1561	5,65%	500	4,51%	1387	17,39%	1039	6,20%
Buses		86	0,47%	124	0,45%	131	1,18%	41	0,51%	117	0,70%
Tractors		6	0,03%	2	0,01%	3	0,03%	4	0,05%	0	0,00%

Table 3: Average daily annual traffic at measuring points on national and voivodeship roads running through Zgierz in 2015. Source: own table based on Generalny Pomiar Ruchu.

4.1.2 Urban structure

The town centre of Zgierz consists of two-parts – historical with buildings from the beginning of the 19th century and historic urban layout and a modern one with blocks of flats. The axis of the entire downtown layout is Długa Street, along which a large part of public institutions and various services are located (Studium, p. 97).

An essential element of the urban structure of Zgierz is also the 650th Anniversary Housing Estate located to the west from the town centre. It is inhabited by nearly 40% of all inhabitants of the town and is a competitive area for the town centre.

A huge problem of the town centre is the lack of a coherent spatial structure and gaps in development. The value of the areas in the centre and the sense of identity are too low to counteract the deconcentration and the progressive urban sprawl effectively. The urbanisation process is incredibly intensive in the northern, northeastern and eastern parts of the town (Studium, 2015, p. 93). There is also no intention to intensify the use of the centre. One of the reasons may be the growing demand for space dedicated to cars and habits of both decision-making groups and the residents, which oppose any attempts to limit the availability of cars (Wesołowski, 2008, p. 40).

The designation of new non-urbanised areas for development planned in the Studium may contribute to further progress of the suburbanisation process. Consequently, it leads to deterioration in the accessibility of services and transport, and thus the dependence on cars of the inhabitants of peripheral areas.

5 INEQUALITIES

5.1 Automobile dependency

This term refers to transport and land-use patterns that are privileging car users and at the same time creating less accessible circumstances for other means of transport, especially pedestrians and cyclists (Victoria Transport Policy Institute, 2016). Shopping centres are a great example of this problem but it also applies to municipal offices.

In Zgierz, most offices and institutions (66,7%) are located in the town centre (Figure 2). Therefore they are available to motorists, pedestrians, cyclists and public transport users. However, some objects of this type (33,3%) are located further from the centre. Their surroundings do not indicate that it is an essential public facility. In their vicinity, extensive single-family housing, industrial facilities, and even open areas are located. Reaching these offices by public transport is significantly tricky because they are located further from main roads and only low-frequency buses stop in the area. However, parking spaces are provided for each of them. Moreover, these offices are at great distances from each other.

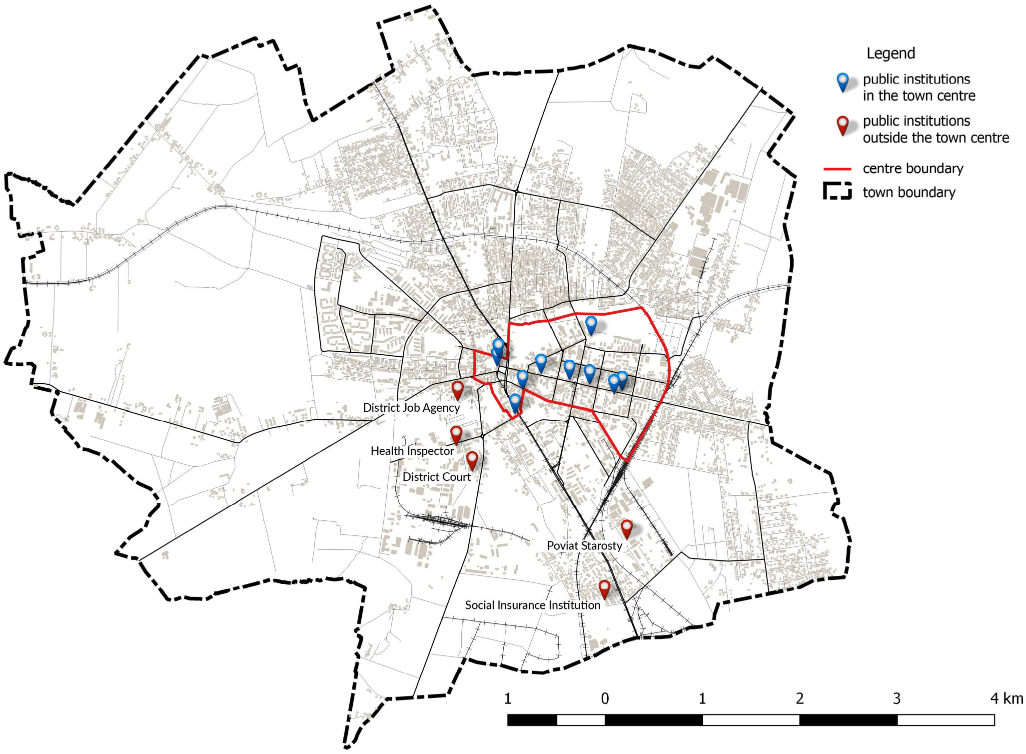

Fig. 2: Location of public institutions in Zgierz. Source: (Olczak, 2019).

5.2 Demand for space

The demand for road space and space for parking is growing. At the same time, space is limited, especially in town centres. Dedicating this much space to cars is a very ineffective way of land use because cars are only actively used for a minimal time and, in most cases, only by one person. Due to limited parking space, car users leave their vehicles on pavements, lawns or crosswalks. Space dedicated to pedestrians or cyclists, which is very limited right now, is even more reduced. Inequality in space distribution is a big problem in towns. Especially in town centres, it is crucial to allocate space in favour of efficient transportation.

5.2.1 Parking space

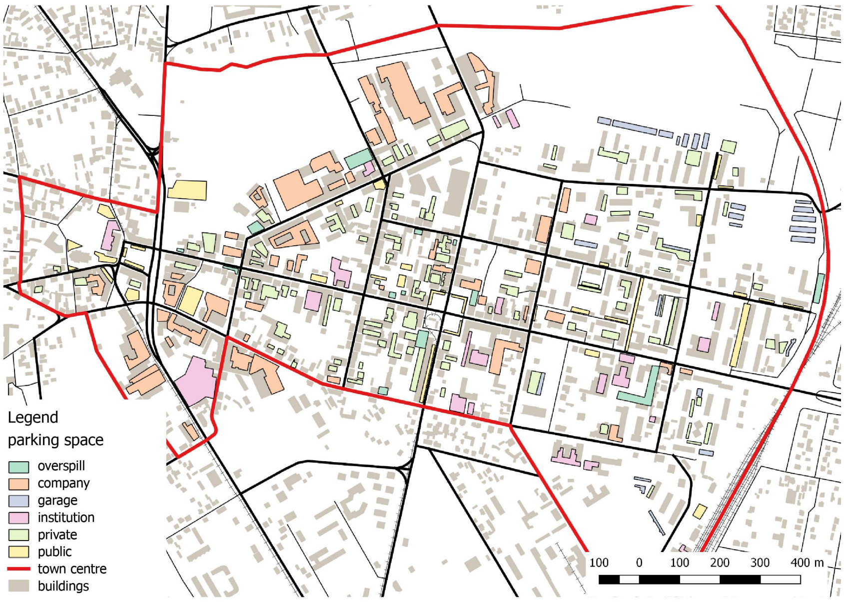

Fig. 3: Parking space in the centre of Zgierz. Source: (Olczak, 2019).

The biggest problem with parking in Zgierz is the area it occupies and the way it is organised. In addition, drivers appropriate space to park illegally in places not intended for this, such as lawns or pavements. In many locations where cars are parked, there should be buildings or greenery.

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The pavements are also occupied by cars, making it difficult for pedestrians. Often this is the case with wide streets with little traffic, where parking space could be located within the street. However, the lack of designated places leads to cars parked in the space dedicated to pedestrians.

Additionally, the lack of a parking policy contributes to the escalation of the problem in the centre of Zgierz. Parking in the entire town is free, which only encourages the use of cars. Moreover, the lack of reaction to illegal parking on pavements or undeveloped plots gives drivers a sense of quiet consent.

5.2.2 Roads

Roads in the town centre also occupy a significant area. According to the law, the maximum width for roads class Z, L and D can be broadened to 3.50 m if it results from the traffic forecast. The regulation also allows reducing by 0.25 m the values given in the table for traffic calming. However, in Poland, it is common that roads have the maximum permissible width of lanes, and often even wider ones, regardless of their class or traffic intensity.

Road class	GP and G	Z	L	D
Minimal width of lane	3,50 m	3,00 m	2,75 m	2,50 m

Table 4: Minimal width of lane. Source: own table based on Rozporządzenie.

In addition, the space dedicated to cars is not fully used. In many places, despite the broad streets, parking takes place entirely or partially on sidewalks, additionally appropriating the space intended for pedestrians.

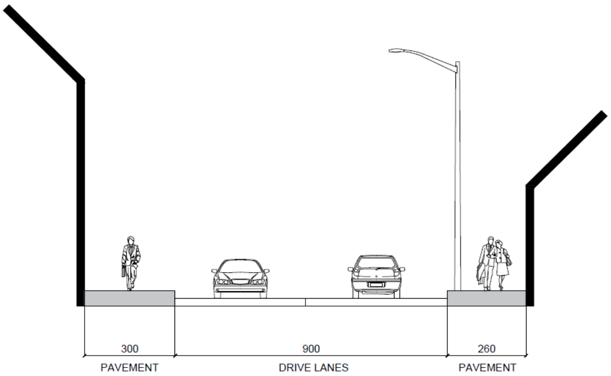

Fig. 4: Street section – Długa street in Zgierz. Source: (Olczak, 2019).

Długa Street (Figure 4), which is the representative space of the town, is 9 m wide, thus significantly exceeding the norms specified in the regulation. There are two lanes within the road and nothing else. However, the width would allow for the separation of parking spaces, greenery or bicycle lanes. The pavements on Długa Street are relatively wide, but there is often infrastructure such as lamps or road signs, which reduce the space on some fragments. Additionally, the pavement space is often occupied by parked cars.

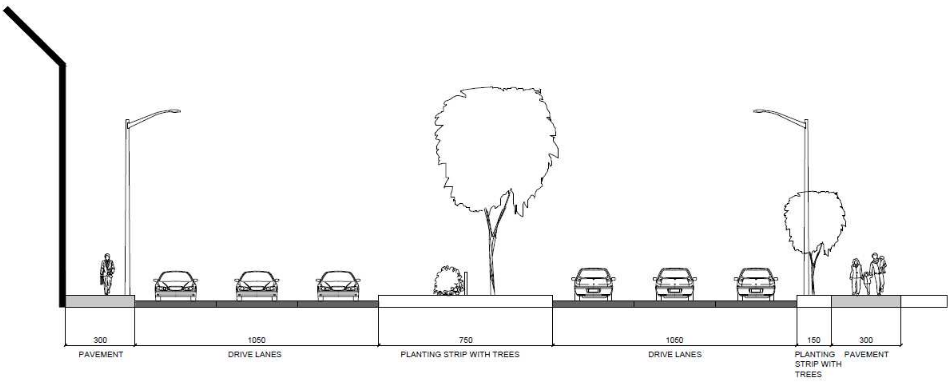

Fig. 5: Street section – the national road no. 91 in Zgierz. Source: (Olczak, 2019).

It is also worth paying attention to the national road no 91 (Figure 5), which runs through the town centre, cutting it into two parts. At the town entrances, both from the south (towards Łódź) and the north (towards Gdańsk), it has a single carriageway with two lanes. In the vicinity of the centre, it widens to 4 lanes, 2 in each direction. The section running directly through the centre has a 2x2 section – 2 roadways with two lanes each. In addition, there are also left-turn lanes and a green belt, which separates both roadways. The road covers a large area and is a spatial barrier that separates the town's structure. It cuts the centre into two separate entities, leaving them unconnected. In addition, due to its width and traffic congestion, this road is an obstacle for pedestrian traffic. To get to the other side of the road, pedestrians have to cover about 30 m. Also, other roads in the centre are barriers to pedestrian traffic. Although their parameters are much smaller – 1x2 (one road with two lanes), they are still very broad (8-9 m wide) and the traffic congestion is very high.

5.3 Road safety

In 2016, 3,026 people died on Polish roads, which accounted for almost 12% of all victims in the European Union. Poland is therefore one of the leading countries, with the highest number of deaths. In addition, the following countries on the list have over a thousand deaths less. (CARE database). In 2015, 915 pedestrians died on Polish roads. Although within ten years (2006-2015) this number has been reduced by half, Poland is still in the infamous first place among the European Union countries, overtaking other countries by nearly 300 victims. Also, with regard to cyclists, Poland ranked high, with the number of victims of 300 in 2015, overtaken only by Denmark (European Road Safety Observatory, 2017).

Almost 87% of road incidents in Zgierz are the fault of the vehicle driver. In addition, they are responsible for 69% of the deaths, 78% of the seriously injured and 85% of the lightly injured. Apart from vehicle collisions, collisions with pedestrians are the most common type of event - 480 events. Many accidents also occur at pedestrian crossings. Moreover, failure to prioritise pedestrians is the most common cause of fatal accidents and severe and slight injuries (SEWiK).

In Zgierz, pedestrians are the largest group of fatalities and are more likely to be severely injured in accidents. The most significant number of deaths among pedestrians was recorded in the over 50 age group, and especially in the over 70 group. In turn, fatalities among vehicle drivers are much younger – under 40 years of age (SEWiK).

The most dangerous roads are located in the town centre. Although the most significant number of incidents (Figure 6) takes place on Łódzka Street (61% more incidents than on Długa Street), the most significant number of victims was recorded on Długa Street (46% more injured than on Łódzka Street). The representative Zgierz street leads in terms of the number of injured, lightly and severely, and fatalities. In addition, the number of casualties significantly exceeds the figures recorded in other streets - 36% more lightly injured and 78% more seriously injured than on the second-ranked streets (SEWiK).

If we look at pedestrian safety (Figure 7), the most significant number of pedestrian incidents also occur in the town centre. Pedestrians were about 50% of all victims (Długa Street - 56.4% and 1 Maja Street - 46.2%) (SEWiK).

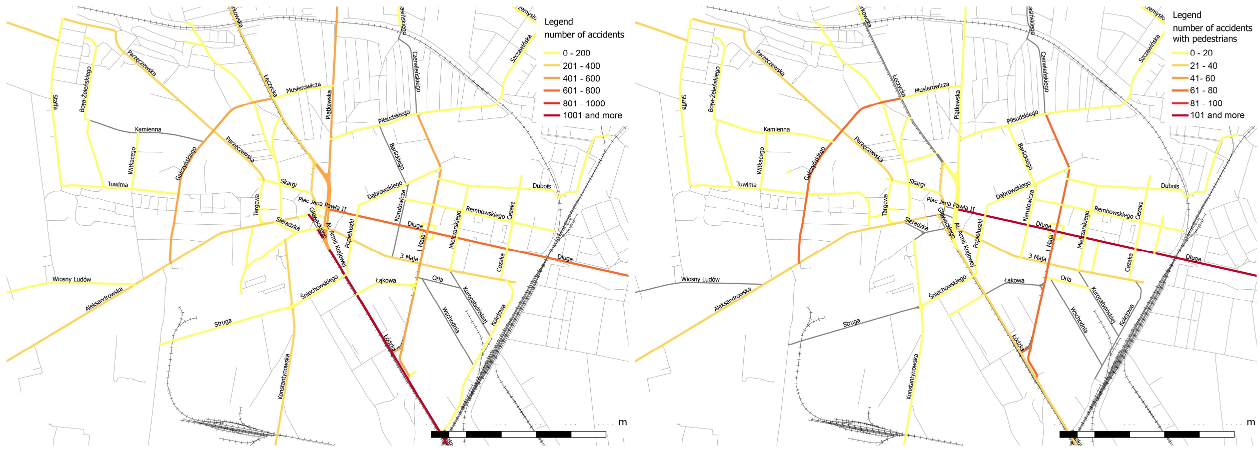

Fig. 6-7: The number of car accidents in total (left) and with pedestrians' involvement (right) in Zgierz in 2007-2017. Source: (Olczak, 2019) based on (SEWiK).

5.4 Air quality

The monitoring results clearly show the growing impact of road transport on the deteriorating air condition. When looking at the reports from the only measuring station in Zgierz (Figure 10) and comparing the PM10

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and PM 2,5 measurement results with Polish (solid line) and European standards (dashed line) (Figure 8-9), significant discrepancies can be noticed. If national limit values are used, bad or very bad air condition is recorded only a few times a year. On this basis, it can be concluded that air pollution in Zgierz is not severe. However, according to European standards, the situation in the town is much worse again. Transgressions are recorded for a significant part of the year. This means that residents breathe poor or very poor quality air most of the time, which can pose a severe health risk, especially to children, the elderly, and pregnant women.

It should also be emphasised that the measuring station is located in the eastern part of the town centre, surrounded by blocks of flats, at a considerable distance from the roads with the highest traffic. This may translate into incomplete accounting for pollutants of transport origin. Therefore, it should be assumed that the actual air pollution near roads may be significantly higher.

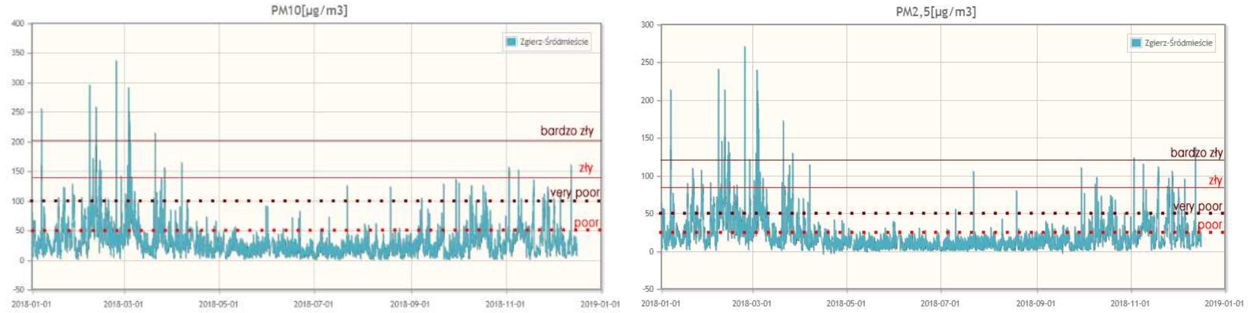

Fig. 8-9: PM10 (left) and PM2,5 (right) measurement results at the Zgierz station in 2018. Source: Wojewódzki Inspektorat Ochrony Środowiska.

6 DISCUSSION

6.1 Automobile dependency

The location of offices in Zgierz is in contradiction with the idea of the compact city. The dispersion of public administration facilities beyond central areas limits individual transport mobility options. For a person who does not have a car and has several official matters to deal with in one day, the route between the facilities can be challenging and time-consuming. It creates mobility inequalities and can lead to social exclusion for vulnerable and marginalised groups such as the elderly or disabled people.

6.2 Demand for space

Roads located in the centre of Zgierz are designed in the cars' favour. In effect, it limits transport options for citizens without cars. It is worth paying attention to how unevenly distributed space is to the needs of different traffic users. Pedestrians, cyclists and even public transport users are put in a worse position. Walking between parked cars is a barrier and obstruction to pedestrians, especially for vulnerable groups such as the elderly, disabled people or people with small children. It is also worth noting that vehicles parked on the pavements reduce the visibility of both pedestrians and drivers, which may also increase dangerous situations on the road.

Furthermore, roads, especially those with heavy traffic, are also barriers in spatial and social terms. They are hindering the development of outdoor activities, neighbourly contacts and freedom of movement. Spatial barriers can also have a significant impact on transport decisions made by residents.

The national road No. 91 – Łódzka Street brings the most negative spatial consequences for the central area. It reaches the largest size, occupying a large area, separating the town structure and creating a spatial barrier, mainly for pedestrians.

6.3 Road safety

Road transport is the most dangerous of all of the modes. Even though everyday people are dying or being injured in car accidents, we seem not to see the problem and treat it as a natural consequence of using cars. As a result, car users are more privileged than pedestrians, who are primarily casualties. This situation is also generating costs for the whole society.

It should be emphasised that, contrary to popular belief, the victims of accidents are not usually drunk or invisible pedestrians and cyclists. On the contrary, often children or the elderly are among the victims. Most of the incidents occur mainly during the day on newly built or modernised roads. In the case of pedestrians on sidewalks and crossings, they should theoretically feel safe.

The level of safety on the streets of Zgierz, as in the rest of Poland, is too low. In particular, the unprotected road users, i.e., pedestrians and cyclists, who cannot feel safe even in their designated areas (sidewalks, pedestrian crossings or bicycle lanes), are at risk. Also, the spatial distribution of both the number of incidents and victims indicates that the town centre is the least secure space. On the other hand, road safety also has a massive impact on the choice of means of transport.

It is also worth paying attention to the massive number of events on Długa Street, the town's representative street. It ranks second in terms of the number of accidents in the town but it is also the most dangerous for pedestrians. On the one hand, it plays a vital role in the centre by concentrating the activity of residents. At the same time, there is heavy traffic on it, leading to conflict situations. Undoubtedly, the intensity of traffic on Długa Street and the high risk of an accident translate into unfavourable conditions for other than cars modes of transport.

6.4 Air quality

Based on air quality measurements from the only one station in Zgierz, it can be concluded that the level of pollution in Zgierz poses a severe threat to the health of its inhabitants. Numerous transgressions of the acceptable standards, both European and World Health Organization, and much less restrictive Polish, indicate the need to improve air quality. In particular, more than 40,000 premature deaths occur annually in Poland due to air pollution (European Environment Agency, 2017). Even though cars are responsible for a significant part of the emissions in the urban area, all citizens have to deal with its adverse effects. In this case, individual transport is privileged because we often do not think about external costs connected to it, for example, polluting the air.

6.5 Recommendations

A proven method of achieving equal mobility is using the push-pull method, on the one hand, introducing restrictions primarily for the use of cars, on the other hand, incentives in the form of, e.g., efficient public transport. However, the implementation of the idea of sustainable mobility should be carried out in a balanced way. Choosing a car as a means of transport is supposed to be an option, not a necessity.

Promoting the idea of sustainable mobility should therefore take place through appropriate shaping of transport behaviour. For this purpose, soft transport should be given preference by providing the shortest route for cycling and walking. This means shaping the infrastructure that prioritises users traveling in this way. The advantageous route should also be provided to public transport. However, individual transport should receive the least priority. Such thinking about shaping transport in the city is a manifestation of the push-pull method.

Actions to change the transport behaviour of residents should also be followed by architectural and urban solutions aimed at restoring the original functions of the street, i.e., public space lost as a result of uncontrolled expansion of the car. High-quality and well-functioning public space can also be a form of compensation for limitations in the use of individual transport.

Recommendations and suggestions for improving mobility equality in Zgierz:

- Intensify the development of the centre of Zgierz and limit the urban sprawl.
- Make the location of new buildings dependent on the possibility of using public transport.
- Provide an attractive public space in the centre to restore social functions to streets and squares.
- Provide the appropriate width of the pavement, including convenient conditions for stopping and resting, especially important in the context of older people, children and people with reduced mobility.
- Ensure space continuity and reduce spatial barriers and hazardous locations.
- Eliminate parking on pavements, thus reclaiming space for pedestrians.

- Introduce traffic calming in the centre area – c¬ombine policy solutions, such as a speed limit of 30 km/h or the introduction of equivalent intersections, with engineering solutions – r¬oad narrowing, speed bumps or chicanes.
- Develop the bicycle infrastructure.
- Integrate public transport systems.
- Adapt the accessibility of public transport to the needs of elderly and disabled people.
- Give priority to public transport in road traffic.
- Introduce parking fees as an instrument to ensure the rotation of parking spaces in the town centre.
- Maintain or reduce the number of parking spaces while eliminating illegal parking.

7 CONCLUSION

Transport not only influences climate change but also introduces inequalities between the different users of the city. The privileging of cars, which takes advantage of their appropriation of space, leads to restricting the freedom of movement of other users.

In particular, much more attention should be paid to a more equitable distribution of space in the centre, emphasising soft transport - pedestrian and bicycle. A significant part of the transport area could be successfully recovered and used for other purposes, such as infrastructure for walking and cycling. The lack of an appropriate setting in the form of small architecture or greenery and appropriate pedestrian and bicycle infrastructure translates into unfavourable conditions for other than cars modes of transport.

In this case, providing safe, affordable, accessible and sustainable transport systems for all has not been achieved yet. It would not be possible without changing the way of thinking about transport and introducing solutions for improving the situation of pedestrians, cyclists and public transport.

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Monitoring Nature-Based Engineering Projects in Mountainous Region Incorporating Spatial Imaging: Case Study of a Hydroelectric Project in Nepal

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1 ABSTRACT

Infrastructure projects pose complex management challenges and require comprehensive solutions for diverse needs, including the monitoring of purpose-built nature-based components at regional scale. Our paper demonstrates the capability of spatial imagery in monitoring the health of a micro-hydro renewable energy generation plant in the mountainous region on the outskirts of Kathmandu, Nepal.

Our modelled results utilising the Normalised Difference Water Index (NDWI) from the longitudinal satellite data between between 1988-2020 show the spatial profiles of the hotspots for potential nature-based infrastructure interventions. This is typically an administrative challenge for wider implementation of such interventions in low/middle income countries such as Nepal. We recommend policy measures for enhancing nature-based local livelihoods can be one way for encouraging community-based local management of such initiatives. We also identify the need for regular data updation vital for providing ground-truthed decision making capability for such integrated infrastructures using an Artificial Intelligence platform.

Keywords: energy, spatial analysis, nature-based, infrastructure, monitoring

2 INTRODUCTION

Nepal's new Federal Constitution is creating higher, inclusive economic growth for the population of circa 31million. Increasing level of infrastructure projects are being proposed integrating blue-green (natural) alongside grey (built structures) components to increase sustainability across key sectors, including transport, energy, adventure sports and inner-city (aka "forest city") developments. The last decade has seen a push for integrated infrastructure projects in Nepal, combining nature-based components alongside built structures to meet the sustainable development (SDG 9 - Build resilient infrastructure). Typical projects include transport corridors, alternative energy installations, adventure sports facilities, etc., both in remote, naturally sensitive locations and in the urban hinterlands. However, there is still a lack of a comprehensive project management framework for ensuring effective delivery and post-delivery long-term monitoring of such nature-based engineering projects. Our study presents a case study demonstrating the role of remotely sensed satellite data in optimising infrastructure sustainability through targeted integration of purpose-built nature-based components at a hydroelectricty generation plant in Nepal.

3 METHODOLOGY

3.1 Case study description

The Kulekhani hydropower project (KHP-1) is a rock-fill dam on the Kulekhani River (also known as Indrasarobar), which was constructed in 1977; a 60 MW hydroelectric power station was later installed at the site in 1982. It is situated in the Bagmati River Basin of Makwanpur district of Nepal (between 27° 35′ 07″ N and 27° 37′ 43″ N latitudes; 85° 8′ 17″ E and 85° 9′ 56″ E longitudes) at an altitude of 1430 metres above sea level (Figure 1). The dam area is 7 km long and 114 m deep, with a total storage capacity of approx. 85 million m3 - 12 million m3 allocated to dead storage and 73 million m3 to live storage (Shrestha et al. 2014, Shrestha et al. 2021). This watershed extends from sub-tropical to temperate climate zone and has been facing the severe impact of climate change in the recent decades; daily precipitation level has decreased and temperature has increased in the past 30 years (Ghimire et al. 2019). The neighbouring region comprises of forested and cultivation areas which are aggressively being replaced by urban built-up areas,

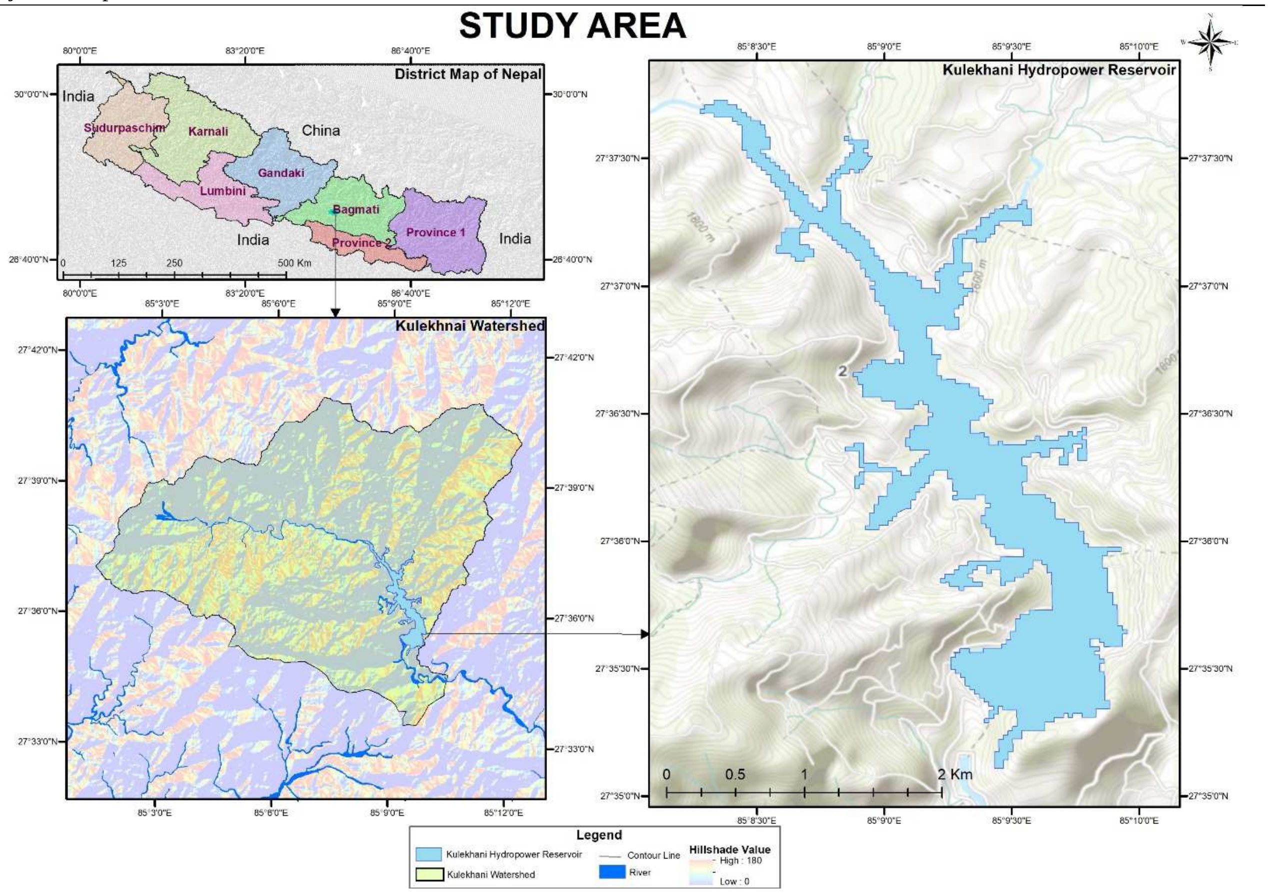

Figure 1: Location map of the study area (the span of the dam area shown in the inset in the right panel).

3.2 Data acquisition

In this study we have collected freely available Landsat Level 2 images 1988-2020 (Landsat 5 Thematic Mapper, TM; Landsat 7 Enhanced Thematic Mapper Plus, ETM+; Landsat 8 Operational Land Imager, OLI) from the United States Geological Survey (USGS), Table 1. All images were verified and analysis was conducted in ENVI v5.3 environment.

Year	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010	2014	2016	2018	2020
Months	29-Nov	4-Feb	23-Oct	13-Oct	18-Oct	8-Oct	22-Nov	27-Oct	9-Nov	30-Oct	20-Nov	25-Oct	23-Dec	25-Oct	31-Oct	22-Jan
Sensor	TM	TM	TM	TM	TM	TM	ETM+	ETM+	TM	TM	TM	TM	OLI	OLI	OLI	OLI

Table 1: Time series Landsat 5, 7 and 8 imagery applied (Path/Row 142/040).

3.3 Evaluation of Kulekhani Dam area

We evaluated the water content and its further reduction/expansion in the dam area between 1988 and 2020 utilising the Normalised Difference Water Index (NDWI) from satellite images following the literature (Zhao et al. 2018, Acharya et al. 2019, Zhang et al. 2019, Li et al. 2020). The positive NDWI threshold value of 0 to 1 were applied for the extraction of the water value for all the years (Zhang et al. 2019, Yan et al. 2020). For the extraction of water value the following equations were applied (McFeeters 1996).

$$NDWI^{OLI} = \frac{Green\ (Band\ 3) - NIR\ (Band\ 5)}{Green\ (Band\ 3) + NIR\ (Band\ 5)} \quad \text{Equation 1}$$

$$NDWI^{TM}\ \&\ NDWI^{ETM+} = \frac{Green\ (Band\ 2) - NIR\ (Band\ 4)}{Green\ (Band\ 2) + NIR\ (Band 4)} \quad \text{Equation 2}$$

RESULT

The NDWI estimates were used as the proxy for surface water level of the Dam area. Based on the results, the surface water of Kulekhani dam appears to have expanded significantly over the assessment period, represented by the NDWIs respectively of 0.182 in 1988 and 0.405 in 2020 (Figure 2). In the early part (1990-1994), the NDWI values remained low, however they have increased rapidly beyond 1994, indicating incremental part of the submerged area due to the dam.

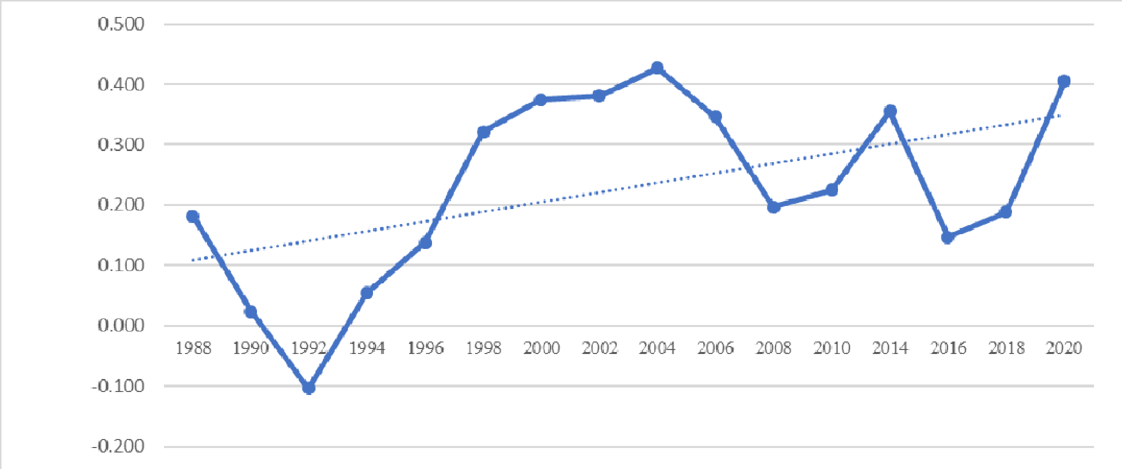

Figure 2. Time-series graph for the NDWI mean pixel values from 1988-2020.

The spatial distribution of the colour-coded NDWI values in the Dam area are plotted in Figure 3, clearly showing the increase in NDWI within the immediate reservoir boundary between 1988-2020. However, the NDWI in the neighbourhood areas of the dam in the corresponding years have been reducing. This could be attributed to multiple factors, such as - climate change impact, variance of precipitation, earthquake, sediment deposition.

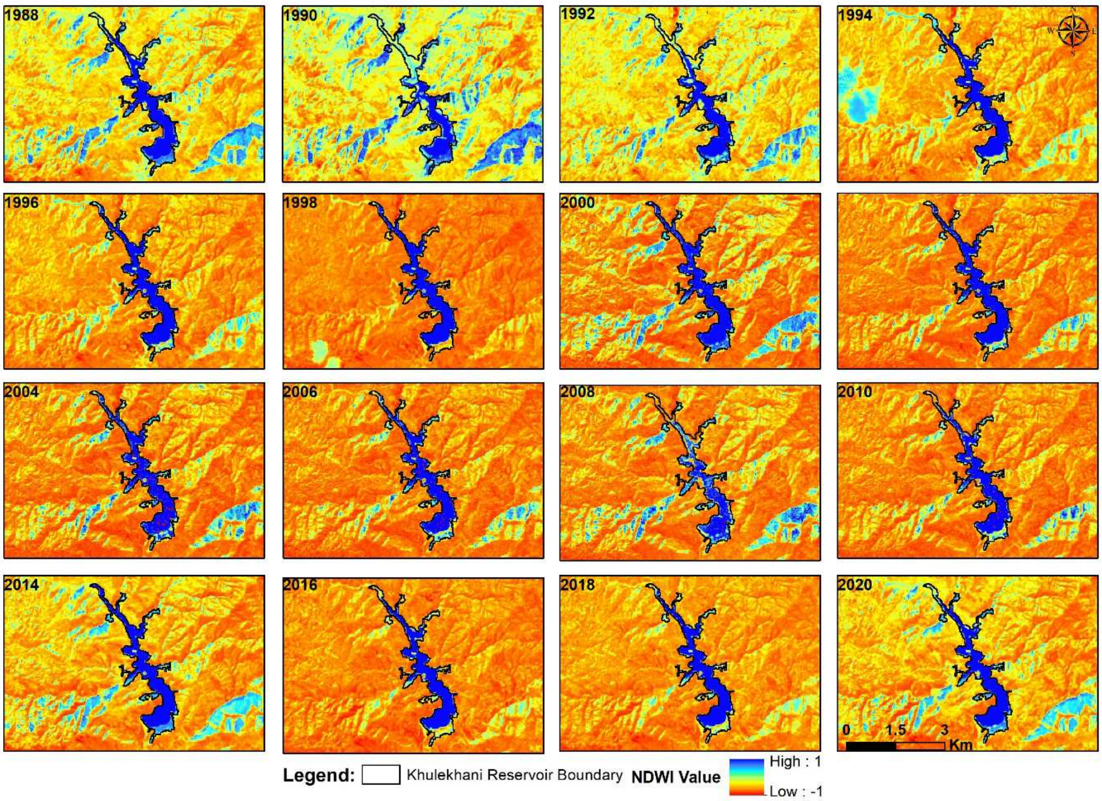

Figure 3: Contour maps of the NDWI profiles showing the reservoir and the neighbourhood areas between 1988 and 2020

4 DISCUSSION AND CONCLUSION

Our study reveals an interesting paradox in relation to the state of hydroelectric power station in mountainous regions - we estimated surface water level of the dam area in the specific case study location increased between 1988 and 2020 (an increase of 122% in the corresponding NDWI values within the reservoir boundary, estimated from satellite imagery from 0.182 to 0. 405). On contrary, the storage capacity

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of Kulekhani reservoir is reported to be reduced from 85 million m3 to 60 million m3 within the last 30 years (Hurford et al. 2014). Although we did not consider the reasons for this contradictory phenomenon within the scope of this study, previous studies have identified sedimentation deposition as one of the key factors leading to this paradox (Shrestha et al. 2014, Ghimire et al. 2019). Adverse anthropogenic encroachment activities have led to further deterioration of the reservoir storage capacity, with increased level of deforestation leading to gully erosion. We consider longitudinal satellite data as a vital tool in monitoring the overall role of nature-based intervention in mitigating such adverse impacts of reservoir capacity. Going forward, we recommend long-term monitoring using remotely sensed satellite data combined with artificial intelligence as essential for understanding the true scale of sediment collection and the potential role of nature-based intervention in mitigating such adverse impacts for infrastructure projects in hard-to-reach mountainous regions.

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reviewed paper

Nachhaltige urbane Gewerbeflächen – ein internationaler Vergleich

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1 ABSTRACT

Seit Beginn der Pandemie im Frühjahr 2020 rücken innerstädtische Gewerbeflächen wieder stärker in den Fokus von Stadtplanerinnen, Stadtplanern, City-Managerinnen und City-Managern. Die Aufenthaltsfunktionen von Stadtzentren wandeln sich. Durch eingeschränkte Nutzungsmöglichkeiten und verändertes Mobilitätsverhalten werden die räumlichen Qualitäten des lokalen Einzelhandels, der großen Bürogebäude, der Gastronomie, des Entertainments und der Kultur infrage gestellt.

Urbane Gewerbeflächen sind elementarer Teil städtischer Nutzungsmischung, da sie vielfältige Nutzungen zulassen und wohnortnahe Arbeitsmöglichkeiten bieten. Bereits vor der Pandemie haben sie sich als resilient gegenüber Veränderungen der Arbeit und der Flächenansprüche durch Internationalisierung und Technologisierung erwiesen. Von daher profitiert in der derzeitigen Situation, neben dem Online-Handel, vielerorts auch die Quartiers-Ökonomie.

Aktuell werden neue Konzepte für das Management des strukturellen Wandels von Innenstädten diskutiert. Für die planerische Transformation von Gewerbe in urbanen Lagen sind bereits einige internationale Beispiele vorhanden. Daher lohnt es sich, einen Blick auf existierende Erfolgsfaktoren zu werfen und für die gegenwärtige Situation zu nutzen.

Anhand von drei Fallbeispielen aus den Niederlanden, Deutschland und Großbritannien beschreibt der Artikel unterschiedliche Steuerungsansätze zur Entwicklung und Umnutzung urbaner Industrie- und Gewerbeflächen sowie deren Effekte auf die lokale Nutzungsmischung.

Im Ergebnis wird deutlich, dass die Stadtverwaltungen in Amsterdam, Berlin und London recht unterschiedlich agieren, um Gewerbe und kleinteilige Nutzungsmischung im Stadtzentrum zu ermöglichen oder zu sichern. Neben prozessualen Formen des kooperativen Umgangs gehören hierzu auch eine flexible Organisation des planungsrechtlichen und immobilienwirtschaftlichen Flächenmanagements.

Keywords: Resilienz, Gewerbeflächen, Quartierstruktur, urbane Produktion, Nutzungsmischung

2 EINLEITUNG: GEWEBE IN DER STADT

Die Frage nach nachhaltigen urbanen Gewerbeflächen hängt eng zusammen mit stadtplanerischen Leitsätzen, bauordnungsrechtlichen Vorgaben sowie städtischen Immobilienrenditen. Die Sicht auf städtisches Gewerbe wandelte sich in den letzten Jahrzehnten. Im Zuge des Strukturwandels der Arbeit und der Internationalisierung veränderte sich auch der Umgang mit Gewerbebetrieben in europäischen Städten grundlegend. Der Artikel beschreibt, wie urbane Gewerbeflächen langfristig und ressourcenschonend genutzt sowie transformiert werden können. Hierfür werden unterschiedliche Steuerungsansätze anhand von drei internationalen Fallbeispielen, die explorativ mittels Ortsbegehungen erhoben wurden, skizziert.

2.1 Wandel von Stadtstrukturen im 20. Jahrhundert

Mit der Charta von Athen (1933) sowie dem Nachkriegs-Leitbild der „gegliederten und aufgelockerten Stadt" entwickelten sich europäische Städte anhand einer funktionsräumlichen Trennung von Arbeiten, Wohnen und Freizeitgestaltung. Industrielle, hafenbezogene und gewerbliche Arbeitsstätten wurden fortan getrennt von Wohnquartieren errichtet, damit Lärm-, Geruchs- und Staub-Emmissionen nicht die Wohnqualität und die Gesundheit der Bevölkerung beeinträchtigen.[1] Diejenigen Stadtbewohnerinnen und Stadtbewohner, die es sich leisten konnten, zogen aus den historischen Stadtzentren an den Rand bzw. in das Umland der Städte. Die „Speckgürtel" und Außen-Stadtteile waren mit Einkaufszentren, Bildungs- und Freizeitangeboten auf die Nahversorgung der neuen Einwohnerinnen und Einwohner ausgelegt. Innenstädte von Großstädten entwickelten sich zu eher monofunktionalen Standorten für unternehmensbezogene Dienstleistungen, großflächigen Einzelhandel, Kultur und Tourismus. Der Ausbau der Verkehrsverbindungen für Pkw, Lkw, Bahn und Schiffe verbesserte die Transportwege für Gewerbebetriebe und unterstützte die Suburbanisierung von Erwerbstätigen.

[1] Beuing & Ahrens 2020:3

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Im Zuge der Tertiarisierung, Internationalisierung, Automatisierung und Digitalisierung wurden kompakte Stadtquartiere mit kurzen Wegen, ressourcenschonender Infrastruktur und einer kleinteiligen Nutzungsmischung gegen Ende des 20. Jahrhunderts zu attraktiven Wohn- und Büroarbeitsstandorten. Produzierendes oder verarbeitendes Gewerbe verschwand aufgrund von Standortschließungen bzw. Verlagerungen in das außereuropäische Ausland, restriktiven Umweltauflagen oder steigenden Bodenrenditen in vielen Fällen aus den Zentren europäischer Städte. Zurück blieben Flächen, die für andere Nutzungen wie Wohnungsbau, Büro- und Einzelhandel oder Freizeitnutzungen verfügbar wurden.[2]

2.2 Urbanes Gewerbe heute

Urbanes Gewerbe ist heutzutage vielfältig. Es kann unter anderem aus Handwerk, Einzelhandel, Kulturbetrieben, Hafengewerbe, vielfältigen Dienstleistungen und Beherbergungsbetrieben bestehen (siehe Abbildung 1). Diese Unternehmen bieten nicht nur wohnortnahe Arbeits- und Ausbildungsplätze, sondern tragen auch zur kulturellen Integration und sozialem Zusammenhalt der Stadtbevölkerung bei.[3] Die Flächen- und Standortansprüche der Unternehmen variieren je nach Unternehmensgröße, Marktausrichtung, Netzwerkbeziehungen, inhaltlicher Spezialisierung sowie Attraktivität für und Anforderungen an die Arbeitskräfte.

Der allgemein steigende Bedarf nach zeit-effizienter Wohn-Arbeits-Organisation sowie nach Qualitäten von urbanen Stadtquartieren ließ die Grundstückspreise in durchmischten, gut angebundenen Stadtgebieten von Metropolen seit einigen Jahren stark ansteigen. In Wachstumsregionen mit einer großen Flächenkonkurrenz kann das den Druck für eine wirtschaftliche Aufwertung oder einen Funktionswandel innerstädtischer Gewerbeflächen erhöhen[4] Das Das in prosperierenden Städten eher geringe Angebot an verfügbaren Gewerbeflächen lässt standortbezogene Expansionen von eingesessenen Gewerbebetrieben oftmals nicht zu.[5]

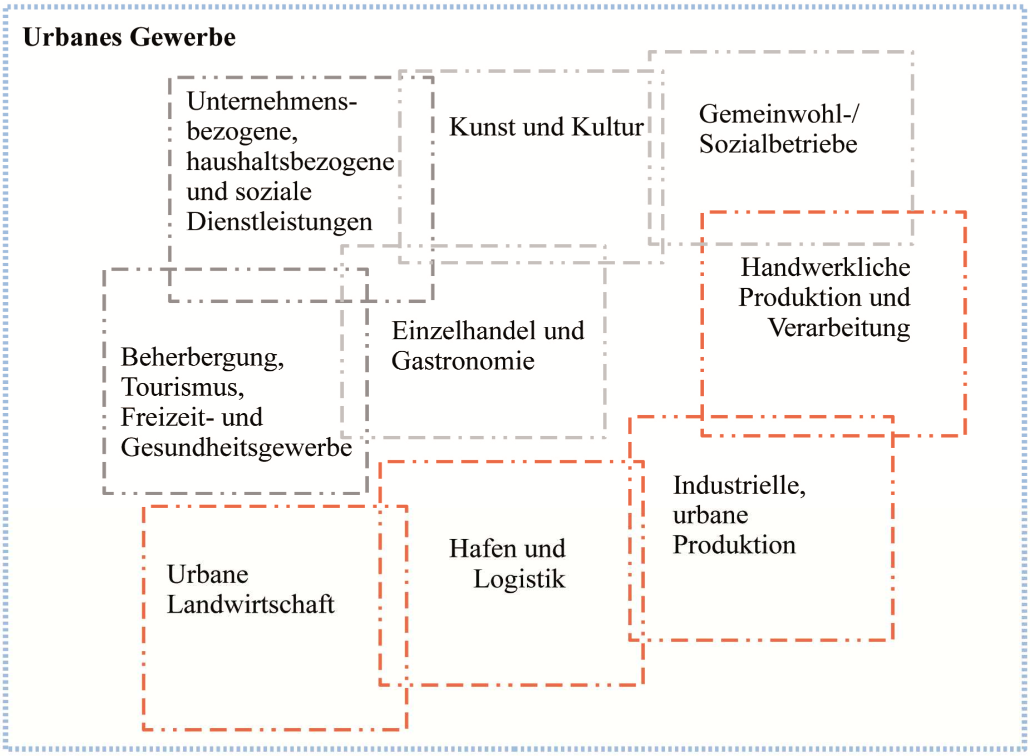

Abbildung 1: Vielfalt und Schnittstellen von urbanem Gewerbe

Bauordnungsrechtliche Vorgaben zum Schutz der Wohnbevölkerung, wie bspw. Lärmschutzauflagen, verstärken den Trend, dass nur noch „störungsarmes" Gewerbe in urbanen Zentren und Mischgebieten

[2] Vgl. Rettich 2021:7
[3] Vgl. Brandt & Butzin & Gärtner & Meyer & Hennings et al. 2017, S. 21 ff.
[4] Vgl. Eckmann et al. 2020:45
[5] Für die Leerstandsquoten und -prognosen für Büromärkte in den deutschen Top 7-Standorten vgl. Colliers International Deutschland GmbH 2021.

stattfinden kann. Emittierende Unternehmen wie Handwerks- oder Produktionsstätten müssen in Industrie- und Gewerbegebiete, oftmals am Stadtrand gelegen, oder in Gewerbeparks in die Region umziehen.

Innenstädte sind klassische Standorte für Büroflächen, Einzelhandel, Kultur und Gastronomie. Diese Nutzungen sind weniger betroffen von Regulierungen bezüglich Emissionsschutz. Für den Bedarf an Einzelhandelsflächen spielt der Strukturwandel, der durch die Digitalisierung und die Internationalisierung beeinflusst wird (Onlinehandel), eine relevante Rolle.[6] Kultur und Gastronomie sind als publikumsbezogene Angebote vor allem auf attraktive Standorte und gute Anbindung angewiesen.

2.3 Covid-19 als Transformations-Treiber?

Urbane Gewerbeflächenmärkte und Immobilienentwicklungsprojekte für innerstädtische Arbeitsplätze werden im Zuge der Covid-19-Pandemie anders betrachtet.

Die (temporäre) Schließung von Einzelhandel-Filialen, Großraumbüros und Kulturstätten in Innenstädten sowie von inhabergeführtem Einzelhandel, Restaurants, Hotels, Dauerarbeitsplätzen für Dienstleistungen sowie sozialen Einrichtungen in Stadtteilzentren machte drei Aspekte deutlich:[7]

- Die Verlagerung mancher Tätigkeiten ins Homeoffice oder einen Coworking-Space ist abhängig vom Digitalisierungs- und Dienstleistungsgrad (Click and Collect, Remote-Zugänge zu Firmennetzwerken o. ä.) des Unternehmens
- Leerstände oder eine Flexibilisierung von Nutzungszeiten großer Gewerbeflächen ermöglicht die Um- oder Zwischennutzung von Gewerbe-Standorten in Innenstadt-Lagen, bspw. für soziale oder kulturelle Zwecke[8]
- Die Verringerung stationärer Innenstadtflächen bedingt ggf. die Bereitstellung von wohnortnahen Gewerbeflächen bzw. Arbeitsmöglichkeiten.

Offen ist, wie sich solche nun erprobten, fragmentierten Tätigkeiten zukünftig auf die städtischen Gewerbeflächenmärkte auswirken werden. Für den Dienstleistungssektor wird wohl mobiles Arbeiten oder Homeoffice eine größere Rolle spielen. Von einer langfristigen Verringerung innerstädtischer Büroflächennachfrage geht jedoch Colliers International für die großen deutschen Büromarktstandorte derzeit nicht aus.[9] Für produzierende und verarbeitende Unternehmen sowie Gast- und Kulturwirtschaft werden ggf. die Mobilität sowie Wohn-Arbeits-Beziehungen der Beschäftigten eine größere Rolle spielen.

Strategien für eine stärkere Verdichtung innerstädtischer Flächen werden derzeit jedoch in Frage gestellt.[10] Denn der öffentliche Raum, Grün- und Freiflächen haben im Zuge der Pandemie eine neue Aufmerksamkeit erfahren.[11]

3 NACHHALTIGE URBANE GEWERBEFLÄCHENENTWICKLUNG

Viele europäische Kommunen verfolgen für ihre räumlich-städtebauliche Entwicklung das Leitbild einer kompakten Stadt mit funktionaler Diversität, kurzen Wegen sowie ressourcenschonender Infrastruktur und Bodennutzung.[12] Die im Jahr 2020 verabschiedete „Neue Leipzig-Charta" ergänzt diese Ziele, indem sie auf die produktiven und transformativen Kräfte von Stadtquartieren, Städten und Regionen abzielt, um eine integrierte und Gemeinwohl-orientierte Stadtentwicklung zu fokussieren. Nachhaltigkeit soll zum zentralen Handlungsfeld für die Stadtplanung in europäischen Städten werden.[13]

3.1 Steuerungsansätze

Mit den aktuellen Zielen der „produktiven Stadt" und der Förderung von „Ko-Kreation" wird ein nachhaltiges Gewerbeflächenmanagement relevant für die Stadtentwicklung. So sollen Produktion und (Klein-)Gewerbe zwar emissionsarm sein, aber (wieder) mitten in der Stadt stattfinden. Voraussetzung

[6] Vgl. Anders et al. 2021:19
[7] Vgl. Anders et al. 2021:19
[8] Vgl. Rettich 2021:6
[9] Colliers International Deutschland 2021
[10] Kunzmann 2021:9
[11] Vgl. Anders et al. 2021:20
[12] Vgl. Rettich 2021:8
[13] Vgl. BBSR 2020

hierfür ist, dass produzierende und verarbeitende Unternehmen innovativ, flexibel und Technologie-basiert agieren. Grundlagen hierfür bilden die Transformations-Effekte der Wissensgesellschaft und der Kreativwirtschaft.[14] Auswirkungen der Digitalisierung auf veränderte Arbeitsorganisation und Flächen-Bedarfe werden nicht nur den urbanen Gewerbeflächenmarkt, sondern auch die innerstädtischen Quartierstrukturen beeinflussen.[15]

Dabei bedienen sich Kommunen verschiedener Steuerungsansätze, die sich auf das städtische Flächenmanagement oder Kooperationen mit privaten Akteuren beziehen:

Eine Umwandlung von Büro- in Wohnflächen wird mit bauordnungsrechtlichen Instrumenten insbesondere in denjenigen Städten unterstützt, die einen Mangel an Wohnraum verzeichnen. Mit der Einführung der Kategorie „Urbanes Gebiet“ in die deutsche Baunutzungsverordnung (2017) wurde außerdem planungsrechtlich eine stärkere Nutzungsmischung in innerstädtischen Lagen ermöglicht.

Mit Agenturen für Leerstandmanagement wird versucht, brach fallende Innenstadtflächen – bspw. Ladenlokale in Fußgängerzonen – für andere Nutzungen wie Kultur, gemeinnützige Initiativen oder Unternehmensgründerinnen und Unternehmensgründer verfügbar zu machen. Dazu werden auch temporäre Nutzungen (Pop-Up-Stores) und kooperative Formen für Büroarbeits- und Werkstatträume (Coworking-Spaces) zugelassen, die gleichzeitig die Umgebung beleben sollen.

Einzelbetriebliche Beratungs- und Kooperationsprogramme können diejenigen Unternehmen unterstützen, die Hilfe bei der Digitalisierung ihrer Wertschöpfungsketten oder bei der Anpassung von Betriebskonzepten benötigen. Diese werden ergänzt durch finanzielle Unterstützungsinstrumente des Bunds und der Länder – bspw. in Form von Krediten der öffentlichen Hand.

3.2 Flächentypen

In Bezug auf urbane Gewerbeflächen zeigt sich, dass kleine, gemischt genutzte Gewerbeflächen und -quartiere tendenziell anpassungsfähiger sind als monofunktionale Flächen.

Aus stadtplanerischer Sicht sind insbesondere die großflächigen Bürostandorte in der City problematisch, aber auch große Handelszentren und Shopping Malls am Innenstadtrand. Denn diese sind bei Krisen bzw. plötzlichen, großen Schwankungen an Kunden, Absatz oder auch Beschäftigten eher von Leerstand betroffen.[16] Ehemalige Großareale von Fabriken, Kasernen oder Infrastruktur (Verkehr, Energie) sind jedoch gut für eine Konversion in gemischte Quartiere geeignet.[17]

Dagegen erweisen sich gemischte Innenstadtquartiere, innerstädtische Gewerbegebiete und kleine Handwerkerhöfe bei guter Selbstorganisation und Vernetzung als ausdauernd – auch in Transformationsprozessen.[18] Sie sind aufgrund ihrer Flächen- und Baustrukturen oftmals gut für Nutzerwechsel geeignet.[19]

Grundsätzlich können folgende Gewerbeflächen-Typen unterschieden werden, die nachhaltig sind, indem sie adaptive und transformative Kapazitäten für Nutzungsänderungen bieten:[20]

Urbane Lage:	City	Cityrand	Innenstadtrand		
Art der Fläche (gem. BauNVO):	Mischgebiet	Urbanes Gebiet	Gewerbegebiet	Industriegebiet	
Art der Immobilie:	Ladengeschäft	Handwerker- und Gewerbehof	Büroplatz/ Coworking-Space	Werkstatt/ ehemalige Produktionsfläche	Büro/Ladenbüro

Tabelle 1: Nachhaltige Gewerbeflächentypen

3.3 Akteure

Inwiefern Gewerbeflächen und -gebiete im urbanen Raum nachhaltig erhalten oder entwickelt werden, hängt maßgeblich von vier Akteursgruppen ab: Den Immobilien-Eigentümerinnen und Immobilien-Eigentümern,

[14] Vgl. BBSR 2020
[15] Beuing & Ahrens 2020:27
[16] Vgl. Scholz 2021:22f.
[17] Beuing & Ahrens 2020:17
[18] Vgl. Scholz 2021:22f.
[19] Vgl. Schreiner 2018: 111ff.
[20] Vgl. Schreiner 2018:111ff., vgl. Beuing & Ahrens 2020:17

der Stadt- bzw. der Kommunalverwaltung, den Unternehmen sowie intermediären Organisationen (siehe Abbildung 2).[21]

Eigentümerinnen und Eigentümer können recht unterschiedliche Entwicklungsziele für ihre Gewerbe-Immobilie haben. Für selbst nutzende Unternehmen, Unternehmer-Kooperationen oder -Genossenschaften steht eine langfristige Nutzung mit Bestandserhaltung im Fokus. Immobilien- oder Fonds-Gesellschaften haben tendenziell spekulative Einnahme-Erwartungen an die Gewerbeflächen. Privatpersonen und Erbengemeinschaften sind eher an einer langfristigen Vermietung oder Verpachtung interessiert, mit denen sie gleichmäßige Renditen erzielen.[22]

Städtische oder kommunale Akteure verfolgen übergeordnete, stadtpolitische Ziele und können diese mit Hilfe von regulierenden Rahmenbedingungen oder finanziellen Instrumenten durchsetzen. Sie können beispielsweise mit bauordnungsrechtlichen Vorgaben oder spezifischen Förderangeboten für nachhaltige Energieversorgung oder Mobilität neue Impulse geben.[23] Sie können auch selbst als Grundeigentümer und/oder Projektentwickler für bspw. Gründerzentren oder Zwischennutzungen für die Kreativwirtschaft agieren, um Wirtschaftsförderung zu betreiben.[24]

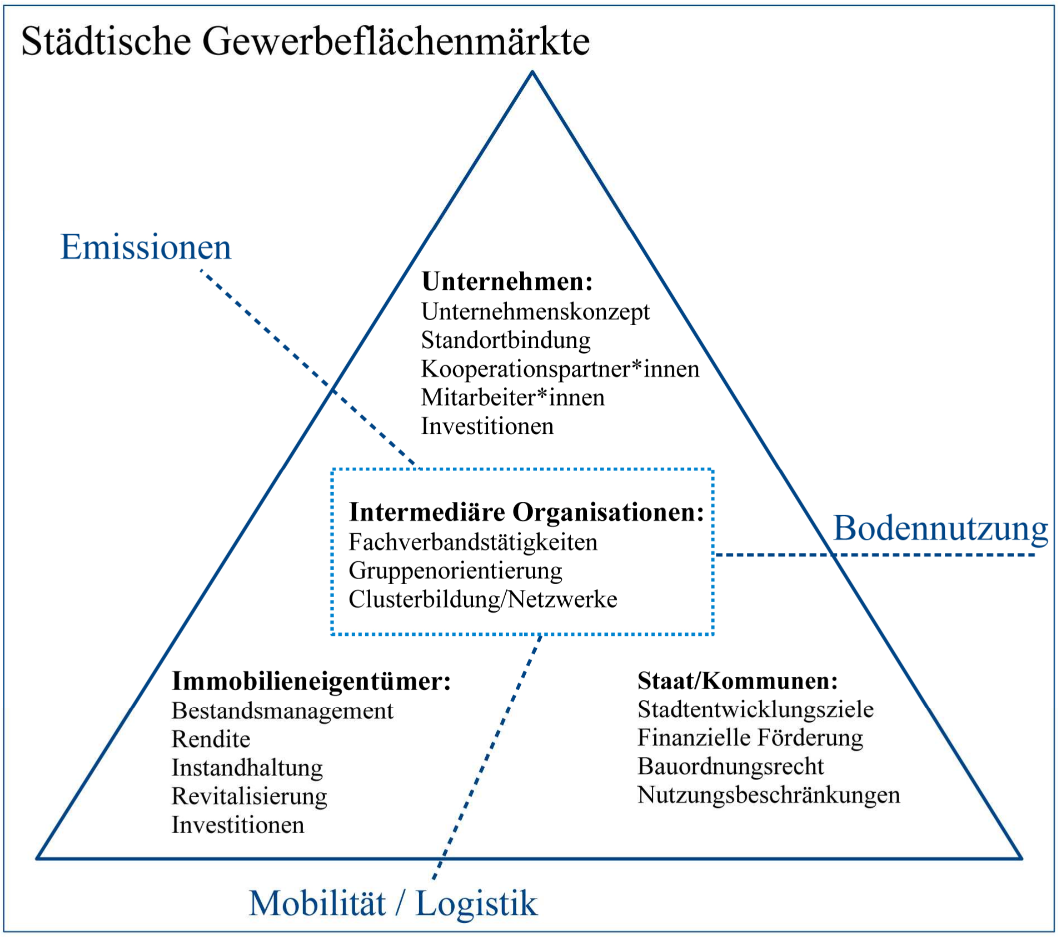

Abbildung 2: Akteurskonstellation für städtische Gewerbeflächenentwicklung (S. C. Schreiner, auf Grundlage von Eckmann et. al. 2020:46)

Für Betriebe, die als Mieter oder Pächter von Gewerbe-Immobilien agieren, spielen vor allem die Unternehmensgröße und der Tätigkeitsbereich sowie, im Fall von lokal eingebetteten Kleinstbetrieben, auch die stadträumliche Lage von Kooperationspartnern eine wichtige Rolle. Wie lange sie eine bestimmte

[21] Eckmann et al. (2020:45f.) gehen im Unterschied dazu von drei Akteursgruppen aus, um bestehende Gewerbe- und Industriegebiete im Stadtraum strategisch für "urbane Produktion" zu entwickeln. Intermediäre Organisationen werden dabei nicht genannt.
[22] Vgl. Eckamnn et. al. 2020:46
[23] Vgl. Eckmann et al. 2020: 44f.
[24] Vgl. Schreiner 2018:77f.

Gewerbe-Immobilie nutzen hängt maßgeblich von ihren betrieblichen Entwicklungsperspektiven ab, zum Beispiel durch Expansionspläne oder Schrumpfungstendenzen.[25]

Intermediäre Organisationen – also Organisationen bestimmter Interessengruppen wie Industrie-, Handwerks- und Handelskammern, Fachverbände für bestimmte Baustoffe, Technologie-Cluster, Stiftungen oder regionale Wirtschaftsförderungsorganisationen – agieren als Mittler zwischen staatlichen Entwicklungszielen, Interessen von Immobilieneigentümerinnen, Immobilieneigentümern und betrieblichen Perspektiven. Sie können Kontakte zwischen der Verwaltung und privaten Akteuren herstellen, vernetzen, Veränderungsprozesse anstoßen oder Managementaufgaben für Restrukturierungsprozesse übernehmen.[26]

Die Interaktionen zwischen Akteuren dieser vier Gruppen können dazu führen, bestehende Gewerbeflächen in der Stadt langfristig zu erhalten, zu qualifizieren oder umzustrukturieren. Abhängigkeiten untereinander machen Abstimmungen, Kompromisse und Zielvereinbarungen bei größeren Veränderungsprozessen wie Umnutzung, Leerstand oder Umbau von Gewerbehöfen und -gebieten erforderlich.[27]

4 INTERNATIONALE BEISPIELE FÜR URBANES GEWERBEFLÄCHEN-MANAGEMENT

In diversen Kommunen werden Konzepte für das Management des strukturellen Wandels von innerstädtischen Gewerbeflächen bereits seit Jahren diskutiert und ausprobiert. Daher soll hier der Blick auf drei Fallbeispiele aus europäischen Großstädten gerichtet werden, die eine planerische Transformation von Gewerbe in urbanen Lagen umgesetzt haben. Die stadträumlichen Voraussetzungen sowie die Ziele und Akteurskonstellationen waren dabei recht unterschiedlich. Konkret handelt es sich um folgende Flächenentwicklungen (vgl. Tabelle 2):

Die Gemeindeverwaltung von Amsterdam hat ein innerstädtisches Werftgelände, das brach gefallen war, zu einem gemischten Quartier umgewandelt. So wurden urbane Gewerbeflächen diversifiziert und nachhaltig gesichert. In London überlassen es öffentliche Akteure dem privatwirtschaftlichen Immobilienmarkt, dass sich urbane Produktionsbetriebe, Handwerk und Dienstleistungsunternehmen ansiedeln und etablieren können. In Berlin konnte eine Mietergemeinschaft einen urbanen Gewerbehof für Kleinunternehmen aus der Kreativwirtschaft, Handwerk, Sozial- und Bildungsorganisationen sowie eine Kantine langfristig sichern und sanieren.

	Amsterdam: NDSM-Gelände	Berlin: ExRotaprint	London: Shoreditch
Größe	8,6 ha	0,8 ha	267 ha
Ehemalige Flächennutzung	Hafen-Industrie, Werft	Maschinenbau-Fabrik	Urbane Produktion (Textil), Kleinhandel
Initiator für Flächenentwicklung	Stadtverwaltung Amsterdam-Noord	ExRotaprint e. V.	Private Immobilien-Eigentümer*innen
Entstehung/ Beginn Umstrukturierung	1999	2005	ca. 2000 – mit verstärkter Ansiedlung von Designern, Künstlern, IT- und Mode-Unternehmen
Förderer	Stadtverwaltung Amsterdam-Noord, Brutstättenfond der Stadtverwaltung Amsterdam, Stadt Amsterdam, Ministerium für Raumordnung	Stiftung trias, Stiftung Edith Maryon; Liegenschaftsfonds Berlin	keine
Heutige Nutzungen (Unternehmen/Branchen)	MTV, Restaurants, Skatepark, Architekten, Designer, Handwerker, Künstler u. a.	Kantine, Schlosserei, Tischlerei, gemeinnütziger Bildungsträger, Musiker, Architekten, Grafiker, Kantine, Gästehaus u. a.	Shoreditch Studios, Forster, Denham The Jeanmaker, The Red Gallery, 11 04 Architects, Denham, SolArt, Hawaii Design, u .a.
Ansässige intermediäre Organisationen	Kinetisch Noord, Quartiersmanagement der Gemeinde Amsterdam	ExRotaprint gGmbH, ExRotaprint e. V.	Royal College of Fashion, Society of Designer Craftsmen

Tabelle 2: Die internationalen Referenzen im Vergleich (eigene Darstellung)

4.1 Amsterdam: Restrukturierung urbaner Hafen- und Industrieflächen

Die Flächen der NDSM-Werft wurden lange Zeit für Schiffsbau und Hafengewerbe genutzt, die jedoch mit dem Niedergang der Niederländischen Schiffsbau-Industrie brach fielen. Das Gelände befindet sich im Stadtteil Amsterdam-Noord, gegenüber der historischen Altstadt am Fluss Ij, und ist somit sehr zentral und am Wasser gelegen. Nördlich dieser Industrieanlagen erstrecken sich Wohngebiete. Im Rahmen der

[25] Vgl. Eckmann et al. 2020:46
[26] Vgl. Schreiner 2018:244f.; vgl. Eckmann et al. 2020:48
[27] Eckmann et a. 2020:46

Gebietsentwicklung wurde eine Fähranbindung des öffentlichen Nahverkehrs eingerichtet, die das Gelände in Zehnminuten-Intervallen mit dem Stadtzentrum (Hauptbahnhof) verbindet.

Die Flächen sind städtisches Eigentum und konnten somit über planungsrechtliche Widmungen recht einfach neuen Nutzungen zugeführt werden. Mit der Revitalisierung der östlichen Docklands und dem Kulturpark Westergasfabriek hatte die Amsterdamer Stadtverwaltung zuvor bereits Erfahrungen mit einer Restrukturierung ehemaliger Industrie-Areale gemacht. Für die Umnutzung des NDSM-Geländes wurden folgende Nutzungen berücksichtigt und folgende Akteure beteiligt:

Eine Werfthalle mit insgesamt 20.000 m² Grundfläche wurde über ein öffentliches Ausschreibungsverfahren an den Verein Kinetisch Noord vergeben, der sich aus Künstlern, Kleinunternehmern und Polit-Aktivisten der Amsterdamer Hausbesetzer-Szene zusammensetzt. Das Konzept von Kinetisch Noord zielt prioritär auf eine Entwicklung preisgünstiger Büro- und Produktions-Arbeitsplätze für Personen aus der Kunstszene, der Kultur- und Kreativwirtschaft sowie aus dem Handwerk. Der zentrale Standort sowie die großen Flächenreserven ermöglichen nicht nur die Ansiedlung unterschiedlich etablierter und spezialisierter Unternehmen, sondern auch einen persönlichen Austausch und Möglichkeiten vielfältiger Unternehmens-Kooperationen. Die Fassade der ehemaligen Schiffbauhalle wurde erhalten, innen mit Einbauten ergänzt und in drei Nutzungsbereiche unterteilt: Skatepark, Kunststad und Oostvleugel. Während der Skatepark eine große Attraktivität für Freizeitaktivitäten von Skatern besitzt, dienen die Kunststad und der Oostvleugel als Gewerbestandorte (Büros, Werkstätten, Lagerflächen) für Kleinbetriebe der Kreativwirtschaft und urbaner Produktion.[28]

Neben dieser Werfthalle wurde eine kleinere Fabrikhalle von dem Fernsehsender MTV saniert und für Büros umgenutzt. Es gibt außerdem eine öffentliche Kantine („Ij-Kantine“) nahe des neu eingerichteten Fähranlegers, ein kleineres Restaurant („Noorderlicht“) in einer selbstgebauten Leichtbauhalle am Fluss, ein städtisches Studentenwohnheim in Baucontainern, ein Schiffshotel („Botel“), einen Kiosk sowie einige größere Büro-Neubauten, in denen u. a. Medienfirmen und Galerien residieren.

Initiiert und teilfinanziert wurde die Entwicklung des NDSM-Geländes und der daran gekoppelten Stadtteilentwicklung von Amsterdam-Noord vom Brutstättenfond der Gemeinde Amsterdam, der Stadtteilverwaltung Amsterdam-Noord, der Stadt Amsterdam sowie dem Ministerium für Raumordnung. Es wurden mehrere Millionen Euro in den Brandschutz, den energieeffizienten Ausbau, den Bau des Skateparks, die Renovierung von Dach und Fassade und den Rohbau der Kunststad-Einbauten in der NDSM-Halle investiert. Die Mitglieder von Kinetisch Noord brachten ebenfalls mehrere Millionen Euro an Eigenmitteln für den Ausbau ihrer Flächen auf und profitieren von sehr geringen Mieten (max. 5,0 Euro/qm). Kinetisch Noord verwaltet mittlerweile im Auftrag der Gemeinde Amsterdam die Werfthalle.

Wichtige Quartiers-Funktionen haben heute der Verein Kinetisch Noord, die öffentlich zugängliche Ij-Kantine und das Restaurant Noorderlicht. Der Verein Kinetisch Noord ist Ansprechpartner für Hallenmieterinnen und Hallenmieter, Mitarbeiterinnen und Mitarbeiter des städtischen Quartiersmanagements, die Bezirksverwaltung und den Brutstättenfond. Der Verein veranstaltet zahlreiche Bildungs- und Kulturevents, die stadtweite sowie überregionale Ausstrahlung haben. Die Ij-Kantine und das Restaurant Noorderlicht sind aufgrund ihrer Nähe zu den zahlreichen Arbeitsplätzen, dem Fähranleger und ihrer Lage am Wasser als Treffpunkte beliebt: Ihre gastronomischen Angebote versorgen in den Mittagspausen die unterschiedlichen Erwerbstätigen, Bewohnerinnen und Bewohnern sowie Touristinnen und Touristen und dienen als Treffpunkte für Besprechungen.

4.2 Berlin: Neue Perspektiven für Kleingewerbe im Wedding

Der Wedding ist ein industriell geprägter Stadtteil im Westen Berlins. Seit den 1980er-Jahren mussten zahlreiche dort ansässige Fabriken mit alten Produktionstechnologien Konkurs anmelden. Diese Produktionsstätten wurden neuen Nutzungen zugeführt; oftmals wurden die Flächen zu Wohnungen oder in reine Büroflächen umgewandelt.

Ein Zentrum lokaler, urbaner Ökonomien hat sich mit der Nutzung des 8.300 qm großen Geländes der ehemaligen Rotaprint Offsetdruckmaschinenfabrik im Berliner Stadtteil Wedding durch die ExRotaprint gGmbH etabliert. Dieser Handwerker- und Gewerbehof, ein unter Denkmalschutz stehendes Ensemble aus

[28] Vgl. Overmeyer 2010:70

Gründerzeit- und 1950er-Jahre-Architektur, beherbergt heute Werkstätten für handwerkliche Verarbeitung und Produktion, Büros von Kleinstunternehmen für kreative Dienstleistungen (u. a. Architektur, Design, Grafik), eine Quartiers-Kantine, ein Seminarzentrum mit Gästehaus sowie stadtteilorientierte Bildungs- und Beratungsangebote.

Nach dem Konkurs der Rotaprint-Fabrik übernahm der stadteigene Berliner Liegenschaftsfonds das Gelände. Der Verein ExRotaprint e. V. wollte als Organisation der Gewerbemieter das Gelände seit 2005 kaufen, um die historische Bausubstanz zu erhalten, vielfältige privatwirtschaftliche und zivilgesellschaftliche Nutzungen – u. a. für kleingewerbliches Handwerk – zu sichern sowie eine positive Entwicklung im Quartier zu stimulieren.[29]

Was heute in stadtplanerischen Diskussionen als Erfolgsmodell für Arbeiten im Quartier und mischgenutzte Gewerbeflächen gilt, musste von den jetzigen Nutzern erkämpft bzw. der städtischen Verwaltung abgerungen werden. Denn der Berliner Liegenschaftsfonds war erst nach massiven Protesten und Öffentlichkeitskampagnen der langjährigen Gewerbemieter bereit, das Grundstück nicht an einen ausländischen Finanzinvestor zu verkaufen. Es ging stattdessen an eine gemeinwohlorientierte Betreiber-Genossenschaft, die das Grundstück mit Gebäuden langfristig der Nutzer-Organisation ExRotaprint gGmbH per Erbpacht überließ.

Über Festlegungen im Erbbau- und Vereinsvertrag ist das Gelände der Finanzspekulation entzogen und wird nun schrittweise saniert.[30] Ein Drittel der verfügbaren Gewerbeflächen von ExRotaprint ist für produzierendes und handwerkliches Gewerbe vorbehalten. Da die Gewerbemieten für die Produktionsbetriebe vergleichsweise gering sind, sind die Standorte dieser Kleinstbetriebe mit ihren Ausbildungs- und Arbeitsplätzen langfristig gesichert.

Die Bestandserhaltung der gewerblichen Flächen mit Ermöglichung neuer, langfristiger Perspektiven für lokales Kleingewerbe im Wedding basiert hier also auf einem selbst initiierten Prozess durch Kleinunternehmen, Anwohnerinnen und Anwohner. Grundlage bildet ein Organisationsmodell von Gewerbemieterinnen und Gewerbemietern, die ihren Handwerker- und Gewerbehof selbst betreiben. Der Einfluss staatlicher Organisationen beschränkt sich in diesem Fall auf den Immobilientransfer über den Berliner Liegenschaftsfonds sowie auf finanzielle Zuwendungen in Form temporärer Projektförderung, zum Beispiel für die denkmalgerechte Sanierung des historischen Baubestands.

4.3 London: Aufwertung gewerblicher Flächen durch private Immobilieneigentümer in Shoreditch

London-Shoreditch ist ein ehemals verwahrloster Arbeiter- und Zuwanderungsstadtteil im Londoner Osten, der in den letzten Jahren stark gentrifiziert wurde.

Textilproduktion und Modehandel sind hier seit dem 19. Jahrhundert beheimatet. Preisgünstige Mieten und Grundstückspreise, eine zentrale Lage, gute Verkehrsanbindung und eine gemischte Bau- und Nutzungsstruktur führten dazu, dass sich diverse Unternehmen ansiedelten.[31] In diesem Kontext gewannen die dort historisch etablierten, urbanen Produktionsstätten und Handelsgeschäfte neue Kunden und ein neues Image.

Die heute ansässigen Unternehmen haben sich weitgehend autark in Shoreditch entwickelt. Die gewerbliche Struktur basiert auf einer Vielzahl kleinteiliger Gewerbe-Immobilien von privaten Grundstücks-Eigentümerinnen und Eigentümern.

Es gibt in Shoreditch heute zahlreiche Ethno-Betriebe, vor allem in der Textil- und Modeproduktion, dem Einzelhandel und der Gastronomie. Daneben sind Modeboutiquen, Antiquitätenhändler, Möbelgeschäfte und Produktdesigngeschäfte, Biolebensmittelhändler und Musikclubs zu finden. Mittlerweile gehört unter anderem die Redchurch Street mit ihren unterschiedlichen Geschäften zu einer der bekanntesten Adressen für Lifestyle-Konsum in London. Zahlreiche Musik-, Theater-, Modedesign- und Architekturunternehmen haben ihre Büros in unmittelbarer Umgebung, vor allem in historischen Fabrik-Lofts. In Shoreditch befindet sich mittlerweile eine national und international renommierte Universität für Modedesign (Royal College of

[29] Vgl. ExRotaprint gGmbH 2010
[30] Vgl. ExRotaprint gGmbH 2010: 15
[31] Vgl. Moore 2012

Fashion). Außerdem existieren zahlreiche Werkstätten für handwerkliche, künstlerische und serielle gewerbliche Produktion – unter anderem in Hinterhofwerkstätten entlang der ehemaligen Transportkanäle.

Shoreditch blieb weitgehend unbehelligt von städtebaulichen Interventionen der Stadtverwaltung, bis die Planungen für Olympia 2012 in den benachbarten Stadtteilen Hackney Wick, Leyton, Stratford und Bromley By Row begannen. In diesem Kontext wurde von städtischer Seite aus vor allem in die Verbesserung der Wegeverbindungen zwischen Shoreditch und den Olympiastätten sowie die Grünflächen investiert, um das Image des Stadtteils aufzubessern.

Günstige Flächen für urbanes Kleingewerbe unterliegen seitdem einem verstärkten Druck von Seiten privater Immobilienentwicklerinnen und Immobilienentwickler, die hochpreisige Wohn- und Büroflächen schaffen.[32] Daher ist urbanes Gewerbe in Shoreditch mittlerweile, sofern die Arbeitsstätten nicht Firmeneigentum sind, von den Verdrängungsmechanismen der gestiegenen Gewerbeflächenpreise betroffen.

5 FAZIT

Urbane Gewerbeflächen sind ein relevanter Faktor für die Quartiersentwicklung, da sie anpassungsfähig sind, somit vielfältige Nutzungen zulassen und wohnortnahe Arbeitsmöglichkeiten bieten. Eine Transformation urbaner Industrie- und Gewerbeflächen kann Potenziale für neue Unternehmensansiedlungen bergen und zu einer heterogenen Flächennutzung beitragen.

Kommunale Akteure, wie Stadtplanungsbehörden oder städtische Wirtschaftsförderungsgesellschaften, haben vielfältige Optionen, die Gewerbeflächenentwicklung einer Stadt zu beeinflussen. Sie können ein nachhaltiges Gewerbeflächenmanagement erreichen, indem sie geeignete Gewerbeflächen und die zugehörige Infrastruktur in urbanen Mischgebieten über Nutzungsfestlegungen sichern.

Die Eindämmung von Emissionen kann über baulich-technische Maßnahmen (bspw. das „Hamburger Fenster“) sowie regulierende Vorgaben umgesetzt werden. Gleichzeitig sollten Angebote möglichst umweltschonender Mobilität für Beschäftigte und Gütertransporte bei urbanen Gewerbeflächenkonzepten berücksichtigt werden.

Die drei internationalen Beispiele haben gemeinsam, dass sie eine heterogene Umgebung und urbane Infrastrukturen – zum Beispiel in Form guter Erreichbarkeit – aufweisen. Die dargestellten Orte zeigen unterschiedlich große Flächentransformationen, die trotz Anpassung an veränderte Nutzungsanforderungen ihre gewerblichen Schwerpunkte beibehalten haben. An ihnen lassen sich recht unterschiedliche Ziele, Instrumente und Akteurkonstellationen ablesen.

Das Amsterdamer Beispiel skizziert, wie finanzielle, planerische und organisatorische Aktivitäten der Stadtverwaltung zu einer diversifizierten Quartierstruktur von ehemals monofunktionalen Großbauten beitragen. Staatliche Eingriffe sind ebenfalls notwendig, um Einfluss auf den Bodenmarkt auszuüben, wie das Londoner Beispiel verdeutlicht; denn ansonsten könnten urbane Gewerbeflächen privater Eigentümerinnen und Eigentümer zu Spekulationszwecken in Wohnraum umgewandelt werden. Allerdings können – anstelle der öffentlichen Hand – auch Gemeinwohl-orientierte Organisationen wie die ExRotaprint gGmbH oder der Verein Kinetisch Noord wichtige Funktionen für eine nachhaltige Gewerbeentwicklung übernehmen, indem sie eine vielfältige Unternehmensstruktur aus Kleinst-, Klein- und mittelgroßen Betrieben im Quartier fördern sowie langfristig sichern.

Im Ergebnis deuten die internationalen Beispiele darauf hin, dass krisenhafte Entwicklungen von urbanen Gewerbeflächen über flexible sowie nachbarschaftliche Akteurs-Organisation sowie -kommunikation gemindert bzw. verhindert werden. können Aufgrund der kleinteiligen Mischung an Gewerbeeinheiten und diversifizierten Nutzungen kann davon ausgegangen werden, dass die dargestellten Gebiete auch bei temporären Schließungen oder dauerhafter Abwanderung bestimmter Unternehmen (bspw. Gastronomie, Hotels) nicht in ihren grundlegenden Quartiersfunktionen bedroht sind.

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[32] Vgl. Moore 2012

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New Technologies for Participatory Planning: Between Parametric Design and Brand Urbanism

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1 ABSTRACT

Cities are called to face new challenges. The actions they plan must conform to their image and future values. This way, they can differentiate themselves and become more attractive. It is, therefore, necessary to involve citizens and brands differently from the past and with tools suitable for change.

The ongoing research intends to develop a new design tool applicable in complex contexts and stimulate participation. It is a conceptual model that integrates parametric design, inclusive communication, and planned forms of brand urbanism.

The research intends to introduce parametric design to evaluate urban transformations and coordinate them according to the future image of the city. The tool must be accompanied by inclusive communication that can involve more people to participate: this will also be possible thanks to new technologies such as social platforms that combine information, images, and sounds.

The problem is addressed in Chiasso, in the cross-border region between the Canton of Ticino (Switzerland) and the Lombardy Region (Italy). It is an important hub and has recently been affected by two projects. The design of the future vision of the territory must necessarily take place with the contribution of local actors and brands.

Keywords: gaming, brand urbanism, parametric design, communication, bottom-up

2 INTRODUCTION

The doctoral research still in progress, deals with the difficulty of collaboration in complex fields. The importance of knowing how to manage complexity also means managing the problem that we intend to address with the help of participatory planning in order to obtain a shared solution.

The cities adopt a new long-term strategy to respond to global challenges. The priority measures follow the plan of action identified at the national and international levels. At this historic moment, actions to contain climate change, rethink spaces and functions following the health emergency are at the center of the debate.

Strategic plans on a territorial scale are drawn up with different levels of participation. On the one hand, directives are implemented at higher levels according to a top-down approach. On the other, opportunities for bottom-up confrontation are envisaged with different types of local actors such as associations and trade representatives, but without the involvement of the private partners present in the territory.

Specific projects and initiatives are inserted within the guidelines that the strategic plans identify in a long-term time.

In this framework, one of the most used tools is tactical urban planning. Its advantages include the limited use of resources in financial and temporal terms, the attractiveness and visibility of the project thanks to the design. This tool takes place in non-central or suburban areas that need to be redeveloped. The projects mainly concern squares or road intersections where there are spaces underutilized or to be modernized. Tactical urban planning also has a social objective: to give citizens the open spaces of proximity and support the use of the meeting space within the cities.

The concrete actions concern the re-appropriation of spaces in favor of slow mobility through the reorganization of existing parking spaces and the arrangement of greenery and furnishings. In particular, low-cost materials and colored dyes are envisaged to give a new image to the area. Different types of actors are involved in the project: administrations, citizens, designers, local associations, neighborhood traders. Often, philanthropic associations finance the project and accompany the lead actor (local administrations). As in strategic urban planning, private partners have no involvement in the project's initial phase.

These types of interventions are placed within more significant projects. An example is the case of Milan which includes the “Open Squares” project in the Neighborhood Plan. The Municipality of Milan defines the Plan "(...) how we try to go beyond the suburbs to enhance the identity and specifics of each district of the city!" [1]. "Open squares" was born in 2018 and is promoted by the city administration in collaboration with Bloomberg Associates and with the support of the National Association of City Transportation Officials (NACTO) Global Designing Cities. In the start-up phase, the leading actors had identified seven squares for tactical urban planning interventions. Over time, eight have been added for a total of 15 redeveloped squares (data of 25.01.2020, source Municipality of Milan). According to the official website, 65 proposals from citizens, committees, and associations were received in the context of "Open Squares in each neighborhood", the public notice launched by the Administration to identify new areas of intervention for 2020 [2].

With the help of tactical urban planning, there are three main objectives: the re-appropriation and liveability of spaces through appropriate redevelopment; make shops and area services more accessible; increase citizens' perception of security. The lead actors monitor the first projects' effects through questionnaires addressed to citizens, associations, and businesses. Out of 640 people interviewed, 76% want to make the project defined [3].

Fig. 1: Piazza Angilberto - The “Open Squares” project in Milan, Source: Municipality of Milan

In order to coordinate interventions according to the same values (for example, liveability, accessibility, and safety), it would be appropriate to coordinate the participation phase at the start of strategic plans and urban projects. Unfortunately, some of the actors who are not involved are the brands present in the area. Often they are called to participate only in a second moment and in a timely or sporadic way.

3 METHOD

Cities need brands, and brands need to express themselves in the city.

In an increasingly competitive world, cities must enhance their characteristics to attract people, goods, and capital. They must build their future image based on values that take into account global trends and local characteristics. After that, around the image, cities must create storytelling that differentiates them from others. As the Lombardini 22 architecture firm argues in Medium, cities must brand themselves by making themselves an authentic “product” to be launched into the competitiveness market [4].

The future image coincides with the strategy to be pursued. It is made up of values and criteria for selecting the projects and partners involved. The actors who decide to participate in creating the city's image will have to abide by the guidelines and contribute to the creation of the brand reputation of the city. Partners who

[1] https://www.comune.milano.it/aree-tematiche/quartieri/piano-quartieri/il-piano/cosa-e-il-piano

[2] https://www.comune.milano.it/aree-tematiche/quartieri/piano-quartieri/piazze-aperte/piazze-aperte-in-ogni-quartiere

[3] “Piazza Aperte in ogni Quartiere”, pp.8, 2020

[4] https://medium.com/@lombardini22/place-branding-non-solo-logo-c0927a16b4be

decide not to follow the established values will not find space for interventions on an urban scale as they would undermine the city's credibility.

The participation of brands is necessary from the earliest stages. Only with collaboration is it possible to work optimally to create the strategy and identify urban projects to be implemented. This method allows to work in an integrated way and to evaluate the effects in the area.

Brands have different potentials that should be used to pursue the aims. First of all, they know the current economic dynamics of the context in which they are and have the tools to intercept new trends on a local and global scale. Private actors choose to position themselves in a context and link their image to it after careful evaluations. On the relationship with the territory, they build storytelling to be immediately recognizable. If it is stimulating and pursues values reward by the community, the brand also benefits from it. In this framework, the brand will be increasingly interested in participating in urban projects. A project that achieves the common objectives, which are implemented and renewed over time. Suppose the territory and the brands work together to give value to a territory and implement urban projects, including those of a social nature. In that case, their reputation will be recognized, and their credibility will be strengthened.

At last, brands have the financial resources to start a project and maintain it over time. Unlike philanthropic associations with interests and financial resources above all to help municipalities in the start-up phase of the projects, local brands have interests and resources over time.

For brands' participation in the planning process to be profitable, local governments must establish new relationships and provide new tools compared to the past.

The contents of the message must be put at the center of the debate. All this means shaping the image of a territory or identifying the territorial strategy to be pursued over time. Brands must be able not to put profit at the center of the dialogue with stakeholders. Therefore, the focus will not be on the logo but on the message you intend to communicate. The analysis of trends in 2020 on digital platforms, evidence that the next challenge for brands will be the message. Users have a large amount of information and "direct" communications that prefer quality messages. Therefore, even brand urbanism will have to deal with this trend. Interventions must be made in a climate of respect for the needs of citizens. Furthermore, they must be interventions with a social value. All this will establish a relationship of trust and, therefore, the participation that will generate long-term processes.

This approach is very different from the one used so far. For example, in place branding, the brand does not play an active role in creating added value. Its success is measured in the display of the logo. Only by making the logo visible does the brand message spread. The values transmitted are interchangeable. As the communication campaign changes, the messages and, therefore, the values disseminated through the imposition of a logo change.

The proposed new tool, brand urbanism, is radically different. In this case, the brand contributes to creating added value. It does not focus on the logo (itself) but on the content (a message), which must comply with the selection criteria established in the territorial strategy.

3.1 Brand urbanism

Brand urbanism is an opportunity and a challenge.

“Brand urbanism is collaboration between a city and a brand in which the brand (partly) launches or funds a project in exchange for visibility. Brands finance brand urbanism projects from their marketing budget, often substituting them for other forms of advertising.” [5] The first applications of brand urbanism have been in Anglo-Saxon countries in recent years.

This tool provides for the participation of brands, local administrations, and stakeholders. It comes from the awareness that, in economic terms, public administrations do not have the same resources as brands to redevelop public spaces, means of transport, and infrastructures.

Furthermore, in agreement with Luca Della Dora, Marketing & Innovation Director of We Are Social. He said that we are in a historical moment in which there is growing mistrust of institutions and governments,

[5] https://popupcity.net/trends/brand-urbanism/

and in which our choices are often guided by the will to find new references that reflect our values. These references are increasingly those brands that demonstrate that they take a position and act concretely. [6]

According to We Are Social agency, there are three forms of brand urbanism. “Light: when the brand works on limited-time operations, temporary interventions that have an immediate effect on the city, but limited in time. Mid: in this case, the brand actively collaborates with institutions, acting on projects with a longer time horizon, and which have a lasting impact on local communities. Hard: these are the most complex and demanding operations, in which the brand decides to undertake a long-term project, collaborating with institutions and citizens, to create something that then remains in the hands of citizens and has a positive impact on long term.” [7]

Pop Up City agency identifies ten characteristics of the urbanism brand: creating real and visible value for residents; large budgets and every city has its price; the project is sustainable, running over a few years and possibly permanent; shared responsibility and intensive cooperation; free publicity and goodwill as ROI; part of a bottom-up strategy; success depends on shared core values; the right moment is the key to success; both brand and city can take the initiative; its about consumer brands rather than brands whose core business is the city itself. [8]

The success of this tool depends on four fundamental factors underlines in the study carried out by the Utopies Agency in collaboration with the JCDecaux Group. The collective interest, the contribution given by a Brand, must be the concrete response to social and environmental needs, expressed or observed; a valuable intervention that requires a preliminary analysis of needs, the choice of a specific urban space and consistency between the project, the Brand's commitment and its values; participation and duration means consultation or co-creation of the project with the inhabitants who must also be involved in the maintenance of what is being done, evaluation and monitoring of the impact of the project; transparency and honesty, or communication and presentation of the objectives of the partnership and traceability of funding with a view to continuous improvement. [9]

Nike made an example of brand urbanism in Milan.

For many years, the Porta Venezia underground station in the historic center has been the stage for classical and modern dance rehearsals. In the first phase, the rehearsals were organized spontaneously by small groups of teenagers. Over time this space has attracted more and more people. Nike made the stage by changing the design of the subway. It made the environment safer, more visible, and accessible.

From a social point of view, the project has a broader meaning. It means recognizing a practice, analyzing needs, and giving it importance. In this case, Nike added value to something that already existed. In the foreground, it was not the brand logo but the message. Like any sporting activity, dance has a quick connection with Nike even if its logo is not put in the center.

[6] https://wearesocial.com/it/blog/2021/03/wtfuture-brand-urbanism-dalla-fiducia-alla-collaborazione

[7] https://wearesocial.com/it/blog/2021/03/wtfuture-brand-urbanism-dalla-fiducia-alla-collaborazione

[8] https://popupcity.net/trends/brand-urbanism/

[9] https://www.igpdecaux.it/blog/our-say/brand-urbanism-lazione-dei-brand-sugli-spazi-pubblici-urbani-parte-1/

Fig. 2: Nike area sport in Milan – Porta Venezia metro station. Source: MAS Thesis by Leonardo Cabianca

Initiatives such as that of Nike in Milan must be planned. There were short-term interventions leased to events, brand pop-ups, or experimental forms of brand urbanism in the past. The city needs that all projects follow the general strategy and, above all its values, to strengthen its brand reputation.

Therefore, it is important that local administrations and the actors involved in participatory planning equip themselves with tools that can plan interventions, simulate them, and evaluate the effects.

3.1.1 Gaming

Often, to better understand a new phenomenon, it is helpful to look at it from another perspective or analyze it in a different field. In this research, it was decided to understand better the impact that brands have on the community by analyzing their role in the gaming world.

The analysis of the "Digital 2021" [10] study conducted by We Are Social highlights that game apps are the most downloaded from the Google Play Store and Apple's iOS. 17% of paid apps downloaded are game apps. As for e-commerce, 135.8 billion dollars are for video games, which increased 23% compared to the previous year. Finally, as regards brand-related online activities, 13.9% of users played a branded game. [11]

The analyzes conducted have shown that since 2018 there is more interest in the sector: the community is increasing, and games are not a closed sector. Indeed an element that has contributed to the success is the possibility of playing online. This element allows the gamers to interact anytime, anywhere with other players around the world. In addition, different types of experiences arise: playing in a team, being a spectator, and a supporter: these are all elements of a community. Like social platforms, games also have chats. Therefore it is possible to dialogue while playing or to dialogue on a specific theme. This possibility has grown considerably in the year of the pandemic crisis. Video games have replaced public spaces for concerts (for example, Travis Scott and Fortnite [12]) and events (for example the anti-racism event on Fortnite [13]).

The choice to analyze this world is not accidental. According to Juval Portugali, "Games accompany humans since early days, and yet, as a category, they are impossible to define in terms of necessary and sufficient conditions. The reason: they form what Ludwig Wittgenstein (1953) in his Philosophical Investigations has termed a family resemblance category. Cities too are hard to define and for the very same reason: they form

[10] "Digital 2021 – Global digital overwiev", pp.218, 2021.

[11] "Digital 2021 – Global digital overwiev", pp.269, 2021.

[12] https://www.youtube.com/watch?v=wYeFAlVC8qU

[13] https://www.eurogamer.it/articles/2020-07-04-news-videogiochi-fortnite-evento-anti-razzismo-modalita-party-royale-4-luglio

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a family resemblance category. The resemblances in such categories are determined by logical connections (e.g. analogies) and imaginative connections (e.g. metaphors), that is, by fantasies.” [14]

There are two similarities between planning and gaming: technical and social.

The first refers to the tools used to create the settings. For example, CityEngine software is used both for parametric design in planning and for video games. Using the same tools allows the same opportunities for developers and the same effects on the stakeholders/community. From this point of view, the evaluation of design alternatives appears similar to choosing a game setting.

This is important to understand the second analogy, the social one. As described above, parametric design and new technologies allow for an immersive experience that engages the actors. The parametric design in gaming helps to create the same effect: the player is immersed in virtual reality with sensations like in real life (joy, fear, anxiety, etc.). In addition, from a social point of view, the multiplayer game mode allows to interact with the community and talk about various topics.

A growing sector attracts the attention of brands. The goal is to make one's presence felt, to position oneself. As with brand urbanism, this does not just mean inserting the logo in the setting but above all communicating their presence to the community. Also in this case, one of the fundamental aspects is respect for the players and the game rules. Brands must make their strength available to the community in order to create a relationship of trust.

From a technical view, there are different ways they can get involved in gaming, and they have different effects. For example, the auto bomb is a poster of the logo within the setting: but it is a positioning that does not allow some interactions. For example, the experience made by Burger King is very interesting. It did not use the logo in the games but created the Stevenage Challenge: on the occasion of the release of FIFA20, one of the most famous football games, it created the jerseys of a small English football team. The colors used remembered the stores. The idea was to support this small team and ask players from all over the world to help Stevenage win the championship. This created tremendous interest and motivated players to make it the biggest team in the online world. Burger King CMO Fernando Machado said “the #StevenageChallenge is here to welcome everyone because thanks to technology, this could also be everyone's team”. [15]

Fig. 3: #StevenageChallenge, Source Stevenage FC

Analyzing cases like this can certainly help to understand how to use brand urbanism in participatory planning. They help to understand people's needs as Ekim Tan founder of Play the City claims “Games are as old as society, yet when a spatial designer enters the world of games, a new world opens, bright with novelty

[14] “Games for cities”, AESOP Meeting, 2019

[15] https://www.insidemarketing.it/stevenage-challenge-sponsorizzazione-sportiva-burger-king/

and possibility as a relatively unexplored instrument for shaping spaces that are more meaningful to humans.” [16]

4 APPLICATION

In this historical moment, thanks also to new technologies, we have shortened distances, enjoyed various types of content, and communicated. It was not possible to participate or share large and small events. Public places must necessarily be rethought to meet current challenges and must also be created based on the new needs of citizens.

The doctoral research still in progress, takes into consideration all these aspects. The research focuses on conceptual models that can help the actors involved in participatory processes to formulate problems. The conceptual model focuses on parametric design and inclusive communication, capable of increasing the level of engagement of the stakeholders involved and creating territorial and urban processes not only in the immediate but also in the medium to long term. The combination of these elements allows to design and focus on inclusion and creativity. It is a tool that allows to translate different plans and projects into the same language and helps to understand problems and make shared decisions.

Parametric design is “an innovative approach based on the use of computational tools to optimize the performance of the system in relation to the goals of the project.“ [17] The technological acceleration of recent years has changed the use of representations in design. Jane Jacobs writes that science passed from the Newtonian two-variable system at the extreme of statistical analysis where myriads of parameters interact. This the true value of the modern digital instrument: present feedback data in real time from complex and necessary scenarios to obtain one higher design quality. The process becomes in thus generative, involving sequentially the variables involved and their implications in comparisons of the completeness of the urban scenario. [18]

The following figure shows an example of the use of parametric design in architecture. The masterplan for Beko was created by Zaha Hadid Architect within the city of Belgrade.

Fig. 4: Beko Masterplan. Source: Zaha Hadid Architect.

Furthermore, the new technologies have revolutionized the use of already known tools. We have moved from traditional 3D shapes to parametric representation and immersive experiences. The use of traditional forms of 3D representation differs from parametric drawing for two main reasons. The old software did not allow for the processing of such data. For this reason, the complex problems were analyzed in a sectoral way. The comparison of design alternatives took time, so often only the definitive solution was represented.

[16] “Games for cities”, AESOP Meeting, 2019

[17] “Urbanistica parametrica. Open data, strumenti e tecniche per la progettazione della città di domani”, pp.26, 2013.
[18] “The parametric representation of the city ”, pp.133, 2010.

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Furthermore, this approach does not include the analysis of the effects on the territory. Thanks to new technologies, parametric design can process data from different fields simultaneously. This allows complex problems to be addressed organically. “Parametric design systems today can adapt to changing context under the influence of parametric languages and scripting techniques and to diverse topological relationships and generative processes of design.” [19]

The second reason is related to the first. The 3D was used to represent a project already already decided: it was often used to communicate a message. Now parametric drawing is used to argue a decision: its use is part of the making process. “The distinction of parametric design in comparison to traditional computer modeling is that rule-sets become basic design procedures in configuring 3D models of parametric design. In building parametric models, designers set variables and digital data flows, adjusting the values of parameters, and revising the rules accordingly. Rather than traditional configuration ways of the object itself, the design of the generative rule set and their logical relationships is becoming the main focus of design thinking. In this way, more alternative solutions can be explored by changing the parameters of the logical relationships.” [20] Parametric design has many advantages but its use should not replace planners and stakeholders because they have the necessary knowledge, an exhaustive vision, and the necessary sensitivity to tackle complex problems.

The new technologies for communication are an instrument that is part of the life of each of us. The annual report conducted by the company We Are Social for 2020 shows that 60% of the world population is online. 90% of the time spent online is on apps where we spend an average of 2 hours and 24 minutes a day. The data refer to the year of the pandemic where there was an increase in the use of the internet for work, education, and leisure. Among the growing trends, the gaming sector's importance is increasingly emerging, not only among enthusiasts. This aspect is due to better graphics, increasingly compelling stories, and technological and furniture products that help live a 360-degree experience.

"The popularity of Facebook, Twitter, Google, Instagram, Youtube, Blogspot and other social media has spurred a demand for new forms of participatory planning and self-organizing governance by citizens. Unlike with many conventional methods, citizens are keen on using social media tools to engage with planners.“ [21] The social platforms connect and involves people of all age and different social groups. As Kleinhans et al. argue well, public administrations should consider these elements for new spatial planning tools. "To overcome the problems of participation as described in the previous section, many governments have turned to social media and social networking tools, with three potential communication strategies: (1) representation; (2) citizen engagement; and (3) networking with the public." [22] It will also be essential to know how to create new networks and strengthen existing ones affect in the territory even in the short and medium time.

The idea is to use parametric design, communication, and brand urbanism for interventions on an urban scale. At the territorial scale, these tools are used to create the future vision based on global issues and based on the identity culture. On an urban scale, parametric design and communication can use the collaboration of brands to create interventions that involve stakeholders over time.

4.1.1 Chiasso

The context for applying the conceptual model is the cross-border region between Switzerland and Italy.

"A cross-border region is a territorial entity that is made of several local or regional authorities that are co-located yet belong to different nation-states. Cross-border regions exist to take advantage of geographical conditions to strengthen their competitiveness."[23]

In recent times, an excellent opportunity is in Chiasso. It is the southernmost municipality in the Canton of Ticino and thanks to its position, it is an important hub for the flow of goods and people.

[19] “Theories and Models of Parametric Design Thinking ”, pp.477, 2015.
[20] “Theories and Models of Parametric Design Thinking”, pp.478, 2015.
[21] “The new generation of public participation: Internet-based participation tools, Planning Practice and Research”, pp.1, 2010.
[22] “Using Social Media and Mobile Technologies to Foster Engagement and Self-Organization in Participatory Urban Planning and Neighbourhood Governance. In Planning Practice and Research”, pp.3, 2015.
[23] “Encyclopedia of the City”, pp.155, 2004.

Currently, there are two important projects under discussion. Their approval would free up large areas for transformation. However, the discussion is currently at a standstill. It is an excellent possibility of conversion, but the territorial strategy is missing. In the absence of a shared image of the territory, it is not simple to orient projects on an urban scale. Chiasso is part of the territory defined as Mendrisiotto. At this scale, It is necessary to develop the idea for the strategy. In recent years, Chiasso and Mendrisio have been interested in various cultural projects with a cross-border character. Also, in the area, there are numerous parks and green areas of cantonal significance. Furthermore, it is the most important area for the production of wine in the Canton of Ticino. Mendrisio is the headquarters of University of Applied Sciences and Arts of Southern Switzerland and the Academy, architecture studios, and headquarters of relevant design brands.

The analysis of all these factors should help define the future image and work for Mendrisiotto's brand reputation. Although only with local actors' involvement will it be possible to make a paradigm shift in the territory's choices and define a new concept of quality.

In recent months, the first application of the conceptual model is carried out with the students of the "Integrated Planning" course held by Prof. Günther at SUPSI (University of Applied Sciences and Arts of Southern Switzerland).

The test had three main objectives. As regards the method, to make the students work in an interdisciplinary and multiscalar way. Regarding the tools, evaluate the effects of the different representation techniques and, in particular, evaluate the parametric design contribution in the final discussion. Finally, as regards the actors involved, verify the need to involve the brands in participation.

The students were divided into five groups, and each represents a different actor who intervenes in their ways and times.

The first step was on a local scale and developing a project proposal within 500m of the railway station close to Mendrisio, and the second step was at the cross-border scale. The last one was at the territorial scale: the students created the future image of Mendrisiotto. The proposals were: a territory of culture, the wine route and green paths, and a territory for commerce.

At the end of the course, a debate was organized to evaluate the effects of representation and the actors involved in the projects.

Thanks to CityEngine, a software application developed by Esri R&D Center Zurich, Parametric design has changed the ongoing discussion. It contributed to creating a climate of dialogue and comparison on the various solutions proposed. Regarding the actors, the groups highlighted the need to involve the brands present to realize the projects.

Then, the second ongoing test of the research involves the participation of brands to create the future image of Mendrisiotto.

Fig. 5: The first result of the test with the students, by A.Rollandi

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5 CONCLUSION

Cities are faced with great challenges. To increase their value, they need to become a brand and differentiate themselves from others. They must create value around their image and the projects they plan. For this reason, they need to involve local actors. Local administrations must communicate and collaborate with brands in a new way compared to the past. They also have to use new tools such as brand urbanism. It considers the values of cities, and It is a tool that will adapt more quickly to citizens' needs than traditional planning tools.

The ongoing doctoral research intends to develop a new planning tool to stimulate participation. It is a conceptual model that integrates parametric design, inclusive communication, and planned forms of brand urbanism. The conceptual model allows obtaining a bottom-up process that combines elements from different disciplines and works at different scales. The research introduces the parametric design to move up the territorial and urban transformations and coordinate them. Furthermore, it will be possible to evaluate design alternatives and their effects on the area. The tool must be accompanied by inclusive communication that can involve more people to participate.

In this context, the model can evaluate the planned forms of brand urbanism. Local administrations and the brands involved also can evaluate the effects in advance and start a discussion with citizens.

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Partizipative Prozesse bei taktischen Interventionen – Einblicke aus Villach

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1 ABSTRACT

Der öffentliche Raum ist überwiegend zugunsten des motorisierten Individualverkehrs verteilt. Dennoch werden Zu-Fuß-Gehen, Radfahren und die Qualitäten des öffentlichen Raums immer mehr diskutiert. Die Transformation des öffentlichen Raums hin zu einem gerechten, klimafreundlichen Lebensraum ist dringlich – insbesondere im Kontext des Klimawandels. Stadt- und Verkehrsplanungsprozesse dauern jedoch oft zu lange und reagieren nur langsam auf diese aktuellen Herausforderungen. Die COVID-Krise hat jedoch gezeigt, dass es in den Städten ein großes Potenzial für mehr Flexibilität und Experimentierfreude bei der nachhaltigen Mobilität und der Nutzung des öffentlichen Raums gibt: In zahlreichen Städten wurden Pop-up-Fahrradspuren eingerichtet, die das veränderte Mobilitätsverhalten aufgrund von Sperrungen und erleichtertem Radfahren während der Krise nutzen. Als Grundgedanke dieses neuen Planungsverständnisses kann der Ansatz des „Tactical Urbanism“ angesehen werden. In diesem Ansatz werden Interventionen als temporäre Veränderungen des öffentlichen Raums umgesetzt und können auch ein wichtiger Teil von Beteiligungsprozessen sein. Erfolgreiche Interventionen und auch die Planung generell hängen in hohen Maßen von der Inklusion und Information betroffener Akteurinnen und Akteure in Beteiligungsverfahren ab.

Das österreichische Forschungsprojekt „Tactical Mobilism – Interventionen für eine nachhaltige Mobilitätskultur“ nutzt diesen Ansatz und zielt darauf ab, zeitlich begrenzte, einfache und kostengünstige Interventionen zu erproben, um Mobilitätsmuster zu verändern und eine gerechte Verteilung des Raums zwischen verschiedenen Mobilitätsmodi im öffentlichen Raum zu unterstützen. In diesem Forschungsbeitrag wird der Anwendungsfall der Stadt Villach beschrieben, wo aktuell der Beteiligungsprozess läuft und zukünftige Interventionen in der Stadt diskutiert werden. Das Projekt wird im Rahmen des Forschungsförderungsprogramms „Mobilität der Zukunft“ durch das Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (BMK) gefördert.

Keywords: participation, intervention, mobility, public space, tactical

2 HINTERGRUND

In vielen Städten hat besonders die COVID-Krise – aber auch die Klimakrise – die Diskussion um die Verteiler des öffentlichen Raumes entfacht oder auch weiter getrieben. Hohe Bodenversieglung und Luftverunreinigungen sind aufgrund des etablierten Verkehrssystem eine Herausforderung. Die Verkehrsleistung – also ingesamt gefahrenenen Kilometer – steigt, auch wenn in den meisten Städten der Motorisierungsgrad rückläufig ist (Quelle)

Während dem Autoverkehr anteilsmäßig viel Fläche zur Verfügung steht, bleibt der aktiven Mobilität nur die Restflächen. Insbensodere das letzte Jahr hat gezeigt, dass Platz zum Verweilen, für einen sicheren Abstand und zum Spazieren in der frischen Luft eine hohe Bedeutung hat. Städte haben mit Pop-Bikelanes, Öffnung von Straßen für Bewohnerinnen, Bewohner, Fußgängerinnen, Fußgänger und Kinder reagiert. Alternative, autofreie Nutzungen des Straßenraums. Ein weiteres Beispiel sind die autofreien Zonen und Straßen der Innenstädte wie die Rue de Rivoli in Paris. Das hat nicht nur die Bereitschaft der Städte gezeigt, nachhaltig zu handeln, sondern auch, wie schnell ein öffentlicher Raum umgestaltet werden kann. Das wird aber für die Mobilitätswende nicht ausreichen. Dafür braucht es flexiblere Rahmenbedingungen und einen umfassenden Kulturwandel zu einer nachhaltigen Mobilitätskultur.

2.1 Umverteilung des öffentlichen Raums und Mobilitätswende

Im öffentlichen Raum überlagern sich vielfältige Nutzungsansprüche einer dynamischen städtischen Gesellschaft. „Dabei steht der öffentliche Raum in einem Wechselspiel aus räumlichen Bedingungen und der Nutzung durch Menschen, die ihn stetig und immer wieder neu herstellen und verändern“ (Fachkonzept

Öffentlicher Raum, Wien). Die Nutzungsanforderungen an den öffentlichen Raum differenzieren sich aufgrund einer älterwerdenden Gesellschaft sowie ethisch-kulturelle Vielfältigkeit immer weiter. Rahmenbedingungen prägen die Nutzungen, welche auch untereinander in Konkurrenz stehen. Insbesondere die motorisierte Mobilität nimmt einen enormen Platz ein und ist sowohl Gefährdungspotenzial als auch Barriere im System der öffentlichen Räume (Berding, U. & Selle, K., 2018). Eine Umkehr der Mobilitätspyramide (mehr Platz für aktive Mobilität) kann mehr Freiräume schaffen. Doch diese Mobilitätswende ist weniger ein Erkenntnis-, sondern ein Umsetzungsproblem (Hochfeld, C. et al. 2017). Es fehlt Wissen über überzeugende, regional angepasste Umsetzungsstrategien für nachhaltige Mobilitätslösungen. Für die Transformation braucht es den Austausch zwischen verschiedenen Akteurinnen und Akteuren, vor allem zwischen Verwaltung, Unternehmen, Wissenschaftlerinnen, Wissenschaftlern, Verkehrsteilnehmerinnen und Verkehrsteilnehmern. Die Städte unternehmen vielfältige Anstrengungen, um die Mobilität der Menschen umweltgerecht zu gewährleisten. Häufig werden die Probleme und mögliche Lösungen in Fachkreisen diskutiert. Bürgerinnen und Bürger sind in diese Diskussionen und in die Umsetzung bislang jedoch kaum einbezogen. In Bezug auf partizipative Ansätze steht „die Entwicklung passgenauer Methoden für diesen Zweck […] jedoch gerade erst am Anfang“ (Schraudner & Schütz 2016).

2.2 Transdisziplinarität und Beteiligung

Transdisziplinären Prozessen wird die Eigenschaft zugesprochen, dass durch die Zusammenarbeit von Akteurinnen und Akteuren aus der Praxis gemeinsam mit Wissenschaftlerinnen und Wissenschaftlern kontextadäquates Wissen entsteht, das das Potential besitzt, Veränderungsprozesse wie die Mobilitätswende voranzutreiben (vgl. Schneidewind 2018). Auf diesen Gedanken fußen auch andere partizipative Forschungsansätze, wie Community Organizing (siehe unten), Reallabore, bzw. Living-Labs (Defila, R., Di Giulio, A., 2018; Liedtke, C. et. al., 2012). Zum Beispiel sind Reallabore eng an eine nachhaltigkeitsorientierte Transformationsforschung und Forschungspolitik gebunden (Schneidewind 2014). Wesentlich ist das Bestreben komplexe sozio-technische Grundlagen für Transformationsprozesse zu verstehen und Veränderungen zu initiieren. Angestrebt wird ein Wissen, das wesentlich auf das „impliziten Wissen“ von Nutzerinnen und Nutzern aufbaut und mit den wissenschaftlichen Expertisen unterschiedlicher Disziplinen verknüpft wird. Bei einem Reallabor steht die Wissensanwendung mit ihren die Gesellschaft verändernden Konsequenzen im Vordergrund. Hier wird also der transdisziplinäre Prozess der Wissensgenerierung durch eine Phase der Umsetzung ergänzt.

2.3 Tactical Urbanism – Neue Wege der Kollaboration

In den letzten Jahren hat sich im wissenschaftlichen Diskurs der Stadtforschung und auch in der praktischen Umsetzung „Tactical Urbanism“ als eine Art Überbegriff für unterschiedliche Interventionsansätze im städtischen Raum entwickelt (Webb D. 2018, Lydon M. 2017). Interventionen sind Eingriffe bzw. zeitlich begrenzte Veränderungen von räumlichen Strukturen im städtischen Umfeld und „werden als Instrument der prozessualen Stadtentwicklung, als Teil von Planungs- und Beteiligungsprozessen und als städtebaulicher Lösungsvorschlag interpretiert. Sie können Ergebnis eines Beteiligungsprozesses sein und als Vorstufe zu einem zukünftigen Projekt dienen“ (Drobek & Tran 2017). Diese Interventionen sind in ihrer Qualität und in ihrem Umfang flexibel und spielen sich auf verschiedenen Maßstabsebenen ab (Marshall et al. 2016). Neben der Erstellung von Modellen zur Nutzung leerstehender Stadträume (Németh & Langhorst 2014) und informellen Aktionen innerhalb rechtlicher Grauzonen (Bermann & Clough Marinaro 2014) umfasst Tactical Mobilism hauptsächlich Interventionen im Bereich der Verkehrsplanung (Mullin 2017). Insbesondere der Verkehrsversuch als Begriff für temporäre Experimente im Straßenraum, um Abläufe in der Verkehrsorganisation testen zu können, gewinnt immer mehr an Bedeutung. Obwohl dieser seine Ursprünge eher aus aktivistischen, Bottom-Up Strömungen hat, ist dieses Instrument in Deutschland mittlerweile formalisiert und rechtlich als „Erprobungsklausel“ in der StVO in § 45 verankert (Bundesministerium für Verkehr und digitale Infrastruktur 2020, Achatz, P. 2021). Hiermit können mit provisorischen Maßnahmen Lösungsansätze getestet werden, die in ihrer permanenten Umsetzung wesentlich kostenintensiver wären. Durch diese temporären Installationen wird außerdem das Bewusstsein für Probleme und alternative Lösungsansätze bei Politik, Verwaltung sowie Bürgerinnen und Bürgern erhöht und eine neue Mobilitätskultur geprägt (Reallabor für Nachhaltige Mobilitätskultur. 2018).

3 BÜRGERINNEN- UND BÜRGERBETEILIGUNG: DIE UMSETZUNG IN VILLACH

Das Projekt „Tactical Mobilism – Interventionen für eine nachhaltige Mobilitätskultur“ versucht zeitlich begrenzte, einfache und kostengünstige Interventionen im Verkehrsbereich zu etablieren. Desweiteren soll aufbauend auf räumliche Interventionsmechanismen eine Verbesserung der Integration in Planungs- und Entscheidungsprozesse erzielt werden, um mehr Raum für aktive Mobilität zu schaffen. Das Testbed ist die Stadt Villach, die gemeinsam mit dem Projektteam (TU Wien, TU Graz, queraum, Artgineering und PLANUM) partizipativ solche Interventionen im öffentlichen Raum aktuell für die Postgasse im Zentrum Villach erarbeitet und im September/Oktober 2021 ausprobieren wird. Follower-Städte sollen aufbauend auf den Erkenntnissen in Prozessen und Konzepten lernen, diese weiterentwickeln und für ihre Interventionen und Mobilitätskonzepte nutzen können. Das Projekt wird von einem intensiven Partizipationsprozess begleitet, um Idee zu gewinnen und die Akzeptanz zu erhöhen.

3.1 Die Postgasse als Interventionsraum

Die Postgasse in Villach ist eine Straße, die zwei verkehrsberuhigter Bereiche und Knoten des öffentlichen Verkehrs verbindet (Begegnungszone Hans-Gasser-Platz und den Hauptplatz). Diese weist eine sehr multikulturelle und vielseitige Nutzungsmischung auf, die unter anderen insbesondere Einzelhandel und Gastronomie in den Erdgeschosszonen, eine hohe Frequenz an Passantinnen, Passanten, Anwohnerinnen und Anwohnern aufweist.

Aktuell ist die Postgasse aber wenig attraktiv für Fußgängerinnen, Fußgänger, Radfahrerinnen und Radfahrer, da die Geh- und Radwege schmal sind und viel Verkehr durchfließt. Es gibt Parkmöglichkeiten, die von Anrainerinnen, Anrainern, Besucherinnen und Besuchern der Innenstadt und Patientinnen und Patienten der ansässigen Ärztinnen und Ärzte genutzt werden. Es ist somit ein Ort mit vielen Potenzialen für aktive Mobilität, Erhöhung der Aufenthaltsqualität und der Begrünung.

Abbildung 1: Vision für Interventionen der zukünftigen Postgasse

3.2 Methodischer Ansatz

Im Rahmen von Tactical Mobilism betten wir die Aktivitäten zur Bürgerinnen- und Bürgerbeteiligung in einen Prozess ein, dessen Ziel es ist, Bürgerinnen und Bürgern zu ermöglichen, für ihre eigenen Interessen einzutreten und eine nachhaltige Verbesserung ihrer Lebensbedingungen zu erreichen. Konkret unterstützen wir Bürgerinnen und Bürger dabei, sich zu informieren, ihre Perspektiven und Ideen in Planungs- und Gestaltungsprozesse einzubringen und Interventionen im öffentlichen Raum mitzugestalten. Hierbei ist es uns ein großes Anliegen, die Sichtweisen und Ideen möglichst vieler Bürgerinnen und Bürger zu berücksichtigen. Sie wissen am besten, wie ihre Stadt gestaltet sein soll, damit sie sich gerne darin bewegen.

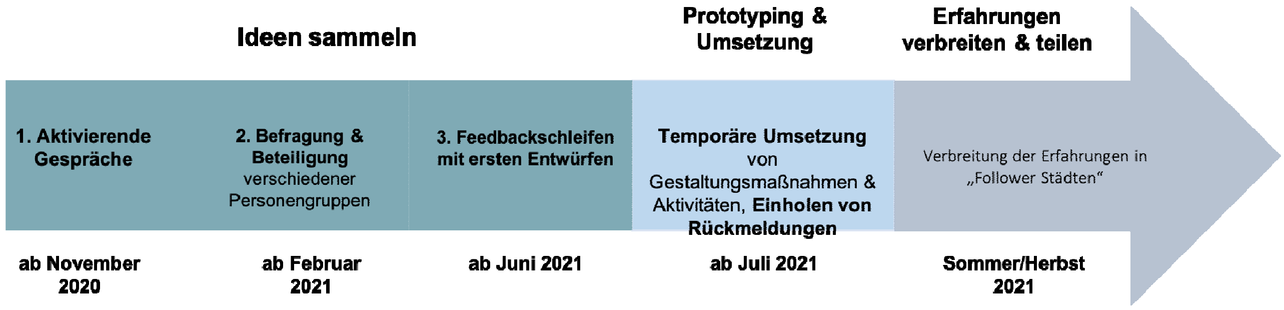

Abbildung 2: Ablauf der Bürgerinnen- und Bürgerbeteiligung

In Anlehnung an die Phasen des Community Organizing (Europäisches Community Organizing Netzwerk (2012) lässt sich der in Villach umgesetzte Prozess der Bürgerinnen- und Bürgerbeteiligung in drei Stufen einteilen: (1) Zuhören, (2) Erarbeiten von Lösungen und (3) Etablieren einer Organisationskultur.

3.2.1 Zuhören: Aktivierende Gespräche, Online-Fokusgruppen & niederschwellige Beteiligungsformate

In dieser Stufe erfolgte die Einbindung verschiedener Bevölkerungsgruppen mittels niederschwelliger und interaktiver Beteiligungsmethoden. Corona-bedingt fand der Austausch bisher hauptsächlich online, in Einzelsettings oder in Kleingruppen statt.

In einem ersten Schritt führte Projektpartner queraum. kultur- und sozialforschung Aktivierende Gespräche mit relevanten Akteurinnen, Akteuren, Interessensvertreterinnen und Interessensvertretern in der Stadt Villach. Ziel dieser Gespräche war es, über das Projekt Tactical Mobilism und die Vorhaben in Villach zu informieren, (Alltags)expertisen, Meinungen und Ideen einzuholen und Möglichkeiten und Interessen der Beteiligung zu besprechen.

queraum versteht Aktivierende Gespräche als eine Erhebungsmethode, um Meinungen, Sichtweisen und Rückmeldungen zu sammeln, die für einen weiterführenden Dialog sowie Entwicklungs- und Planungsmaßnahmen hilfreich sind. Zudem stellen die Gespräche ein Startschuss für einen längerfristigen gemeinsamen Prozess dar, indem interessierte Gruppen in verschiedene Beteiligungsformate bzw. in konkrete Projektaktivitäten eingebunden werden (Partizipation 2021). Wie die Erfahrungen zeigen, ermöglichen die Gespräche den Zugang zu weiteren Expertinnen, Experten, Bevölkerungsgruppen und zu Insiderwissen.

Konkret wandte sich das Projektteam an Interessensgruppen und die organisierte Öffentlichkeit. Kontaktiert wurden lokale Akteurinnen, Akteure und Schlüsselpersonen, die sich für die Interessen verschiedener Zielgruppen engagieren (u.a. Gleichstellungsbeirat der Stadt Villach, Seniorinnen- und Seniorenbeauftragter der Stadt Villach, Jugendbüro der Stadt Villach, etc.) bzw. sich mit den Themenbereichen Aktive Mobilität und Stadtplanung auseinandersetzen (z.B.: Stadtmarketing, Tourismusinformation, Radlobby Kärnten).

In einem nächsten Schritt war es das Ziel, unterschiedliche Akteurinnen und Akteure zusammenzubringen und deren Sichtweisen zu diskutieren. Stadtplanerinnen und Stadtplaner vom Institut für Städtebau an der Technischen Universität Graz und Verantwortliche für Bürgerinnen- und Bürgerbeteiligung vom Forschungsbüro queraum konzipierten und moderierten Online-Fokusgruppen und konnten mit diesem Austauschformat Akteurinnen und Akteure u.a. aus den Bereichen Jugend, Seniorinnen und Senioren, Frauen- und Mädchengesundheit, Kunst und Kultur, Tourismus, Polizei, Gesundheit und Mitglieder des Gleichstellungsbeirats erreichen.

Mit Unternehmerinnen und Unternehmern in der Postgasse fanden persönliche Einzelgespräche direkt in ihren Geschäftslokalen bzw. Restaurants statt. Mitglieder des Jugendrates der Stadt Villach haben ihre Ideen in einer Videobotschaft übermittelt. Mit Teilnehmerinnen und Teilnehmern an Angeboten des Mädchenzentrums Standorte Villach & Klagenfurt haben die Projektverantwortlichen Workshops umgesetzt. Mittels unterschiedlicher Methoden (z.B. Lego-Bausteine, Begehungen) brachten die teilnehmenden Mädchen und jungen Frauen ihre Ideen für die Postgasse ein (siehe Abb. 3).

Anders als ursprünglich geplant, konnten aufgrund der COVID-19 Pandemie und den damit verbundenen Einschränkungen keine größeren öffentlichen Veranstaltungen stattfinden. Um dennoch auch die breite Öffentlichkeit anzusprechen, entwickelte queraum. kultur- und sozialforschung eine interaktive Erkundungstour (mittels der APP Actionbound, siehe Abb. 3) durch die Postgasse. Von März bis Juni 2021 könnten interessierte Bürgerinnen und Bürger die Postgasse mit dem Smartphone oder Tablet auf eigene Faust erkunden, verschiedene Aspekte der Postgasse bewerten und konkrete Vorschläge zur Gestaltung machen. Die gesammelten Ideen wurden direkt an das Projektteam geschickt. Zudem gab es auch die Möglichkeit, Ideen schriftlich einzubringen. Das Projektteam hat dazu eine Postkarte gestaltet, die in Geschäften in der Postgasse und in öffentlichen Einrichtungen in Villach (z.B. Bürgerinnen- und Bürgerservice, Stadtmarketing, Tourismusinformation) aufliegen. Bis Ende Juni 2021 nutzten mehr als hundert Bürgerinnen und Bürger die Möglichkeit, uns ihre Ideen auf diesem Wege mitzuteilen. Insgesamt konnten wir mit den Aktivitäten zur Bürgerbeteiligung mehr als 170 Personen einbinden.

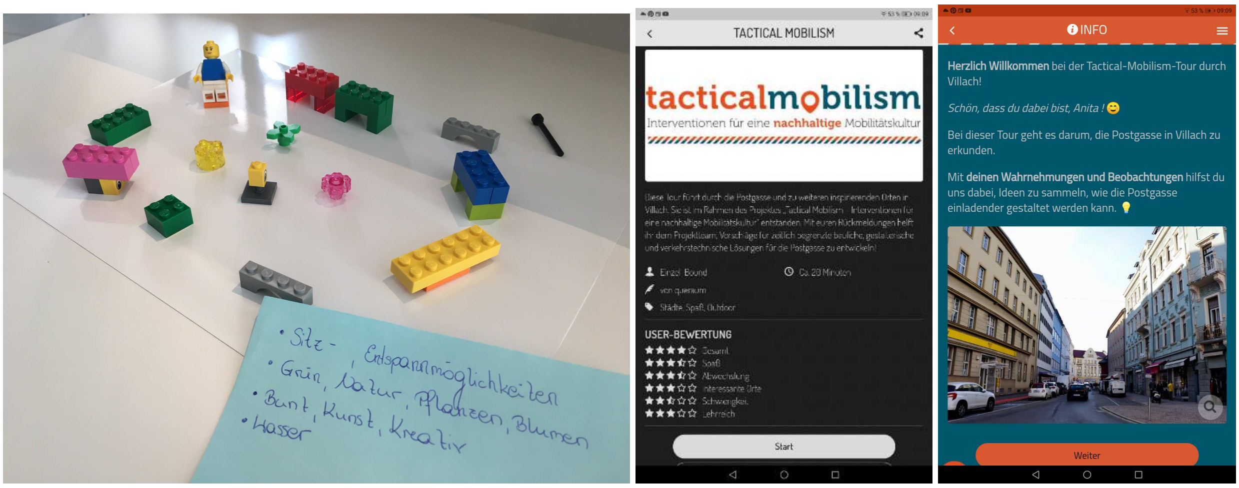

Abbildung 3: Fokusgruppe Mädchenzentrum (links); Screenshots der APP Actionbound (rechts)

Formate Befragung von Bürgerinnen und Bürgern	Ausgewählte Ergebnisse	
	Wünsche & Ideen zur räumlichen Gestaltung	Wünsche & Ideen für Aktionismus & Aneignung
Aktivierende Gespräche Online-Fokusgruppen Gespräche mit Unternehmerinnen und Unternehmern Workshops & Erkundungstouren Begehungen Postkarten- Ideensammlung Interaktive Erkundungstour	• Von **Ausweitung der Fußgängerzone** über **Verkehrsberuhigung und Park- & Haltemöglichkeiten** (z.B. Post, Ärztinnen, Ärzte) erhalten bis hin zu **mehr Parkplätze** bzw. bestehende Parkplätze für Kundinnen und Kunden „reservieren“ (Dauerparkerinnen und Dauerparker raus) • Gleichberechtigte Nutzung von Radfahrerinnen, Radfahrern, Fußgängerinnen, Fußgängern, Autofahrerinnen und Autofahrern • Soll als attraktive Verbindung zwischen Hans-Gasser-Platz und Hauptplatz räumlich spürbar und erlebbar werden • Leitsystem zum Spielplatz im Park • Mehr Aufenthaltsqualität (u.a. Begrünung, konsumfreie Räume, Beschattung & Überdachung, Attraktive Möblierung) • Barrierefreiheit	• Unterschiedliche Nutzungsmöglichkeiten: z.B. Begegnungszone ganztägig & temporäre Schließung für den Verkehr (z.B. an ausgewählten Abenden) • Aktionen zur Bewusstseinsbildung zu „Aktive Mobilität“ & Aneignung (u.a. „Offene Bühnen, Begegnungsmöglichkeiten) • Kunst im öffentlichen Raum • Generationenübergreifende Aktivitäten & Veranstaltungen (z.B. Tag der Generationen) • Multikulturelles Postgassen-/Nachbarschaftsfest • Tour durch die Postgasse mit Aktionen/Veranstaltungen in den Geschäften und Lokalen der Postgasse

Tabelle 1: Ausgewählte Ergebnisse der Beteiligung

3.2.2 Erarbeiten von möglichen Lösungen: Feedbackschleifen & gemeinsame Weiterentwicklung

In einem weiteren Schritt werden Bürger und Bürgerinnen dabei begleitet, ihre Ideen zu konkretisieren und Lösungen zu erarbeiten. Das Institut für Partizipatives Gestalten spricht hierbei von kollaborativer Beteiligung (Rohr, J. et al. 2017). In Formaten wie Ideen- und Gestaltungswerkstätten oder Living Labs entstehen gemeinsame Maßnahmen, Planungen oder Interventionen und die Zusammenarbeit aller

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Beteiligten wird ermöglicht. Im Rahmen des Projektes Tactical Mobilism ist geplant, erste Entwürfe der Stadt- und Verkehrsplanerinnen sowie Stadt- und Verkehrsplaner an interessierte Bürgerinnen und Bürger zurück zu spielen und gemeinsam weiter zu entwickeln. Zudem ist das Projektteam bereits in Kontakt mit Gruppen und Akteurinnen und Akteuren (z.B. Höherbildende Schulen, Mädchenzentrum, Klimabündnis Kärnten), die Interesse bekundet haben, sich aktiv an Interventionen in der Postgasse zu beteiligen. Erste Ideen, wie beispielsweise das Bauen von vielseitig nutzbarem Stadtmobiliar oder Kunstaktionen, werden in den nächsten Monaten gemeinsam weiterentwickelt und mit der Stadt Villach abgestimmt.

3.2.3 Etablierung einer Organisationskultur: Nachhaltigkeit

Ziel der dritten Stufe ist es, lokale Akteurinnen und Akteure zu vernetzen und Strukturen zu etablieren, die eine nachhaltige Auseinandersetzung mit Aktiver Mobilität ermöglichen. Dazu sind im Herbst Workshops und Gespräche mit Verantwortlichen der Stadt Villach und relevanten Akteurinnen und Akteuren geplant.

3.3 Erste Ergebnisse und aktueller Stand

Trotz der corona-bedingten Einschränkungen haben bis Ende Mai 2021 Akteurinnen, Akteure, Unternehmerinnen, Unternehmer, Bürgerinnen und Bürger an aktivierenden Gesprächen, Online-Fokusgruppen, Workshops, Begehungen oder persönlichen Gesprächen teilgenommen. Wie bereits beschrieben, haben sich Mitglieder des Jugendrates der Stadt Villach zudem in Form eines selbst erstellten Videos eingebracht. Die Befragung mittels APP-basierter Erkundungstour und Postkarten läuft bis Mitte Juni 2021. Informationen zur Anzahl der retournierten Postkarten und absolvierten Erkundungstouren liegen daher noch nicht vor.

Das Resultat der bisher umgesetzten Beteiligungsmöglichkeiten sind unterschiedlichste Ideen zur Aufwertung, Umgestaltung und Aneignung der Postgasse. Dazu gehören u.a. der Wunsch nach Verkehrsberuhigung, neuen Begegnungs- und Verweilräumen, Begrünung und Beschattung wie auch ansprechendem und vielseitig nutzbaren Stadtmobiliar. Auch gemeinschaftliche Aktionen, um das Miteinander in der Postgasse zu stärken (z.B. gemeinsames Tanzen, Spiele, Feste, Kunst im öffentlichen Raum) und die Besucherinnen- und Besucherfrequenz zu erhöhen, wurden vorgeschlagen. Mehrere Gruppen haben bereits Interesse bekundet, sich bei der Umgestaltung der Postgasse aktiv zu beteiligen (z.B. Bau von Stadtmobiliar, Mitorganisation von Festen und Kunstaktionen bzw. Aktionen zur Förderung der Aktiven Mobilität).

Eine erste Interessens- und Ideensammlung wurde bereits an die Verantwortlichen der Stadt Villach rück gespielt und bietet den Stadt- und Verkehrsplanerinnen sowie Stadt- und Verkehrsplanern eine wertvolle Grundlage für die Ausarbeitung erster Entwürfe.

4 REFLEXION DER BISHERIGEN PARTIZIPATIVEN VORGEHENSWEISE

Bei der Planung und Umsetzung der Bürgerinnen- und Bürgerbeteiligung im Rahmen des Projektes Tactical Mobilism ist es uns wichtig, Anforderungen einer „guten Beteiligungspraxis“ zu berücksichtigen. In Anlehnung an die vom Netzwerk Bürgerbeteiligung formulierten Qualitätskriterien Bürgerbeteiligung (Netzwerk Bürgerbeteiligung) erscheinen uns daher folgende Aspekte besonders relevant:

4.1 Möglichkeiten schaffen, damit sich möglichst viele Personengruppen beteiligen können

Aus unserer Sicht ist Bürgerinnen- und Bürgerbeteiligung erfolgreich, wenn möglichst viele unterschiedliche Blickwinkel und Sichtweisen einbezogen werden. Zu unseren Zielgruppen zählen daher lokale Akteurinnen und Akteure, Personen, die sich beruflich mit dem Thema Stadtgestaltung befassen, Interessensvertretungen, lokale Unternehmerinnen und Unternehmer, Vertreterinnen und Vertreter von Organisationen und Vereinen sowie interessierte Bürgerinnen und Bürger.

Um auch Gruppen und Einzelpersonen einzubinden, die einen erschwerten Zugang zur Beteiligung haben, sich von Beteiligungsmöglichkeiten tendenziell nicht angesprochen fühlen oder aufgrund ihrer bisherigen Erfahrungen keinen persönlichen Nutzen erkennen, haben wir gezielt Akteurinnen und Akteure angesprochen, die aufgrund ihrer ehren- oder hauptamtlichen Tätigkeit persönlichen Kontakt zu tendenziell schwer zu beteiligenden Zielgruppen (z.B. Menschen mit Behinderung, Migrantinnen und Migranten, Menschen mit psychischen Beeinträchtigungen, Menschen in Not) haben. Die Akteurinnen und Akteure fungierten als „Multiplikatorinnen“ und „Multiplikatoren“ und haben ihre Zielgruppen über das Projekt informiert und sie dabei unterstützt, ihre Ideen einzubringen.

4.2 Vielfältige Beteiligungsmöglichkeiten bieten

Anders als ursprünglich geplant, war es aufgrund der Covid-19 Pandemie nicht möglich, unterschiedliche Personengruppen persönlich zusammenzubringen. Wir haben jedoch gute Erfahrungen damit gemacht, zielgruppenspezifische Formate anzubieten und die Kommunikationswege auf die Bedürfnisse und Möglichkeiten der verschiedenen Gruppen und den Covid-19 bedingten Rahmenbedingungen anzupassen. Bei Unternehmerinnen und Unternehmern haben sich beispielsweise persönliche Gespräche und Besuche vor Ort als passend herausgestellt. So konnten Ideen, Erfahrungen und etwaige Bedenken individuell und in einer niederschwelligen Atmosphäre und ohne zusätzlichen zeitlichen Aufwand für die Unternehmerinnen und Unternehmer besprochen werden. Für lokale Akteurinnen und Akteure sowie Vertreterinnen und Vertreter unterschiedlicher Bereiche (z.B. Gesundheit, Soziales, Stadtmarketing, Tourismus, Polizei, usw.) haben sich wiederum Online-Fokusgruppen als passende Beteiligungsformate herausgestellt.

Mitglieder des Jugendrates wiederum haben es vorgezogen, ihre Sichtweisen in einem selbstgestalteten Video einzubringen. In Absprache mit den Verantwortlichen des Mädchenzentrums, haben wir für Mädchen und junge Frauen Workshops konzipiert und mit ihnen gemeinsam vor Ort Ideen für die Postgasse gesammelt. Mit der interaktiven Erkundungstour durch die Postgasse sprachen wir technikaffine Bürgerinnen und Bürger an und boten gleichzeitig mit den Postkarten eine „analoge“ Alternative der Beteiligung an. Diese vielfältigen, zielgruppenspezifischen und aufeinander abgestimmten Beteiligungsmöglichkeiten haben unserer Einschätzung nach zur Akzeptanz der Aktivitäten beigetragen und die Bereitschaft zur Teilnahme erhöht.

4.3 Den Beteiligungsprozess transparent und nachvollziehbar gestalten

Die klare Kommunikation und Transparenz des Beteiligungsprozesses sind uns besonders wichtig. Im regelmäßigen Austausch werden daher die Methoden und Aktivitäten der Bürgerinnen- und Bürgerbeteiligung mit den Projektpartnerinnen, Projektpartnern und den Verantwortlichen in der Stadt Villach abgestimmt. Auch die beteiligten Bürgerinnen, Bürger, Akteurinnen und Akteure werden regelmäßig über die einzelnen Aktivitäten, den Fortschritt des Beteiligungsprozesses und weitere Maßnahmen informiert. Im Sinne der Wertschätzung und Anerkennung für ihre Beiträge, erhalten die Teilnehmerinnen und Teilnehmer an Online-Fokusgruppen, persönlichen Gesprächen und anderen Beteiligungsformaten zeitnah eine Zusammenfassung der bisher vorliegenden Rückmeldungen.

In Abstimmung mit den Stadt- und Verkehrsplanerinnen sowie Stadt und Verkehrsplanern bereitet queraum die Ideen und Bedürfnisse der Beteiligten so auf, dass diese für den weiteren Planungsprozess eine nützliche Grundlage bieten. Eine enge Kooperation zwischen den Verantwortlichen für die Bürgerinnen- und Bürgerbeteiligung und den Stadt- und Verkehrsplanerinnen sowie Stadt- und Verkehrsplanern ist eine wichtige Voraussetzung dafür, dass der Informationsfluss gelingt. Besonders hilfreich war die gemeinsame Planung und Durchführung einzelner Beteiligungsformate (z.B. Online-Fokusgruppen).

5 SCHLUSSFOLGERUNG UND AUSBLICK

Das Projekt ist nicht nur ein wichtiger Beitrag, um das Konzept der „taktischen“ Interventionen in der Planungspraxis bekannt zu machen und daran Beteiligungsmaßnahmen anzuknüpfen, sondern auch langfristig neue Handlungsoptionen in der Planung aufzuzeigen und ein Umdenken seitens der verschiedensten Akteurinnen und Akteure zu bewirken. Die Ergebnisse des Beteiligungsprozesses in konkrete Entwürfe zu übertragen, wo sich die Beteiligten auch wiederfinden und damit identifizieren können, wird der nächstegroße Schritt sein. Die Umsetzung im September und die Reflexion mit den Vertreterinnen und Vertretern aus anderen Klein- und Mittelstädten wird zeigen, wie zukunftsorientiert und umsetzbar taktische Interventionen sind in ihrer Praxis. Villach als innovative Mittelstadt traut sich bereits an das Experiment. Es wird sich zeigen, wie in einem nächsten Schritt – nämlich die tatsächliche Umsetzung – die Politik, Bevölkerung, verschiedene Initiativen und Vereine auf das Vorhaben reagieren, sich einbringen und weiter vorantreiben.

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🏆 *reviewed paper*

Patterns and Practices of Spatial Transformation: a Historical Review of Approaches

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1 ABSTRACT

Over the past few decades, particularly after the democratic dispensation in South Africa, the state of spatial transformation has not been documented extensively and adequately in the country's cities. To deliver and promote sustainable development; economically, socially and environmentally; spatial planning is critical in creating more stable and predictable conditions for investment and development. Responsive spatial planning is critical for securing community transformation benefits and promoting the prudent use of land and natural resources for sustainable urban development. The paper aims to assess the strategies, procedures, and elements that inform spatial transformation in developing cities. A bibliometric literature analysis was adopted and applied to the study to examine spatial planning trends in developing cities. The results reveal the right to the city has been used as a tool for developing frameworks to guide spatial planning. These frameworks have been used in the production of space in cities while also allowing planners to understand spatial transformation as a socio-spatial (multidimensional) process. Evidently, spatial planning is an essential tool for promoting sustainable development and improving the quality of life. Overall, the paper recommends the need to develop strategic spatial planning processes as tools for economic bridging plans that can retrofit existing neighbourhoods to improve liveability in cities.

Key words: right to the city, spatial transformation, production of space, socio-spatial, Johannesburg

2 INTRODUCTION

Over the past few decades, particularly after the democratic dispensation in South Africa, the state of spatial transformation has not been documented extensively and adequately in the country's cities. To deliver and promote sustainable development; economically, socially and environmentally; spatial planning is critical in creating more stable and predictable conditions for investment and development. Responsive spatial planning is critical for securing community transformation benefits and promoting the prudent use of land and natural resources for sustainable urban development. South Africa has implemented many spatial planning policies, with all the policies having a clear mandate, which was to build inclusive, productive, sustainable and well-governed cities. There has been mixed progress made towards addressing the socio-economic inequality and spatial injustice. However, the majority of black people continue to live far from jobs, shops, institutions of higher learning and other urban opportunities. Apartheid geographies are more difficult to change in cities, where the majority of South Africans live, than they were in 1994. Clearly, business as usual will not work, and new approaches will be necessary to reshape the apartheid-designed city spatially. The paper aims to assess the strategies, procedures, and elements that inform spatial transformation in developing cities.

3 RELATED WORK

There has been a noticeable gap in the literature that discusses spatial transformation in South African cities. According to Oranje (2014), spatial change in South Africa is primarily concerned with initiatives to address the physical manifestations of Apartheid planning. The trends in literature also follow this trend of spatial transformation as one of the initiatives to address the physical manifestation of the apartheid system of planning. In 2014, Johannesburg hosted a conference on the "Spatial Transformation of Cities." It looked into a variety of major themes in order to better grasp what it takes to transform urban landscape in practice (SACN, 2014). It was used to review the performance of other cities, obtain information and insight at the city level, and increase understanding and learning about constraints and options for spatial change (Maritz et al., 2014).

The event reaffirmed that in order to gauge if actions to transform are manifesting actual change, evidence needs to be tracked. Thus, creating a new trend in the spatial transformation literature, which was tracking the progress of spatial transformation of South African cities. This can also be seen on the South African City Network Reports which focus mainly on tracking the progress made. There is a clear gap in literature that focuses on the strategies, procedures, and elements that would inform spatial transformation in South Africa and the literature that focuses on the conditions that need to be established for the current spatial planning policies to be able to stand a chance to be implemented properly and have fruitful outcomes. Other literature focuses on the theoretical framework that informs the spatial transformation concept in South Africa. This theoretical discussion will focus on the right to the city concept in order to lay the groundwork for interpreting different right to the city claims that are crucial in the transformation of cities in South Africa.

Henri Lefebvre, a radical French Marxist sociologist and philosopher, invented the term "right to the city" in 1968 to describe the rights of all urban people, regardless of citizenship, ethnicity, ability, gender, or other factors, to participate in shaping the city (Brown, 2009). ‘It is about the rights of the excluded and marginalised to participate in the production of the city, for their wants and ambitions to be addressed in the process, rather than solely those of capitalists, as is the case in most urban development’ (Lamarca, 2009). As a result, the right to the city profoundly challenges current power relations as well as the deep roots of the capitalist system that drive urban development and the production of urban space, including economic, social and political ties (Lamarca, 2009).

There is no definite definition that has been provided for the theory, however many scholars have come up with different perceptions of what the theory seeks to address. Lefebvre summarises the idea as a “demand...[for] a transformed and renewed access to urban life". The Right to the City is defined by David Harvey as: "far more than the individual liberty to access urban resources: it is a right to change ourselves by changing the city. It is, moreover, a common rather than an individual right since this transformation inevitably depends upon the exercise of a collective power to reshape the processes of urbanisation. The freedom to make and remake our cities and ourselves is, I want to argue, one of the most precious yet most neglected of our human rights."

The ‘Right to the City,' as Harvey (2008) points out, has gained popularity in the light of spatially inequitable and exclusionary development projects in and across urban regions. Lefebvre envisioned the city as an ongoing work, or oeuvre. He saw the Right to the City as a demand by residents to participate fully in urban life and to negotiate its possibilities, providing them full access to the city and everything it has to offer (Coggin and Pieterse, 2011). The right to habitation, appropriation, and participation is enshrined in the right, which is perceived as grounded in both current, everyday realities and visions and contestations of a better urban future for all.

The Right to the City advocates for a more inclusive, equitable, and creative interpretation of rights (Purcell, 2002). Various social movements have appropriated the term to highlight a variety of urban concerns, including livelihoods, access to opportunities, political and social expression, and basic dignity. Many of South African cities aim at achieving spatial transformation in such a way that many of them have the need to address socio-economic inequalities, racially divided cities and the transformation of the urban spaces on their political and planning agenda since (Oranje, 2000). In all the spatial planning policies that these municipalities adopted, the right to the city is at the centre of all these policies aiming at improving inclusivity.

There has been critiques to the concept of right to the city. The critiques resulted in that the growing popularity of the concept has nonetheless raised some criticism and concerns on how the original vision of Henri Lefebvre could be reduced to a “citizenship vision”, focused on the mere implementation of social and economic rights in the city leaving aside its transforming nature and the concept of social conflict behind the original concept. In “Which right to which city? in defence of political-strategic clarity” Marcelo Lopes de Souza has for instance argued that as the right to the city has become "fashionable these days", "the price of this has often been the trivialisation and corruption of Lefebvre's concept" and called for fidelity to the original radical meaning of the idea (Lopes de Souza, 2010).

The only way to connect physical and social space, according to Lefebvre (1991), is to focus on the production of space. This is exemplified by what he refers to as the three moments of social space: mental, physical, and social. The first is spatial practice, which relates to the organisation and use of space. Spatial practice promotes consistency and cohesion, since it ‘embodies a close relation, within perceived space, between daily reality (daily routine) and urban reality (routes and networks that connect together spaces set aside for work, "private life," and leisure").’

The second phase focuses on spatial representations, which emphasise sensations, signals, and significations, allowing material objects to be spoken out (Lefebvre 1991:38- 40). It refers to the imagined environment inhabited by scientists, planners, and engineers who connect what is lived and perceived with what is conceived. This is the main space in any society that is moving "towards a system of verbal (and thus intellectually developed) signs."

The third moment concerns representational space, which is defined as "space as directly experienced through its associated pictures and symbols," and thus the space of inhabitants and users, as well as a space comprehended in nonverbal terms. Representational space is a passively perceived dominated place that overlaps physical space and makes symbolic use of its object (Lefebvre 1991:38-40).

Lefebvre argues for the interconnectivity of various moments (as in the case of western towns from the Renaissance to the nineteenth century), where each is unique from, but integral to, a unitary approach to space and its evolution. To reflect this contradiction and distinguish it from abstract space, he introduces the concept of differential space: space that emphasises and accommodates differences and incorporates physical, social, and mental space. Abstract space is concerned with undefined or unbounded space; it is detached from reality and human experience, and is solely linked to abstract concepts or constructs. The city's historical space, according to Lefebvre, has been taken over by an abstract space, "the space of bourgeoisie and capitalism" (Lefebvre 1991: 57). This necessitates a greater understanding of space production, including how it is done, what is involved, and who is engaged, or a socio-spatial approach to spatial transformation.

As a result of the preceding arguments, the spatial analysis of urban transformation cannot be limited to physical space and form. It must also take into account social and mental space. To comprehend physical form, its transformation, and meaning, spatial research must embrace the concept of differential space and employ a socio-spatial method. As a result, an emphasis on the process, including the dimension of time and the aspect of place, is required. As part of the process of spatial transformation in cities, it also necessitates an examination of what physical and social space comprises.

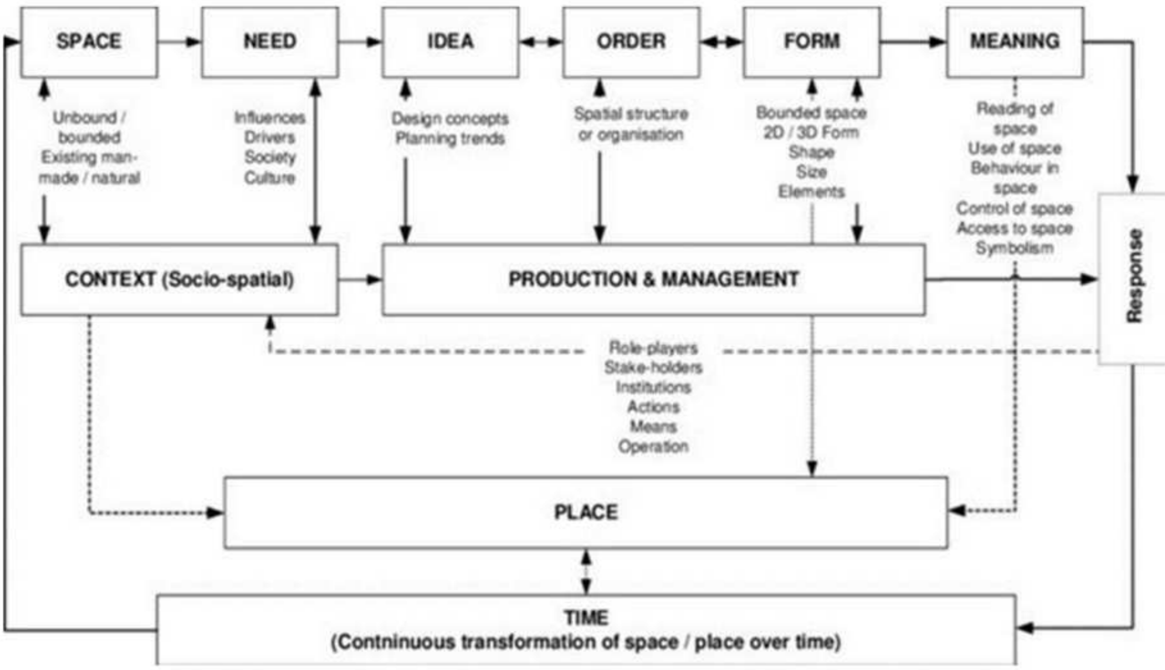

Figure 1: A conceptual framework to explain the making and changing of urban space (Source: Landman, 2014)

To comprehend the transformation of urban space, one must first comprehend urban space and the factors that influence its evolution. Focusing on development agencies, the structures they interact with in the form

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of resources, laws, and ideas, and the social and geographical environments in which they work is the best method to comprehend the urban development process (Madanipour 1996a:154). This emphasises the strong connection between space and society: social factors influence spatial change, which leads to distinctive social interpretation and response, as mentioned. The process as summarised by Landman (2014), can be seen in the diagram.

This framework provides a way to conceptualise spatial transformation as a multifaceted socio-spatial process. This occurs as a result of a process including space, need, idea, order, shape, and meaning, as well as the creation and control of spatial interventions in a given environment (Landman, 2006). The term "space" refers to unbounded natural or man-made space. This does not occur at random. It is frequently influenced by special requirements at a specific period (related to the context). As a result of the need/demand, an idea for how to meet it emerges. This is the start of order, of structural organisation to guide shape and order the notion. The physical expression of a desire or notion is called form, and it takes on a specific shape, texture, and size that can be measured. It reflects the intangible nature of an area and contributes to the construction of a certain place, which can then be transformed throughout time.

Space and location are not chosen at random. They are full of meaning. As a result, spaces or locations can be ‘read' and ‘experienced,' appealing to people's moods or emotions, such as feeling at ease in a place, feeling safe, or feeling at home (Landman, 2006). It can also influence how people use space and thus their behaviour patterns in this way. As a result, it's not surprising that people react differently to diverse situations and situations. Their reaction could be influenced by a variety of factors, including predispositions, current sentiments, and past experiences. Places can provoke a variety of responses, which, if thought appropriate by a sufficient number of people, might contribute to the transformation of specific spaces. This starts the cycle all over again, with a need to modify existing man-made space. This process is influenced by a variety of individuals involved in the production and management of space, all of whom affect the need/demand, idea, form, order, and meaning in settlements on a continuous basis. The framework is used to demonstrate a method for conceptualising space and location in the urban planning process, as well as to provide insight into the urban transformation process.

4 METHODOLOGY

This paper used document analysis to collect information. A systematic technique for reviewing or evaluating documents, both printed and electronic (computer-based and Internet-transmitted) material, is known as document analysis. Document analysis, like other qualitative research methodologies, necessitates the examination and interpretation of data in order to extract meaning, gain insight, and develop empirical knowledge (Corbin & Strauss, 2008). The study reviewed relevant and related literature on spatial planning and transformation of cities across the country. The literature review was undertaken at a national level and a local level. At national level the literature review focused on books, peer-reviewed articles, reports on the current state of spatial transformation of South African cities, reports on urban planning and spatial planning. The search engines that were used included Elsevier elibrary, JSTOR, Google Scholar, Scopus, SAGE Journals online and the Google Search.

The local level literature review examined development plans and legislations obtained from national and decentralised institutions such the City of Johannesburg Municipal planning documents, polices and legislative framework. The documents that were reviewed included the SPLUMA, SDF, GDS, IDP and Precinct Based Plans. The review of these documents was important to establish the spatial transformation policies and legislative framework potential in improving or constraining urban development in South Africa.

Additionally, some structural plans within the city of Johannesburg’s jurisdiction were also analysed to provide insight into the effectiveness of spatial plans in guiding urban transformation and management. The structure plan was used because it remains the main spatial development framework for guiding the development of many areas in Johannesburg. Due to time constrains and Covid-19 restrictions, structural plans selected were limited to Johannesburg jurisdiction, these were also selected to provide a situation specific reflection of the state of spatial transformation. It also enabled to track the development trends in Johannesburg.

5 RESULTS AND DISCUSSION

Any well-functioning metropolis relies heavily on spatial transformation. To remain competitive in a global environment, the ability to alter and improve space, existing infrastructure, possibilities, and facilities is critical. It' is also vital to adjust to the changing needs of city dwellers. This section will focus on dynamics around spatial planning systems in South Africa. Furthermore, it will then draw on the policies adopted for addressing spatial planning challenges in South Africa as a country and using Johannesburg as a case study.

In order to understand the spatial planning field better, in addition to the process that makes up the planning activity, the term planning must be defined. As per Glasson (1978:17), humanity has had an almost instinctive need to plan since the dawn of civilisation, which does not necessarily stem from our biological make-up, but has been learned over many years and acts as one of society's basic social drivers. Over the last century, this need for planning has increased drastically, particularly in terms of spatial planning, and may well be the result of society not accepting situations arising from a lack of planning (Glasson, 1978:17). The income disparities between various groups and regions are one area where the absence of planning can be measured (Glasson, 1978:18). The need for spatial planning has become more important since the industrial revolution, as rapid urbanisation and technological improvements have seen masses of people sharing the same space in a more complex way (Glasson, 1978:18).

5.1 Planning

The concept of planning is difficult to define, according to Hall (1975:3), but he continues by stating that “planning is concerned with deliberately achieving some objective, and it proceeds by assembling actions into some orderly sequence”. Planning may or may not require physical plans or blueprints showing the different elements of the 'plan' from the above-mentioned regard (Hall, 1975:6). Planning is an ongoing process used to regulate specific effects. In addition, spatial planning could be seen as a sub-section of the wider planning process (Hall, 1975:269). Town planning also refers to a spatial or geographical component according to which the spatial structure is better organised prior to planning, which implies a physical component (Hall, 1975:7).

Planning action can presumably be used to improve a community's current status in a wide variety of areas that affect the lives of people. One of the general planning characteristics is that it consists of a sequential chain of actions aimed at solving future economic and social problems (Glasson, 1978:19). As per Friedman (1964:61) ‘planning is primarily a way of thinking about social and economic problems, planning is orientated predominantly towards the future, is deeply concerned with the relation of goals to collective decisions and strives for comprehensiveness in policy and programme. Wherever these modes of thought are applied, there is a presumption that planning is being done.’

In addition, planning can be broken down into four categories (Glasson, 1978:19): The first category is the difference between 'economic' planning and 'physical' planning. A source of concern is most often the differentiation of these two categories. Physical planning is concerned with an area's physical structures, such as infrastructure and utilities, and has its origins in the need to regulate urban development (Glasson, 1978:19). Physical planning also relies heavily on direct controls such as land use, while economic planning is concerned about the financial structures of the area and its level of prosperity, and thus relies on market forces (Glasson, 1978:19-20).

A second distinction can be made in regional planning between 'allocative' and 'innovative' planning (Friedman, 1967:12). The above types of planning differ from one another in terms of their area of concern. Allocative planning is primarily concerned with coordination and efficiency (Glasson, 1978:20). In economic production processes, this type of planning can be observed, whereby inputs are coordinated to produce a higher level of output in a certain way. Innovative planning is not only concerned with the efficient functioning of existing systems, as in the case of allocative planning, but aims at improving the system as a whole and is sometimes referred to as development planning (Glasson, 1978:20).

A third distinction is between the objective planning of 'multi' and 'single' (Glasson, 1978:20). There could be several variations in planning, but there are always goals and goals that the planning process aims to achieve (Glasson, 1978:20). According to Young (1966:76) “a goal is an ideal and should be expressed in abstract terms, an objective is capable of both attainment and measurement, its inherent purpose is explicit rather than implicit”.

A fourth distinction can be made between 'indicative' and 'imperative' planning (Glasson, 1987:20). This distinction relates heavily to the plan's method of implementation. Indicative planning merely lays down general rules, whereas it is more specific to imperative planning.

Planning students in the United Kingdom (UK) were taught during the early parts of the 20th century that three phases were followed by the sequential planning method; survey, analysis and plan (Hall, 1975:12). The very first phase consisted of the collection of data relevant to the subject, the second phase was to analyse the data by the planner and try to project the future state of the variables collected, and the third phase was to develop a plan to realise the future projected in the second step (Hall, 1975:12). This planning process is more simplistic in nature than the later planning process, which aimed to integrate more elements.

The correct sequential planning process begins with the identification of a set of 'goals' and 'goals' for the development of an area, according to Hall (1975:274-293) and should be redefined during the planning process in addition. After that, in order to project the future state of the region, the planner should create a model. This model should be sufficiently flexible to accommodate alternative future states that can be assessed against the original set of objectives and objectives, and the plan should ultimately be put into effect.

5.2 Spatial Planning

At the 6th European Conference of Ministers responsible for Regional Planning (CEMAT) in 1983, spatial planning originated for the first time. In 1983, two points defined the concept of spatial planning, which were, to be precise, points 8 and 9. The definition of the idea was as follows: 8. “Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society; 9. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards balanced regional development and the physical organisation of space according to an overall strategy”. The regional/spatial planning characteristics defined at the conference were democratic, comprehensive, functional and long-term-oriented. (Prospects of development and of spatial planning in maritime regions, 1983).

In almost 30 years, the interpretation of spatial planning has revolved almost at the same characteristics: participation or inclusion (democratic), coordination (comprehensive), common interests or cultures, etc. (functional), sustainable (long- term oriented). In recent decades, new additions and changes have been made to Spatial Planning approaches to maintain the characteristics initiated at the 1983 conference.

In order to address various kinds of situations such as radical changes in politics, economy, transformation etc., an ideal spatial planning system always reinvents itself (Friedmann, 2005). Innovation is important to continually allowing spatial planning practices to adapt as per the conditions in institutional spatial planning settings (Reimer, 2014). Spatial planning innovation can be derived from advances in technological instruments (Blaschke, 2010), the joint effort of formal and informal institutions with a common objective, and the ability of formal and informal institutions to adapt to project-based development. “The task of the planning enterprise is to critically interrogate the governance practices that currently exist and to help governance communities concerned with place qualities to develop different approaches where these are seen to be failing. This involves attention to both policy and practices; to what already exists, what is emerging and what might possibly emerge in a specific context” (Healey, 2003).

5.3 Spatial Transformation

Transformation can be seen as ‘a spatially defined, socially embedded process; […] an interrelated series of materially driven practices, whereby the form, substance and overall dimensions of urban space are purposefully changed to reflect the principles of a more equitable social order’ (Williams, 2000: 169). Transformation, as Williams defined it more than a decade ago, is a “programmatic, plan-oriented, project-directed effort to change unequal access to and occupation/ownership of socio-politically differentiated space in South Africa... [It is] a multi-dimensional open-ended, fluid process of change, organically linked to the past, present, and future...” (Williams, 2000: 169).

It is becoming increasingly clear that ‘spatial transformation' is essential to redress historical injustices. However, it is a concept with a lot of ambiguous interpretations. The word has been broadly defined in public policy, academic research, and popular writing to describe to "significant urban change or reorganisation" (Turok, 2014: 74). Instead of attempting fundamental change, spatial transformation is also used interchangeably with the idea of urban restructuring, which can refer to efforts that restructure while keeping the underlying power structures in order to minimise disruption and turbulence (Oranje, 2014).

The public's perception of the government's involvement in shaping and developing cities and towns in South Africa has shifted in the last two years. Institutional reforms, capacity building, and the reconfiguration of power and influence are all integrally tied to the transformation of space (Williams, 2000).

Fundamentally, the experience of urban residents can be related to the transformation of space. Residents of an inclusive, productive, sustainable, and well-governed city enjoy a high quality of life, benefiting from what the city has to offer while also contributing to its creation and moulding. It is critical to recognise that certain pathologies emerge in the city when people are unable to determine, influence, and ultimately access opportunities (Max-Neef, 1992).

5.4 Principles of spatial transformation

Scholars have noted that South African cities have different histories, configurations and challenges (SACN, 2016). Therefore, the vision of a spatially transformed city needs to allow for different variations. Therefore, in a South African cities' perspective, there cannot not be a descriptive or a specific intervention, but rather an emphasis on a set of principles that can inform the decisions made to ensure that they are in line with the spatial transformation goals and objectives. At a fundamental level, Williams (2000) proposed that meaningful transformation requires:

- a change in power imbalances;
- the restructuring of space to achieve increased efficiency, spatial justice and equity;
- institutional transformation;
- developing organisational and managerial capacity; and
- a focused vision and plan to achieve a transformative goal.

The NDP (NPC, 2012) refers to certain principles that are critical for achieving spatial transformation. These principles are meant to inform and guide interventions in the built environment, the economy and the development of spaces in South Africa. More specifically, the NDP calls for a spatial vision to be developed which:

- tackles the inherited apartheid spatial legacy of exclusion, distorted growth patterns and inefficiencies;
- unlocks developmental potential through targeted investment in economic and social infrastructure;
- guides and informs investments in infrastructure that supports long-term inclusive growth;
- manages economic and demographic shifts to achieve productivity through agglomeration; and
- facilitates coordination between government and various actors which shapes and informs spatial development.

5.5 Local Government as Best Placed to Achieve Spatial Transformation

According to the Constitution and the White Paper on Local Government, local government's developmental duty is to "work with residents and groups within communities to identify sustainable solutions to address their social, economic, and material needs and to improve the quality of their lives" (Powell, 2012:15). The expectation of local government is to be the most redistributive and transformative realm of government closest to the people (Powell, 2012).

However, the local government faces difficulties in carrying out its development mandate since it is expected to achieve more with less financial and personnel resources while also developing and maintaining the capacity and skills necessary for transformative delivery (Powell, 2012). According to Powell (2012), the 'idea that local government is best placed to serve inhabitants and drive transformation is not challenged.' However, it is crucial to emphasise that local government's ability to achieve national policy objectives is a source of concern due to various problems. Institutional reform, corruption, political involvement, inadequate financial management, and a lack of capacity development are among the problems (Powell,

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2012). Due to these obstacles, the local government is unable to build the necessary competence and capability to carry out these functions efficiently.

The role of local government in transformative development is to act as a navigator and facilitator. Its mandate, scope, and control allow it to build more integrated delivery based on sufficient planning. This entails creating a vision, strategic goals, and execution frameworks that will lead to desired cities. Local government, according to Powell (2012), is also intended to 'regulate and incentivise improved cooperation among urban stakeholders and actors, and build more meaningful relationships with business sector agencies, communities, and civil society organisations.'

5.6 Spatial planning in South Africa

The National Spatial Development Perspective (NSDP, 2006), Provincial Growth and Development Strategies (PGDS), Spatial Development Frameworks (SDF), the Constitution of the Republic of South Africa (Act 108 of 1996), and the Municipal Systems Act (Act 32 of 2000) are among the policies and legislation that govern the spatial planning system in South Africa.

The South African spatial planning system generally took the form of master or comprehensive planning during the apartheid era (Dewar & Uytenbogaardt, 1991:114). Master or comprehensive planning, according to Njoh (2008:20), includes a number of key assumptions that may not always translate well into practice. One such assumption is that there is only one 'best method' to solve any given problem, and that planners are capable of determining what that 'best method' is. Another assumption made by master planning is that there is a single identified public interest, which cannot be assumed in a varied country like South Africa.

An abstract design approach centred on the usage of nodes and corridors became the key focus point in the post-apartheid era (Todes 2008:1). This method appeared to be in line with arguments for urban restructuring and was centred on guiding future spatial development. This type of planning can also be viewed as a reaction to earlier planning styles, both locally and globally (Todes, 2008:1).

5.7 Spatial Transformation Patterns and Practices: A case study of Johannesburg

One of the main functions of spatial planning in the post-apartheid South Africa is to "attempt to promote more compact and integrated cities, and to redress patterns of inequality of the past" (Todes, 2012). Towards the end of the Apartheid era, the occupation of Johannesburg was still mainly reserved for the white, coloured and Indian people in the white suburban area whereas the Townships where reserved for occupation by Africans. "With almost no economic base and predominantly low incomes, these 'townships' inevitably suffered from low levels of infrastructure and services" (Todes, 2012). In the early 1990s due to the struggles for the 'one city approach' by political and civic organisations, the Central Witwatersrand Metropolitan Chamber was formed.

The 'one city approach' was an approach that would allow resources as well as finance to be shared across the city (Todes, 2012). The Metropolitan Chamber's spatial planning did respond to the one city's approach and it also "reflected the ideas of restructuring the city towards greater integration and compaction" (Harrison, Todes, & Watson, 2008). The ideas of restructuring the city then became a basis for the post-apartheid planning legislation which are the "1995 Development Facilitation Act and the 2000 White Paper on Spatial Planning and Land Use Management" (Todes, 2006). During this time, spatial planning reacted to the racially divided cities that were enforced by the apartheid regime as well as the urban sprawl as a result of urbanisation. "Strategic spatial planning focused on the development of corridors centred on public transport routes which existed or could be encouraged, and which would attract higher density residential and other development" (Todes, 2012).

Such planning attempted to shift from a master planning approach to a greater focus on broad guidelines aimed at informing the investments of all departments within a municipality, how private sector planning applications were considered, and which projects were conducted. The focus of such planning was shifted towards a 'facilitative approach' that paid more attention to the previously disadvantaged areas and specific projects (Todes, 2012). Johannesburg since 2000, increasingly became "shaped by the spatial framework and now by the growth management strategy", and thus making almost all planning applications that involve land use change to be evaluated against these policies (Zanty, 2010).

Since then, the level of service delivery has improved substantially, even with a rapid population growth that the city is faced with. With this change, the position of planners and the role that strategic spatial planning policy plays has been strengthen (Todes, 2016). There has been a series of plans that were introduced since 2000 with the aim of these plans to direct the work of the municipality and these includes:

- The 2006 Growth and Development Strategy (GDS) lays out a long-term strategy for the city's development. This strategy superseded the previous Joburg 2030 plan, shifting the emphasis from a ‘world class city' to a ‘world class city for all,' with a stronger emphasis on redistribution (Gotz, 2010).
- The Integrated Development Plan (IDP) is statutory by law and is reviewed and changed every five years. IDPs outline the municipality's overarching priorities and development goals, the foundation for sector plans and budgets, as well as the major programmes and capital projects for the following five years.
- SDFs (Spatial Development Frameworks) are also mandatory by law. The SDFs describe the city's spatial vision and how it will be implemented. The initial SDF was released in 2003, and it was updated every two years after that. Eight Regional Spatial Development Frameworks (RSDFs) were created from these plans, offering more specific planning guidelines. Local areas in need of attention, such as the Sandton CBD, have evolved more particular Urban Development Frameworks. These plans are used to evaluate individual development applications and to direct capital investment. Land use regulation is based on an inherited system of town planning schemes, which have not been substantially revised (other than amendments to bring them into a common scheme), but developers' proposals for changes in land use are assessed in terms of spatial frameworks and the growth management strategy. Recently, a policy has been developed to formalise and control informal settlements through limited land use management systems that focus on critical issues such as environmental preservation, risk reduction, health, and safety.
- Area-based plans, programmes, and projects, such as the Alexandra Urban Renewal Project and the comprehensive inner-city regeneration plans respond to specific issue areas. These are usually multi-sectoral initiatives that include a variety of activities.

With the emergence of new suburban nodes and edge cities, the development of gated communities in sprawling settlements, the growth of publicly provided housing and informal settlements generally on the periphery, and racial change and densification in the inner city, Johannesburg's spatial change has been rapid since then. Despite the fact that new growth patterns have been generally at greater densities than in the past, the city has continued to sprawl. While there has been some de-racialisation in middle-class regions in the north (Selzer & Heller, 2010), there are still significant geographic differences along class lines.

6 CONCLUSION

The paper aimed at assessing the patterns and practice of spatial transformation in developing countries, South Africa was used with a focus on the trends in city of Johannesburg. It looked at the concepts of planning, spatial planning and spatial transformation and the trends in South Africa and revealed that the trend in literature is spatial transformation being used as process to address the country’s physical manifestation of the apartheid planning. The results reveal that the right to the city has been used as a tool for developing frameworks to guide spatial planning. These frameworks have been used in the production of space in cities while also allowing planners to understand spatial transformation as a socio-spatial (multidimensional) process. Evidently, spatial planning is an essential tool for promoting sustainable development and improving the quality of life. Overall, the paper recommends the need to develop strategic spatial planning processes as tools for economic bridging plans that can retrofit existing neighbourhoods to improve liveability in cities.

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Performance of Urban Agriculture in Tokyo: a Geospatial Perspective of the Food-Water-Energy Nexus

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1 ABSTRACT

Urban agriculture plays a role in modern food systems to reduce transportation energy, improve local production for local consumption, and so on. However, the demand for local food, the supply of farmland, and even the attitudes of farmers may vary with the process of urbanization as well as the urban structure of cities. This is significant particularly in Asian megacities such as Tokyo, where the built-up areas have mostly spread to suburbs along rail lines and expanded outward from train stations on topographic and historical fundamentals. Furthermore, urban agriculture in Tokyo is facing strong pressure from urban development, the aging of farmers, and depopulation. Few previous studies have discussed the performance of urban agriculture in a megalopolis like Tokyo based on detailed evidence.

The aim of this study was to clarify the relationship of food, water and energy in Tokyo through input-output analysis ofresource use and vegetable production. We created a database of water and energy resource inputsfor greenhouses, fertilizers, and pesticides, etc., for farming and vegetable production. We quantitatively calculated the input-output efficiency of energy and water resources per unit of food production in the Tokyo metropolitan area and visualized regional characteristics by hierarchical cluster analysis.

We found that Tokyo produced 75,566t of vegetables per year, or an average of about 5.5kg per capita for its 13.8 million population, with 426.1TJ of energy consumed,especially in greenhouses and manufacturing compost, and 8.7 ML of water, especially in manufacturing phosphorus fertilizer. With cluster analysis identified four types of urban agriculture in terms of environmental load: “lowenvironmental load,”“medium environmentalload,”“highwaterload,” and “highenergyload.” In summary, the closer to the CBD, the more intensive the agriculture type in the sense of environmentally burden, due to the impacts of urbanization; the central part of the Tama area, with more open space for agriculture, shows moderate consumption of energy and water; and the farmlands in western Tama far from the CBD are less intensive and often cultivated with low environmental load.

These findings suggest that the conservation and promotion of urban agriculture in Tokyo should consider geospatial characteristics. As land prices rise, could become more intensive, meanwhile, with a possible transition from “low environmentalload” to “mediumenvironmental load” and from “mediumenvironmental load” to “high water load” or “high energy load” to environment. This is a challenge for urban policymakers to manage the synergistic effects and conflicts in agriculture-inclusive urban development.

Keywords: Urban structure, environmental load,input-output efficiency,hierarchical cluster analysis

2 INTRODUCTION

Many cities expect that urban agriculture plays an important role in improving the sustainability of the modern food system (Morgan, 2015; Mohareb et al., 2017; Howe & Wheeler, 1999).Cities typically depend on the outside for resources such as food and consume them in large quantities, and have an enormous environmental load.Moreover, the environmental impact of the food system is in many cases the leading one (Goldstein et al., 2017). Large amounts of food consumption are required to support huge urban populations, but their production and distribution processes need to be rethought to reduce the environmental impacts. Urban agriculture, on the other hand, has diverse ecological, economic, and social-environmental benefits (Lovell, 2010; Lovell & Johnston, 2009; Peng et al., 2015), andcan serve five major functions: energy generation, urban symbiosis, supply chain efficiency, and in situ and ex situ environmental improvement (Goldstein et al., 2016b). From a food system perspective, shorter transportation distances reduce food miles and the environmental impact of production and distribution, while also providing a fresh and diverse supply of vegetables. With growing awareness of the high environmental load and the verified environmental benefits of urban agricultural food systems over the past two decades, cities try to reconnect with urban agriculture.

Nevertheless, urban agriculture is not free from environmental loads. In many cases, agriculture consumes resources such as fertilizers and pesticides to increase vegetable production (Foley et al., 2011) and emits large amounts of greenhouse gases (Weber & Matthews, 2008). It has been pointed out that despite the environmental benefits of urban agriculture, it also hasenvironmental impacts, such as high water consumption, inability to respond to local conditions, and soil management problems (Sanyé-Mengual et al., 2018, 2019). Meanwhile, inefficient siting, production practices, and transportation methods can lead to greater environmental impacts; one study found that urban agriculture did not necessarily lead to carbon reduction, using tomato and lettuce cultivation in Boston as a case study (Goldstein et al., 2016a). Although there arecurrently only a few studies that show urban agriculture is rather environmentally burdensome, the environmental impacts in urban agriculture may be contrary to the intentions of cities to reduce environmental impacts. Therefore, it is necessary to evaluate the relationship between the input resources for production and the vegetables produced, i.e., the input-output efficiency, when developing urban plans aimed at the environmental performance of urban agriculture.

Some studies have been conducted to clarify the input-output efficiency of urban agriculture. In a study of urban and surrounding areas, researchers compared environmental indicators, including life-cycle carbon emissions and water use in lettuce production for five farms near and far from Sydney (Rothwell et al., 2016). Another study assessed the possibility that life-cycle carbon emissions could be reduced by using urban agriculture in Lisbon, with the challenge of assessing the entire food system rather than a single commodity(Benis & Ferrão, 2017). Even within cities, the input-output efficiency of urban agriculture under different conditions has been compared and characterized.Researchers comparedtwo conventional and organic farming systems in urban Seville, Spain, and characterized their life-cycle energy demand and CO2 emissions (Pérez-Neira & Grollmus-Venegas, 2018).Another study compared life-cycle greenhouse gas emissions based on economic value for conventional and home delivery agriculture in Beijing (Hu et al., 2019). Thus, it is important not only to clarify the input-output efficiency of urban agriculture from comparisons between areas inside and outside the city, but also to reveal the diverse input-output efficiencies of urban agriculture based on several different characteristics in recent years.

This study asked how the urban structure of a region affects the input-output efficiency of urban agriculture production. Tokyo and other Asian megacities have developed in complex ways from the CBD to the suburbs and from train stationsoutwards through rail lines development. As a result, urban land use sprawls in a wedge shape along the rail lines, and agricultural land is relegated to areas stretching away from train stations and more distant suburbs (Yamamoto et al., 1977). We can assume that urban structure factors such as topography, distance from CBD, and population,affect input-output efficiency. However, few studies have quantified such differences. To reconnect urban agriculture to urban planning, it is important to understand the underlying urban structures, and such an understanding would be a great advantage in formulating new strategies.

Therefore in this study, we aim to clarify the relationships between urban structure, resource use and the production of vegetables, in order to assessinput-output efficiency for municipalities. To achieve this, we constructed a framework that combines the food-water-energy (FEW) nexus approach with input and output analysis.Using this analysis, we quantitatively calculated the efficiency of energy and water resources per unit of food production for cities in the Tokyo metropolitan area and visualized regional characteristics by hierarchical cluster analysis.

3 METHODOLOGY

3.1 Food-water-energy nexus approach

In this study, we use the nexus approach of FEW to quantify the input-output efficiency of urban agriculture in different municipalities. The nexus approach is based on the idea that integrated management across sectors and scales can produce synergistic effects as a system (Hoff, 2011). In particular, food, energy and water are core factors at the heart of sustainable development, and the visualization and management of their nexus is an important issue (Liu et al., 2018). A literature review showed that the study of the FEW nexus is rapidly expanding, with nearly 1,000 papers published up to 2017 (Newell et al., 2019).

One of the features of the FEW nexus approach is that it can quantitatively show the relationships among water and energy used for food production, food and energy used for water production, and food and water used for energy production, and thereby the interrelationships can be clarified. Looking at agriculture, vegetables are obtained by using water and energy.Examples of applying FEW to urban agriculture are sprouting up(Caputo et al., 2021).

One study focused on wastewater-based irrigation to evaluate its impact on energy use, food production, and health (Miller-Robbie et al., 2017). It found that the use of treated wastewater can lead to reduced energy use and increased food productivity while clearing pathogens. Other researchers reviewed individual farming methods, materials, and resource uses, and summarized the indirect and direct energy uses and their impacts in urban agriculture from the perspective of the FEW nexus (Mohareb et al., 2017). They discussed the possibility of efficiency variations and trade-offs between energy and water. The results of the review suggested that there was a need to study urban agriculture in individual regions, paying close attention to the context of operations, crops, and climates.

3.2 Research framework

In this study, to quantitatively examine the input-output efficiency from resource utilization to vegetable production, it is first necessary to define the system boundary. In the life-cycle assessment study of vegetable production and distribution in Japan, the energy used for cultivation, fertilizer, pesticide, heating, cooling, and drying was defined as production energy (Nishizono & Moteki, 2007). Of these, our study usedfertilizer, pesticides, and heating in the production sector. In the case of fertilizer, potassium (K2O, hereinafter referred to as K), phosphorus (P2O5, hereinafter referred to as P), nitrogen (N), and compost are mainly required (Nishizono & Moteki, 2007; Tokyo Metropolitan Government, 2003). Irrigation is not considered for open field cultivation because rainfed agriculture is the main form of agriculture in the suburbs of Tokyo, and water use is considered only in greenhouse production. Thus, rainwater use was not considered as a load.

Within the system boundary, the amounts of energy and water used as inputs were converted into joules and liters, respectively, and added up. The intensity of use of each resource was quantified and visualized in a Sankey diagram. The vegetables produced were shown by weight for each item. This ability to visualize the relationship among FEW is a unique feature of the FEW nexus approach.

3.3 Analysis and dataset

Within the system boundary of this study, energy and water consumption and vegetable production were calculated from the following formulae. Growing vegetables usedsome resources:fertilizer (energy: $IE_{fertilizer}$,water:$IW_{fertilizer}$), pesticide ($IE_{pesticide}$and $IW_{pesticide}$), and greenhouse ($IE_{greenhouse}$ and $IW_{greenhouse}$). Vegetable production ($OF_{vegetables}$) is defined as fruit vegetables (OF_{fruit}), root vegetables (OF_{root}), leafy vegetables (OF_{leaf}), and tubers (OF_{tubers}).

$$IE_{vegetables} = IE_{fertilizer} + IE_{pesticide} + IE_{greenhouse} \#(1)$$

$$IW_{vegetables} = IW_{fertilizer} + IW_{pesticide} + IW_{greenhouse} \#(2)$$

$$OF_{vegetables} = OF_{fruit} + OF_{root} + OF_{leaf} + OF_{tubers} \#(3)$$

To compare the food production of different regions, a cluster analysis was conducted to classify the municipalities using the amount of energy input per unit weight of vegetable production($ie_{vegetables}$) and the amount of water input($iw_{vegetables}$). We normalized these to mean 0 and variance 1. The datasets were subjected to hierarchical cluster analysis using the “scipy.clujster.hierarchy” library in a Python 3 runtime environment.

$$ie_{vegetables} = \frac{IE_{vegetables}}{OF_{vegetables}} \#(4)$$

$$iw_{vegetables} = \frac{IW_{vegetables}}{OF_{vegetables}} \#(5)$$

3.3.1 Vegetables

We used the Tokyo Metropolitan Crop Production Survey, published annually by the Tokyo Metropolitan Government (2015).The survey providesdata on production items, volumes, and cropping area. We

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obtainedOF_{fruit},OF_{root},OF_{leaf}, and $OF_{tubers}$for 2013. We also obtain the cropped area (A_v)for each vegetable. In general, it is not easy to grasp the actual situation of urban agriculture, but the Tokyo Metropolitan Government has started to conserve and promote urban agriculture earlier than the national government (Tokyo Metropolitan Government, 2019), and this survey can be a valuable dataset to grasp the actual situation of urban agriculture.

3.3.2 Fertilizer

It is difficult to understand the actual situation of fertilizers used in agricultural production because of the wide variety of fertilizers used and the lack of statistical data available. Therefore, in this study, based on some studies(Chen et al., 2018; Kobayashi & Sago, 2001; Nishizono & Moteki, 2007; Tokyo Metropolitan Government, 2003), we used the amount of fertilizer used per cropped area(K_v, P_v, N_v, and COM_v), energy used per unit of vegetable production(ie_K, ie_P, ie_N, and $ie_{compost}$) and water (iw_K, iw_P, iw_N, and $iw_{compost}$).

$$IE_{fertilizer} = ie_K * \sum(K_v * A_v) + ie_P * \sum(P_v * A_v) + ie_N * \sum(N_v * A_v) + ie_{compost} * \sum(COM_v * A_v) \#(6)$$

$$IW_{fertilizer} = iw_K * \sum(K_v * A_v) + iw_P * \sum(P_v * A_v) + iw_N * \sum(N_v * A_v) + iw_{compost} * \sum(COM_v * A_v) \#(7)$$

3.3.3 Pesticides

It is difficult to obtain statistical data on pesticide use, and the wide variety of pesticides makes it difficult to understand life-cycle costs. In existing data(Ministry of Economy Trade and Industry, 2016), average cost and unit price were used to calculate pesticide use per unit of area for each crop(PES_v). The amount of input energy per unit of pesticide use($ie_{pesticide}$=250MJ/kg) and the amount of water($iw_{pesticide}$=4.0909kg/kg) were obtained from previous studies(Natalia & Robert, 2016; Nishizono & Moteki, 2007).

$$IE_{pesticide} = ie_{pesticide} * \sum(PES_v * A_v) \#(8)$$

$$IW_{pesticide} = iw_{pesticide} * \sum(PES_v * A_v) \#(9)$$

3.3.4 Greenhouse production

As data on greenhouse production, we used the 2015 Census of Agriculture and Forestry published by the Tokyo Metropolitan Government. We obtained the area of greenhouse production($A_{greenhouse}$). However, it is not possible to know the use of each greenhouse. The amount of energy required to operate greenhouses($IE_{greenhouse}$)was obtained by multiplying by $A_{greenhouse}$, the amount of heavy oil A used per area of greenhouse production, anda coefficient to convert heavy oil A into energy. In the study on greenhouses (tomatoes), the facility area was 5,848m^2 and the fuel power cost was 3,326,000 yen in 266 greenhouses (Japan Finance Corporation Agriculture Forestry Fisheries and Food Business Unit, 2017). Based on the average monthly price of fuel oil A in 2017 from the Agency for Natural Resources and Energy, the price was assumed to be 67.7 yen per liter. The conversion factor between A fuel oil and energy was assumed to be 38.9MJ/L. The amount of water used ($IW_{greenhouse}$) was obtained by multiplying the area of greenhouseproduction $A_{greenhouse}$ by the water consumption and cultivated area ratio obtained from previous studies. The water consumption was set at 816mm per year and the cultivated area ratio was set at 90% (Nishide, 1990).

3.4 Study area

This study area covers 49 cities, excluding islands and rural areas under the Tokyometropolitan area(Fig.1). However, some cities donot have farmland, so this study effectively covers 36 municipalities. The central business district (CBD) is located in the eastern part of the study area, and major sub-districts such as

Otemachi, Shibuya, Shinjuku, and Ikebukuro are located along and inside the Japan Railway Yamanote Line. Currently,in terms of population density, most cities in the Tokyo region have a population of more than 4,000persons per km2. The central part of the study area is on the Musashino plateau, which includes suburban communities. Meanwwhile, in the western part of the study area, the population density is lower due to topographical conditions such as hills and mountains and reduced accessibility to the CBD.

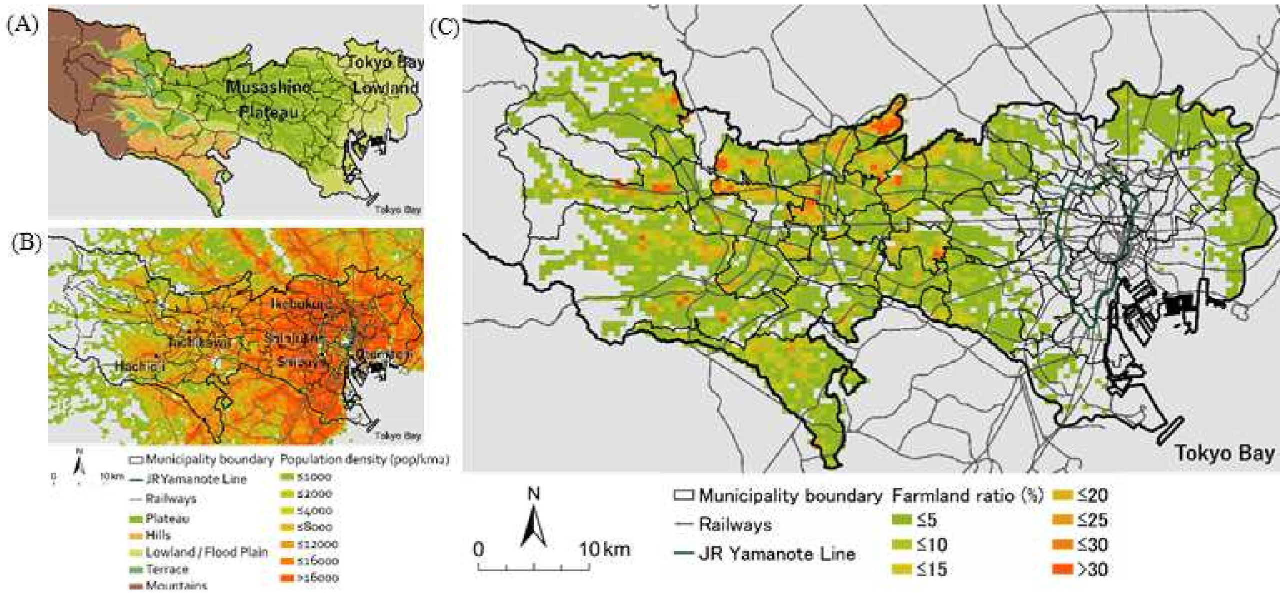

Fig.1:Three maps of the study area showing the urban structure.Processed from National Land Information (Railway, Municipal Data) (Ministry of Land, Infrastructure, Transport and Tourism).(A) shows the topography of the area.Processed from "National Land Survey" (Ministry of Land, Infrastructure, Transport and Tourism). (B) shows the population density. Processed from 2015 Census. (C) shows the farmland ratio.

4 RESULTS

4.1 Descriptive statistics

Fig.2 shows the input-output indices for vegetable production. Energy consumption in greenhouseswas the greatest.Greenhouses in the study area include 1,674 facilities with a total of 13,168 m2 in area, but a large amount of input energy per unit area (32,679.5MJ/m2). To produce one ton of vegetables, they consume energy at 5,714MJ/t on average, or 426.1TJ for the study area. However, there is a large difference among municipalities. Manufacturing compost(from mulch, manure, organic waste, etc.) consumed an average of 3,234.3MJ/t of energy, or 241.2TJ for the study area. Compost accounted for 85.6% of the total energy of fertilizer. Manufacturing pesticides consumed an average of 1,704.5MJ/t of energy, or 127.1TJ for the study area. In contrast to the above, the values of various fertilizers other than compost were very small. Manufacturing nitrogen consumed an average of 326.6MJ/t and 24.4TJ for the study area, phosphorus consumed an average of 208.3MJ/t of energy and 15.5TJ for the study area, and potassium consumed an average of 11.3MJ/t of energy and 0.84TJ for the study area. In total, the energy input of Tokyo as a whole amounted to 835.1TJ. The energy consumption per farm unit of area was 19.1MJ/m².

Comparing water inputs, phosphorus had the largest value, while facilities hada very small value. On average, manufacturing phosphorus used 116.2L/t per vegetable and consumed 8.7ML in total. The results were similar except for phosphorus and facilities. Manufacturing potassium consumed at an average rate of 44.5 L/t, and 3.3ML for the study area. Manufacturing nitrogen consumed at an average rate of 33.2L/t, or 2.5ML for the study area. Manufacturing compost consumed at an average rate of 32.3L/t, or 2.4ML for the studyarea. Manufacturing pesticides consumed 27.9L/t on average, and 2.1ML for the study area. In contrast, greenhouse production consumed an average of 0.013L/t of water per vegetable production or 957.5L for the entire area. With these water inputs, 18.9ML was used for the entire Tokyo metropolitan area.Water consumption per unit of farmland area was 0.434L/m².

As for the output of food production, leafy vegetables were the largest category, followed by fruit vegetables, root vegetables, and tubers (including potatoes, sweet potatoes, taro, konjac, etc.). The output of leafy vegetables, fruit vegetables, root vegetables, and tubers was 32,566t, 19,964t, 13,192t, and 7,825t,

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respectively, for a total of 75,566t. Among leafy vegetables, cabbage was the most abundant at 8,033t, followed by komatsuna (Japanese mustard spinach) at 7,525t. Tomatoes and eggplants accounted for 5,904t and 5,872t, respectively, of the fruit crops. As for root crops, 8,097t of radish and 3,669t of carrot were produced, and 4,310t of potato were produced for tubers. The production per unit of farm area was 1.71kg/m².

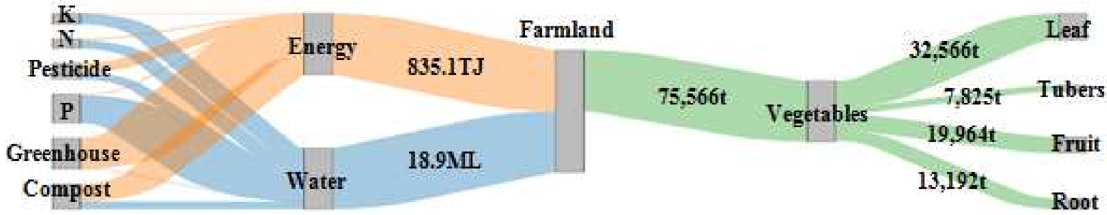

Fig.2:Sankey diagram showing the inputs of water and energy and outputs of vegetables in urban agriculture in the study area. Orange indicates energy, blue indicates water, and green indicates food. The line widths were normalized so that the maximum values for food, water, and energy are equal. The thicker the line, the larger the volume.

	Per unit of weight (tons) of products		Per unit of area (m^2) of farmland		
	E (MJ/t)*	W (L/t)*	E (MJ/m^2)*	W (L/m^2)**	F (kg/m^2)***
Low environmental load	7.6 (1.7)	200 (17)	12.7 (4.8)	0.333 (0.087)	1.67 (0.44)
Medium environmental load	11.6 (2.0)	264 (28)	20.0 (5.6)	0.451 (0.101)	1.71 (0.32)
High water load	18.6 (7.0)	404 (27)	25.7 (19.4)	0.513 (0.262)	1.28 (0.67)
High energy load	26.5 (8.6)	270 (33)	63.9 (51.9)	0.753 (0.673)	2.60 (2.10)

Table 1:Amount of energy and water per unit of production in each cluster and per area of farmland. Mean (standard deviation). *<0.01, **<0.05, ***>0.1 with Kruskal-Wallis test with SPSS.

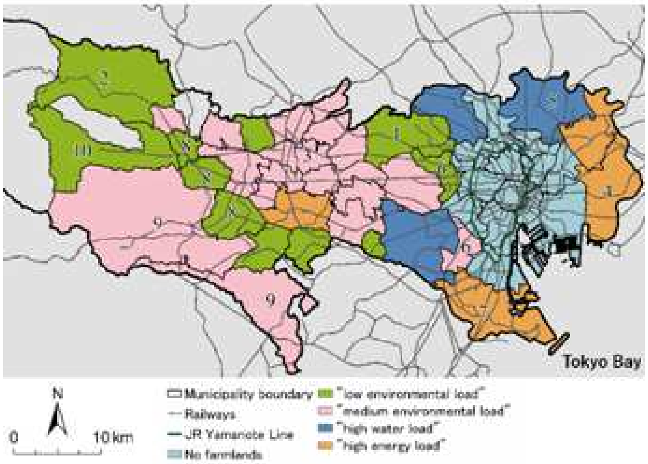

Fig.3:Results of cluster analysis based on production efficiency. The numbers in the map arethe areas mentioned in the Fig.4, results, and discussion.Processed from National Land Information (Railway, Municipal Data) (Ministry of Land, Infrastructure, Transport and Tourism).

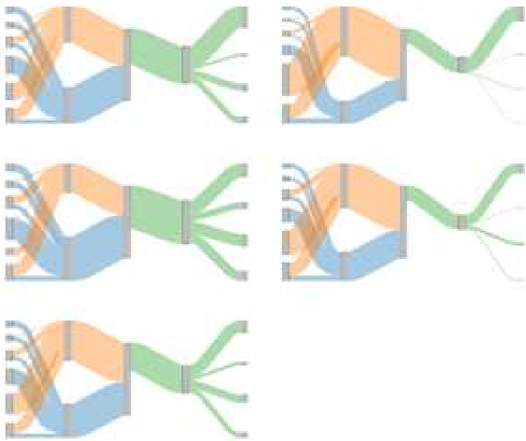

Fig.4:Sankey diagram in five cities as an example. The order of the items is the same as in Fig.2.The thickness of the lines is standardized based on Nerima.

4.2 Cluster analysis

Hierarchical cluster analysis produced four clusters. The clusters were named “low environmental load,”“medium environmental load,”“high water load,” and “high energy load” based on their characteristics (Table 1).Fig.3 shows a map of the distribution of each cluster, and Fig.4 shows the Sankey diagram for the five citiesas an example.

The “low environmental load” type was a cluster that uses less energy and water. Totalsfor energy and water consumption of fertilizer were 2,621.9MJ/t and 177.8L/t, respectively, much lower than other clusters. Water and energy per unit of area was also minimal.The most significant feature of the cluster was the polarization of the location distribution. The cluster was mostly located in the central and western parts of the study area.

The “medium environmental load” type was a cluster in which the energy and water consumption was higher than that of the “low environmental load” type. A total of 18 municipalities fell into this category, making it the largest cluster. Many of the regions located on the Musashino Plateau (Fig.1), which are suburban communities, belonged to the "medium environmental load" type.

The "high water load" type was a cluster in which water consumption was larger than energy use. This cluster was characterized by the high consumption of fertilizers and pesticides. The water consumption per unit of vegetable production was 404.2L/t, or twice that of the "low environmental load" type. In contrast, the weight of food production per farmland unit of area was the smallest. Only three municipalities are highly urbanized areas close to the CBD fell into this category.

The "high energy load" type was a cluster that used more energy than water. Itwas characterized by the large amount of energy used in greenhouses. For example, Ota City(Area 7 in map) consumed 33,700.8MJ/t of energy per unit of vegetable production. This cluster included only four municipalities, and the energy and water consumption per unit of area varied greatly, but it tended to be larger than that of other municipalities.

5 DISCUSSION

This study clarified input-output efficiency of Tokyo urban agriculture by quantifying energy and water inputs and vegetable production outputs, then classified and mapped municipality characteristics by cluster analysis.

5.1 Influence of urban structure on input-output efficiency in Tokyo

The urban structure affected the distribution of each cluster in several ways. First, the "high water load" and "high energy load" clusters were concentrated in the CBD. In both clusters, the proximity to the CBDis reflected in the agricultural production of leafy vegetables, as well as the cultivation of a wide variety of plants, leading to high energy and water consumption. In addition, different topography distinguished these clusters. The "high water load" cluster was located on the Musashino plateau in the western and northern parts of the CBD, while the three "high energy load" municipalities in the CBDwere located in the Tokyo Bay lowlands in the eastern and southern partsof theCBD. It is important to note that greenhouses are used not only for vegetable production but may also be used for flower cultivation.However, "high water load" cluster has less food production per unit of area because it produces more low-weight leafy vegetables, while the "high energy load"cluster produces more intensively. Although some municipalities can be interpreted as outliers because of their small agricultural scale (Area6 in the map), it is worth considering that Nerima City was classified as a "low environmental load" type (Area 1). Although Nerimawas not outstanding in terms of population structure and topography, it hasmany farmlands and boasts one of the highest agricultural yields in Tokyo. Nerima has the potential to become an advanced case study of urban agriculture in that it can abundantly produce agricultural products with low impacts despite being in a highly urbanized area (Fig.4).

The plateau area located in the center of the study area isdominated by the "mediumenvironmental load" type. The plateau isa suburban area for workers commuting to the CBD, with a high density of railway lines and urbanization around train stations. Fields are present on a small scale further away from train stations."Medium environmental load" agriculture in these areasispositioned between intensive agriculture and less intensive agriculture in the more suburban areas.

In the western and southern regions, there were "lowenvironmental load" and "medium environmental load"areas. The "low environmental load"areas included two cities with a low degree of urbanization (Area 2 and 10) and small municipalities located along rail lines (Area 8). The "medium environmental load"areasincluded two cities where urbanization was well advanced (Area9). The former is likely to haveless-intensive agriculture and a high proportion of fruit crops and tubers. In the latter case, the reason is not clear, but it is reasonable to interpret it as being relatively less intensive compared to the CBD.

The spatial distribution of the clusters shown above is similar to the distribution of agriculture with the degree of urbanization traditionally revealed by geography (Kikuchi et al., 2002). However, urban agriculture is more sensitive to urbanization, and small changes in railway lines, topography, and population distribution are immediately reflected in clusters. The visualization of urban structure at a detailed level reveals differences in the input-output efficiencies of urban agriculture. We also found some good examples of low environmental load even near the CBD, such as Nerima City. Small geographic differences in urban agriculture appear to make a big difference, but are often not noticed in traditional analysis on a large scale.

Further studies could provide important data for the conservation and promotion of small-scale and fragile urban agriculture.

5.2 Impacts of input-output efficiency on urban environmental performance

In the input-output efficiency of urban agriculture in Tokyo, the use of greenhouses, in particular, loaded energy inputs, while the use of fertilizers and pesticides, including phosphorus, loaded water inputs. In this study, the total inputs of 426.1TJ of energy and 8.7ML of water resulted in an output of 75,566t of vegetable production. This efficiencyis similar to that of a study that investigated the input energy for vegetable production in Gunma Prefecture in Japan (Nishizono & Moteki, 2007). However, the study by Nishizono &Motekiwas more extensive than the system boundary of this study, and if this study is adapted to their system boundary, the environmental performance of urban agriculture may produceworse results. This confirms that urban agriculture has the same or even greater environmental impacts than regular agriculture. This is contrary to the objectivesof cities that want to use urban agriculture to improvetheir environmental performance.

However, in urban agriculture in the study area, a wide variety of vegetables are beingcultivated, mainly leafyvegetablesfor whichfreshness is important. This freshness and availability of local vegetables is a service that contributes more to the enrichment of choices, nutrition, preservation of local culture, and education, rather than production or food self-sufficiency. The 75,566t of vegetablesproduced in Tokyo is equivalent to 5.5kg per capita, or only 15 days of consumption if we assume that each person consumes 350g per day aspromotedby national health programs.

In light of the above, the main benefit in terms ofenvironmental performance of cities provided by the input-output efficiency of urban agriculture is not the reduction of environmental load, but rather the non-material services and added values arising simultaneously with the supply of food. To increase non-material services and added value, we can shift from greenhouses to open field cultivation, reduce pesticide use, and shift to organic farming. Those actions may reduce the food supply, but actually improveinput-output efficiency.

5.3 Hints for policy decisionsaffecting urban agriculture

Based on the impacts of urban structure on urban agriculture and impacts of urban agriculture on environmental performance of cities, we can find several hints on how cities can be reconnected with urban agriculture.

In reconnecting cities with urban agriculture, it is important to design, plan, and implement areas based on evidence. There is a growing movement to explore the policies and possibilities of converting vacant urban land, rooftops, and brownfields to agriculture(Hara et al., 2018; Saha & Eckelman, 2017). This study calculated amounts of water and energy per unit of vegetable production and agricultural land area (Table1). These values can be included in such measures for preliminary assessments of the environmental performance of urban agriculture. Alternatively, it is possible to reflect on the current environmental performance of urban agriculture and explore ways to reduce the environmental impacts of farming. The approaches used here can also provide an opportunity for farmers and citizens to review the methods of urban agriculture.

The population of Tokyo is expected to continue growing until around 2030, and then remain high (National Institute of Population and Social Security Research, 2018). Conversion of farmland to urban uses is expected to continue due to the pressures of urban development and the aging of farmers. In other words, the urban structure and the performance of urban agriculture will continue to change, and the input-output efficiency of urban agriculture may be affected by these changes. Given that urbanization will continue, there is a great possibility that urban agriculturetypologies will move from “lowenvironmental load” to “medium environmental load,” and from “medium environmental load” to a “highwater load” or “highenergy load.”Such shifts would not be favorable changes for urban planning in terms of environmental performance.

Finally, urban planning has important roles to play in predicting how the urban structure of a region will change in the future, examining things from a wide range of perspectives, including population, nature, and industry, and in adapting predictions of changes in urban structure to urban agricultural management, or in adjusting the urban structure to control impacts on urban agriculture.Meanwhile, farmland in urbanized areas is no longer regarded only as private property but also as public space.If local governments wish to promote good environmental performance, they must continue to intervene actively in the transformation of urban agriculture toward organic farming, in the conservation of farmland, and in providing an environment that makes it easier for farmers and businesses to continue farming. These efforts can prevent deterioration of input-output efficiency of urban agriculture and in fact improve it further.These measures are described in the Basic Plan for Urban Agriculture Promotion, howeverlocal governments should incorporate these measures more concretely into urban planning. In Japan,Productive Green LandAct helps prevent the conversion of agricultural land, because owners of Land designated as Productive Green Landcannot convert it to other land use for 30 years in general (Yagi & Garrod, 2018).Furtehr, it may be desirable to develop new urban planning strategy such as Location Normalization Plan.

6 CONCLUSION

By visualizing the relationship between vegetable production and the use of water and energy resources in the case of urban agriculture in Tokyo, we found that small differences in urban structure affected the input-output efficiency of urban agriculture, and conversely, the input-output efficiency of urban agriculture can have negative impacts on environmental performancecompared with non-urban agriculture. Based on the above, the role of urban planning is to use the prediction of urban structure for urban agriculture management and to adjust urban structure so that it does not affect urban agriculture.Since it is the farmers who ultimately sustain urban agriculture, a key point for future discussion will be how urban planning can intervene in the relationship between the agricultural sector of a municipality and the farmers.

7 ACKNOWLEDGEMENTS

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Popping Up Public Streets – Not for Cars, but for People by Tranformative Approaches

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1 ABSTRACT

The topic of "living in the city" has been discussed for a long time. Many authors have commented on it, such as the well-known Lefebvre (1996) and Harvey (2008). Our study focuses exactly on this topic "how to make life in a city more livable". In the project "Pop-up Piazza" we have the possibility to implement transformative ideas with explorative methods. For this purpose, the project uses the instrument "tactical urbansim". The goal of the project is to test new ideas and try them out with the help of new prototypes. We focus on small selective interventions or actions like parklets, which are also combined with larger actions. In this way, we discuss whether our approaches are well received by the population before we embark on large-scale, cost-intensive changes.

Public street spaces are mostly dominated by motorized individual traffic. Our pop-up piazza transformations enable a perception of car-free space and its potential to make public space more people-friendly. Small simple and low-cost interventions should enable applications for many cities. In this project, we have developed cargo bike-based prototypes (called StreetFormators) and are now testing them in the urban spaces of Graz and Vienna. Following the principle of opensource, we also provide the StreetFormator construction plans to the public if other cities, organizations and communities want to use them. In addition to development and testing, we have focused on impact evaluation of the implementations. From this, recommendations are generated for urban planners, administrative authorities, and policy makers that indicate the benefits and desires of the public. The case studies in Graz and Vienna show that the framework conditions strongly contribute to the success of the measures. The temporary redesigns of public street space create more space for social interaction and thus fulfill an important function for neighborhoods and increasing the quality of life in cities.

Other companies and institutes are involved in the project, namely AIT (Austiran Institute of Technology GmbH), DieFahrBar, Mobilitätsagentur Wien GmbH (mobility agency) and the University of Graz (Institute of Geography and Regional Sciences). Experts from FGM-AMOR GmbH (Austrian Mobility Research) are also involved. The research project is funded by the FFG (Österreichische Forschungsförderungsgesellschaft) in the field of industrial research.

Keywords: urban development, urban design, public space, tactical urbanism, city planning

2 INTRODUCTION

Cities are growing all over the world. People are drawn to cities because of the wide range of activities and jobs available. As a result, various challenges are becoming more apparent. Deteriorating air quality, noise pollution, and higher temperatures in cities are just examples of the many other challenges facing urban planners and developers (Detzlhofer 2020). The importance and urgency of the issue are underscored by the OECD (2015) report "The Century of Metropolises."

Sustainable and environmentally friendly approaches should ensure that the city presents itself as more livable again. This includes adapted administrative structures that can better respond to the needs of the population. Traffic and land use planning must be adapted to the needs, so that ordinances or laws create a balance between green spaces and new developments. Regarding transportation planning, it is necessary that planning evolve away from the automobile. Growth pressures on existing land mean that wasting space with the automobile is no longer contemporary (Detzlhofer 2020). Much more attention should be paid to the quality of public transportation while providing incentives for micro-mobility. This would reduce air pollution and the associated illnesses, as well as reduce the warming of the city by the waste heat from the engine (OECD 2015).

While in the early days of the automobile all road users were more or less equal, since the 1970s a trend set in which people were pushed to the margins and road space became too much for private motorized traffic. However, street space fulfills more needs than just getting around. Important functions such as social interaction, trading place, playground and recreational activities are more and more challenged. As a result, more and more voices are being raised that the use of the street in urban space should partly change, moving away from the automobile towards attractive mobility and thus bringing about a transformation of public spaces. The car-free city will remain a utopia in the near future, but hybrid forms of use are being sought. The vision is to open "streets for people" so that they can be used as recreational spaces, places of social interaction and playgrounds. The entirely under the motto "together and not against each other"(Harvey 2008, Holden 2019, Lefebvre 1996, Lydon 2015, Norton 2015).

The Mariahilfer Strasse in Vienna (Fruchtlehner and Lička 2017) and the Sonnenfelsplatz in Graz ("shared space") are first experiences Austria is gaining in this field. There are also some school and residential streets where traffic calming measures are implemented. Nevertheless, public space is dominated by motorized individual traffic. The cityscape also suffers from the sight of parked cars. Here is the example of stationary traffic from Graz:

	Land requirement (in %)
Bicycle parking facilities	2
Pedestrian areas	3
Areas for public transport	3
Car parking space	92

Table 1: Spatial distribution of stationary traffic in Graz (source: Austrian Mobility Research 2016, based on data from the City of Graz)

Table 1 shows how the public space in Graz is divided. From this it can be deduced that a large proportion of the space is available for car parking. The ratios of the space requirements favor the car unilaterally. This shows the potential for conflict and the relevance of the topic for the city's inhabitants.

3 THEORETICAL CONTEXT

The basis of the project is the appropriation of space. When looking at the city, you can see that there are many different spaces. Here the question arises of their affiliation and thus also their right of use. A very simple division of the city into different spaces could be the following: Living space, movement space, leisure space, recreation space, shopping space and working space. From this simple listing, the demands and conflicts of the most diverse spaces can already be guessed.

This research deals with the public space and in particular with the street. City dwellers also make demands on a street, such as leisure space, transit space, recreation space, play space and so on. In many European cities, however, the street is mostly seen only as a transit space. Especially for the city of Graz and partly also for Vienna it is true that the street is available for the motorized individual traffic and other demands are secondary.

In order to give a voice to the other stakeholders and to create an opportunity for participation, tactical urbanism developed. This involves interventions that are low-budget and localized. These small interventions in public space are intended to create a more livable environment in cities. Synonyms for this are "pop-up" and "guerrilla" urbanism (Lydon 2012, Talen 2014).

The prefaces of urbanism describe their nature. Tactical, suggests precise planning, pop-up describes the way the intervention takes place, namely quickly and for a limited time. Guerrilla again describes the action itself, namely that it is not quite legal, thus in conflict with the law. Not only the kind of intervention is described in this way, but also the people behind it. These are usually driven by a desire to transform the city into a more pleasant environment.

The goal of tactical urbanism is to achieve a great effect with little risk. A wide audience should be made aware of the action in order to give an idea of a change and to create the desire of the inhabitants for more. Thus, it also aims to create the experience that city life can be colorful, safe and simple, and not only characterized by gray, stress and danger.

Interventions can range from coloring bike lanes to transforming parking lots into recreational platforms, for escapes from the daily stresses of the vibrant city. The success of tactical urbanism occurs when residents or groups get involved in urban planning and demand change (Lefebvre 1996, Lydon 2012, Webb 2017, Silva 2016).

Guerrilla urbanism has existed for a long time. Again, and again, cities have to face various challenges and, for example, have to adapt to new economic systems, as Lefebvre mentions in his book "writings on the city". Urban planning is usually left to intellectuals, who are supposed to take into account every possible aspect (Lefebvre 1996, Harvey 2008). Urban planners focus mainly on securing the development of settlements, the use of building land and the design of traffic areas. The planners try to satisfy the economy and only what makes a profit is interesting. Thus, the needs of ordinary people are not considered or are considered only last. It is assumed that everybody wants to move to the city anyway and therefore there is a permanent demand for living space in the city. The well-being of people living along a busy street is not taken into account. Nor is any thought given to the wishes of elderly people on their daily walks, such as benches for resting. The fact that children who live along a busy road would also like to play outside is also overlooked, as are the previous concerns. This is because the city's planning is based primarily on economic needs. (Lefebvre 1996)

To make their needs known, pop-up urbanisms are a simple means for city dwellers. Although this approach may be classified as civil disobedience, it still achieves its goals. According to Silva (2016), processes that lead to further development are always accompanied by continuous and intense confrontations between those who carry the claims of legitimacy and those who are responsible for their sanctions. Furthermore, legitimate actions that have enough impact, i.e., continuity or relevance, lead to these short-term interventions being later recognized and incorporated by official bodies. An example of this is "urban gardening". What was once illegal in Berlin became a normal phenomenon due to widespread support from residents (Biedermann and Ripperger 2017, Prinzessinnengärten 2021). The same is true of the "walk [your city]" movement. The city of Raleigh in the USA prohibited the project and classified it as illegal. Due to the high media attention and the support of the population, the city changed its attitude and integrated the interventions as a pilot project (Tomasulo 2013).

Projects that are classified as "guerilla urbanism" can be found in many cities. For example, Rotterdam and Copenhagen are considering new functions for the streets, such as surface rainwater management for the whole city. Rotterdam and Copenhagen are pioneers in opening the streets to bicycles and pedestrians. Individual experiments are also taking place in Austria, such as the "cool streets - cool streets". For this, a heat map was used to select places in the city where the heat stress for the population is particularly high in summer. At these places the streets will be closed for car traffic, mobile plants, benches and water sprinklers will be placed. In this way, the streets will become a meeting place and children will be able to play in the streets (Mobilitätsagentur Wien 2021).

The initiative "Grätzloase" so-called neighborhood oases have a similar goal. Based on usage plans, areas are designated where the population is to be shown how life can return to the streets. Parklets are used for this purpose - the use of car parking spaces as lounges.

Building on this idea from Vienna, we want to use new tools to develop and test simple and inexpensive pop-up transformations (Lokale Agenda 21 Wien 2021).

4 APPLIED PROJECT POP-UP PIAZZA

Temporary transformations are usually simple and quick to implement, are inexpensive, and have tremendous hidden value for both civil society and urban administrative and planning levels. The focus is on reclaiming public street space and opening it up to a variety of uses. This project therefore combines different use cases of temporary transformation to conceptualize temporary appropriation as part of the social urban landscape and as an emerging product of bottom-up initiatives, the digitalization of administrative processes, and the present legal and organizational framework.

Temporarily freeing traffic areas from cars and transforming them into public spaces, offers a "low-cost", "low-time" and "high gain" opportunity to reduce the obstacles associated with the transformation of urban structures towards new traffic concepts and paradigms. The principle is to temporarily test a measure before the cost-intensive detailed planning and implementation of construction measures. A wide variety of temporary transformations is to be developed as an efficient, potentially widely used planning and implementation tool for sustainable, permanent solutions.

Pop-up Piazza aims to make the temporary transformation of streets and squares much easier and faster to implement and to make it easier for other cities to apply (ForschungsgesellschaftMobilität FGM-AMOR 2017).

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These are the main objectives of the project "Pop-up Piazza" (ForschungsgesellschaftMobilität FGM-AMOR 2017):

- Development and testing of cargo bike-based research prototypes, which – as mobile "StreetFormators" – will enable fast pop-up transformations.
- Further development and testing of a digital citizens’ tool, which is suitable for the broad employment on different topics all over Austria.
- The respective "testing" is about the validation of the functionalities – how the respective solution is proven or not proven in the real laboratory environment.
- State of the art analysis and analysis of the legal and organizational framework conditions.
- Evaluation and recommendations for policy, administration, planners and developers.
- Efficient dissemination of research results, open-source access for prototypes and the citizens’ tool.

4.1 Procedure

After the initial analysis of the status quo regarding temporary freeing of roads from motor vehicle traffic and pop-up techniques in public road space, it was first of all of high importance to also sound out the legal and organizational framework conditions. The next major step was to develop the prototypes. These are based on cargo bicycles and have different possible uses. As mobile "StreetFormators", they are intended to enable rapid pop-up transformations. The designs were developed on the basis of an ideas workshop with various stakeholders. In parallel, a digital citizen tool was developed. This should quickly show the potential for such transformations based on maps.

The current step is the testing of the research prototypes. This involves validating the functionalities - whether or not the tool proves itself in the real-lab situation. Some pilot implementations have already been carried out and evaluated in Vienna and Graz. Methodologically, observations were primarily used for the impact evaluation. These were combined with traffic counts and surveys (digital and analogue). Furthermore, it is planned to use an interactive voting tool. This paper will report results and experiences from the impact evaluation so far.

4.2 Project experience

A central point of the project are the interventions, i.e., the testing of the StreetFormators in different settings and the evaluation of the impact. The goal is to conduct 20 and 10 interventions in the cities of Vienna and Graz, respectively. Due to the changed situation caused by Covid, there was a delay in the completion of the prototypes. Therefore, the existing "Raumwandler" (in English: "space-transformers") from the previous project Metamorphosis were also used (in Graz). One ready-built StreetFormator – a cargo bike equipped with games, fun and sports equipment – was already in use in Vienna (figure 1). Since spring 2021, the two new StreetFormators have also been ready for use. The findings from the first test phase were incorporated into the design of the StreetFormators, which were then still under construction: In the case of the "Meet & Greet Bike" (figure 2), seating is attached directly to the cargo bike so that it can be used directly. In addition, different add-ons, that can be installed flexibly, depending on the purpose/location are utilized (figure 3).

In addition to the different transformation tools that were used, they were also applied in different contexts. While one focus was a host system, it was also carried out in the context of events. The second means that the StreetFormators are used, for example, at street festivals. Mostly it is then an official closure of the street or street section - the StreetFormator then additionally upgrades the space that has been freed up, alongside the other activities.

The host system on the other hand is designed in such a way that the used space is provided by third party hosts such as stores. Usually in these cases the street was used "normally" for traffic and the StreetFormator temporarily converted an existing car parking space.

Another difference in the method of use is that of "active placement". On the one hand, it is possible to actively play and support the StreetFormator. In this way, passers-by are directly invited to use it. Barriers can be broken down in this way. On the other hand, we also wanted to test how it works when the StreetFormator is "left out in the wild", i.e., simply standing in a parking lot without supervision.

Figure 1: The new StreetFormator called "playing-bike" and the existing space-transformers (photo credits: xyz cargo 2020; metamorphosis 2020).

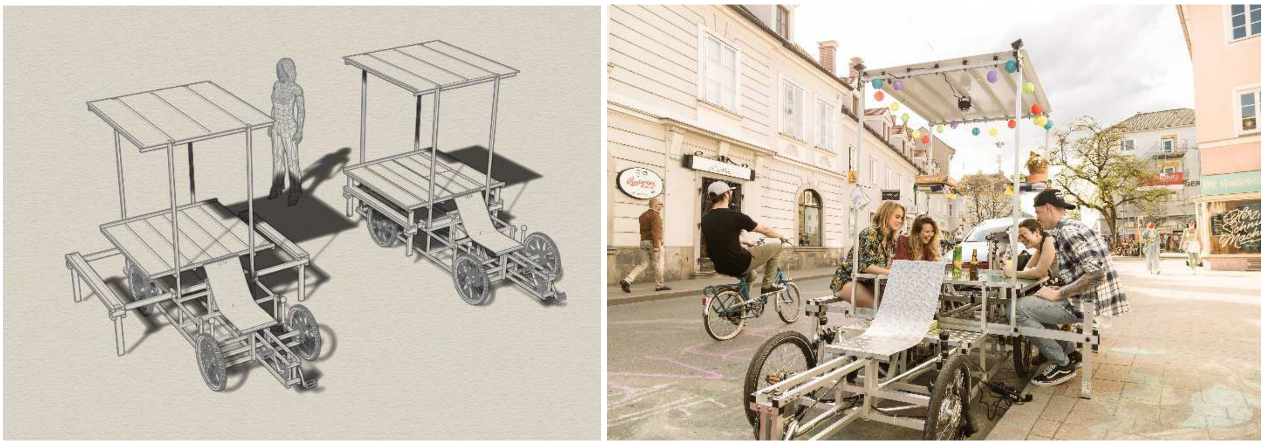

Figure 2: Planning sketch of the StreetFormator named "Meet & Greet Bike" (photo credits: xyz cargo 2020) and the finished StreetFormator in use (photo credits: Bergschaf 2021).

Figure 3: Different uses of the StreetFormator by means of add-ons: music, lighting, board games, table tennis, ... (photo credits: Irene Stockinger 2021, Bergschaf 2021).

The Graz deployments were conducted in a "modified bottom-up" framework. Specifically, this means that the selection of the sites themselves was not a top-down measure on the part of authorities or administrative units. Nor have citizens themselves had any direct influence on the location of the deployed space-transformers yet. Instead, cooperative partnerships were formed in which the location was jointly fixed. In addition to the project partners, non-profit organizations, local companies and associations were represented in such partnerships (Bafaro, Senger and Giesch 2020).

Along the way, a space-transformer (the so-called "garden bike" with seating and plant boxes) was hosted for a time each by a local store and by a neighborhood center in Graz. By means of interviews with the hosts, the experiences were documented and analyzed. The results are summarized below.

The general perception of the space-transformer by the hosts was consistently positive. Both the visual perception and the transformation of the space were perceived positively. The seating in particular added value here. In both cases, much takes place in front of the hosts' premises - particularly the social interactions. Especially in pandemic times, where distances have to be kept, but also at normal times, the space-transformer therefore offers a good extension. A reassessment of the distribution of space can definitely be seen as a success here. The special feature of a host system is the security and trust aspect: someone takes care of the space-transformer and always keeps an eye on it, so on the one hand vandalism can be prevented. In addition, trust is created and passers-by know that this is a safe place to sit or let their children play on it. The host also provides a contact person who can be used for all kinds of concerns. The hosts in Graz have often had the experience of receiving complaints from residents and drivers, almost exclusively because of the loss of parking space. In the case of the neighborhood center, the complaints have subsided over time. Now everyone seems to have gotten used to it. In the case of the small store in a district of Graz, the host has observed aggressive behavior by motorists towards the space-transformer from time to time (e.g., deliberately hitting it when parking). He also had to engage in heated discussions time and again. However, it should also be said that a lot of positive feedback has been received. In general, one can speak of a high level of interest, as many passers-by cast interested glances at the previously unusual street scene. In addition, many passers-by have also asked what it is about. The reactions to the transformations were then mostly joyful.

In both cases, there were many different user groups: First and foremost, families with children use the space-transformer. But senior citizens also benefited from the additional seating and groups of young people were also able to meet there. There was almost daily use in front of the store - especially during opening hours. The use of the space-transformer in front of the district center, on the other hand, is much more closely oriented to opening hours. Then it is always in use and very popular. In both cases, the space-transformer provides the necessary additional space for the otherwise rather limited physical premises and primarily assumes a function of social exchange. An important result of the experience of popularity with children is to separate the space-transformer from passing motorized traffic in order to create additional safety. A structural boundary or a natural wall of plants is suitable for this purpose.

At this point it should be noted that the two locations are different: The store is located in an inner district, in a busy, hip neighborhood close to many other stores and gastro venues. The neighborhood center, on the other hand, is located in an outer district and is characterized by its location on a busy state road. Despite the traffic rushing by (along with the noise pollution), however, the space-transformer is used actively and also gladly, thus enhancing this space all the more.

The host system has also proven to be good at reducing barriers. This is because many passers-by do not perceive the space-transformer as a public space and do not know that they are allowed to use it without further ado. Good experiences have therefore been made especially when the cargo bike transforms car parking spaces into recreational areas in cooperation with district centers or neighborhood offices. These can actively use the space as part of their activities. Since the temporary transformations should generally draw attention to the usability of public space (especially the reclamation of public street space), it is recommended to provide information in addition to the transformation tool. For example, the shop windows could be creatively played with it (Host1 2021 and Host2 2021).

Another focus in Graz has so far been the coordination of temporary play streets and residential streets with the space-transformer. In Austria, in declared residential streets, walking on the roadway and playing is expressly permitted. Driving is only permitted for the purpose of access and departure. Pedestrians and cyclists must not be hindered or endangered in the process. The pilot tests in the residential streets have shown how important it is to draw attention to this issue. In both survey periods, there were numerous violations of the road traffic regulations. The results of the traffic count show this clearly (table 2).

One can even speak of a vicious circle here, since this traffic in turn creates an unsafe environment and as a result child of residents are not allowed to play on the street at all (Bafaro, Senger and Giesch 2020).

Based on the experience of the pilot tests in residential streets in Graz, it can be concluded that the Pop-up Piazza project can make an important contribution towards raising awareness. The drivers could be made aware of their misconduct through the campaign and above all through the targeted playing on the street - which led to the traffic being slowed down further. Here, with a little support, the street space was reclaimed by children. In addition, the residents were able to enjoy the benefits of the traffic-calmed area and were made aware of it. In addition to a lot of positive feedback from neighbors about the created "living room in front of their door", there were, however, some complaints from motorists who felt robbed of their parking space.

Survey / Traffic participants	25 July 2020 (4-5pm) (before intervention)	22 September 2020 (4-5pm) (during intervention)
Passenger cars *(of which passed through)*	15 *(7)*	37 *(23)*
Pedestrians	72	123
Cyclists	36	150
Motorcycles	0	6 *(5)*
Skateboarders	2	3

Table 2: Traffic count results of the pre-survey and the survey during the intervention in the residential street (Muchargasse) in Graz.

The implementations in Vienna took place mainly within the framework of organized events. During the summer months, 18 street(-sections) in Vienna were temporarily transformed into so-called "CooleStraßen" ("cool streets") - as a heat adaptation measure. The street space, which is normally occupied to a very large extent by stationary traffic, was opened up to people. The StreetFormator, in this case the playing bike, was also used for the "cool street". It brought various toys and sports equipment to the "place of action" and thus took over an important supplementary function for temporary traffic relief. The positive feedback from the supervisors and the results of the observations show that the playing bike primarily fulfills a transport function. In addition to the shady function of the integrated sunshade, the cargo bike itself is occasionally used for climbing attempts by younger children, its table proved practical, e.g., for painting, but the greatest attention was focused on the toys brought along, which were very well received. The bike itself was in the background during use. In this case, it is "only" a means to an end, which is limited here, as previously mentioned, to the transport of toys. It transforms the space only indirectly. However, the fact that the street section is officially closed contributes to the transformation much more. In this case, the StreetFormator as a cargo bike that brings the games is a good complement to the road closure to make the most of it (Bafaro, Senger and Giesch 2020).

From the evaluation and the interim results so far, both from the surveys in Graz and in Vienna, the conclusion can be drawn that overall, the advantages of the additional public space outweigh the disadvantages. The majority of the people involved (both active users and passers-by) reacted positively to the StreetFormators. Only a few people expressed rather negative opinions about the action. It has been shown that the topic of parking space reduction is a very emotional issue. Here it is particularly important to "pick up" these people, i.e., to involve them from the beginning and to raise their awareness. This is because in many cases the desire is expressed for longer-term traffic calming, greening and reuse of the street space. It has been shown that the campaign gives people a way to use public space and this also has a social impact. The StreetFromators bring people together in their neighborhoods and offer them the opportunity to compensate for the lack of private or semi-public open spaces and to use the street as a meeting place, playground and communication space.

However, an obstacle to the implementation of temporary interventions in the street space can be the legal framework. It is essential to check the legalities and specifications of the city before implementation. These can be handled very individually. If one refers to the current Austrian legal situation, bicycles may be parked in public parking spaces. For this reason, bicycle-based transformation tools are being tested in the pop-up piazza project. Nevertheless, it is advisable to inform the responsible authority about the project in as much detail as possible in order to have the need for a permit officially clarified for the further course of the project.

5 CONCLUSION

As stated in chapter four, the majority of the local residents appreciates the "guerrilla interventions". The StreetFormator allows people to rest and have a gathering place. This creates new opportunities for social interaction and new acquaintances are formed. We observed that especially the host system, where local stores"take care" of the StreetfFormator, proved to be most successful. Neighborhood centers and stores that also have a social function were able to upgrade the public space.

Many drivers are afraid that they will lose their parking space because of the StreetFormator. These potential conflicts combined with the theory from chapter three show that we are on the right track to make a difference. The emotions about street space mentioned in Chapter four consider also the city restictions and their legal positions. It is important that not only tactical urbanism is pushed through, but that opponents are also heared and a common basis is sought. Legal framework and municipal requirements have to be integrated too. We have received a lot of positive feedback from locals.So, we believe that we have correctly assessed the needs and have found a promising path on which we will continue to go forward.

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Post-Earthquake Quality of Life: Assessing the Bam Recovery Process

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1 ABSTRACT

This paper examines the recovery process of the Bam (earthquake hits on December 26, 2003) on the survivors' quality of life after 17 years. Our purpose is to explore the main root causes of the success or failure of the Bam recovery process. The results of this research could be effective in the success of the future disaster recovery process. For this reason, a self-report questionnaire designed to collect data on socio-demographic attributes, quality of life, and earthquake effects and its recovery rate from Bam's citizens' point of view. Cross-sectional data were collected during the summer of 2020 in Bam city by the snowball sampling method. The total sample comprised 150 of 164 (91.4% response rate) citizens who lived in Bam at least one year before the earthquake (and until now). Three analysis methods were applied, first descriptive statistics, second a statistical test (one-sample t-test), and third Ishikawa diagram. The results show that the Bam recovery process was not successful and Bam recovered only 54% in quality of life dimensions. The research hypothesis (H0: The recovery process of Bam city has improved citizens' quality of life) has been rejected based on the findings. Finally, in the last part of the analysis, eight main causes have been determined for the Bam recovery's failure in increasing the quality of life. Although failure causes are in both management and physical dimensions, it seems that the physical causes are also rooted in the management system of Bam city.

Keywords: Recovery; Quality of life; Resiliency; Vulnerability; Disaster management; Bam

2 INTRODUCTION

According to EM-DAT and NOAA reports, the number of reported natural disasters increased 7.5 times in 2010 compared to 1950. Moreover, due to the population growth, new urban developments, and increasing densities in urban areas, the number of human deaths has increased more than 2.5 times between the late 20th and early 21st centuries (The international Disaster Database, 2020; National Centres for Environmental Information, 2020).

Iran is considered as one of the most vulnerable countries in the world to natural hazards due to its geographical location and location in an earthquake-prone area. According to the national centre for environmental Information Centre (National Centres for Environmental Information, 2020), over the past 30 years, earthquakes have directly caused the death of 86,200 persons and nearly 168,000 injuries. Besides, Iran's earthquakes have indirectly injured more than 1.7 million people during 1988-2018. On December 26, 2003, the catastrophic Bam earthquake measuring 6.6 on the Richter scale, resulted in the deaths of more than 26,000 persons, and left more than 15000 casualties. This earthquake affected more than 268000 people's lives (Statistical Centre of Iran, 2003).

A four-phase disaster management strategy cycle has been applied worldwide to cope with increasing disaster events and their consequences. These phases include mitigation, preparedness, response, and recovery (David E Alexander, 2002). Most urban planners' actions and plans are focused on the two stages of mitigation and recovery, and this research particularly focuses on the recovery phase. The recovery phase will be effective and successful when it has four main goals: having long-term effects, reducing vulnerability, increasing resilience, and increasing the quality of life in disaster-affected cities (Diana Contreras, 2016; FEMA, 2006; J Eugene Haas et al., 1977). Therefore, due to this phase's long-term nature and its complexities, in many cases, the recovery phase in post-disaster planning has either been neglected or not even considered by the decision-makers (Diana Contreras, 2016). Although several studies have been done on mitigation and response phases in the urban planning field (Harriet Bulkeley et al., 2011; David R Godschalk, 2003), just a few of them focused on the recovery phase. Diana Contreras, (2016), James Schwab et al., (1998) and Gavin Smith (2012) in particular, examined the recovery in terms of quality of life. This aspect of recovery has an integral role in the recovery's success. As we can see, many urban plans look successful at first but practically failed because of citizens' dissatisfactions.

Quality of life has a multidimensional structure (including physical, psychological, economic, social relationships, and environmental domains) and can be examined from objective and subjective aspects. Previous studies in post-disaster quality of life could be categorised into three groups: some studies focus on a particular group in society (age or gender) (A Ardalan et al., 2011; Ting Hu et al., 2018; Zhaobao Jia et al., 2010; Mau-Roung Lin et al., 2002); some studies analyse post-disaster quality of life in a specific field such as sociological, psychological, economical, etc. (Zhaobao Jia et al., 2010; Ying Liang, 2015; Jin Wen et al., 2012); and some studies analyse post-disaster quality of life in the short term (from months to 5 years) after a disaster event (A Ardalan et al., 2011; Zhaobao Jia et al., 2010; Jin Wen et al., 2012). To our knowledge, this is the first research in which the long-term recovery process has been evaluated from the citizens' point of view (subjective aspect) in general dimensions of quality of life.

Therefore, this research aims to explore the main root causes of the success or failure of the Bam recovery process 17 years after the earthquake. There were three research questions: (a) Has the Bam recovery process been successful in the opinion of the citizens? (b) How much has Bam recovered in quality of life dimensions? (c) What were the main root causes of the success or failure of the Bam recovery process? The study conducts a population-based survey of 150 Bam citizens who have been living in the city after the earthquake. Data collection and analysis took place in three stage yo answer the research question: (1) descriptive data was analysed; (2) research hypotheses were tested (Hypotheses 0 (H0): the recovery process of Bam city has improved the citizens' quality of life and Hypotheses 1 (H1): the recovery process of Bam city has not improved the citizens' quality of life); (3) root causes of the main problem have been identified.

3 DISASTER RECOVERY

The literature provides a variety of definitions of disaster recovery. Early literature defined recovery as a predictable part of the post-disaster process to return to normalcy (J Eugene Haas et al., 1977, p. 262; Enrico Louis Quarantelli, 1999). Today, disaster recovery is defined as a non-linear, dynamic, complex, and challenging process that involves all national and international parts and sources. In this definition, recovery aims to reduce society's risk and bring it to a better situation than it was before (J Eugene Haas et al., 1977).

Smith and Wenger broadly defined recovery as "the differential process of restoring, rebuilding, and reshaping the physical, social, economic, and natural environment through pre-event planning and post-event actions" (Gavin P Smith & Dennis Wenger, 2007, p. 237).

Disaster recovery is a complex and challenging process that involves all sectors of a community and outside interests. It is not even clear if and when recovery has been achieved in many cases because of the community's varying stakeholder goals. For example, some stakeholders want to return society to its pre-disaster status, and others like it to change and be less vulnerable to risks (William A Anderson, 2008).

FEMA (2006) stated that recovery activities might be designed to return systems to normal or a new and less vulnerable status. This has led some researchers to distinguish between short-term and long-term recovery. The short-term phase focuses on the restoration of pre-disaster functions, and the long-term phase focuses on community improvements (FEMA, 2006, p. 52; James Schwab et al., 1998).

Based on the literature review, recovery does not have a single and particular definition. This term is a broad and macro concept and cannot be easily measured (Recovery indicators give in table 1). In this research, recovery defines as a "post-disaster long-term plan and efforts that aim to develop the system, compensate the damages, improve the environmental conditions compared to the past, and sustain the society to future disasters." This process includes repairing, restoring, and reconstructing (not only repairing physical damages of hazardous events) to bring society to a normal and even better situation. According to this definition, recovery has three main goals for its process; First, improving the society's resilience; second, reducing society's disaster vulnerability; third, improving citizens' quality of life.

This term can be defined by three main concepts: resilience, vulnerability, and quality of life (fig 1). Based on this, most of the recovery actions, plans, and programmes are defined in one of these three concepts. It should be noted that although these concepts are not separate and have common parts, this research focuses on the quality of life concept. Concepts' overlaps mean there is a possibility that the causes of increasing or decreasing quality of life in the recovery process root in other concepts.

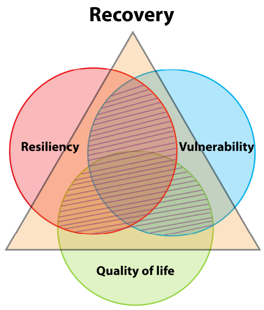

Figure 1: main concepts of recovery

3.1 Post-disaster quality of life

Although most definitions of quality of life have somewhat the same meaning, no exact and uniform definition has been provided for this concept. This term is difficult to define for four main reasons. First, the quality of life can be described and interpreted differently by different mental frameworks and conceptual filters. Second, this term highly depends on the values of the society. Third, the quality of life is a reflection of the human growth and development process. This reflection can change over a person's lifetime (by transforming mental processes, environmental factors, and system values). Fourth, different scientific disciplines only defined a part of the quality of life concept (based on their field of action) (J-C Dissart & Steven C Deller, 2000). The lack of a unique definition of quality of life has led researchers to use other terms instead. These terms include well-being, the standard of living, lifestyle, life satisfaction, and happiness.

Definitions of quality of life can mostly divide into two main categories. Several studies have been done about the quality of life, which focuses on one or both aspects of this term. These two aspects are described below.

(1) Endogenous attributes of quality of life: Endogenous attributes of quality of life (or the subjective approach) are designed to collect primary data at the individual level. The quality of life is defined by people's mental perceptions, their living conditions, and the individual's standard of living. This aspect of quality of life is measured by using subjective indicators.

(2) The exogenous attributes of quality of life: Exogenous attributes of quality of life (or the objective approach) are designed to work with and analysing secondary data. These data were collected from official governmental data collections, official reports of institutions, and census. In this respect, the quality of life is determined based on the external conditions of people's lives and measured by using objective indicators (Robert W Marans & Robert J Stimson, 2011, pp. 2-3; Mark Rapley, 2003).

This research is focusing on subjective facts of quality of life in post-disaster recovery plans and finding the root causes of success or failure of the Bam recovery process.

4 METHODS AND ANALYSIS

In this research, a descriptive-analytical path and a process based on three steps is developed. The analysis is done in three parts. In the first part, descriptive statistics (frequencies, percentages, mean and standard deviation) are used to describe the participants' background information and quality of life domains. In this part, two variables were defined that include "quality of life" and "earthquake effects and its recovery rate." These variables are divided into sub-classes and indexes weighted by employing the Delphi method (Münevver Özge Balta & Havva Ülgen Yenil, 2019; Afshin Gorbani Param et al., 2018; Mehrnaz Molavi, 2018; Mohsen Ahadnezhad Reveshty et al., 2014).

A Delphi questionnaire was designed based on binary comparisons, which are determined between the variables, sub-classes, and indexes. The digital scale was used as suggested by Saaty, ranging from 1 to 9 (Table 2) in the pair comparison matrices (Thomas L Saaty, 2008, p. 6). In total, 15 questionnaires were completed by disaster experts, researchers, and university professors to determine the data's weight. Each weight was calculated based on the arithmetic mean of the experts' opinions. At the end, the total quality of life score was calculated.

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Value	Preference level numeric
1	Equal Preference
3	Moderate Preference
5	Strong Preference
7	Very strong Preference
9	Absolute Preference
2, 4, 6, 8	Intermediate value between them

Table 2: The digital scale suggested by Saaty ranging from 1 to 9 (Thomas L Saaty, 2008).

In the second phase, the research hypotheses were defined and evaluated by comparing means and one sample t-test (Mehrnaz Molavi, 2018; Kusa Bill Noni Nope et al., 2020; De-Graft Owusu-Manu et al., 2020; Stephan Pauleit et al., 2005). The research hypotheses are H0 (the recovery process of Bam city has improved citizens' quality of life) and H1 (the recovery process of Bam city has not improved citizens' quality of life). The adopted decision level for the statistical significance level was 5 percent ($p<0.05$), which means if the significance level is higher than 0.05, the H0 hypothesis is acceptable. The data was analysed by the Statistical Package for the Social Sciences (IBM SPSS) version 24.

The third part, based on the findings pf the first two parts concerns the success or failure causes of the recovery process and is identified by the Ishikawa diagram. This method has been applied in different researches to find causes and effects (Xuedong Liang et al., 2016; L Luca et al., 2018; Nedjima Mouhoubi & Souad Sassi Boudemagh, 2019; Fazilat Tahari, 2014).

4.1 Data collection

Our team performed a cross-sectional survey in the summer of 2020 in Bam city in Iran for data collection. The total sample comprises 164 participants with a 91.4 response rate (150 participants answered the questions completely). Participants have one thing in common; living there for at least a year before the earthquake and until now.

As this study's data collection was hindered by the COVID-19 pandemic situation and its corresponding travel restrictions, we decided to employ Snowball sampling (Leo A Goodman, 1961) to improve our dataset. This approach applies to studies in which there is no easy access to participants (Leith Deacon et al., 2018; Celine Rendon et al., 2021; Andrew Rumbach et al., 2016). Moreover, we sent the questionnaires to three active NGOs and two social workers in Bam. For those participants with literacy problems, the questionnaires were read out and the answers were noted down.

4.2 Instruments

The self-report questionnaire was designed to collect data on socio-demographic attributes (gender, age, education, and residence time and history), quality of life (social capital, satisfaction with social, public services, housing, and living conditions), and earthquake effects and its recovery rate from Bam citizens' point of view. All items were covered using three sets of data as follows:

Basic socio and demographic variables: Basic socio and demographic variables were set as a dummy variable. These variables included age, gender, residency time, history of residence in Bam city, and educational attainment. Age was divided into four groups: 18-40 (coded as 1), 41-50 (coded as 2), 51-65 (coded as 3), and +65 (coded as 5). Gender coded as 1 (male) and 2 (female). The level of education coded as; 1 (high school), 2 (diploma), 3 (pre graduated), and 4 (post graduated).

Quality of life: based on previous studies and literature review, the quality of life in this research is captured by five subclasses. These subclasses include public services, housing, social capital, cooperation with the public, and satisfaction with life. Public services were evaluated with questions like "overall, how satisfied are you with the health services/educational services, etc.?". Housing conditions were assessed by questions such as "overall, how satisfied are you with your current housing situation?" or "overall, how satisfied are you with the security of your neighbourhood?". Social capital was indicated by trust in authorities and participation in public affairs, and social networks. In this research, social networks are measured by neighbourhood cohesion and sense of belonging (measured by a tendency to migrate). Cooperation with the public was evaluated by the level of citizens' cooperation with decision-making institutions. Finally, satisfaction with life was evaluated by questions like "Overall, how much happiness do you feel in your current life?" or "Overall, how satisfied are you with your current life?"

It should be noted that all the quality of life variables were measured by five Likert scales ranging from 1 to 5, representing the increased degree of each indicator. This range was considered as "Completely satisfied," "very satisfied," "moderately satisfied," "slightly satisfied," and "not at all satisfied."

Earthquake effects and its recovery rate: Questions in earthquake effects and its recovery rate subclass were designed as open-ended questions. Questions about Earthquake effects and its recovery rate was "how much the earthquake damages have been compensated in the Bam city recovery process?", "How much attention has been paid to the main elements (Bam citadel, palm fields, Qantas, etc.) of the city in the recovery process?", "how successful was the Bam recovery process in the past 17 years? If you are satisfied or not, please state your reasons". In the end, all the answers were gathered and coded into different fields.

5 FINDINGS

There were 150 participants (47.0% male and 53.0% female) aged 25 to 78 years (mean 42, standard deviation 10.9). Of the total, 92 (62.3%) were born in Bam, and 37.7% migrated from other provinces to Bam city. Participant's average reported residence time in Bam was 34.4 years. The majority of the participants were literate with an academic education (65.4%) and married (87.4%). The demographic characteristics of the research sample are given in Table 3. The mean age of the 150 participants was 41.5 years (ranging from 25 to 78 years), and the majority (i.e., 58%) of the subjects were female. The mean household number was 4.05, which is similar to the national level. Overall, the education level was relatively high and just 35.3% of the respondents had non-academic education.

5.1 Summary of measures

The frequencies, percentages, means, and standard deviations for the entire sample variables are reported in Table 2. Among the 150 participants in the study, the satisfaction with public services (health care, educational services, sports, parks, etc.) was 48.2%, which is low. The results in "satisfaction with public services" show that the most satisfaction is with educational (66%) and health care services (56%), and the last satisfaction is with parks and open spaces (37%) and cultural recreational land-use (32%).

Satisfaction with housing conditions was 67%; this high value is due to the post-earthquake reconstruction. It should be noted that some dissatisfaction with housing conditions is not because of the low quality of structure or building, but due to the lack of housing facilities such as a cooling system, central heating system, Wi-Fi, etc.

According to the respondents, social capital in Bam city is high and 71%. Social capital was assessed by three questions, "How satisfied are you with your current neighbourhood safety," "How close are you to your neighbours?", and "Do you want to continue living in Bam? (No tendency to migrate)."

Cooperation with public administrations and decision-making institutions was reported relatively low. The results show that 41%. 5 (3%) participants described their cooperation with public administrations "very much," 13 (9%) claimed it to be "somewhat," 28 (19%) believed it to be "Medium," 39 (26%) regarded it "not much," and 65 participants (43%) declare it 'not at all'. The last quality of life's subclass is satisfaction with life (including "life satisfaction" and "level of personal happiness"), which is quite well at 69%.

According to the respondents' opinion, the damages have been compensated by 47%. Concerning the city's main elements (including the palm fields, Qanats, and the citadel of Bam) only 48% were considered in the Bam recovery and reconstruction process, which is not satisfying. The success rate of the recovery process was reported 50%; just 1 (1%) claimed to be "completely satisfied," 7 (13%) believed to be "very satisfied," 23 (43%) declared to be "moderately satisfied," 14 (17%) regarded to be "slightly satisfied," and 20 participants (25%) assessed to be "not at all satisfied."

In an overview, the mean of "quality of life" and "earthquake effects and its recovery rate" subclasses is 30% and 24% in respondents' opinion. Scores in both subclasses could be assumed as "slightly satisfied/ not much." According to the analysis, the total recovery score is 54% which is quite low for a city where 71% of it was destroyed, and new developments have taken place over the past 17 years.

5.2 Assessing the hypothesis

The research hypotheses have been evaluated by comparing means and one-sample t-test. The adopted decision level for statistical significance level was 5 percent ($p<0.05$). It means that if the significance level is higher than 0.05, the hypothesis is acceptable. In this research, the test level 0.6was adopted.

As the results show, the significance level is 0 and below 0.05. It shows that the research hypothesis (H0) is not acceptable and the recovery process of Bam city has not improved citizens' quality of life (Table 4).

	One-Sample Test					
	Test Value = 0.6					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
QOL	-2.978	149	.003	-.0278815	-.046380	-.009383

Table 4: one-sample t-test results.

5.3 Problem formulation

This research aims to find the root causes of the success or failure of the Bam recovery process, and according to previous analysis, Bam recovery was not successful in citizens' opinions. For exploring the failure causes, two main questions were asked from participants; first, "what damage has been done to your life by the earthquake?" and second, "state your reasons of satisfaction or dissatisfaction from Bam recovery process."

Based on answers, "the earthquake's consequences" were classified into three themes (personal, physical, and socio-economic) and eight codes. Results show that 124 (82.6%) people lost at least one of their family or relatives, 110 (73.3%) suffered from physical and psychological injuries, 106 (70.6%) lost their houses, 31 (20.6%) lost their jobs, and have economic problems, 9 (6%) lost their agricultural land (Figure 2). Although some damages (i.e., lost at least one of their family or relatives) are irrecoverable, the others could be recovered in midterm and long-term developments.

According to the answers, "recovery dissatisfaction" reasons are categorised into four themes and 12 codes (Figure 3). 60% of respondents believed the recovery failure is because of "improper physical reconstruction of the city," 34% declare it is "lack of urban services and facilities," 28% said it's "weakness in the institutional and management structure," and 22% regarded it to be "failure to reconstruct the identity elements of the city." Generally, most of the reasons mentioned for the Bam recovery process's inefficiency could be easily solved by efficient plans and programmes.

In this phase, finding problems and their causes is done by Ishikawa diagram (Fish Bone Technique), which is based on creative thinking. We grouped the factors identified into two main categories to achieve the fishbone diagram: management, institutional and physical. The main categories are shown in the diagram by the main-line/bone of the fish, and the corresponding root causes are indicated by sub-line/bones going off from the main-line/bone of the fish. In Figure 4, the authors root the causes of the problem with the Fishbone Diagram's help.

The following identified the root causes of the main problem that have been observed from the Bam city survey:

(1) Management and institutional problems: In this study, authors have seen some causes that led to management and institutional problems in the Bam recovery process. Most of the recovery failure roots found in figure 4 show that the Bam city management system has not been recovered properly after 17 years. Today, Bam is still dealing with the earthquake's challenges and problems, which could be solved in the city's mid-term development.

This research's outcomes find the following root causes of the Bam recovery process's management and institutional problems.

- Lack of integrative urban management: during a crisis, integrated management is more needed than ever before. In this situation, due to the conflicts of interest of the city organisations urban management faced a challenge; it is necessary therefore to create an integrated management structure (both vertical and horizontal relations of organisations) in cities (especially cities in crisis).
- Lack of decision support systems: The existence of decision support systems in crisis will increase the resilience of the impacted system. Lack of such a system may lead the urban management

structure to collapse (like the Bam situation after the earthquake, which is only partially restored after 17 years).

- High deceleration of the recovery process after the early stages of the disaster: The speed of reconstruction in the early stages of the disaster (due to national and international intervention) was very high. Usually, the reconstruction pace slows down after the early stages. It is expected that the urban management system has the ability to recover itself in mid-term development.
- Lack of an effective post-crisis development plan: The prescriptive scope of urban comprehensive plans in Iran is the same everywhere and must follow a specific type. For this reason, comprehensive plans do not have the resilience to adapt to the new conditions.
- Low citizen cooperation with decision-making institutions: The structure of urban planning and management in Iran is centralised and does not have the capacity to accept public participation in decision-making. Although actions have been taken to decentralise management and to involve citizens in many cities, this has not happened in Bam.

(2) Physical problems: Physical actions play an integral role in recovery success. The authors have found out the following root causes for the physical problems of the Bam recovery process.

- Lack of adequate (quantity and quality) public services: Urban plans in Iran use the concept of per capita to provide public services. The per capita concept does not discuss the quality of public services and only discusses quantitative issues. Density is also neglected in this concept. Due to this, the quantitative discussions of public services and the required area for them are also a challenge.
- Destruction (relative) of the main elements (Bam citadel, Qanats, palm fields) of the city in the recovery process: The main elements of Bam city are the city's identity and the economic source, and citizens' income. The Qanats and palm fields, which were the main source of city income, were severely damaged by the earthquake and have not been rehabilitated during the reconstruction/recovery process.
- Failure to complete the reconstruction process: In the reconstruction process and Bam recovery, there are many problems from the citizens' point of view, which have led the recovery to fail. The reasons given by citizens are factors such as debris existence in parts of the city, some citizens still living in the temporary situations after 17 years, lack of reconstruction of the city for the disabled, etc. Most of the problems stated could be solved in mid-term planning.

The root causes of Bam's recovery failure are divided into two scales, national (or supra-national) and local. Causes with national scale roots are outside the planning agenda and couldn't be solved by urban planning actions. Causes at this scale, which couldn't be solved at the local level, are because of reasons like:

- centralised planning structure;
- the prescriptive scope of urban comprehensive plans and their inflexibility;
- using traditional planning tools instead of new methods and technology;
- uncertainties outside the planning system like inflation rate, etc.

At the local level, Root causes are mostly related to the strategic level of the decision making, interconnection between actions, actors, and decisions on the urban project.

6 DISCUSSIONS

Why has the city of Bam recovered just 54% after 17 years? Although earthquakes cause massive destruction, they can also act as a window of opportunity for better development. Despite this fact, why is Bam still involved with basic physical problems? Especially as these problems can be easily solved in mid-term planning.

In the "Problem formulation" section, the main causes of the failure of the Bam recovery process to increase citizens' quality of life are identified with the Ishwaka diagram. These failure causes include:

- lack of integrative urban management
- lack of decision support systems

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- high deceleration of the recovery process after the early stages of the disaster
- lack of an effective post-crisis development plan
- low citizen cooperation with decision-making institutions
- lack of adequate (quantity and quality) public services
- destruction (relative) of the main elements (Bam citadel, Qanats, palm fields) of the city in the recovery process
- failure to complete the reconstruction process.

Although the causes of the Bam recovery failure are divided into two "management" and "physical" categories, it seems most of these causes are rooted in Bam's management system. Reasons such as centralised planning structure, inflexibility of comprehensive plans, the traditional urban management system, and planning at both national and local levels led to Bam's recovery failure after 17 years. Most of these reasons are rooted at the national level and couldn't be solved at the local level. At the local level, most causes are about local strategic planning and its inefficiency to cope with disasters.

It should be noted that in this study, recovery was evaluated in terms of subjective aspects of quality of life. Thus, all research findings stated about the Bam recovery process should not be generalised. Obviously, future research is needed for an extended view of examining the function of Iran's planning system in coping with disasters and the post-disaster recovery process.

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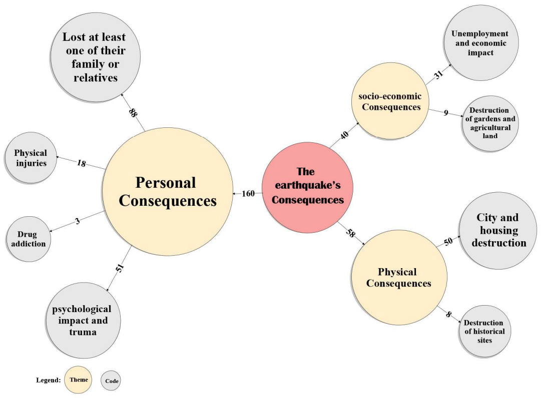
9 APPENDICES

Domains	Indicates	Concepts	Sources
Social	Educational level	Resiliency/ vulnerability/ Quality of life	(W Neil Adger, 2000), (Susan L Cutter et al., 2008), (Iuliana Armaş, 2012), (Luis Delfim Santos & Isabel Martins, 2007)
	Health coverage	Resiliency/quality of life	(Syed Ainuddin & Jayant Kumar Routray, 2012) ,(Luis Delfim Santos & Isabel Martins, 2007)
	Social capital (migration, social communication, community trust, etc.)	Resiliency/quality of life	(Syed Ainuddin & Jayant Kumar Routray, 2012) ,(Fran H Norris et al., 2008), (Susan L Cutter et al., 2008), (Mohammad Reza Rezvani et al., 2013)
	Demographic characteristics (age, sex, household number, vulnerable groups, population density, etc.)	Resiliency/ vulnerability/ Quality of life	(Fran H Norris et al., 2008), (Susan L Cutter et al., 2000), (Jayajit Chakraborty et al., 2005), (Luis Delfim Santos & Isabel Martins, 2007)
	Vitality and livability (sense of place, the identity of the city, etc.)	Resiliency/quality of life	(W Neil Adger, 2000), (F Fahy & M Ó Cinnéide, 2008), (Mohammad Reza Rezvani et al., 2013)
	Social equity	Resiliency/quality of life	(Fran H Norris et al., 2008), (Mohammad Reza Rezvani et al., 2013)
economical	Housing (Percentage of house ownership, housing area per household number, occupancy per room, etc.)	Resiliency/ vulnerability/ Quality of life	(Susan L Cutter et al., 2010), (Susan L Cutter et al., 2000), (Jayajit Chakraborty et al., 2005), (Dong Keun Yoon, 2012), (Iuliana Armaş, 2012), (Luis Delfim Santos & Isabel Martins, 2007)
	Economic structure (employment, economic growth, etc.)	Resiliency/ vulnerability/ Quality of life	Res (Syed Ainuddin & Jayant Kumar Routray, 2012), (Dong Keun Yoon, 2012), (F Fahy & M Ó Cinnéide, 2008), (Luis Delfim Santos & Isabel Martins, 2007)
	Income (household multiple source incomes, income per household number, Percentage of the population above the poverty line, etc.)	Resiliency/ vulnerability/ Quality of life	(Graham A Tobin & Linda M Whiteford, 2002), (Jayajit Chakraborty et al., 2005)
	Properties (vehicles, telephone, etc.)	vulnerability	(Jayajit Chakraborty et al., 2005)
Institutional	Mitigation (hazard mitigation Plan)	Resiliency	(Syed Ainuddin & Jayant Kumar Routray, 2012)
	Municipal services and budget (municipal expenditures for fire and emergency management system and medical services)	Resiliency	(Syed Ainuddin & Jayant Kumar Routray, 2012)
	Public participant (NGOs, participant in decision making, etc.)	Resiliency/ Quality of life	(Susan L Cutter et al., 2010), (Luis Delfim Santos & Isabel Martins, 2007)
	Information and Communication (databases, decision support systems, etc.)	Resiliency	(Fran H Norris et al., 2008)
Physical and Infrastructural	Buildings (density, age, structure, building codes, housing facilities, etc.)	Resiliency/ vulnerability/ Quality of life	(Philip R Berke & Thomas J Campanella, 2006), (Susan L Cutter et al., 2008), (Dong Keun Yoon, 2012), (Iuliana Armaş, 2012), (F Fahy & M Ó Cinnéide, 2008)
	Location (housing units located in the city's core, proximity to hazard-prone, distance to emergency services, distance to services, etc.)	Resiliency/ vulnerability/ Quality of life	(Philip Buckle et al., 2001), (Iuliana Armaş, 2012), (F Fahy & M Ó Cinnéide, 2008)
	Shelter capacity (vacant Houses)	Resiliency	(Syed Ainuddin & Jayant Kumar Routray, 2012)
	Public services (education, health care, parks, satisfaction with public services, etc.)	Resiliency/ Quality of life	(Susan L Cutter et al., 2010), (Luis Delfim Santos & Isabel Martins, 2007),
	Urban form (open spaces, development structure, etc.)	Resiliency/ vulnerability	(Syed Ainuddin & Jayant Kumar Routray, 2012) ,(Seunghoo Jeong & DK Yoon, 2018)
	Environmental Conditions (pollutions, water quality, etc.)	Quality of life	(Luis Delfim Santos & Isabel Martins, 2007)

Table 1: Recovery domains and indicators

Classes	Subclasses	Frequency	Percent	Mean	Std. Dev
Sex	Female	87	58.0	-	-
	Male	63	42.0		
Age	18-40	78	52.0	41.5	10.8
	41-50	42	28.0		
	51-65	20	13.3		
	+65	10	6.7		
Household Number	0-2	18	12.0	4.05	1.3
	3-4	84	56.0		
	+5	48	32.0		
Education	High school	17	11.3	-	-
	Diploma	36	24.0		
	Pre Graduated	80	53.3		
	Post Graduated	17	11.3		
Total		150	100.0		

Table 3: Demographic Characteristics of the participants in the questionnaire, Bam 17 years after Bam earthquake.



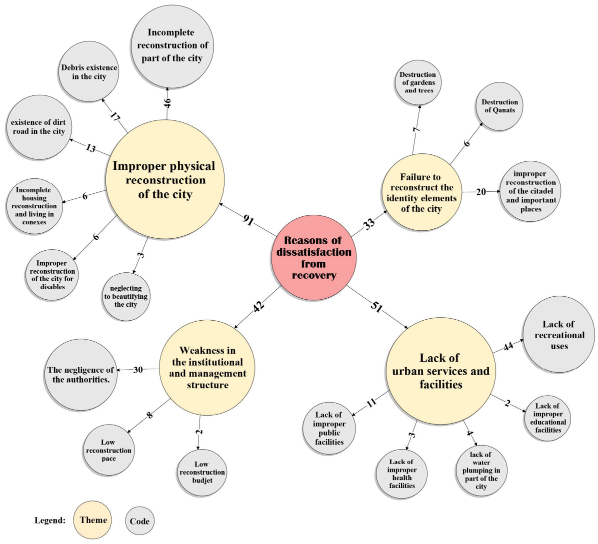


Figure 2 (left): classifications of the earthquake's Consequences. Gigure 3 (right): classifications of the recovery dissatisfaction.

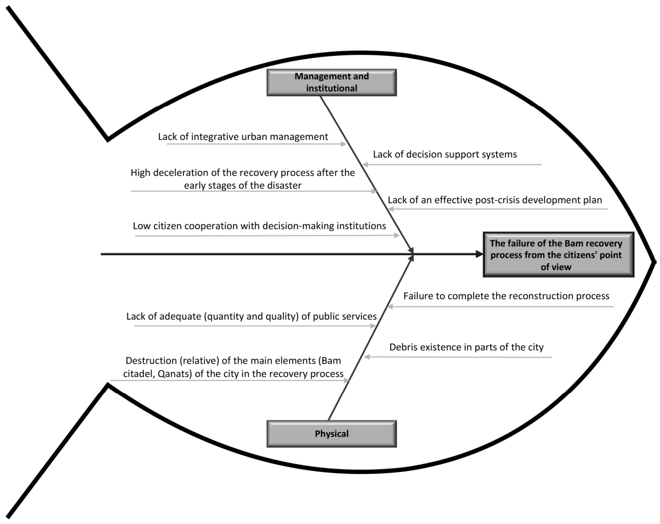


Figure 4: finding problems and their causes in the recovery process by Ishikawa diagram.

weight	variables	weight	Subclasses	weight	indexes	Percent% 5[1]	4[2]	3[3]	2[4]	1[5]	Yes	No	Mean	Std. Dev	Score			
0.5	Quality of life	0.23	Public services	0.20	Satisfaction with health care services	1	21	51	13	14			0.56	0.19	0.013	0.06	0.30	0.54
				0.20	Satisfaction with Educational services	23	15	37	17	7			0.66	0.24	0.015			
				0.20	Satisfaction with Sports use	3	19	34	19	25			0.51	0.23	0.012			
				0.20	Satisfaction with Cultural recreational land-use	0	2	17	19	62			0.32	0.17	0.007			
				0.20	Satisfaction with parks and open spaces	0	3	19	34	43			0.37	0.17	0.008			
		0.29	housing	1.00	Satisfaction with Housing conditions	10	33	45	7	5			0.67	0.18	0.096	0.096		
		0.11	Social capital	0.46	Satisfaction with Neighborhood safety	16	26	41	13	3			0.68	0.20	0.017	0.04		
				0.22	Level of neighborhood cohesion	11	25	43	9	13			0.62	0.23	0.007			
				0.32	No tendency to migrate						83	17	0.83	0.38	0.014			
		0.06	cooperation with public	1.00	Level of cooperation with decision-making institutions	3	9	19	26	43			0.41	0.23	0.011	0.011		
		0.32	Satisfaction with life	0.50	Life Satisfaction	21	29	41	8	1			0.72	0.19	0.050	0.10		
				0.50	Level of Happiness	15	24	41	16	3			0.66	0.21	0.053			
0.5	Earthquake effects and its recovery rate	1	Recovery	0.45	Earthquake damage compensation	6	9	33	20	33			0.47	0.24	0.107	0.24	0.24	
				0.09	Level of attention to the main elements	1	20	32	13	34			0.48	0.23	0.022			
				0.45	The success rate of the recovery process	1	13	43	17	25			0.50	0.21	0.113			

Table 3: Frequency (%) distributions of variables measured in the assessment among 150 Bam citizens.

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🏆 *reviewed paper*

Quantifying the Benefits of Sustainable Transport for the Urban Economy

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1 ABSTRACT

There is ample research on health benefits and benefits due to the prevention of environmental damage induced by the use of sustainable means of transport. For the political acceptance of measures for the promotion of sustainable urban transport it is important in addition to evaluate how a more sustainable system of urban transport directly affects urban businesses with regard to transport cost and productivity. This question leads to the very purpose of urban transport which is providing accessibility. It can be shown that beginning from a very low percentage any increase in the modal share of car traffic in a given system of urban transport causes accessibility to fall due to increased congestion. With regard to urban businesses this means that access of potential labour force to places of work, the so called „effective size of the labour market“ is reduced. Research also has shown that productivity is positively linked to the size of the labour market. Hence it is possible to attribute a marginal cost or benefit to any increase or reduction of urban car traffic. In case of the city of Vienna this benefit can be estimated at 4000 to 5000 Euro per year for every commuter changing from car to public transport walking or cycling. This adds to the already well researched benefits brought about by the reduction of congestion cost.

Keywords: Benefits of agglomeration, Sustainable Transport, Urban Businesses, Economic Benefits, Accessibility

2 BENEFITS OF AGGLOMERATION

2.1 Productivity depends on the effective size of the labour market

It has been shown that the productivity of businesses in urban areas depends on the so called „effective size of the labour market“ with the latter depending mainly on average speed of commuters and urban density. In an article „Size, Sprawl, Speed and the Efficiency of Cities“ [Prud'homme R., Lee C., 1999] it is stated as follows: „The hypothesis put forward here – and tested – is that the efficiency of the transport system (in short: speed) and the relative location of jobs and homes (in short: sprawl), which are the output of transport policies and urban policies resspectively, combine with city size to determine the effective size of the labor market. This effective size of the labor market – the number of jobs that can, on average, be reached in less than t minutes – in turn is a major explanation of labor productivity."

Prud'homme and Lee look at efficiency which is "defined as labor productivity, that is output per worker." What is relevant for the following discussion is the elasticity of this economic output (Y) with regard to changes in the effective size of the labour market (L). By analyzing data from 22 French Cities Prudhomme and Lee come to the conclusion that an "elasticity of 0.18 seems a reasonable order of magnitude." The analysis was done for labour market sizes within 20, 25 and 30 minutes isochrones (L(t) = L20, L25 and L30). An analysis of data from three South Korean cities (Seoul, Busan, Daegu) shows similar results.[1]

Based on these findings, the gross regional product of a city per head of population (labelled GRP) where the effective size of the labour market L is a function of the modal share of car travel m_c and with "ceteris paribus" assumptions can be written in logarithmic version as follows [derived from Prud'homme & Lee, 2001, p. 140]:

(1) $$\ln GRP = C + \mathcal{E} * \ln L(m_c)$$

C is constant and Ɛ is the elasticity of productivity with regard to the effective size of the labour market.

2.2 Elasticity of producitvity with regard to labour market size

There has been research done into many factors affecting agglomeration benefits like city size, employment density or size of certain industries. A comprehensive overview is given among others by Graham [Graham, 2005]. One important aspect is mentioned by Prud'homme and Lee already in their introduction. As there is no consistent data available for total productivity in cities they had to settle for output per worker. Attractive

[1] The elasticity in question is 0.24 in average for the three cities.

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cities attract investment which amplifies agglomeration effects caused by the size of the labour market. This component of agglomeration is merely a relocation not a creation of additional wealth. Taking into account all these aspects, it seems to be appropriate for a cautious approach to use 0.06 or 6% instead of 0.18 as estimate for agglomeration benefits related to the effective size of the labour market [Rauh W., 2008, p.71].

3 HOW URBAN TRANSPORT AFFECTS THE SIZE OF THE LABOUR MARKET

3.1 Defining an indicator for the effective size of the labour market

The aim is now to analyze how changes in modal split affect the average speed of travel and hence the effective size of the labour market at a given urban density and with a given urban transport infrastructure. For this purpose a simple modelling approach which shows the basic mechanisms and allows a rough estimate of producitvity effects is applied to the example of Vienna. For this simplified approach it is assumed that jobs as well as homes are evenly spread over the area of the city and that this area is larger than the labour market which can be reached within 30 minutes travel time. An indicator for labour market size (L) can be described as a function of the average speed of trips by car (V_c) and the average speed of trips by public transport plus cycling plus walking (V_p). Public transport, walking and cycling are summarized under "other transport".[2] What is further required is the share of car trips M_c respectively the share of other transport M_p with $M_c + M_p$ being 100%. The indicator $L(M_c)$ is a proxy for determining relative changes in the effective size of the labour market caused by changes in the modal share of car trips M_c. It is calculated as follows:

(2) $$L(M_c) = V_c^2 * M_c + V_p^2 * (1-M_c)$$

V will be given in kilometres per hour (km/h) and M – the modal share with regard to workday trips – in percent with Mp + Mc = 100%. If it were multiplied by the average density of available labour force and the speeds were changed from cartesian to polar velocity and the result multiplied by π it would be an estimate of the number of potential employees within a one-hour isochrone.[3]

The model for calculating the speed of travel is based on the modal split of transport performance (person-kilometres). For the effective size of the labour market, as shown in equation (2) the modal split of trips is relevant. As the size of the labour market is defined by the same time-span for all travel modes the modal share of car trips M_c can be derived from the modal share of person-km travelled by car m_c by taking the average speed of travel into account:

(3) $$M_c = (m_c/V_c)/(m_c/V_c + (1-m_c)/V_p)$$

3.2 Impact of the modal share of car travel on speed and labour market size

V_c as well as V_p depend on traffic load. At a given intensity of person-traffic, traffic load varies with modal split as car traffic causes more PCU-km per Passenger-km than more efficient types of transport. With rising share of car travel the regulation of surface traffic has to be adapted to accomodate higher traffic loads. This affects all types of transport and adds to the delays caused directly by congestion. The model for calculating the impact of modal split on the speed of door-to-door traffic (as shown in Fig.1) is based – among other – on empirical data on the average speed of travel measured in Vienna during workdays at varying traffic load (Rauh, 2008 p.41).[4]

[2] This simplification is not far fetched. Walking, cycling and public transport are complementary and therefore inseparable in practice. Together they form a typical and very common way of getting around in a city like Vienna. For short trips walking or cycling are fastest among „other transport“. For longer trips public transport is the most attractive option combined with walking and / or cycling to and from stations.

[3] Absolute figures are not required as only relative changes are relevant in the context of this paper.

[4] With q being actual traffic load relative to traffic load at peak time the average time to travel 1 kilometre by car in Vienna can be estimated at $1{,}91 - 0{,}16\,q + 1{,}31\,q^2$ [min/km] (see Rauh, 2010, p. 22). With additional data from mobility surveys an estimate for travel time respectively speed from door to door for car travel and other transport can be given.

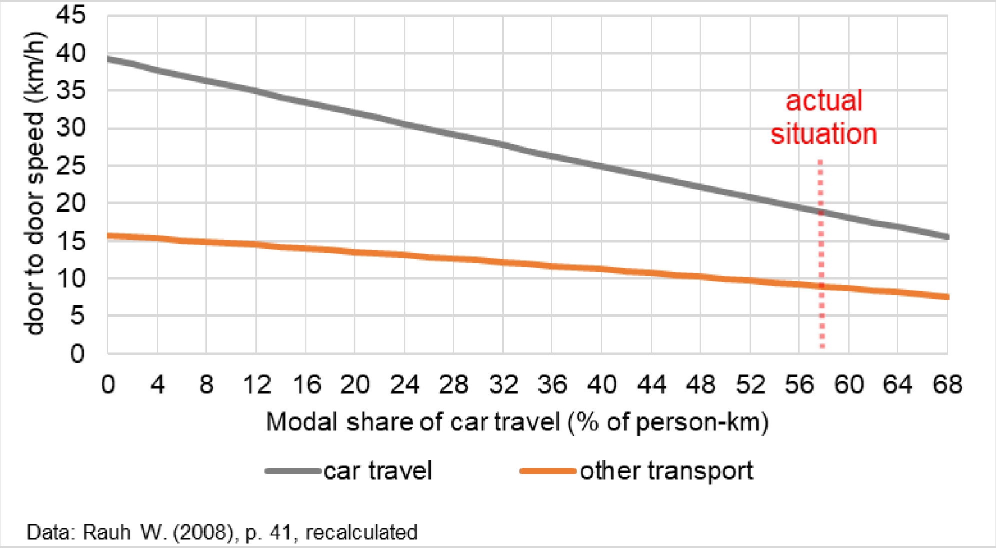

Fig.1: Impact of the modal share of car travel on average speeds of travel V_c and V_p

Based on the respective speeds of travel the indicator $L(m_c)$ is determined according to equations (2) and (3).

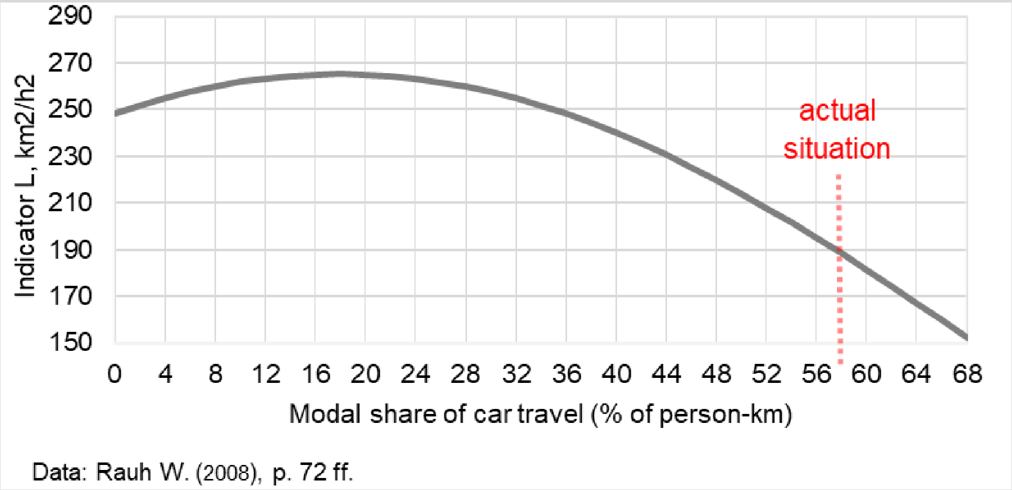

Fig.2: Impact of the modal share of car travel on the effective size of the labour market

Up to 18% of person-kilometres driven by car, increasing modal share of car traffic leads to an increase in the effecive size of the labour market. This is due to the increase in the speed of travel by switching to car-use. Above that limit the effect of the individual increase in travelling speed is more than offset by the individual contribution to the general decline in speed for all means of transport.

3.3 Marginal effect of car travel on producitivity

The creation of wealth could be related to all trips or to commuting trips only. To avoid overstating the effect per trip, the first option is chosen here. It can be assumed though, that the choice of a means of transport for a cummuting trip probably has a higher effect on productivity than it has per trip in general.

The wealth generated in Vienna is 100.3 bn € per year or 185€ per head of population per workday.[5] The number of car trips per head of population per workday can be estimated at 1.085 with m_c = 58% of distances within the urban area travelled by car.[6] Car trips per head of population and workday as a function of m_c is calculated as

(4) $CPH(m_c) = m_c * 1.085 / 58\%$

The impact of the size of the labour market on GRP in Vienna is calculated according to equation (1) with $\mathcal{E}$ = 6% and C derived from the actual values of L, GRP and m_c:

[5] Statistik Austria, data for 2019
[6] Rauh W. (2008), p.125

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(5) $GRP(m_c) = \exp(C+0{,}06 * \ln L(m_c))$ with $C = \ln 185 – 6\% * \ln L(58\%) = 4{,}9062$

By means of numerical differentiation the marginal effect of additional car trips on $GRP(m_c)$ can be determined. This effect in € per car trip is labelled MRP:

(6) $MRP(m_c) = (GRP(m_c+\Delta m_c) - GRP(m_c)) / ((CPH(m_c+\Delta m_c) - CPH(m_c))$

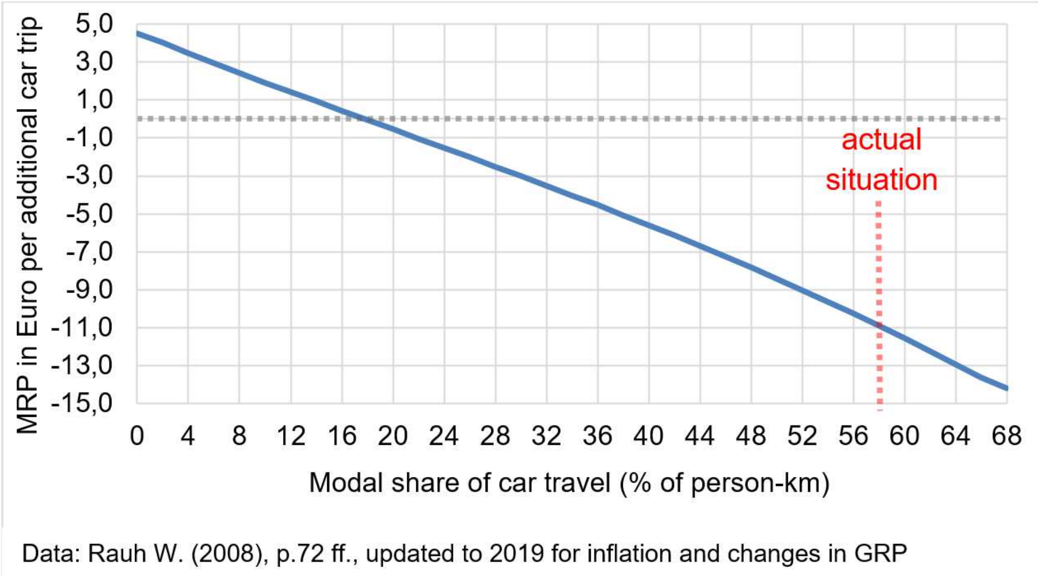

Fig. 3: Marginal effect of peak-time-car travel on economic output in Vienna

If MRP is divided by the average trip length of 4.9 km within the urban area [Rauh W. 2010, p.22] the result is € per car-km respectively so called PCU-kilometres (PCU = person car unit[7]):

It can be recognized that up to a modal share of 18% car travel can be expected to contribute positively to agglomeration effects. Above that level the negative effects of increasing congestion prevail.

4 CONCLUSION

4.1 Short term effects of urban car travel on agglomeration benefits

According to the above result, the marginal effect per additional car-commuter per year on productivity in Vienna can be estimated under minimum-assumptions as a loss of about 5000 Euro in economic output.[8] The annual benefit with regard to productivity which could be gained per year per commuter changing from car to other means of transport would be slightly less than the mentioned amount. Walking, cycling, tram and bus traffic can cause delays and related loss of agglomeration benefits too but it is more than one order of magnitude less than it is for car traffic [Rauh W., 2010, p.24].

Marginal external congestion cost caused by car traffic in Vienna can be estimated at more than 4000 Euro per commuter per year [Rauh W., 2010, p.24].[9] It can be assumed that this amount is partly contained in the beforementioned losses of agglomeration benefits as far as business travel and commercial freight traffic is affected.

4.2 Long term effects of urban car travel on agglomeration benefits:

It could be rewarding to do additional research in the long term effects of car traffic on urban density and on the resulting effects on agglomeration benefits. The point where the contribution of car traffic to productivity turns negative – about 18 percent of transport performance in present-day Vienna – could be moved to higher percentages if density were reduced. This is a tendency that happens “naturally” by the process of suburbanisation. By reducing density the city adapts to a higher traffic load to reach a new optimum of

[7] In traffic enginieering every type of vehicle, depending on its space requirements, is attributed a certain number of PCU

[8] 230 workdays per year, loss of 10.9 Euro caused by reduction of productivity per additional car-trip to or from work at peak time. = 2 * 230 * 10.9 = 5014 Euro per year.

[9] The exact result would be 4481 Euro if the data from 2010 is updated for inflation.

accessibility and hence effective size of the labour market.[10] Even if this new optimum is higher than it was at the original density with above-optimum traffic load, it is still lower than it would have been with reduced traffic load at the original density [Rauh W., 2008, page 42]. Long term adaptation of urban densitiy can slightly reduce the loss of agglomeration benefits by above-optimum car traffic. What is excluded from this consideration apart from environmental cost is also the additional private and taxpayers cost incurred for longer travel distances and the higher cost of infrastructure to serve lower density settlement structures.

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6 ANNEX

6.1 List of labels and constant values

Constant/ Label	Description
1,085	actual number of car trips per head of population per workday in Vienna
185	actual size of the gross regional product in € per head of population per workday in Vienna
58%	actual modal share of person kilometres travelled by car in Vienna
6%	actual estimate for the elasticity of GRP with regard to L
CPH	number of car trips per head of population per workday in Vienna
GRP	gross regional product in € per head of population per workday
ε	elasticity of the gross regional product with regard to the effective size of the labour market.
L	indicator for the effective size of the labour market in km^2/h^2
Mc	modal share of car trips (based on number of trips)
mc	modal share of person kilometres travelled by car
MRP	marginal agglomeration effect on gross regional product in € per additional car trip
Vc	average speed of travel from door to door by car in kilometres per hour.
Vp	average speed of travel from door to door by other means of transport in kilometres per hour.

[10] This can be interpreted as a market process whereby residents and businesses gradually move to areas on the fringes of the city where they experience less congestion and higher resulting level of accessibility.

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🏆 *reviewed paper*

Radfahren auf realen und virtuellen Flächen – Das NRVP-Projekt Cape Reviso

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1 ABSTRACT

Das durch den Nationalen Radverkehrsplan (NRVP) vom Bundesministerium für Verkehr und digitaler Infrastruktur (BMVI) geförderte Verbundprojekt Cape Reviso (Cyclist And PEdestrians on REal and VIrtual Shared rOads) befasst sich mit der Problematik, welche möglichen Konflikte Fußgängerinnen, Fußgänger, Radfahrerinnen und Radfahrer im täglichen Verkehr ausgesetzt sind. Ziel ist es, Optimierungsstrategien für Führungsformen und Knotenpunkte durch Erfassung des gegenwärtigen Zustandes und Simulationen von Variationen in Living Labs zu entwickeln. Der Ansatz verfolgt Methoden im realen und virtuellen Raum. Die aus den Erkenntnissen entwickelten Werkzeuge und Empfehlungen für eine moderne Stadt- und Verkehrsplanung sollen helfen, durch gute Infrastruktur die Attraktivität des Zu-Fuß-Gehens und Radfahrens zu steigern, speziell vor dem Fokus der Reduktion von Stress und Konflikten. Oftmals bilden diese eben ein persistierendes Hemmnis in der Gruppe der unentschlossenen Radfahrerinnen, Radfahrer, Fußgängerinnen und Fußgänger. In der Realität bleiben gefährliche und Stress auslösende Knotenpunkte und Führungsformen oft unerkannt, da die Unfallzahlen in einem Erhebungsgebiet zu gering sind. Die zu entwickelnden Werkzeuge zielen daher darauf ab, Situationen und Orte zu erfassen und zu messen, in denen Radfahrende und Zu-Fuß-Gehende sich subjektiv unsicher fühlen (Stress empfinden) oder es zu gefährlichen Situationen (Beinahe-Unfällen) kommt. Zielgruppe des Projektes sind nicht ausschließlich Stadt- und Verkehrsplanerinnen sowie Stadt- und Verkehrsplaner. Die entwickelnden Werkzeuge sind quelloffen und verhältnismäßig günstig. Sie können so nicht nur von Kommunen für die Planung, sondern auch von Initiativen und Verbänden eingesetzt werden, um sich für sichere Verkehrsbedingungen einzusetzen. Um breite Zielgruppen mit den Projektergebnissen anzusprechen, werden die entwickelten Werkzeuge direkt angewendet und aus dieser Anwendung allgemeingültige Empfehlungen abgeleitet. Beispielhaft werden in diesem Beitrag erste Ergebnisse aus der freiwilligen Messkampagne mit dem OpenBikeSensor (OBS) in Stuttgart sowie erste Analysen des Straßennetzwerkes mit „Space Syntax“ vorgestellt.

Keywords: living labs, sensoring, virtual reality, Zu Fuß Gehen, Radfahren

2. EINLEITUNG

Urbane öffentliche Verkehrsräume unterliegen ständigem Wandel: temporär durch Baustellen oder Verkehrsteilnehmerinnen und Verkehrsteilnehmer, praktisch durch Nutzungsansprüche verschiedenster Teilnehmerinnen und Teilnehmer und politisch, wie "Verkehrsplanung" in den Städten und Gemeinden betrieben werden soll. Gemein ist dieser Tatsache, dass der knappe Verkehrsraum in Städten zwischen allen Verkehrsteilnehmerinnen und Verkehrsteilnehmern aufgeteilt werden muss, oftmals kann er nur gemeinsam genutzt werden. Die Wahl des Verkehrsmittels hängt neben den Faktoren wie Kosten und Wegzeit auch davon ab, ob Mobilität als angenehm oder unangenehm empfunden wird. Potentielle Konflikte entlang des Weges und subjektiv empfundener Stress beeinflussen die Wahl. Fuß- und Radverkehr kann nur dann sinnvoll gefördert werden, wenn die Planenden sich dieser Konflikte bewusst sind, und sie diese in Hinblick auf die Nutzungsmuster der besonders schwachen Verkehrsteilnehmerinnen und Verkehrsteilnehmern reduzieren. Die Analyse offizieller Unfallzahlen mit der Beteiligung von Radfahrerinnen, Radfahrern, Fußgängerinnen und Fußgängern ist aufgrund der geringen Fallzahlen oftmals schwierig. Nach DESTATIS (Statistisches Bundesamt DESTATIS, 2021) liegen in den Partnerkommunen im Jahr 2017 nur 50 gemeldete Unfälle zwischen Radfahrerinnen, Radfahrern, Fußgängerinnen und Fußgängern mit Verletzten in Stuttgart (16), Karlsruhe (34) und Herrenberg (0) vor. Während bei statistisch relevanten Unfallhäufungen an einer Stelle Maßnahmen ergriffen werden können, bleiben gefährliche und konfliktreiche Knotenpunkte und Führungsformen oft unerkannt und bilden ein persistierendes Hemmnis für unentschlossene Radfahrerinnen, Radfahrer, Fußgängerinnen und Fußgänger.

Das in diesem Projekt vorgeschlagene Verfahren zielt auf eine Verbesserung von Knotenpunkten und Führungsformen in der Schnittstelle zwischen dem Rad- und Fußverkehr durch Erfassung der Verkehrssituation mit Machine Learning und Humansensorik in der Realität und durch Simulation zukünftig geplanter Varianten mit Menschen als Probandinnen und Probanden in der virtuellen Realität (VR) und im Living Lab.

3. STAND DER FORSCHUNG

Im folgenden Kapitel werden schlaglichtartig einige der wichtigsten Quellen im Kontext von Zu-Fuß-Gehen, Radfahren, der Detektion von subjektivem Sicherheitsempfinden und der Dokumentation von Beinaheunfällen kurz angerissen.

3.1. Radfahren

Der Radverkehrsanteil in Deutschland soll in den nächsten Jahren kontinuierlich erhöht werden, auch durch den Ausbau der Fahrradinfrastruktur, beschlossen im Nationalen Radverkehrsplan 3.0 (BMVI, 2021). Jedoch zeigen Studien, dass gerade das fehlende Sicherheitsempfinden viele Menschen davon abhält, auf das Rad umzusteigen. Dieser Trend verstärkt sich in Städten mit einem geringen Radverkehrsanteil (Horton, 2007; Hull und O'Holleran, 2014; Thornton et al., 2011; Wang et al., 2014). Das subjektive Sicherheitsempfinden verschiedener Nutzungsgruppen sollte dementsprechend im Planungsprozess – nicht nur bei Radverkehrsanlagen – mehr Beachtung finden. Einige Radfahrexpertinnen und Radfahrexperten wie Graf (2016) empfehlen mittlerweile sogar die „Reduzierung von Stress" im Radverkehr als einen wesentlichen Faktoren zur Steigerung des Radverkehrsanteils (Graf, 2016). Alrutz et al. (2009) identifizierten große bauliche Unterschiede der Radverkehrsanlagen als einen der Hauptfaktoren auf das subjektive Sicherheitsempfinden. Die Integration von „Stressmessungen" beim Radfahren sind u. a. die Emocycling-Ansätze (Groß und Zeile, 2016; Höffken et al., 2014), die neben biostatistischen Messungen auch videobasiert Radfahrten auswerten. Negativ wie bei anderen videobasierten Studien ist die lange Auswertungszeit der Videos (Götschi et al., 2018; Groß, 2015; Schleinitz et al., 2015). Weitere Studien legen den Fokus stärker auf den Ansatz der mobilen Partizipation (Lißner und Francke, 2017; Werneke, Dozza, und Karlsson, 2015). Das UK Near Miss Project versuchte sich der Problematik analog zu nähern, indem durch Wegetagebücher Beinahe-Unfälle in Verbindung mit Verkehrsverhalten und infrastrukturellen Bedingungen dokumentiert wurden (Aldred, 2016; Aldred et al., 2018).

3.2. Zufußgehen

Im Kontext der Alltagsmobilität werden rund 95 % der Kurzstrecken unter 100 Metern zu Fuß zurückgelegt (Schwab et al., 2012), jedoch wurde das „Zu-Fuß-Gehen" als Verkehrsmittel lange Zeit noch nicht ernsthaft berücksichtigt und auch nicht gemessen (Sauter und Wedderburn, 2008). Dieser Aspekt ändert sich langsam, aber es mangelt immer noch sowohl an Sensibilität, politischem Willen, als auch an geeigneten Methoden für die Bewertung des Zu-Fuß-Gehens: Es fehlten, wie auch im Radverkehr, verlässliche Daten, die die Gründe der Entscheidung für das „Gehen" auch unter Berücksichtigung subjektiver Wahrnehmung und Emotionen miteinbeziehen (Ma, 2000). Ein Hilfsmittel zur Identifizierung von „Fußgängerfreundlichkeit" ist die sogenannte „Walkability", die versucht mithilfe quantitativer und qualitativer Aspekte das Gehen in Städten zu bewerten. Die verschiedenen Konzepte sowie eine kritische Bewertung inklusive des Überblicks über eingesetzte Methoden ist bei Dörrzapf et al. (2019) zu finden sowie als Methodenkanon im städtebaulichen Kontext bei Gehl (2011) und Flückinger & Leuba (2015). Neben Audit-basierten Ansätzen (z. B. bei Giles-Corti und Donovan, 2002; Pikora et al., 2003) wird auch die Zuhilfenahme von Sensoren empfohlen.

3.3. Sensoren und digitale Tools

Zur Detektion von Beinaheunfällen, subjektiver Sicherheit und negativer Erregungen – vulgo "Stress", wird der Einsatz unterschiedlicher Sensoren vorgeschlagen: seien es stationäre Sensoren zum „Dynamic Scene Understanding" (Buxton, 2003) bzw. zur automatisierten Detektion und Klassifikation von Zufußgehenden (Romero-Cano, Agamennoni und Nieto, 2016), mobile Sensoren wie GPS-Empfänger oder Mikrofone zur Erfassung von Geräuschen (Maisonneuve, Stevens und Steels, 2008), Lichtintensität und Farbe (Gutierrez-Martinez et al., 2017; Harari et al., 2016), Schadstoffkonzentrationen via USB-Schnittstelle (Schäfer et al., 2017) oder eben biostatistische Sensoren (Kanjo, Al-Husain und Chamberlain, 2015; Kreibig et al., 2007; Kyriakou und Resch, 2019; Osborne und Jones, 2017). Ein weiteres Werkzeug ist die Space Syntax Analyse, eine räumliche Netzwerkanalyse bzw. geometrische Erreichbarkeitsanalyse, basierend auf der Graphentheorie (Hillier, 2007). Die Methode beschreibt und quantifiziert, wie gut (öffentlicher) Raum bzw.

Straßen- und Wegenetzwerke zugänglich und navigierbar sind, indem sie konfigurative Beziehungen der gebauten Umwelt berechnet (Dembski, 2020, S. 31; Yamu et al., 2021).

Für die mikroskopische Untersuchung von Verkehrsströmen kann auf die Open-Source-Software SUMO (Simulation of Urban MObility, Deutsches Zentrum für Luft- und Raumfahrt) zurückgegriffen werden (Alvarez Lopez et al., 2018), die sowohl intermodale Verkehrsmodelle, Modellentwicklungen als auch eine Schnittstelle zur Simulator-Kopplung anbietet. Über das modulare Open-Source-Visualisierungssystem COVISE (COllaborative VIsualization and Simulation Environment, Höchstleistungsrechenzentrum Stuttgart), das für die kollaborative Visualisierung von Daten in virtuellen Umgebungen sowie auf dem Desktop entwickelt wurde, werden die digitalen Modelle visualisiert und Simulationen sowie andere Daten integriert. Die Architektur von COVISE ermöglicht es Entwicklern, die vorhandene Funktionalität durch die Integration von neuen Codes als Module zu erweitern. In einem visuellen Application Builder werden diese Module zu einem Datenflussnetz verbunden (Dembski, Wössner, und Letzgus, 2019, S. 7). Am Ende der Pipeline befindet sich ein Render-Modul, das entweder ein Desktop-Renderer oder das VR-orientierte Render-Modul OpenCOVER sein kann. COVISE bietet bereits Lesemodule zum Einlesen von Ergebnissen aus unterschiedlichen Simulationen und die vorhandenen Module können zur Visualisierung von Geometrie, Schnittflächen, Isoflächen, Stromlinien usw. verwendet werden. In früheren Projekten wurden auch Module entwickelt, um Space-Syntax-Daten einzulesen, die georeferenzierten Daten zu projizieren und 2D-zu 3D-Modellen zu verarbeiten (ibid), was die Darstellung verbessert und in VR verständlicher macht. Alle diese Daten werden dann in OpenCOVER zusammen mit dem 3D-Stadtmodell im digitalen Zwilling gerendert. OpenCOVER basiert auf OpenSceneGraph und unterstützt jede Art von projektionsbasierter VR-Umgebung wie CAVEs (Cave Automatic Virtual Environments), Powerwalls, Domes oder Tiled Displays. Außerdem unterstützt es VR und AR Head Mounted Displays (HMDs). C++-Plugins können für eine Erweiterung der Funktionalität von OpenCOVER programmiert werden. Eine Reihe von Plugins wird entwickelt oder erweitert, um die Daten für dieses Forschungsprojekt zu visualisieren. Großflächige Terrains werden mit Virtual Planet Builder (VPB) oder osgEarth gerendert. Punktwolken aus terrestrischen LIDAR-Scans (Light Detection und Ranging) werden für ein effizientes Rendering in einer Octree-Datenstruktur geordnet. 3D-Stadtmodelle können in verschiedenen Datenformaten geladen werden – zum Beispiel als CityGML oder DXF (ibid).

OpenCOVER ermöglicht nicht nur die 3D-Navigation im virtuellen Modell, sondern auch die Interaktion mit den Visualisierungsmodulen. Durch Farbskalen oder die unterschiedliche Dimensionierung von Tubes (röhrenartige Darstellung), die z. B. die Space-Syntax-Analysen repräsentieren, können Ergebnisse visuell und grafisch nach Belieben angepasst und visualisiert werden.

2 CAPE REVISO – PROJEKTKTZIELE

In „Cape Reviso" werden unterschiedliche Methoden, die aufeinander aufbauen bzw. einander bedingen eingesetzt. Schlagworte hierbei sind Machine Learning, Echtzeit-Humansensorik, zenarienbasierte Fahrsimulation und die Nutzung von digitalen Zwillingen in Virtueller Realität zur Analyse und Reduktion der Konflikte zwischen Radfahrerinnen, Radfahrern, Fußgängerinnen und Fußgängern. Das angestrebte Methoden-Set soll soweit als möglich „offen" vorliegen: Das Projekt soll Nachahmer finden, welche die offene Werkzeugbox nutzen, weitertragen, und in das aktive Methodenrepertoire von Planerinnen und Planern in Kommunen einsetzen. Ähnlich dem Mash-up Gedanken der Web2.0-Ära sollen die Technologien einzeln eingesetzt werden, aber auch als Methoden-Set funktionieren, das Erweiterungen zulässt. Die Entwicklung erfolgt auch unter dem Aspekt, aus dieser ein Werkzeug für die Stadt- und Verkehrsplanung (Planning- and Decision-Support-Tool) ableiten zu können.

2.1 Bausteine in Cape Reviso

Um die sich gegenseitig bedingenden, aber zeitgleich auch individuell einsetzbaren Module im Gesamtkontext des Projektes besser zu verstehen, werden diese im nachfolgenden sowohl hinsichtlich des Einsatzortes, der Komplexität und der Verknüpfung mit anderen Bausteinen näher erläutert (Abb. 1).

Prinzipiell sind die einzelnen Elemente auch solitär einsetzbar, die Stärke liegt allerdings in ihrer Verknüpfung.

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2.1.1 Unfallatlas

Einen ersten Überblick bietet der vom Statistischen Bundesamt veröffentlichte Unfallatlas (Statistisches Bundesamt DESTATIS, 2021), der alle Unfälle mit Personenschaden für jedes Jahr geografisch als auch in Straßenabschnitten verortet. Über die tatsächliche Zahl der Unfälle als auch der Beinaheunfälle gibt das Planwerk keine Auskünfte, da alleinige Sachschäden nicht in die Statistik aufgenommen werden. Die Datensätze der Jahre 2016-2019 sind im csv- und shp-Format frei verfügbar (Statistisches Bundesamt DESTATIS, 2021a) und geben in aggregierter Form einen ersten Überblick, wo Unfälle mit Radfahrerinnen, Radfahrern, Fußgängerinnen und Fußgängern stattgefunden haben.

2.1.2 .Netzwerkanalyse mit OBS und Space Syntax, angereichert mit biostatistischen Daten

Ein Kernelement ist die „Abstandsmessung“ der Probandinnen und Probanden zu anderen Verkehrsteilnehmerinnen und Verkehrsteilnehmern. Dafür wird der sogenannte OpenBikeSensor verwendet, der als offene Sensor-Plattform konzipiert wurde (GitHub, 2021; OpenBikeSensor, 2021). Durch Ultraschallsensoren wird fortlaufend der physische Abstand zu anderen Verkehrsteilnehmerinnen und Verkehrsteilnehmern gemessen und georeferenziert gespeichert. Pate für den OBS ist der Radmesser (Tagesspiegel, 2018). Konzipiert ist dieser für die Nutzung am Fahrrad, jedoch ist durch die offene Bauweise auch die Kombination mit einem Rucksack für Fußgängerinnen und Fußgänger in Konzeption. Durch die Aggregation aller Datensätze können Bereiche identifiziert werden, in denen Überholvorgänge unter 150 cm Abstand vermehrt auftreten.

In Kombination mit den Daten aus der Space Syntax Analyse, gefüttert mit Daten der Verkehrsüberwachung etc. ergeben sich erste Verdachtspunkte für potentielle Hotspots von Beinahe-Unfällen und anderen Konfliktbereichen. Space Syntax eignet sich sehr gut für Analysen von Straßen- und Wegenetzwerken für unterschiedliche Verkehrsmodi, zum Beispiel für Fuß- und Radverkehr oder den motorisierten Individualverkehr. Die Modelle des Status quo können dazu beitragen, das Untersuchungsgebiet für eine eingehendere Analyse zu definieren aber auch zu einem späteren Zeitpunkt die Entwicklung von Szenarien für Living Labs oder längerfristige Interventionen zu unterstützen.

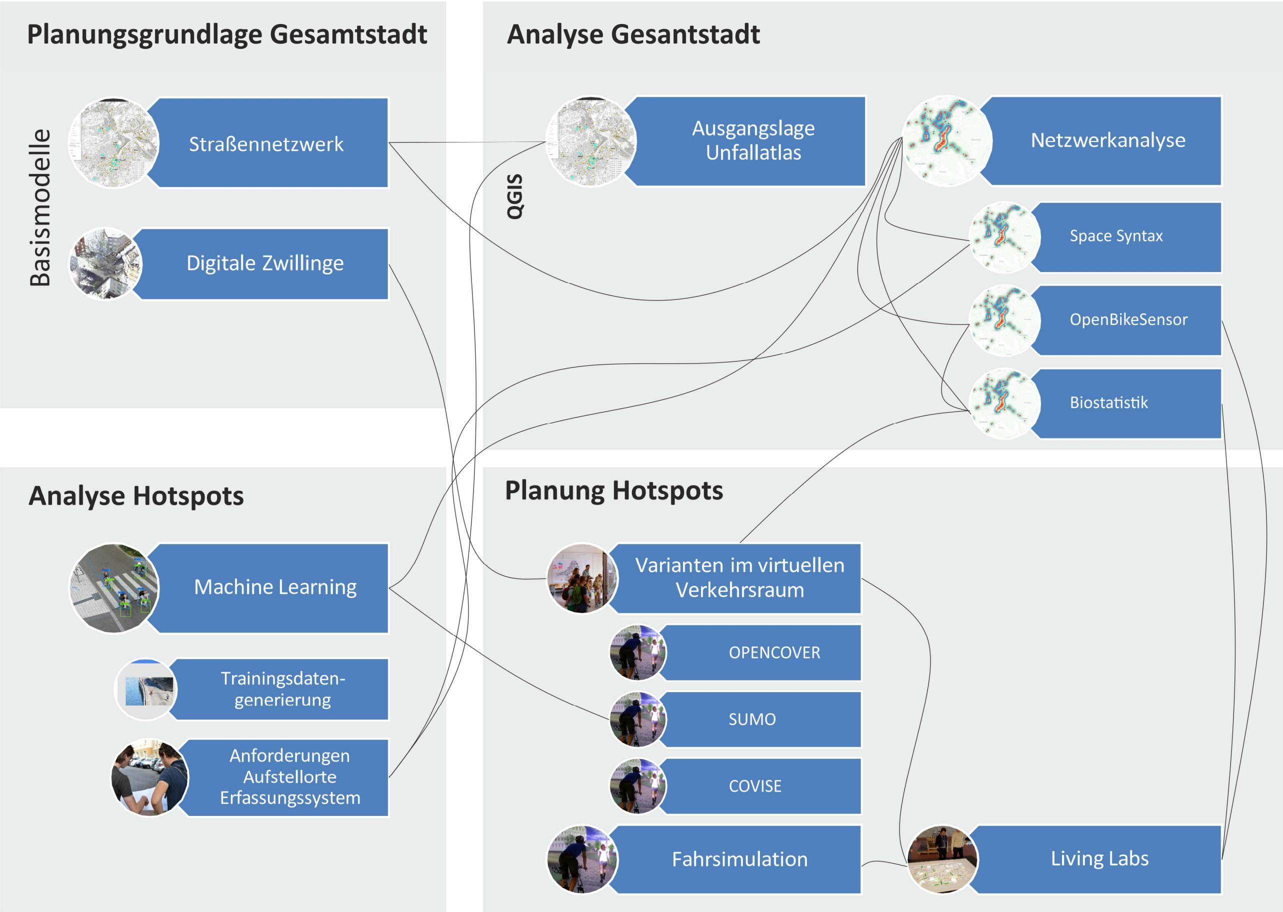

Abb. 1: Bausteine im Cape Reviso Projekt

2.1.3 Machine Learning / Trainingsdatengenerierung

An bestimmten (Beinahe-) Unfall-Hotspots wird mithilfe von stationären Kamerasystemen eine Langzeiterfassung von Videodaten durchgeführt, um der Frage nachzugehen, an welchen Stellen, zu welcher Uhrzeit und wie häufig es zu Konflikten, gefährlichen Situationen oder sogar Unfällen kommt.

Das Kamerasystem analysiert dabei mithilfe neuronaler Netzwerke zur Bilderkennung das Mobilitätsverhalten der Verkehrsteilnehmerinnen und Verkehrsteilnehmer. Der Datensatz soll mithilfe von Crowdsourcing-Methoden über ein eigens dafür eingerichtetes Portal trainiert werden. Die so gewonnenen Trainingsdaten sollen später die Klassifikation der Verkehrsteilnehmerinnen und Verkehrsteilnehmer über anonymisierte Metadaten des Verkehrs erlauben. Im Detail sind dies die Fortbewegungsart bzw. die Kategorisierung der Teilnehmerinnen und Teilnehmer (Fahrrad, Zu Fuß Gehende, Roller, Rollstuhl, Person mit Kinderwagen, etc.), deren Geschwindigkeit sowie Beschleunigung bzw. Bremsrate, ihre Trajektorien und ihr Abstand zu anderen Verkehrsteilnehmerinnen und Verkehrsteilnehmer. Durch die schon auf dem Kamerasystem intern erfolgte Auswertung werden keine Videoaufnahmen oder personalisierte Daten gespeichert, sondern nur Metadaten die datenschutzrechtlich unbedenklich sind. Langzeitziel ist die Erfassung dieser Daten über den Zeitraum eines Jahres, sodass Effekte wie unterschiedliche Witterung (Regen, Schnee, Glätte), die Koinzidenz von Dämmerung oder Dunkelheit mit den Hauptverkehrszeiten, die Änderung im Modalsplit im Jahresverlauf und weitere jahreszeitliche Phänomene untersucht werden können.

2.1.4 Digitale Zwillinge

In den digitalen Zwillingen werden die Daten aus der Netzwerkanalyse (OBS, Biostatistische Auswertungen, Space Syntax) gesammelt und in bestehende 3D-Stadtmodelle integriert. Diese werden in der CAVE als immersive Umgebung mit einem Fahrradsimulator „befahren“ und getestet. Durch die SUMO-Schnittstelle wird anhand der Beobachtungen bzw. der Daten der Kamerasysteme ein realitätsnaher Verkehrsfluss mit allen am Verkehr Beteiligten simuliert. Gleichzeitig werden die Probandinnen und Probanden biostatistisch auf eventuell auftretende Stress-Situationen überwacht. Neuralgische oder in der Realität potentiell gefährliche Stellen werden im digitalen Zwilling in verschiedenen, „sichereren“ Varianten planerisch geprüft, in iterativen Prozessen auf die Stressreaktionen der Nutzerinnen und Nutzer hin getestet und entsprechend optimiert. Die besten so entwickelten Szenarien werden in den Living Labs im realen Raum (temporär) umgesetzt.

2.1.5 Living Labs

Durch die Umsetzung einzelner Szenarien im Living Lab sollen die Auswirkungen der planerischen Veränderungen aus der digitalen Welt in der realen Welt untersucht und verifiziert, sowie wiederum als iterative Schleife zur Anreicherung des Machine Learning Algorithmus des Systems zur automatischen Verkehrserfassung untersucht und verglichen werden. Als temporäre räumliche Interventionen sind z. B. die farblich-grafische Gestaltung öffentlicher Flächen (Straßenraum, Parkplätze, Geh- und Radwege etc.), temporäre Stadtmöblierung, oder Absperrungen (z.B. mittels Leitkegeln) angedacht.

3 ERSTE ERGEBNISSE

Die COVID-Pandemie beeinträchtigte den Start des Projektes, da direkter Kontakt zwischen Forschenden und Probandinnen und Probanden – Radfahrenden und Zu-Fuß-Gehenden – dafür notwendig ist. Begleitende Workshops, wie der zum Bau des OpenBikeSensors, konnten bisher nur online als „Inkubatorenworkshops“ durchgeführt werden.

3.1 Unfall-Atlas

Eine erste gesamtstädtische Analysemöglichkeit zur Detektion der Häufungen von Unfällen ist der Unfallatlas des Statistischen Bundesamtes DESTATIS. Dort werden Unfälle mit Personenschaden nach Kalenderjahren erfasst. Ein Nachteil dieser Datensätze ist allerdings, dass Unfälle, bei denen nur Sachschaden entsteht, nicht abgebildet werden. Der Atlas ermöglicht eine erste Übersicht über Stellen, an welchen Konflikte auftreten können, da neben Unfallort und -häufigkeit in Straßenabschnitten auch Attribute zur Unfallkategorie (Art und Anzahl der Verunglückten), Unfallart (z.B. Zusammenstöße oder Abkommen von der Fahrbahn), Unfalltyp (Fahrunfall, Abbiegeunfall etc.) sowie Angaben zu „Arten der Verkehrsbeteiligten“ auch separat erfasst werden (Statistisches Bundesamt DESTATIS, 2021b).

Als offene Datensätze liegen Informationen zu den Jahren 2016 bis 2019 vor. Diese werden für eine erste Übersicht in der Open-Source-GIS-Software QGIS aggregiert bzw. zusammengeführt. Im Projektgebiet mit den Arealen der Städte Karlsruhe, Herrenberg und Stuttgart sind für den Zeitraum von 2016 bis 2019 insgesamt 22.848 Unfälle mit Personenschäden registriert worden (davon mit Fußgängerinnen und Fußgängern 2134, mit Radfahrerinnen und Radfahrern 5736). Fokussiert auf die Stadt Stuttgart (7853 gesamt, 966 Fuß, 1693 Rad) ergibt sich je nach Unfallbeteiligten ein differenziertes Bild der Unfall-Hotspots:

Sind im Gesamtstadtgebiet die absoluten Unfälle sehr konzentriert auf die Hauptverkehrsadern wie B10, B27 und B14, so sind die Hotspots für den nicht motorisierten Verkehr heterogener verteilt. Ein für die städtebauliche Entwicklung interessanter Raum ist der Marienplatz (s. Abb. 2). Dort findet eine Vielzahl von Verkehrsmittelwechseln statt, er ist urbaner Aufenthaltsort, teilweise Fußgängerzone und liegt an der Hauptfahrrad-Route 1. Herzog (2021) fordert in ihrer Studie über den Marienplatz, dass mehr Platz für Radfahrende und Zu-Fuß-Gehende Stress reduzieren wird. Diese Aussagen sind jedoch mithilfe des Datensatzes von DESTATIS nicht quantifizierbar.

Bei den im Unfallatlas erhobenen Daten handelt es sich, wie weiter oben erwähnt, um Situationen, in denen Unfalldaten mit Personenschäden verzeichnet sind. Für eine Unfallprävention sind aber auch die Konfliktsituationen interessant, die nicht (aktenkundig) aufgenommen werden. Unfälle ohne Personenschaden als auch Beinahe-Unfälle zwischen nicht motorisierten Verkehrsteilnehmerinnen und Verkehrsteilnehmern werden in vielen Fällen nicht zur Anzeige gebracht. Diese Ereignisse und Orte gehen nicht in die Statistik ein. So können die Konflikte quantitativ nicht als Grundlage für die Planung von Straßen, Geh- und Radwegen oder andere öffentliche Flächen integriert werden (vgl. Statistisches Bundesamt B, 2016). Klassische Konfliktsituationen z.B. auch zwischen Radfahrerinnen, Radfahrern, Fußgängerinnen und Fußgängern – insbesondere an Orten, wo wenig Fläche bereitsteht oder die Verkehrsführung sich abrupt ändert – müssen also anders erfasst werden.

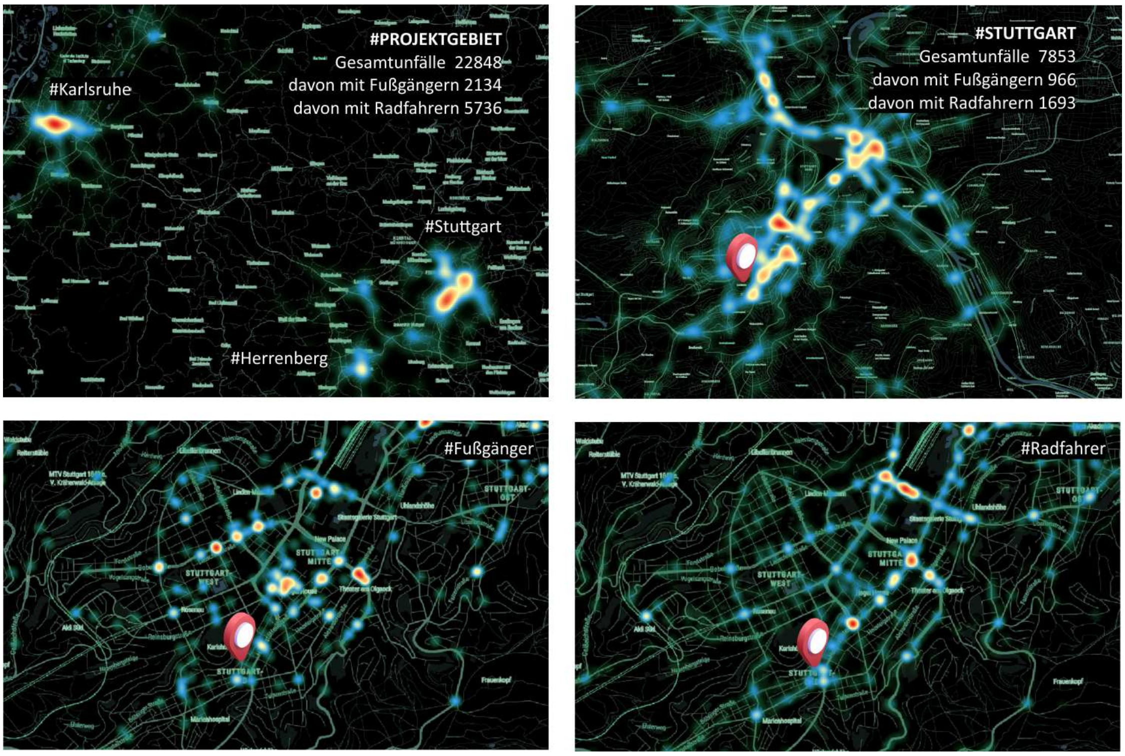

Abb. 2.: Aus Opendata generierte Übersichten der Unfallhotspots im Untersuchungsraum aus den Jahren 2016-2019, Marienplatz in Stuttgart mit Pin markiert

3.2 OBS

Wie schon oben erwähnt, wurden die OpenBikeSensoren (OBS) im Rahmen von Inkubatoren-Workshops gebaut. Die Gehäuse liegen als freie Geometriedateien zum 3D-Druck vor, ebenso die Bauteilliste für den OBS (Github 2021). Durch die Community wurden mittlerweile zwei Gehäusetypen bzw. Anbringungsmöglichkeiten entwickelt – für die Sattelstütze und das Oberrohr des Fahrades (s. Abb. 3).

Mithilfe zahlreicher freiwilliger Nutzerinnen und Nutzer konnten im ersten Projekthalbjahr Daten auf über 6.000 km Strecke gesammelt werden.

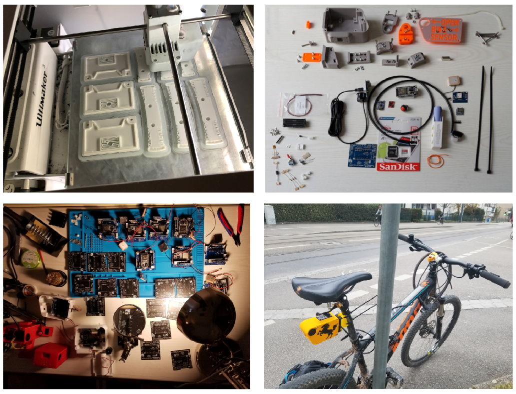

Abb 3.: Aus STL-Dateien geplottetes Gehäuse des OBS, Bauteile und Montage des Sensors sowie angebrachter Sensor inklusive Display (in Gelb) am Fahrrad.

Die durch den OBS gesammelten Daten liefern interessante Informationen bezüglich der Radverkehrsnutzung und der Situation für Radfahrerinnen und Radfahrer vor Ort und in Bewegung. Der Sensor misst neben der Position kontinuierlich auch die „Weite des Raumes“ links und rechts der radfahrenden Person. So werden die Abstände zu anderen Verkehrsteilnehmerinnen und Verkehrsteilnehmern aufgezeichnet. Außerdem können „gefühlte“ Abstände bzw. subjektiv zu knappes Vorbeifahren oder Überholen (unter 150 cm) durch Nutzerinnen und Nutzer mit Hilfe eines am Steuersatz bzw. Display angebrachten Knopfes verifiziert werden.

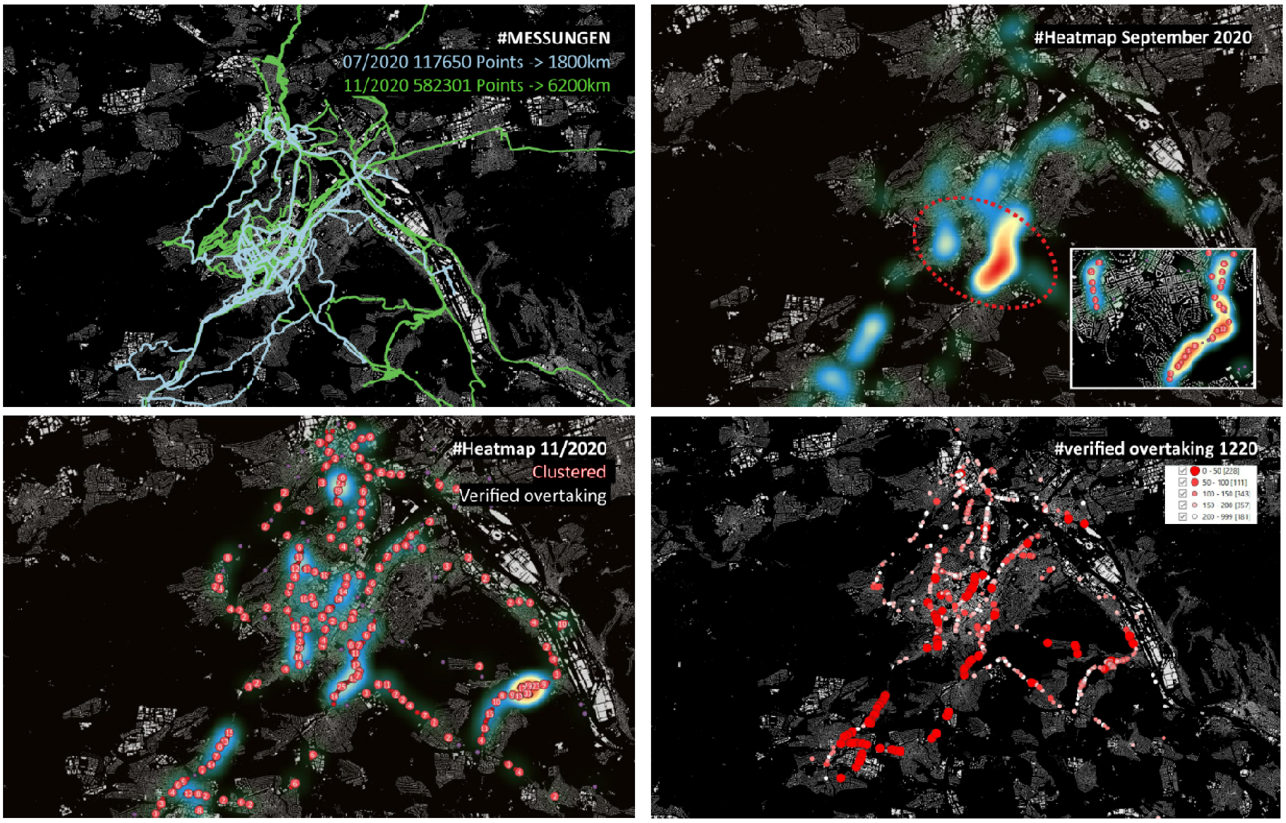

Abb. 4: Aus den Messungen des OBS generierte Informationen zum Gesamtmesssatz: Schwerpunkte der nahen Überholvorgänge im September 2020, Schwerpunkte mit Clusteranzahl im November 2020 sowie die gemappten Situationen, in denen Überholvorgänge unter 150 cm stattgefunden haben.

Insgesamt wurden mehr als 600.000 Punkte bis Dezember 2020 im Untersuchungsgebiet eingemessen. Aus den bestätigten „nahen Überholvorgängen“ konnten so im September von 419 aufgenommenen Überholvorgänge 244 Überholvorgänge unter 150 cm detektiert werden. Hotspots waren bis dahin die „Neue Weinsteige“ und der Bereich der Schickhardstraße / Schreiberstraße / Karl-Kloß-Straße. Im November zeigt sich ein anderes Bild: Im Bereich der Hedelfinger Filderauffahrt konzentrierten sich die „Near-Passbies“, im

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übrigen Stadtgebiet kamen neue Punkte hinzu – insgesamt 1.220. Durch eine differenziertere Sichtweise sind auch Klassen der Abstandsmessungen ablesbar, von den 1.220 total registrierten Punkten waren 228 in der Klasse von 0-50 cm, 111 in 50-100 cm, 343 zwischen 100-150 cm, die restlichen Punkte (357 in 150-200 cm, sowie 181 >200 cm) befinden sich außerhalb des gesetzlichen Mindestabstands bei Überholmanövern, sind aber als „nahe Manöver“ empfunden worden und klassifiziert, und dementsprechend auch zu berücksichtigen. Gerade auf Straßen mit Geschwindigkeiten über 50 km/h wirken starke Seitenkräfte auf Radfahrende ein (Gromke und Ruck, 2021), sodass zumindest das subjektiv empfundene Sicherheitsgefühl negativ beeinträchtigt werden kann.

3.3 Space Syntax

Mit Space Syntax Analysen kann auf Basis von Geoinformationsdaten das „Potential Through-Movement“ (Durchgangspotenzial des Wegenetzwerkes einer Stadt) – wie in diesem Fall für Stuttgart – analysiert werden. Potential Through-Movement (Hillier et al., 1987) referenziert auf die Bewegung beim Zurücklegen der kürzesten Routen – von jedem beliebigen Ausgangsort zu allen anderen Orten in einem Netzwerk bzw. im gesamten System oder innerhalb eines vorgegebenen Radius. Mit dem Maß „Choice“ wird das Durchgangspotenzial berechnet bzw. prognostiziert (Dembski et al., 2019, S. 45.).

Abb. 5: Die globale Analyse des Straßennetzwerks in Stuttgart für Fahrradfahrerinnen und Fahrradfahrer des Status quo (Mai, 2021; NACH (Normalised Angular Choice) Radius N). Anmerkung: Die Normalised Angular Choice (NACH) ist sozusagen eine „korrigierte Form“ des Space-Syntax-Maßes der Choice.

Dies lässt Rückschlüsse auf die Zentralität in Netzwerken zu (siehe Abb. 5), insbesondere der „Betweenness Centrality“ – einem Maß zur Quantifizierung der Wahrscheinlichkeit, mit der ein Straßensegment auf einen zufällig ausgewählten kürzesten Pfad fällt, der ein beliebiges Paar von Segmenten verbindet. Mathematisch gesehen bedeutet dies effektiv dasselbe wie das Space-Syntax-Maß der „Choice“ (Freeman, 1977, p. 37; Hillier und Iida, 2005).

Mit Space Syntax wurde so der Status quo (Stand: 2021) des für Fahrradverkehr geeigneten Straßennetzwerks analysiert. Die Ergebnisse zeigen die unterschiedliche zu erwartende potenzielle Nutzung von Wegen bzw. Straßen und ihrer Segmente. Der Einfluss der Verkehrsplanung der zweiten Hälfte des 20. Jahrhunderts ist auch im Netzwerk für Fahrradfahrerinnen und Fahrradfahrer stark erkennbar (Abb. 5): Entlang der von Autos stark befahrenen Hauptstraßen ist auch die Zentralität bzw. das Durchgangspotenzial (Potential Through-Movement) im Radwegenetzwerk am höchsten. Dies deutet auf hohes Konfliktpotenzial hin, oder darauf, dass die Zentralität und damit die mathematische Wahrscheinlichkeit hoch ist die Wege zu nutzen, aber aufgrund der Gefahren durch den Autoverkehr von Radfahrerinnen und Radfahrern auf weniger zentrale oder ideale Routen ausgewichen wird.

In einem weiteren Schritt sollen auch die Netzwerke für den Fußverkehr sowie den motorisierten Verkehr berechnet und anschließend zur genaueren Analyse – auch hinsichtlich potenzieller Konfliktsituationen und zur Analyse der Routenführung – gegenübergestellt bzw. überlagert werden.

Die Space Syntax Analysen werden mit depthmapX erstellt – einer Multiplattform-Software für räumliche Netzwerkanalyse auf unterschiedlichen Maßstäben. Die Software wurde ursprünglich von Alasdair Turner von der Space Syntax Group als Depthmap entwickelt und ist jetzt open source verfügbar (https://www.ucl.ac.uk/bartlett/architecture/research/space-syntax/depthmapx).

4 AUSBLICK UND FAZIT

In weiterer Folge sollen die unterschiedlichen Space Syntax Modelle mittels einer Kombination aus GRASS-GIS Toolkits zur Datenverarbeitung der georeferenzierten Ergebnisse (als Vektoren bzw. Straßensegmente) und digitalen Geländemodelle (Raster/Höhenmodell) in ein 3D-Modell umgewandelt werden. In COVISE und OpenCOVER Virtual Environment Renderer können die Daten extrudiert und farblich codiert für die Nutzung im 3D-VR Modell visualisiert werden (Dembski, Wössner & Letzgus, 2019).

Parallel dazu sollen die Ergebnisse aus Machine Learning integriert und Space Syntax auch zur Unterstützung bei der Szenarienentwicklung und für Planungsvarianten eingesetzt werden – zum Beispiel für die Analyse bzw. Prognosen bei Änderung der Wegeführung oder Umgestaltung von Plätzen. Zusätzlich sollen nach Ende der Kontaktbeschränkungen die Daten der Emotionsdetektion bei Radfahrenden integriert werden. Außerdem ist auch ein Experiment mit einem abgewandelten OpenBikeSensor für Zu-Fuß-Gehende (die Abstandssensoren werden in einen Rucksack integriert) geplant. Alle Erkenntnisse werden dann in die digitalen Zwillinge integriert, virtuell auf dem Fahrradsimulator getestet wie im Experiment von Zeile & Resch (2018) vorgeschlagen.

Inhaltlich wird einer der nächsten Schritte sein, Korrelationen zwischen Near-Passbies und Tempo 50 und Tempo 30 Strecken zu ermitteln. Insbesondere aufgrund der in §45 StVO limitierten Möglichkeiten einer Tempo 30-Anordnung (vgl. VCD 2018, Bundesgesetzblatt 2013) könnte die vorgeschlagene Methode eine Grundlage zur Ableitung von Argumentationssträngen sein, um die Umwidmung aufgrund von Gefährdungspotenzial von Radfahrern auf Tempo 50- Straßen in Tempo 30-Zonen zu vereinfachen.

Die hier beschriebenen Bausteine und die schon erzielten Ergebnisse sind vielversprechend als ergänzendes Werkzeug im planerischen Methodenkanon bezüglich Fuß-und-Radverkehrsplanung. Sie sind frei verfügbar, und werden durch eine dynamische Community auch kontinuierlich weiterentwickelt.

5 DANKSAGUNG

Das Projekt Cape Reviso (Cyclist And PEdestrians on REal and VIrtual Shared rOads) wird vom Deutschen Bundesministerium für Verkehr und Digitale Infrastruktur BMVI im Rahmen des Nationalen Radverkehrsplans(NVRP) 2020 unter den Förderkennzeichen VB2013A-C gefördert und vom Bundesamt für Güterverkehr BAG, Team Radverkehr, durch Manuel Hundt betreut. Weitere Informationen sind unter https://nationaler-radverkehrsplan.de verfügbar.

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Raumplanerische Steuerungsansätze für Photovoltaik-Freiflächenanlagen

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1 ABSTRACT

Der Ausbau der Photovoltaik spielt eine zentrale Rolle zur Erreichung von Österreichs Ziel, bis zum Jahr 2030 durch Ausbau der Produktionskapazitäten für erneuerbare Energie um insgesamt 27 TWh eine 100 % Versorgung (national bilanziell) mit Ökostrom sicherzustellen. Dabei wird für den PV-Ausbau auf Freiflächen in Österreich bis 2030 ein Flächenbedarf von 75 bis 100 km² erwartet. Dies stellt zweifellos eine große Herausforderung für die nachhaltige Raumentwicklung sowie ein starkes Potenzial für Landnutzungskonflikte dar.

Zur Analyse und Weiterentwicklung des Steuerungsinstrumentariums wird ein dreigliedriger Steuerungsansatz dargestellt – Mengensteuerung, Standortsteuerung und qualitative Steuerung – um den Ansprüchen an ein Planungsinstrumentarium gerecht zu werden, die Entwicklung von Photovoltaik-Freiflächenanlagen unter sozialen, ökologischen, technischen und ökonomischen Gesichtspunkten zu optimieren. Damit können, ausgehend von der Legitimation durch eine quantifizierte Zielsetzung und einer Zuteilung auf die Ebene der Planungsträger, Regularien zu Auswahl und Bewertung geeigneter Standorte festgelegt werden und über standort- und anlagenspezifische qualitative Standards eine raumverträgliche Umsetzung dieser Ziele gesteuert werden.

Neue Steuerungsansätze für eine wirkungsvolle Umsetzung der Energieausbauziele bei gleichzeitiger sorgsamer Raumplanung brauchen ein aufeinander abgestimmtes Instrumentarium, das sowohl den Flächenbedarf zur Erfüllung der Ausbauziele, die Standortfestlegung für einzelne Anlagen, als auch die raumverträgliche Ausführung konkreter Projekte zum Steuerungsgegenstand hat. Die Kombination dieser drei Handlungsebe-nen kann eine effektive Erreichung der Energieausbauziele in Verbindung mit einer gesamthaften nachhaltigen Entwicklung unterstützen.

Vorliegender Beitrag basiert in wesentlichen Teilen auf: KOSCHER, R.: Photovoltaik-Freiflächenanlagen in der Raumplanung – Steuerungsansätze zwischen Energiewende und nachhaltiger Raumentwicklung. Wien, 2021.

Keywords: Landnutzungskonflikte, Photovoltaik-Freiflächenanlagen, Energieraumplanung, Österreich, Steuerungsansätze

2 EINLEITUNG

Photovoltaik gehört zu den erneuerbaren Energieträgern, die in Österreich bei der Umsetzung der Energie- und Klimaziele in den nächsten Jahren und Jahrzehnten eine zentrale Rolle spielen werden. Vor dem Hintergrund des europäischen Green Deal hat sich Österreich im aktuellen Regierungsprogramm das Ziel gesetzt, bis zum Jahr 2030 die Produktionskapazitäten für erneuerbare Energie um insgesamt 27 TWh auszubauen, wobei 40 % davon (11 TWh) auf Photovoltaik entfallen sollen (vgl. EAG).

Eine quantitative Aufteilung zwischen gebäudegebundenen Anlagen und Freiflächenanlagen findet sich jedoch weder im Regierungsprogramm noch im Erneuerbaren Ausbau Gesetz. Folgt man aktuellen Studien und Abschätzungen (zB Resch et al., 2017; Fechner, 2020) kann man von einem Freiflächenanteil im Bereich von etwa 50 % bzw. 5,5 TWh ausgehen, was einem Flächenbedarf von 75 bis 100 km² für den PV-Ausbau auf Freiflächen in Österreich bis 2030 entspricht. Ebensowenig existiert bis dato eine verbindliche Aufteilung des Ausbaukontingentes auf die neun Bundesländer. Eine Summation der dokumentierten Ausbauziele für Photovoltaik auf Ebene der Bundesländer ergibt bis 2030 eine Erzeugung von 4,2 TWh was in einem Zielanpassungsbedarf von 8,2 TWh resultiert (Baumann et al., 2021). Aus diesen beiden Unschärfen der nationalen Strategie lassen sich sowohl ein starkes Potenzial für Landnutzungskonflikte als auch große Herausforderungen in der Umsetzung prognostizieren.

Zwar werden die politischen Zielsetzungen zum Ausbau erneuerbarer Energie allgemein und Photovoltaik im speziellen sowie die entsprechenden Fördergesetze auf nationaler Ebene vereinbart, die relevanten Gesetzesmaterien zur Umsetzung und räumlichen Steuerung von PV-Freiflächenanlagen befinden sich jedoch fast ausschließlich auf Landesebene (Elektrizitätsrecht, Raumordnungsrecht, Naturschutzrecht, Baurecht). Daraus ergeben sich nicht nur unterschiedliche Schwellenwerte (z.B. elektrizitätsrechtliches Genehmigungsverfahren in Kärnten ab 5 kWp, im Burgenland ab 500 kWp erforderlich) und Genehmigungsgänge (z.B. ist ein baurechtliches Verfahren bei Vorliegen einer elektrizitätsrechtlichen Genehmigungspflicht in fünf Bundesländern nicht erforderlich, in zwei Bundesländern liegt grundsätzlich eine Genehmigungspflicht vor, in einem Anzeigepflicht und im neunten sind Photovoltaik-Freiflächenanlagen von einer baurechtlichen Genehmigungspflicht ausgenommen, sofern eine Widmung Grünland-Solaranlagen vorliegt), sondern auch unterschiedliche Landespolitiken und entsprechend darauf aufbauende Programme.

Eine Analyse der relevanten Raumordnungsinstrumente in Österreich (Koscher, 2021) hat gezeigt, dass in den einzelnen Bundesländern eine Vielzahl an Instrumenten existiert, die theoretisch zur räumlichen Steuerung von PV-Freiflächenanlagen geeignet sind, auch wenn diese in den meisten Fällen nicht nur aktiviert, sondern auch adaptiert und kombiniert werden müssen. Was jedoch bislang gänzlich fehlt, ist eine verbindliche Verankerung der Ausbauziele des Bundes in den einzelnen Bundesländern. Aufgrund der Kompetenzverteilung zwischen Bund und Ländern ist keine direkte Umsetzungskompetenz dieser Ziele gegeben. Es bedarf daher einer Lösung, um die Energieausbauziele auf Landesebene verbindlich zu machen.

3 PROBLEMANALYSE

3.1 Steuerungsdefizite

Die Betrachtung der österreichischen Energieziele (vgl. EAG), der räumlichen Wirkungen von PV-Freiflächenanlagen (vgl. z.B. Günnewig et al., 2006; Günnewig et al., 2007; Herden et al., 2009; Bayerisches Landesamt für Umwelt (LfU), 2014; Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg, 2019) sowie der vorhandenen anwendbaren Steuerungsinstrumente (vgl. Koscher, 2021) lässt vor allem folgende Steuerungsdefizite hervortreten, die den Ausbau hemmen bzw. in eine aus gesamtheitlicher Sicht ungewünschte Richtung lenken können:

Dualität von Ziel- und Umsetzungsebene: Mit den Ausbauzielen auf Bundesebene ist keine direkte Umsetzungskompetenz auf derselben Ebene verbunden. Mit dem Förderungssystem im EAG werden zwar Anreize für einen Ausbau gesetzt, aktive Steuerungsmöglichkeiten oder Durchsetzungsinstrumente fehlen jedoch. Die Umsetzung über Raumplanung sowie Angelegenheiten des Elektrizitätswesens und nicht zuletzt über Landesenergiestrategien erfolgt auf Landesebene.

Durch die fehlende (räumliche) Zuordnung auf die einzelnen Planungsträger (Länder bzw. Gemeinden) kann auch ein öffentliches Interesse eines bestimmen Vorhabens nicht klar hergeleitet werden. Zwar finden sich in vielen Raumordnungsgesetzen allgemeine Zielbestimmungen bezüglich ausreichender Versorgung mit technischen Einrichtungen, jedoch sind diese derart allgemein gehalten, dass eine stringente Herleitung für ein konkretes Projekt in einem bestimmten Standortraum nur schwer gefunden werden kann. Diese fehlende Zuordnung äußert sich auch in teilweise erheblichen Abweichungen der Landestrategien von der nationalen Ausbaustrategie.

PV-Freiflächenanlagen können je nach Standortsensibilität, Dimensionierung und baulicher Gestaltung erheblich unterschiedliche Raumwirkungen haben. Das derzeitige Instrumentarium, wie z.B. die bloße Flächenfestlegung im Flächenwidmungsplan, bildet diese Varianzen jedoch nur unzureichend ab. Durch die fehlende Abbildung der qualitativen Umsetzung in der Planung müsste zur Bewertung der möglichen Auswirkungen daher immer der schlimmste Fall angenommen werden, wodurch viele Standorte als nicht geeignet ausgeschieden werden müssten.

3.2 Anforderungen an die räumliche Steuerung von Photovoltaik-Freiflächenanlagen

Der erwartete Flächenbedarf von 75 bis 100 km² zeigt deutlich die Notwendigkeit einer geordneten Steuerung, vor allem da jeder Eingriff auch negative Auswirkungen auf konkurrierende Raumnutzungsansprüche hat. Dies kann sowohl die bestehende Nutzung einer potenziellen Fläche betreffen wie z.B. agrarische Nutzung, aber auch weitere Anforderungen wie die „Nicht-Nutzung“ von Flächen zur Verbesserung der Biodiversität oder zukünftige Nutzungen wie Siedlungserweiterungsflächen.

Die Steuerung der Flächennutzung ist eine der Kernaufgaben der Raumplanung (vgl. Schindegger, 1999). Die dafür notwendigen Instrumente können – einem Ansatz von Heiland et al. (2006) folgend – in drei

Kategorien klassifiziert werden: Mengensteuerung, Standortsteuerung und qualitative Steuerung, wie in Abbildung 1 dargestellt.

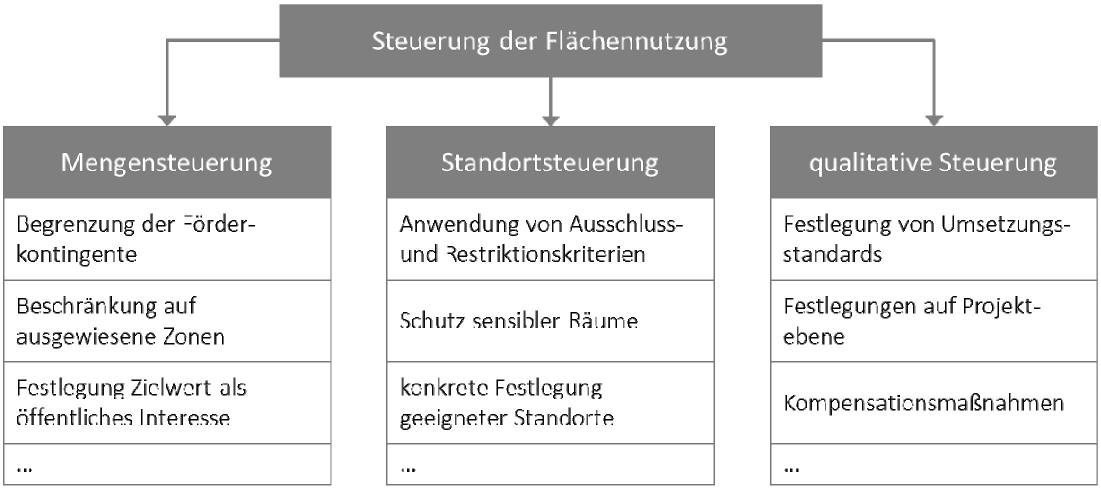

Abbildung 1: Steuerungsformen der Flächennutzung (Koscher, 2021; angelehnt an Heiland et al., 2006)

4 INSTRUMENTE ZUR MENGENSTEUERUNG – PARAMETRISCHE STEUERUNG

Unter parametrischer Steuerung wird eine „Steuerung der nachgeordneten Planungsträger und Adressaten durch Vorgabe bzw. Vereinbarung von operationalisierten Zielen (Parametern)" verstanden (Cools et al., 2002). Durch den bewussten Verzicht von konkreten räunlichen Festlegugen auf übergeordeter Ebene wird Art und Weise der Zielerreichung dem Adressaten bzw. der ausführenden Planungs- und Umsetzungsbehörde überlassen. Von der steuernden Instanz kann entweder ein Handlungsspielraum eröffnet bzw. ein Handlungsauftrag erteilt werden oder aber über bestimmte Parameter Restriktionen festgelegt werden.

Eine effektive Mengensteuerung des PV-Ausbaus existiert in Österreich bislang kaum. Eine Mengensteuerung mittels parametrischer Planung kann jedoch ein wichtiges Instrument als Grundlage für eine bedarfsorientierte Flächenvorsorge und die Erfassung von möglichen Kumulationswirkungen darstellen. (vgl. Koscher, 2021).

Zur Steuerung von Photovoltaik-Freiflächenanlagen ergeben sich zwei konkrete Anwendungsbereiche für parametrische Steuerung: Die Bestimmung der Beiträge der Bundesländer an der Erreichung des nationalen Ausbauzieles sowie die regionale Steuerung innerhalb der Bundesländer.

4.1 Mengenverteilung auf Bundesländer

Aufgrund der föderalen Struktur Österreichs ist auf Bundesebene eine verbindliche Aufteilung der Ausbauziele auf die Bundesländer nicht ohne neue Verfassungsbestimmungen möglich. Ohne Mitarbeit der Bundesländer können also lediglich Anreize geschaffen werden.

Möglichkeiten zur Aufteilung der geplanten Ausbaumengen auf die Bundesländer ergeben sich in Form von Bund-Länder-Vereinbarungen gemäß Art 15a B-VG oder als gemeinsame Willenserklärung z.B. als Ergebnis eines Koordinationsprozesses im Rahmen der österreichischen Raumordnungskonferenz. Zweiteres stellt zwar keinen verbindlichen Rahmen dar, jedoch bleibt auch bei verbindlich vereinbarten Zielen die Frage nach Sanktionsmöglichkeiten offen. In beiden Fällen könnte ein Anreizsystem für eine vereinbarungsgemäße Umsetzung der Ziele wirkungsvoller sein als die reine Bestimmung von Soll-Werten.

Bei der Aufteilung der Ausbaumengen auf die Bundesländer können mehrere Aspekte in unterschiedlicher Gewichtung Beachtung finden:

bisherige Elektrizitätsproduktion im Bundesland

Verbrauch an Elektrizität im Bundesland

Verbrauch an anderen, substituierbaren Energieformen im Bundesland (substituierbarer Anteil an Mobilitäts- und Wärmeenergie)

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indirekter Verbrauch außerhalb des Bundeslandes durch Inanspruchnahme von Dienstleistungen, Wareneinkauf, Arbeitsplätze oder auch anteilige Zurechnung des Elektrizitätsbedarfs von zentralen Verwaltungseinrichtungen

räumliches Potenzial für Photovoltaik, Windkraft und Wasserkraft

4.2 Festlegung regionaler Ausbaukontingente und Eignungsbereiche

Die Zuteilung der Ausbaumengen auf die Bundesländer ist eine Voraussetzung, damit sich Zielsetzung und Planungsträger auf einer Ebene treffen. Als nächsten Schritt bedarf es einer weiteren Konkretisierung, indem einzelne Ausbaukontingente als Zielsetzungen bestimmten Regionen oder Standorträumen zugeordnet werden, und somit zum „aktiven Tun“ aufgefordert wird (vgl. Cools et al, 2002). Dabei kann eine Bandbreite mit minimalen und maximalen Ausbaumengen vorgegeben werden.

Für die Steuerung von Freiflächenanlagen können in Regionen Eignungsbereiche festgelegt werden, in denen gewisse Flächenanteile tatsächlich genutzt werden können (z.B. auf 10 % des ausgewiesenen Eignungsbereichs). Die konkrete Standortfestlegung erfolgt in einem nachgelagerten Schritt entweder auf interkommunal abgestimmter regionaler Ebene oder auf kommunaler Ebene im Rahmen der örtlichen Raumplanung.

Die Umsetzung einer Festlegung solcher Eignungsbereiche kann beispielsweise in Form eines landesweiten Energie(versorgungs)konzeptes oder innerhalb eines integrierten Landesentwicklungsprogrammes erfolgen, das als Grundlage für die weitere regionale und kommunale Raumplanung mit konkreten Standortfestlegungen dient.

Durch die Ableitung von regionalen Ausbaumengen und die Zuteilung zu konkreten Eignungsbereichen wird eine räumliche Spezifizierung des öffentlichen Interesses erreicht und somit eine Grundlage für die Legitimierung eines räumlichen Eingriffes durch eine PV-Freiflächenanlagen geschaffen.

5 INSTRUMENTE ZUR STANDORTSTEUERUNG

Eine **Standortsteuerung** kann sowohl auf räumlich-konkreter Ebene als auch auf kriteriell-abstrakter Ebene erfolgen:

kriteriell-abstrakte Ebene:

Festlegung von konkreten Standorttypen als geeignet bzw. ungeeignet

Definition von Ausschluss- und Restriktionskriterien

räumlich konkrete Ebene:

Verortung in Form von regionalen Zonierungen auf Basis von Ausschluss- bzw. Restriktionskriterien.

Ausweisung im Flächenwidmungsplan

Die räumlich-konkrete Ausweisung von Flächenwidmungen ist im österreichischen Raumplanungssystem am stärksten ausgeprägt, stellt aufgrund seiner Binarität allerdings für komplexe Fragestellungen für sich alleine kein ausreichendes Instrumentarium dar (vgl. Koscher, 2021)

5.1 Festlegung von Kriterien des Standortes

Um die Eignung eines Standortes auf abstrakt-kriterieller Ebene zu steuern, können Kriterien zur Eignung bzw. zum Ausschluss oder zu einer vertieften Prüfung von bestimmten Standorttypen definiert werden. Das Sachgebietsprogramm für Photovoltaikanlagen im Land Kärnten (LGBl. Nr. 49/201) definiert in § 4 Kriterien für Photovoltaik-Standorte. Dabei werden sowohl in Abs 1 wirkungsspezifische als auch in Abs 3 und 4 standortspezifische Ausschlusskriterien sowie in Abs 2 standortbezogene Voraussetzungen genannt.

Die Kärntner Photovoltaikanlagen-Verordnung bestimmt allerdings nur sehr allgemeine Kriterien und bietet vor allem in der Bewertung der Erheblichkeit der Umweltauswirkungen einen beträchtlichen Interpretationsspielraum, insbesondere weil auch im Flächenwidmungsplan nur die generelle Festlegung von PV-Freiflächenanlagen vorgesehen ist und keine näheren Kriterien zur konkreten Ausführung bestimmt werden können. Bei strenger Auslegung der Verordnungsbestimmungen könnten also viele Standorte versagt werden, auf denen jedoch bei einer entsprechenden baulichen Gestaltung und Einbindung in den Raum keine erheblichen Umweltauswirkungen ausgehen würden.

Eine Festlegung von Standortkriterien für PV-Freiflächenanlagen sollte daher immer möglichst spezifisch erfolgen, wobei zwischen verschiedenen Bauformen unterschieden werden soll eine Kombination mit Festlegungen zu Umsetzungsstandards anstrebenswert ist.

5.2 Zonale Festlegungen auf überörtlicher Ebene

Die Festlegung von Zonen zur Steuerung von bestimmten Flächennutzungen übergeordneter Bedeutung kann auf drei verschiedene Arten stattfinden:

Negativausweisungen, um Flächen von einer oder mehreren bestimmten Nutzungen freizuhalten: z.B. Freihaltegebiete (vgl. z.B. § 18 Abs 5 Vbg. RPL) oder Freihalteflächen (vgl. z.B. § 20 Abs 2 Z 18 NÖ ROG) die von einer Bebauung freizuhalten sind, aber auch Ausschlusszonen für Windkraft (vgl. Stmk. Entwicklungsprogramm für den Sachbereich Windenergie LGBl. Nr. 91/2019).

Positivausweisungen, um eine bestimmte Flächennutzung überhaupt zu ermöglichen: z.B. Windkraft-Eignungszonen (vgl. Pkt. 3.2 Bgld. LEP 2011, § 20 Abs 3b NÖ ROG 2014) oder Zonen für PV-Freiflächenanlagen mit mehr als 2 ha (vgl. § 20 Abs 3c NÖ ROG 2014).

Vorrangausweisungen, um die Fläche für eine bestimmte Flächennutzung zu sichern: z.B. Eignungszonen für die Gewinnung grundeigener mineralischer Rohstoffe (vgl. Regionale Raumordnungsprogramme in Niederösterreich) oder Vorrangzonen (vgl. Stmk. Entwicklungsprogramm für den Sachbereich Windenergie LGBl. Nr. 91/2019).

Während die diesbezüglichen Regelungen und praktischen Handhabungen in Österreich mit seinen neun eigenständigen Landesgesetzen sehr heterogen sind, existiert in Deutschland eine eindeutige Definition und abschließende Auszählung für Gebietsfestlegungen in Raumordnungsplänen (§ 7 Raumordnungsgesetz vom 22. Dezember 2008; BGBl. I S. 2986; vgl. auch Scholich, 2018):

Vorranggebiete: Diese sind vorgesehen für bestimmte raumbedeutsame Funktionen oder Nutzungen. Andere raumbedeutsame Funktionen oder Nutzungen sind in diesem Gebiet ausgeschlossen, soweit diese nicht vereinbar sind.

Vorbehaltsgebiete: Diese sind bestimmten raumbedeutsamen Funktionen oder Nutzungen vorbehalten. Bei der Abwägung mit konkurrierenden raumbedeutsamen Funktionen oder Nutzungen wird diesen besonderes Gewicht beigemessen

Eignungsgebiete: Diese sind als für eine bestimmte raumbedeutsame Maßnahme oder Nutzung geeignet erklärt. Daraus folgt, dass diese Maßnahme oder Nutzung außerhalb von Eignungszonen ausgeschlossen ist.

Zonale Festlegungen für PV-Freiflächenanlagen sind seit 2020 im NÖ ROG 2014 und seit 2021 im Bgld. RPG 2019 verankert. In beiden Fällen handelt es sich um Eignungszonen im Sinne des deutschen ROG, d.h. außerhalb dieser Zonen ist die Errichtung von PV-Freiflächenanlagen nicht zulässig, wobei in Niederösterreich eine Zonierung nur für Flächen ab einer Größe von 2 ha vorgesehen ist und daher kleinere Anlagen auch außerhalb dieser Eignungszonen möglich sind.

Eine zonale Festlegung für bestimmte Nutzungen sollte als Legitimation für diesen Planungseingriff immer die Erreichung eines oder mehrerer konkreter Ziele anstreben. Im Fall einer Zonierung für PV-Freiflächenanlagen bedeutet dies, dass mit der Ausweisung dieser Zonen dem Ausbauziel der Gewinnung elektrischer Energie durch Photovoltaik gedient sein muss und auch nur so viele Zonen ausgewiesen werden, wie zur Erreichung dieses Zieles notwendig sind. Es benötigt also eine Verknüpfung mit einer nachvollziehbaren Mengensteuerung. Dies ist besonders im Fall von PV-Freiflächenanlagen relevant, da die räumlichen Wirkungen und Standortansprüche einer einzelnen Anlage in vielen Fällen nicht sehr weitreichend sind und somit eine Vielzahl an Flächen für sich gesehen als „geeignet“ eingestuft werden kann, jedoch erst in einer gesamthaften Betrachtung die Kumulationswirkungen sichtbar werden. Um diesem Umstand Rechnung zu tragen, erscheint es auch empfehlenswert, eine generelle Eignungsbeurteilung der einzelnen Flächen mit Mengenkontingenten zu verknüpfen (vgl. Koscher, 2021).

Um die Vermeidung erheblicher Umweltauswirkungen durch ungeeignete Bauformen und Umsetzungen sicherzustellen, ist zusätzlich auch eine Kombination mit Instrumenten zur qualitativen Steuerung zu empfehlen. Als ein Schritt in diese Richtung kann die Regelung in § 20 Abs 3c NÖ ROG 2014 gewertet werden, wonach *„im überörtlichen Raumordnungsprogramm […] weitere Festlegungen getroffen werden können (z.B. maximale Größe der Photovoltaikanlagen in einer Zone, Regelungen für innovative Anlagen)“*.

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Ein weiterer Vorteil einer landesweiten Zonierung liegt auch im dadurch geschaffenen Gesamtüberblick über mögliche und tatsächliche Standorte von PV-Freiflächenanlagen. Somit kann eine Evaluierung der Zielerreichung leichter und systematischer erfolgen, als wenn die Steuerungskompetenz lediglich bei den einzelnen Gemeinden liegt. Eine sorgsam durchgeführte Zonierung kann durch die qualitative Vorauswahl der Flächen Planungssicherheit für Planungsträger und Projektentwickler schaffen (vgl. dazu auch ÖROK, 2011).

5.3 Erweiterte Regelungen im Flächenwidmungsplan

Der Flächenwidmungsplan ist in allen österreichischen Bundesländern als ein zentrales Instrument der örtlichen Raumplanung verankert. Er gliedert das Gemeindegebiet grundsätzlich in Bauland, Grünland und Verkehrsflächen, wobei unter Bauland im Regelfall nur jene Flächen zu verstehen sind, die für eine Bebauung mit Wohn- oder Betriebsgebäuden vorgesehen sind. Sonstige bauliche Anlagen wie PV-Freiflächenanlagen oder Windkraftanlagen, aber auch andere technische Infrastruktur wie Kläranlagen oder auch Sportstätten sind üblicherweise in Sonderkategorien des Grünlandes festgelegt.

Zwar gibt es in acht von neun Bundesländern eigene Widmungskategorien oder Sonderausweisungen für PV-Freiflächenanlagen, weitergehende Regelungen oder Spezifizierungen abseits der reinen Flächenabgrenzung sind jedoch mit wenigen Ausnahmen bislang kaum möglich. Folgende Regelungsinhalte des Flächenwidmungsplanes können sich für die räumliche Steuerung PV-Freiflächenanlagen als nützlich erweisen:

5.3.1 Festlegungen innerhalb der Widmung

Niederösterreich ist das bislang einzige Bundesland, in dem explizit vorgesehen ist, dass in der Widmungskategorie Grünland-Photovoltaikanlagen eine Festlegung der beanspruchten Flächen und/oder der zulässigen Anlagenarten erfolgen kann (vgl. § 21 Abs 2 Z 21 NÖ ROG 2014). In der Steiermark können allgemein im Wortlaut des Flächenwidmungsplans *„Festlegungen zur Bebauung und Freiraumgestaltung, Höhenentwicklung, zu nicht bebaubaren Flächen und Regelungen zur Geländeveränderung vorgenommen werden.“* (§ 26 Abs 2 StROG).

Für die Raumverträglichkeit großflächiger PV-Freiflächenanlagen sind nicht nur Standort und Größe, sondern auch besonders Bauweise (insbesondere Höhe und Überschirmungsgrad) und Ausgestaltung der Nebenflächen maßgebend (Koscher, 2021). Eine entsprechende Verankerung könnte in allen Bundesländern einen Schritt weg von einer binären Widmung, hin zur Möglichkeit über die Festlegung im Flächenwidmungsplan auch die qualitativen Wirkungen des Vorhabens zu steuern bieten, womit nicht nur die Mindeststandards für nachfolgende Genehmigungsverfahren sichergestellt werden können, sondern auch die Akzeptanz in der Bevölkerung erhöht werden kann.

5.3.2 Mehrebenenwidmung bzw. differenzierte Widmungsfestlegungen

Mit Ausnahme des Burgenlands und Vorarlbergs verfügen alle Raumordnungsgesetze über die Möglichkeit, für übereinanderliegende Ebenen desselben Planungsgebietes verschiedene Widmungsarten festzulegen (Ebenen- bzw. Schichtenwidmung). Nützlich ist diese Regelungsmöglichkeit zur Festsetzung von Mehrfachnutzungen, wie Parkplätze oder Ackerflächen die mit PV-Modulen überbaut sind.

Die gesonderte Festlegung von übereinander liegenden Nutzungen ist jedoch nicht anwendbar bei z.B. vertikalen PV-Modulen mit landwirtschaftlicher Nutzung der Abstandsflächen oder um eine ökologisch hochwertige Gestaltung sicherzustellen. Daher erscheint es auch überlegenswert, eine weitere Differenzierung der Widmungsart Grünland-Photovoltaikanlage vorzunehmen. Diese könnte z.B. sein:

Photovoltaikanlage mit Landwirtschaft bzw. weitere Differenzierung in:

Photovoltaikanlage mit Tierhaltung

Photovoltaikanlage mit Ackerbewirtschaftung

Parkplatz mit Photovoltaikanlage

Photovoltaikanlage auf Deponiestandort

Kläranlage mit Photovoltaik-Nutzung

Photovoltaikanlage mit Biotopflächen

Auf Basis dieser differenzierten Widmungsarten können in weiterer Folge die Umsetzungskriterien auf übergeordneter Ebene genauer spezifiziert werden und so für PV-Freiflächenanlagen mit gleichzeitiger landwirtschaftlicher Nutzung, für PV-Freiflächenanlagen mit ökologischer Aufwertung oder für PV-Freiflächenanlagen auf kontaminierten, versiegelten Böden von Deponiestandorten adäquate und spezifische Standards formuliert werden.

5.3.3 Befristete Widmung

Die Möglichkeit, einzelne Widmungsfestlegungen zu befristen, existiert in den meisten Raumplanungs- und Raumordnungsgesetzen der österreichischen Bundesländer. Jedoch beschränkt sich deren Wirkung auf den Fall der Nicht-Inanspruchnahme der jeweiligen Widmung und zudem meist auf Bauland. Eine befristete Flächenwidmung auf Dauer des Nutzungszyklus einer PV-Freiflächenanlage (25 bis 40 Jahre) jedoch könnte die Möglichkeit schaffen, etwa am Siedlungsrand langfristige Baulandreserven wiederzuerlangen, oder generell eine Neubewertung der Nutzungsansprüche durchzuführen, ohne individuelle Rechte der Grundstückseigentümer zu verletzen oder Entschädigungsansprüche zu erwachsen zu lassen.

Mit einer solchen Befristung kann auch die Grundlage geschafften werden, dass für die zeitgerechte Erreichung der Ausbauziele für erneuerbare Energien in relativ kurzer Zeit große Kapazitäten auf Freiflächen geschaffen werden, die langfristig von PV-Anlagen auf Dächern abgelöst werden und so die von ihnen beanspruchte Fläche wieder für andere Nutzungen freigeben.

6 INSTRUMENTE ZUR QUALITATIVEN STEUERUNG

Für die räumlichen Auswirkungen von PV-Freiflächenanlagen sind nicht nur der Standort an sich, sondern vor allem die Art und Weise der Umsetzung ausschlaggebend (vgl Demuth, 2019). Zur planerischen Bewertung möglicher erheblicher Umweltauswirkungen bedarf es daher einer qualitativen Steuerung, da sonst bei vielen Standorten eine Raumverträglichkeit nicht gewährleistet werden kann (vgl. Koscher, 2021).

In den bisherig in Österreich bestehenden Regelungsinstrumentarien sind solche Festlegungen allerdings kaum vorgesehen. Verbunden mit den geringen Erfahrungswerten bezüglich großflächiger PV-Freiflächenanlagen führt dies oftmals zu Verunsicherung von sowohl Bevölkerung als auch den zuständigen Entscheidungsträgern auf kommunalpolitischer Ebene. Zur Sicherstellung einer entsprechend den Schutzansprüchen von Bevölkerung, Landschaft und Ökologie optimierten Ausführung von PV-Freiflächenanlagen ist es daher sinnvoll, Standards und Umsetzungskriterien auf planerischer Ebene festzulegen. Dies kann auf strategischer Ebene bzw. auf Ebene des einzelnen Standorts erfolgen. Die größte Wirksamkeit wird durch eine Verschränkung der beiden Ebenen erreicht, indem auf übergeordneter strategischer Ebene Festlegungen getroffen werden, auf die im konkreten Einzelfall referenziert werden kann.

6.1 Festlegung von Umsetzungsstandards

Eine Festlegung von Umsetzungsstandards auf strategischer Ebene ermöglicht sowohl eine frühzeitige Steuerung aufseiten des Planungsträgers als auch eine erhöhte Planungssicherheit und Transparenz aufseiten der Projektwerberin. Eine Festlegung von qualitativen Kriterien kann an mehreren Stellen erfolgen:

6.1.1 Kriterium für die Vergabe von Fördermitteln

Planerische Umsetzungsstandards können als Voraussetzung definiert werden, damit überhaupt ein Förderanspruch für PV-Freiflächenanlagen entsteht. Dies ist z.B. im EAG der Fall, wonach PV-Anlagen auf Flächen im Grünland eine entsprechende Flächenwidmung aufweisen müssen. Im deutschen Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare-Energien-Gesetz – EEG 2021) ist in ähnlicher Weise in § 37 festgelegt, dass PV-Freiflächenanlagen nur dann förderberechtigt sein können, wenn sie im Geltungsbereich eines Bebauungsplans liegen[1]. In Erweiterung dieser bestehenden Regelungen könnte die Umsetzung gewisser Qualitätskriterien auch bestimmend für die Höhe einer gewährten Förderung sein.

[1] Eine Ausnahme besteht für Flächen, die im Eigentum des Bundes oder der Bundesanstalt für Immobilienaufgaben stehen, von der Bundesanstalt für Immobilienaufgaben verwaltet und für die Entwicklung von Solaranlagen auf ihrer Internetseite veröffentlicht worden ist.

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6.1.2 Umsetzungsstandards als Inhalt von Entwicklungsprogrammen

In (räumlichen) Entwicklungsprogrammen können neben einer zonalen Festlegung auch Qualitätsstandards für die Errichtung von PV-Freiflächenanlagen in ausgewiesenen Zonen oder Standorträumen festgelegt werden. Diese Möglichkeit ist in Niederösterreich durch eine Bestimmung in § 20 Abs 3c NÖ ROG 2014 geschaffen worden, wonach *„im überörtlichen Raumordnungsprogramm […] weitere Festlegungen getroffen werden können (z.B. maximale Größe der Photovoltaikanlagen in einer Zone, Regelungen für innovative Anlagen)“*. Derartige Regelungen können global für das gesamte Planungsgebiet des Entwicklungsprogramms, für einzelne Standort- bzw. Anlagentypen oder auch spezifisch für jede ausgewiesene Zone getroffen werden.

Sofern im Flächenwidmungsplan für PV-Freiflächenanlagen über die geographische Abgrenzung hinaus keine weiteren Festlegungen getroffen werden können, entfalten die qualitativen Bestimmungen aus einem übergeordneten Entwicklungsprogramm jedoch in machen Bundesländern keine direkt rechtsverbindliche Wirkung. Dies ist der Fall, wenn im elektrizitätsrechtlichen Genehmigungsverfahren sowie im naturschutzrechtlichen Bewilligungsverfahren lediglich eine Widerspruchsfreiheit mit dem Flächenwidmungsplan, jedoch nicht mit rechtswirksamen überörtlichen Raumordnungsprogrammen gefordert ist. In diesen Fällen ist für die Anwendung dieses Instrumentes eine entsprechende Anpassung der rechtlichen Bestimmugen sinnvoll.

6.1.3 Definition des Stands der Technik

Umsetzungsstandards können auf globaler Ebene als ‚Stand der Technik‘ im Sinne eines Leitfadens für gute Planung definiert werden. Dieser Leitfaden kann als Bewertungsgrundlage der Amtssachverständigen im Genehmigungsprozess herangezogen wird. So wird zwar keine Rechtsverbindlichkeit hergestellt, jedoch sind gerade im Falle von PV-Freiflächenanlagen die Forschungslage und der Erfahrungsschatz der Amtssachversständigen derart gering, dass ein solcher Leitfaden hilfreich für die Bewertung und somit für effiziente Verfahren zur Umsetzung der Ausbauziele unter Berücksichtigung aller Schutzansprüche sein kann.

6.1.4 Freiwilliges Gütesiegel als Selbstverpflichtung von Anlagenbetreibern

Zur Erhöhung der Akzeptanz in Bevölkerung und Politik sowie zur Deklaration des Selbstverständnisses können von Anlagenbetreibern oder deren Interessensverbänden Umsetzungsstandards als freiwilliges Gütesiegel erarbeitet werden. In Deutschland hat der Bundesverband Neue Energiewirtschaft e.V. im Jahr 2020 eine Checkliste „Gute Planung von PV-Freilandanlagen“ herausgegeben (Bundesverband Neue Energiewirtschaft (bne) e.V., 2020), in welcher Verpflichtungen gegenüber Verwaltung und Bevölkerung, gegenüber Grundeigentümern, zur Integration in die Landschaft, zur Steigerung der Artenvielfalt sowie weitere Verpflichtungen bezüglich Planung, Umsetzung und Technik formuliert sind, welche mit Stand 01/2021 von über 21 PV-Unternehmen unterzeichnet war.

6.2 Bebauungsplan, -richtlinien

Im österreichischen Raumordnungsrecht zielt der Bebauungsplan primär auf die Regelung der Bebauung mit Gebäuden ab (vgl. Koscher, 2021). Die Steuerungsmöglichkeiten für PV-Freiflächenanlagen durch einen Bebauungsplan sind in der aktuellen Rechtslage daher stark begrenzt. In Deutschland dagegen existiert das Instrument eines vorhabenbezogenen Bebauungsplanes mit welchem konkrete Bauvorhaben wie z.B. PV-Freiflächenanlagen über ein hoheitliches Planungsinstrument im Detail geregelt werden können (vgl. § 12 Baugesetzbuch). Der Bebauungsplan wird dabei mit dem Vorhabenträger abgestimmt und dieser verpflichtet sich mittels Durchführungsvertrag zur Durchführung innerhalb einer bestimmten Frist sowie zum Tragen der Planungs- und Erschließungskosten.

Getroffene Regelungen betreffen beispielsweise die genaue Abgrenzung der Energiegewinnungsfläche, Grundflächenzahl, maximale Anlagenhöhe, Lage von Verkehrsflächen, Ackerbrache-Flächen, Wald-, Wasser- und Freihalteflächen. Weitere Regelungsinhalte, die textlich festgelegt werden können eine Befristung von z.B. 30 Jahren, Abbaubestimmungen und eine Folgenutzung sowie Bestimmungen über die Grünlandpflege (z.B. Düngemittelverbot, Mahdzeitpunkte etc.) beinhalten.

Zur Umsetzung in Österreich müssten einerseits die in den Raumordnungsgesetzen festgelegten Inhalte des Bebauungsplans dahingehend umformuliert werden, dass sie auch auf andere Bauwerke als Gebäude anwendbar sind, z.B. „Bauwerkshöhe“ anstatt „Gebäudehöhe“. Darüber hinaus müsste die Rechtswirksamkeit eines Bebauungsplans gegenüber dem elektrizitätsrechtlichen Genehmigungsverfahren sichergestellt werden. Dies ist derzeit nur in wenigen Bundesländern der Fall.

6.3 Inhalte der qualitativen Steuerung

Die möglichen Inhalte einer qualitativen Steuerung lassen sich in folgende drei Gruppen gliedern (vgl. auch z.B. Günnewig et al., 2006; Günnewig et al. 2007; Herden et al., 2009; Bayerisches Landesamt für Umwelt (LfU), 2014; Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg, 2019):

6.3.1 Bauliche Parameter

Regelung zu Überschirmungsgrad, Grundflächenzahl

Regelung zu Versiegelungsgrad, Gestaltung der Fundamente (Rammpfähle, Schraubfundamente, Betonstreifenfundamte)

Festlegung von maximaler Breite der durchgängig überschirmten Fläche

Festlegung von minimaler lichter Höhe der Modultischunterkanten (zur Sicherstellung von Vegetation unter den Modulen und um Mahdintervalle zwischen den Modulen zu verlängern)

Festlegung von maximaler Bauhöhe der Module bzw. anderer Bauwerke zur besseren Einbindung in die Landschaft.

Regelung zur Beleuchtung der Anlage

Regelungen bezüglich Einzäunung (keine Zäunung, hochgestellte Zäune zur Durchlässigkeit von Kleinsäugern, max. Zaunhöhe)

Festlegung von besonderen Bauformen für landwirtschaftliche Doppelnutzung

6.3.2 Boden- und Vegetationspflege, Maßnahmen zur ökologischen Verbesserung

Regelung zu Verwendung von Saatgut (standortgerechte Saaten)

Regelung zu Herbizid- und Düngerverwendung

Beweidungs- bzw. Mahdmanagement

Regelung zu Ausgleichsflächen, Trittsteinbiotopen (Festlegung von Anzahl und Größe bzw. konkrete Verortung)

Festlegung von maximalen Sektorengrößen und freizuhaltenden Korridoren für Großsäuger (Festlegung von Anzahl und Breite bzw. konkrete Verortung)

6.3.3 Einbindung in Landschaft und Eingrünung mit Hecken

Regelungen zur Ausrichtung an bestehenden landschaftsgliedernden Elementen und Strukturen

Regelungen zu Eingrünung mit Heckenpflanzungen (bezugnehmend auf gewachsene Landschaftsstruktur, bestehenden topographischen Mustern folgend)

Gestaltung des Übergangs zwischen gewachsenem Siedlungsgebiet und PV-Freiflächenanlage bei siedlungsnahen Anlagen

7 FAZIT

Zur Analyse und Weiterentwicklung des Steuerungsinstrumentariums wurde ein dreigliedriger Steuerungsansatz dargestellt – Mengensteuerung, Standortsteuerung und qualitative Steuerung – um den Ansprüchen an ein Planungsinstrumentarium gerecht zu werden, die Entwicklung von Photovoltaik-Freiflächenanlagen unter sozialen, ökologischen, technischen und ökonomischen Gesichtspunkten zu optimieren. Damit können, ausgehend von der Legitimation durch eine quantifizierte Zielsetzung und einer Zuteilung auf die Ebene der Planungsträger, Regularien zu Auswahl und Bewertung geeigneter Standorte festgelegt werden und über standort- und anlagenspezifische qualitative Standards eine raumverträgliche Umsetzung dieser Ziele gesteuert werden.

Neue Steuerungsansätze für eine wirkungsvolle Umsetzung der Energieausbauziele bei gleichzeitiger sorgsamer Raumplanung brauchen ein aufeinander abgestimmtes Instrumentarium, das sowohl den

Flächenbedarf zur Erfüllung der Ausbauziele, die Standortfestlegung als auch die raumverträgliche Ausführung konkreter Projekte zum Steuerungsgegenstand hat. Die Kombination dieser drei Handlungsebenen kann eine effektive Erreichung der Energieausbauziele in Verbindung mit einer gesamthaften nachhaltigen Entwicklung unterstützen.

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Regionalplanerische Festlegungen zur Eigenentwicklung und ihr Beitrag zum Klimaschutz

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1 ABSTRACT

Vor dem Hintergrund des Ziels der deutschen Bundesregierung, bis 2030 die Flächenneuinanspruchnahme auf weniger als 30 Hektar pro Tag zu reduzieren, erlangen raumordnerische Instrumente zur Steuerung der Siedlungsentwicklung eine besondere Bedeutung. Gleichzeitig gilt es die gesetzten Klimaziele zu erreichen. Hierfür gilt es von Seiten der Raumordnung sowohl einen Beitrag zu leisten, um Freiraum zu erhalten als auch den Ausstoß von Treibhausgasen zu verringern, die den Klimawandel auslösen und beschleunigen. Eine sparsame Siedlungsflächenentwicklung, sowie eine Eindämmung des Siedlungsflächenverbrauchs an Standorten ohne angemessene Versorgungsinfrastruktur verringern das Verkehrsaufkommen und damit insgesamt den CO_2-Ausstoß.

Zur Beschränkung der Siedlungsentwicklung in Gemeinden mit geringer infrastruktureller Ausstattung und folglich mangelnder Eignung für eine verstärkte Siedlungsentwicklung steht der Raumordnung das Instrument „Eigenentwicklung“ zur Verfügung. In sogenannten Eigenentwicklerorten bzw. -ortsteilen ist die Deckung von Siedlungsflächenbedarfen aus Wanderungsgewinnen und größerer gewerblicher Neuansiedlungen weitgehend ausgeschlossen und lediglich auf den „Eigenbedarf“ beschränkt. Da sich insbesondere in kleineren, ländlich gelegenen Orten die Siedlungsflächenentwicklung unverhältnismäßig und deutlich losgelöst von der dortigen Bevölkerungsentwicklung gestaltet, vermag das Instrument Eigenentwicklung einen wesentlichen Beitrag zur Verringerung der Flächenneuinanspruchnahme zu leisten.

Dieser Beitrag fasst die Ergebnisse einer bundesweiten Analyse von regionalen Raumordnungsplänen hinsichtlich der Verwendung und Ausgestaltung des Planelements Eigenentwicklung zusammen und leitet daraus Empfehlungen zur künftigen Ausgestaltung ab. Hierbei steht im Fokus, welche Ausforumung der regionalplanerischen Festlegung zur Eigenentwicklung eine bestmögliche Umsetzung der zentralen Steuerungsintentionen des Instruments der Verringerung der Flächenneuinanspruchnahme und der räumlichen Konzentration der Siedlungsentwicklung erreichen kann. In diesem Kontext wird aufgezeigt, welches Potenzial raumordnerische Eigenentwicklungsfestlegungen bei einer restriktiven Ausformung und Anwendung für die Reduzierung der Flächenneuinanspruchnahme und somit für einen Beitrag zum Klimaschutz aufweisen. Zweifellos kann sich die Steuerungswirkung des Instruments nicht voll entfalten, wenn dieses nicht verbindlich festgelegt wird, unbestimmte Angaben zum räumlichen Umgriff und zum Maß der Siedlungsentwicklung beinhaltet oder auch exogene Bedarfe zulässt.

Keywords: Flächenneuinanspruchnahme, Eigenentwicklung, Regionalplanung, Klimaschutz, Siedlungsentwicklung

2 EINLEITUNG

2.1 Problemstellung

Regionalpläne dienen neben den landesweiten Raumordnungsplänen der Entwicklung, Ordnung und Sicherung des Gesamtraums sowie der Teilräume Deutschlands[1] und fungieren somit als „überörtliche und fachübergreifende Planwerke“[2]. Die Formulierung rahmengebender Vorgaben für die siedlungsstrukturelle Entwicklung und die anzustrebende Freiraumstruktur gilt dabei als elementare Aufgabe der Landes- und Regionalplanung.[3] Betraut mit dieser Koordinierungsaufgabe ist die Raumordnung demnach eine wichtige Instanz, um eine klimagerechte Raumentwicklung voranzubringen. Durch die Steuerung der Siedlungs- und

[1] Vgl. §1 Abs. 1 S. 1 ROG i.V.m. §13 Abs. 1 ROG.

[2] Runkel in: Spannowsky / Runkel / Goppel 2010, Rd Nr. 61 zu §1 ROG.

[3] Vgl. §13 Abs.5 ROG.

Freiraumentwicklung schafft sie Raumstrukturen, die wiederum die wesentlichen Rahmenbedingungen für die künftige Reduzierung von Treibhausgasen darstellen.[4]

Im Fokus des vorliegenden Beitrags ist das regionalplanerische Planelement der Eigenentwicklung. Dieses dient der Beschränkung der Siedlungsentwicklung in ausgewählten Gemeinden auf den sogenannten „Eigenbedarf“.[5] Die Normgeber beabsichtigen mit der Festlegung von Eigenentwicklungsgemeinden oder -gemeindeteilen in Regionalplänen, die Siedlungsentwicklung an Standorten mit unzureichender infrastruktureller Ausstattung zu beschränken und so einen Beitrag zur Konzentration der Siedlungsentwicklung auf geeignete Standorte zu leisten.[6] Durch die Beschränkung der Siedlungsentwicklung kann das Planelement „Eigenentwicklung“ Freiraum erhalten, die Flächenneuinanspruchnahme reduzieren und dadurch nicht unwesentlich zum Klimaschutz beitragen.

Das Planelement „Eigenentwicklung“ hat in einigen Regionalplänen mit großer Regelungsintensität und strikten Vorgaben Eingang gefunden. Dabei unterscheidet sich die Ausgestaltung der Festlegung zur Eigenentwicklung jedoch länder- sowie bundesweit unter anderem hinsichtlich der Verbindlichkeit sowie hinsichtlich qualitativer und quantitativer Regelungsinhalte.[7] Vor diesem Hintergrund wird seitens der Wissenschaft bereits ein Forschungsdefizit bekundet und die Erforderlichkeit eines deutschlandweiten Vergleichs der Eigenentwicklungsfestlegungen betont.[8] Zudem zeigt sich im Rahmen von Forschungsarbeiten, dass insbesondere Einschätzungen zur Eignung verschiedener Ansätze zur rechnerischen Ermittlung der zulässigen Siedlungsentwicklung im Rahmen der Eigenentwicklung wesentlich wären.[9] Die Ausgestaltung der Festlegungen zur Eigenentwicklung hat darüber hinaus im Kontext des fortlaufenden Diskurses zur Reduzierung der Flächenneuinanspruchnahme und zum Klimaschutz höchste Aktualität.

2.2 Zielsetzung und Methodik

Zunächst erfolgt eine theoretische Einführung zum „Flächensparen“, bestehenden Zielen zur Reduzierung der Flächenneuinanspruchnahme in Deutschland und zu Möglichkeiten der Raumordnung, einen Beitrag zum Klimaschutz und zur Reduzierung der Flächenneuinanspruchnahme zu leisten.

Ziel des vorliegenden Beitrags ist die Darstellung eines Überblicks der Ausformung von Eigenentwicklungsfestlegungen in Regionalplänen Deutschlands. Methodisch basiert dieser Arbeitsschritt auf einer vergleichenden Analyse der Eigenentwicklungsfestlegungen ausgewählter regionaler Raumordnungspläne anhand von einschlägigen Vergleichskriterien.

Aufbauend auf der vergleichenden Plananalyse wird im Rahmen von konkreten Empfehlungen die Frage beantwortet, wie die Festlegungen zur Eigenentwicklung optimiert werden können, um einen möglichst großen Beitrag zum Klimaschutz zu leisten.

3 „FLÄCHENSPAREN“ ALS BEITRAG ZUM KLIMASCHUTZ?

Die Diskussion in der Raumplanung, welche raumplanerischen Handlungsfelder identifiziert und bearbeitet werden können, um einen Fachbeitrag zur Erreichung der Klimaschutzziele zu leisten, wird nunmehr seit einigen Jahren geführt.[10] Neben einer rämlichen Vorsorge für den raumverträglichen Ausbau erneuerbarer Energien, werden regelmäßig auch die Handlungsfelder einer vorsorgendenm Standortsicherung für Anlagen zur CO2-Speicherung sowie v.a. effiziente und verkehrsvermeidende Siedlungsstrukturen genannt.[11]

Ein sparsamer Umgang mit der endlichen Ressource “Fläche” gilt dabei als eine wesentliche Aufgabe des Klimaschutzes. Grund hierfür ist, dass der “Verbrauch” von Fläche bzw. Freiraum vielfältige negative ökologische Auswirkungen mit sich bringt, die den Klimawandel begünstigen und vorantreiben und dem primären Ziel des Klimaschutzes der Reduzierung des Ausstoßes von Treibhausgasen entgegenstehen. Hervorzuheben ist hierbei die Funktion des Freiraums als CO_2-Speicher, weswegen der Freiraumerhalt zur

4 Vgl. Umweltbundesamt 2016.
5 Vgl. Schmidt-Eichstaedt et al. 2001, S. 11.
6 Vgl. Schwabedal 2011, S. 19.
7 Vgl. ebenda, S. 19f.
8 Schwabedal 2009, S. 21.
9 Vgl. Umweltbundesamt unveröffentlicht, o.S.
10 Vgl. nur beispielhaft ARL (Hrsg.) 2013, BMVBS (Hrsg.) 2010
11 Vgl. Fleischhauer, M.; Overbeck, G., Janssen, G., Kufeld, W. 2013, S. 95

Reduzierung des Treibhausgasausstoßes eine besondere Bedeutung hat und folglich mit einem Flächenverbrauch wichtige Kohlenstoffsenken verloren gehen. Des Weiteren bewirken ein sparsamer Umgang mit Fläche, vorrangige Innenentwicklung und eine Beschränkung der Siedlungsflächenentwicklung an Standorten ohne angemessene Versorgungs- und Verkehrsinfrastruktur eine kompakte Siedlungsstruktur, die sich durch gute Erreichbarkeiten der Daseinsgrundfunktionen auszeichnet. Dadurch sind Nutzungen fußläufig oder mit dem Fahrrad zu erreichen und Verkehrsnetze können aufgrund einer angemessenen Auslastung effizienter ausgebaut werden. Demnach kann „Flächensparen“ und die Schaffung von kompakten Siedlungsstrukturen zur Reduzierung des motorisierten Individualverkehrs und somit zu einem ökologischeren Verkehrsverhalten beitragen, wodurch der Ausstoß von CO2 reduziert und dem Klimawandel entgegengewirkt werden kann.[12]

3.1 Ziele zur Reduzierung der Flächenneuinanspruchnahme der Bundesrepublik Deutschland

Vor dem Hintergrund der besonderen Relevanz des Freiraumerhalts für den Klimaschutz, verfolgt die Bundesregierung Deutschlands das Ziel, bis 2030 die Flächenneuinanspruchnahme auf weniger als 30 Hektar pro Tag zu reduzieren. Die Zunahme der Flächenneuinanspruchnahme für Siedlungs- und Verkehrszwecke pro Jahr ist zwar in Deutschland seit Jahren rückläufig, lag jedoch im Jahr 2019 noch bei 52 Hektar pro Tag.[13] Neben dem „30-Hektar-minus-x-Ziel“ hat sich die deutsche Bundesregierung zum Ziel gesetzt, bis zum Jahr 2050 eine Flächenkreislaufwirtschaft zu erreichen, sodass die Flächenneuinanspruchnahme bei Netto-Null liegt.[14] Zur Einhaltung dieser Ziele bedarf es demnach zwingend einer weiteren Reduzierung der täglichen Flächenneuinanspruchnahme durch Siedlungs- und Verkehrsvorhaben in Deutschland und in diesem Kontext auch eine möglichst restriktive Steuerung der Siedlungsentwicklung. Folglich erlangen raumordnerische bzw. regionalplanerische Instrumente zur Steuerung der Siedlungsentwicklung eine besondere Bedeutung.

3.2 Siedlungsentwicklung und Flächenneuinanspruchnahme in Deutschland

Im ländlichen Raum ist die Siedlungs- und Verkehrsfläche pro Einwohner im Vergleich zu den Verdichtungsräumen besonders hoch. Die Siedlungs- und Verkehrsfläche liegt 2014 in kreisfreien Großstädten bei durchschnittlich 260 Quadratmetern pro Einwohner, wohingegen in dünn besiedelten, ländlichen Regionen die Flächenbeanspruchung pro Einwohner durchschnittlich bei 1.140 Quadratmetern lag. Demnach bestehen in den ländlichen Räumen auch die größten Flächeneinsparpotenziale. Nennenswert ist in diesem Kontext, dass von 2011 bis 2014 die Siedlungs- und Verkehrsfläche pro Einwohner in den Verdichtungsräumen abgenommen hat und im gleichen Zeitraum in den ländlichen Räumen angestiegen ist.[15] Darüber hinaus weisen Städte und Gemeinden Deutschlands mit Bevölkerungsrückgang eine deutliche Zunahme der Gebäudeflächen auf. Demnach sind die Gebäudeflächen- und die Bevölkerungsentwicklung in diesen Gemeinden und Städten deutlich voneinander entkoppelt. Auch in Städten und Gemeinden Deutschlands, deren Bevölkerung wachsend ist, ist die Gebäudeflächenentwicklung nicht konform mit der Bevölkerungsentwicklung, sondern steigt prozentual stärker an als die Bevölkerungszahl.[16] Da sich schrumpfende Städte und Gemeinden meist im ländlichen Raum befinden,[17] zeigt sich folglich insbesondere in ländlichen Räumen eine besonders hohe und zugleich unverhältnismäßige Inanspruchnahme von Flächen für Gebäudeflächen.

Zusammenfassend besteht demnach aufgrund der geschilderten Flächeninanspruchnahme pro Kopf und der Verhältnismäßigkeit von Bevölkerungs- und Gebäudeflächenentwicklung in städtischen und ländlichen Räumen ein deutliches Gefälle zwischen diesen Raumtypen. Um demnach zum Klimaschutz beizutragen, bedarf es insbesondere in ländlichen Räumen einer deutlichen Reduzierung der Flächenneuinanspruchnahme.

[12] Vgl. Umweltbundesamt 2016.
[13] Vgl. Umweltbundesamt 2021.
[14] Vgl. BMU 2019.
[15] Vgl. BBSR o.J.
[16] Vgl. BBSR 2015, S. 14f.
[17] Vgl. ebenda, S. 7.

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3.3 Klimaschutz und Flächensparen in der Raumordnung

In den Ländern Deutschlands sind Raumordnungspläne zum einen auf Landesebene (Landesentwicklungspläne oder Landesentwicklungsprogramme), als auch zum anderen für die Teilräume der Länder (Regionalpläne) aufzustellen.[18] Raumordnungspläne werden definiert als „zusammenfassende, überörtliche und fachübergreifende Pläne“[19]. Aufgabe der Raumordnung ist es, den „Gesamtraum der Bundesrepublik Deutschland und seine Teilräume […] zu entwickeln, zu ordnen und zu sichern.“[20] Demnach gehören die Abstimmung aller raumrelevanten Belange und die Sicherstellung einer ausgewogenen Raumnutzung zur Aufgabe der Raumordnung bzw. der Raumordnungsplanung.[21] Im ROG werden zudem Angaben zu Regelungsinhalten der Raumordnungspläne gemacht. Demnach sollen „Raumordnungspläne […] Festlegungen zur Raumstruktur enthalten.“[22] Hierzu zählen vor allem Festlegungen zur anzustrebenden Siedlungs- und Freiraumstruktur sowie zu den zu sichernden Standorten und Trassen für Infrastruktur.[23] Hierfür können in Raumordnungsplänen Ziele und Grundsätze festgelegt werden.[24] Ziele der Raumordnung sind „verbindliche Vorgaben in Form von räumlich und sachlich bestimmten oder bestimmbaren, vom Träger der Raumordnung abschließend abgewogenen textlichen oder zeichnerischen Festlegungen in Raumordnungsplänen zur Entwicklung, Ordnung und Sicherung des Raums.“[25] Dahingegen sind Grundsätze der Raumordnung „Aussagen zur Entwicklung, Ordnung und Sicherung des Raums als Vorgaben für nachfolgende Abwägungs- und Ermessensentscheidungen.“[26] Folglich unterscheidet sich bei Zielen und Grundsätzen der Raumordnung auch die Bindungswirkung. Ziele der Raumordnung müssen grundsätzlich *beachtet* werden. Die Grundsätze der Raumordnung sind lediglich in Abwägungs- und Ermessensentscheidungen zu *berücksichtigen*.[27] Für die Gemeinden besteht bei der Bauleitplanung eine verschärfte Bindungswirkung in Form einer Anpassungspflicht an die Ziele der Raumordnung.[28]

Das ROG gibt vor, dass „Regionalpläne […] aus dem Raumordnungsplan für das Landesgebiet zu entwickeln [sind].“[29] Demnach wird die Regionalplanung als Teil der Landesplanung verstanden und dient der Konkretisierung der landesweiten Planung auf regionaler Ebene.[30]

Durch die Koordinierung aller raumrelevanten Belange und die Steuerung der Siedlungs- und Freiraumentwicklung kann die Raumordnung eine klimagerechte Raumentwicklung voranbringen und Raumstrukturen schaffen, die die wesentlichen Rahmenbedingungen für die künftige Reduzierung von Treibhausgasen darstellen.[31] Neben dieser Relevanz der Raumordnung für eine klimagerechte Raumentwicklung, die sich direkt von der (Koordinierungs-)Aufgabe der Raumordnung ableiten lässt, ist darüber hinaus im Bundesraumordnungsgesetz verankert, dass „den räumlichen Erfordernissen des Klimaschutzes Rechnung zu tragen [ist], sowohl durch Maßnahmen, die dem Klimawandel entgegenwirken, als auch durch solche, die der Anpassung an den Klimawandel dienen.“[32] Dieser Grundsatz verdeutlicht, dass der Bundesgesetzgeber die Raumordnung als wichtige Akteurin im Bereich des Klimaschutzes und auch der Klimaanpassung ansieht.

Auch im Bereich des „Flächensparens“ werden der Landes- und Regionalplanung Kompetenzen zugesprochen. Der Bundesgesetzgeber gibt vor, dass „die erstmalige Inanspruchnahme von Freiflächen für Siedlungs- und Verkehrszwecke […] zu verringern [ist], insbesondere durch quantifizierte Vorgaben zur Verringerung der Flächeninanspruchnahme sowie durch die vorrangige Ausschöpfung der Potenziale für die

[18] Vgl. §13 Abs. 1 ROG.
[19] §3 Abs. 1 Nr. 7 ROG.
[20] §1 Abs. 1 ROG.
[21] Vgl. Runkel in: Spannowsky / Runkel / Goppel 2010, Rd Nr. 49 zu §1 ROG.
[22] §13 Abs. 5 ROG.
[23] Vgl. §13 Abs. 5.
[24] Vgl. ebenda, Rd Nr. 62 zu §1 ROG.
[25] §3 Abs. 1 Nr. 2 ROG.
[26] Ebenda.
[27] Vgl. §4 Abs. 1 Nr. 3 ROG.
[28] Vgl. §1 Abs. 4 BauGB.
[29] §13 Abs. 2 ROG.
[30] Vgl. Goppel 2011, S. 445.
[31] Vgl. Umweltbundesamt 2016.
[32] §2 Abs. 2 Nr. 6 ROG.

Wiedernutzbarmachung von Flächen, für die Nachverdichtung und für andere Maßnahmen zur Innenentwicklung der Städte und Gemeinden sowie zur Entwicklung vorhandener Verkehrsflächen.“[33]

Zur Verringerung der Flächenneuinanspruchnahme kann die Raumordnung durch verschiedene Festlegungen zur Siedlungs- und Freiraumentwicklung beitragen.[34] Zur Einordnung und zum Überblick werden im Folgenden die zentralen Planelemente zur Steuerung und Beschränkung der Siedlungsentwicklung aufgeführt. Hierbei kann grundsätzlich zwischen Planelementen zur großräumigen und kleinräumigen Standortsteuerung künftiger Siedlungsentwicklung unterschieden werden.[35]

Großräumige Standortsteuerung erfolgt beispielsweise durch Festlegungen zur Konzentration der Siedlungsentwicklung auf Standorte, die für eine verstärkte Siedlungsentwicklung geeignet sind. Eine solche Konzentration kann beispielsweise durch eine Festlegung zur verstärkten Siedlungsentwicklung in Zentralen Orten oder an Verkehrsachsen oder -knotenpunkten erfolgen. Gleichsam kann durch Festlegungen zur Eigenentwicklung die Siedlungsentwicklung in nicht für verstärkte Siedlungsentwicklung geeigneten Gemeinden beschränkt werden. Auch Festlegungen zur Sicherung von Freiräumen durch Vorrang- oder Vorbehaltsgebiete oder regionale Grünzüge und Grünzäsuren zählen zu den Planelementen zur Steuerung der Siedlungsentwicklung, da diese negativplanerisch eine Beschränkung der Siedlungsentwicklung bewirken. Hinsichtlich der kleinräumigen Standortsteuerung haben sich in der Raumordnungspraxis insbesondere Festlegungen zur vorrangigen Innenentwicklung sowie zur Anbindung neuer Siedlungsflächen an bestehende Siedlungskörper und somit zur Verringerung der Zersiedelung durchgesetzt.[36]

Quantitative Festlegungen zur Siedlungsentwicklung in Raumordungsplänen erlangen derzeit zunehmende Aufmerksamkeit und werden vermehrt in der Raumordnungspraxis und -forschung diskutiert, da diese durch die Vorgabe von verbindlichen Schwellenwerten eine besonders restriktive Beschränkung der Siedlungsentwicklung bewirken.[37] Diese Festlegungen können auch mit weiteren quantitativen Vorgaben zur baulichen Dichte kombiniert werden. Quantitative Festlegungen zur Siedlungsflächenentwicklung werden oftmals mit dem Planelement Eigenentwicklung verknüpft.[38]

Besonders bedeutend für die letztendliche Steuerungswirkung des jeweiligen Planelements ist die Festlegung als Ziel oder Grundsatz der Raumordnung und damit die Bindungswirkung der Festlegung.[39]

4 EIGENENTWICKLUNG ALS REGIONALPLANERISCHE FESTLEGUNG ZUR BESCHRÄNKUNG DER SIEDLUNGSENTWICKLUNG

Das Instrument Eigenentwicklung ermöglicht es, Gemeinden festzulegen, die keine Eignung für eine verstärkte Siedlungsentwicklung aufweisen.[40] Der Begriff „Eigenentwicklung“ ist „weder ein per Gesetz definierter Begriff, noch auf ein anerkanntes Berechnungsmodell zurückzuführen“[41]. In Gemeinden mit Beschränkung auf die Eigenentwicklung besteht die Möglichkeit zur Deckung der örtlichen Siedlungsflächenbedarfe.[42] Diese differenzieren sich in den Wohnungsbedarf aus der natürlichen Bevölkerungsentwicklung und der ortsansässigen Bevölkerung sowie den Bedarf der ortsansässigen Gewerbetreibenden. In den Orten mit Beschränkung auf die Eigenentwicklung ist in der Regel keine über den örtlichen Bedarf hinausgehende Siedlungsentwicklung vorgesehen. Die Deckung von Siedlungsflächenbedarfen aus Wanderungsgewinnen sowie größerer gewerblicher Neuansiedlungen sind demnach in Eigenentwicklerorten ausgeschlossen.[43] Das Instrument Eigenentwicklung wird meist auf der Ebene der Regionalpläne, die sich im Vergleich zu den landesweiten Raumordnungsplänen durch einen erhöhten Konkretisierungsgrad auszeichnen, ausgestaltet.[44]

[33] Ebenda.
[34] Vgl. BMVBS 2012.
[35] Vgl. Umweltbundesamt o.J., S. 304f.
[36] Vgl. Ebenda.
[37] Vgl. Landeshauptstadt München 2019, S. 6f.
[38] Vgl. Briegel 2020, S. 46ff., S. 87ff.
[39] Vgl. Ebenda, S. 124f.
[40] Vgl. Akademie für Raumforschung und Landesplanung 2019; Lexica Stichwort Eigenentwicklung.
[41] Vgl. Bovet 2009, S. 18f.
[42] Vgl. Priebs 2013, S. 133.
[43] Vgl. Schmidt-Eichstaedt et al. 2001, S. 11.
[44] Vgl. Priebs 2013, S. 133.

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4.1 Vergleichende Plananalyse der Festlegungen zur Eigenentwicklung in ausgewählten Regionalplänen Deutschlands

Für die vergleichende Plananalyse werden pro Bundesland zwei Planungsregionen mit möglichst unterschiedlichen raum- und siedlungsstrukturellen Rahmenbedingungen sowie demographischen Entwicklungen ausgewählt. Auf diese Weise kann erfasst werden, wie es einerseits strukturschwache, ländlich geprägte Regionen, die mit Schrumpfung zu kämpfen haben, und andererseits strukturstarke Regionen mit prosperierenden Ballungsräumen und Bevölkerungsdruck mit den Regelungen zur Eigenentwicklung handhaben. Im Rahmen dieses Auswahlverfahrens wird darüber hinaus geprüft, ob die Regionalpläne der Untersuchungsregionen überhaupt Festlegungen zur Eigenentwicklung beinhalten. Sind in den Regionalplänen eines Bundeslands keine Eigenentwicklungsregelungen vorhanden, werden in diesem Bundesland keine Untersuchungsregionen ausgewählt. Ebenso wird geprüft, ob Regionen innerhalb eines Bundeslandes sehr ähnliche oder gar identische Regelungen zur Eigenentwicklung aufweisen. Dann wären keine zwei, sondern lediglich eine Untersuchungsregion im entsprechenden Bundesland auszuwählen. Nach Anwendung dieses Auswahlverfahrens werden die folgenden regionalen Raumordnungspläne bzw. Regionalplanentwürfe in der vergleichenden Plananalyse untersucht[45]:

- Baden-Württemberg: Regionalplan Stuttgart 2009[46]; Regionalplan Schwarzwald-Baar-Heuberg 2003[47];
- Bayern: Regionalplan Oberland 2001[48]; Regionalplan Main-Rhön 2008[49];
- Hessen: Regionalplan Mittelhessen 2010[50];
- Mecklenburg-Vorpommern: Regionales Raumentwicklungsprogramm Rostock 2011[51]; Laufende Teilfortschreibung des Regionalen Raumentwicklungsprogramms Rostock 2011, Entwurf 2019[52]; Regionales Raumentwicklungsprogramm Mecklenburgische Seenplatte 2011[53];
- Niedersachsen: Regionales Raumordnungsprogramm Hannover 2016[54]; Regionales Raumordnungsprogramm Cuxhaven 2012[55];
- Nordrhein-Westfalen: Regionalplan Düsseldorf 2018[56]; Regionalplan Münsterland 2014[57];

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45 Im Rahmen der vergleichenden Analyse des Instruments Eigenentwicklung in Untersuchungsregionen werden in aller Regel die derzeit rechtskräftigen regionalen Raumordnungspläne untersucht. Gibt es Regionalpläne, die derzeit fortgeschrieben oder geändert werden und deren Fortschreibung oder Änderung auch das Planelement Eigenentwicklung betrifft, wird im Rahmen dieser Analyse der neue Entwurf des Plans und die darin beinhalteten Planelemente zur Eigenentwicklung verwendet, um zu gewährleisten, dass die neusten Ausformungen des Instruments Eingang in die vergleichende Analyse finden.

46 Vgl. Verband Region Stuttgart 2009, Z 2.4.0.3ff., S. 55ff.; Begründung zu Z 2.4.0.3ff., S. 58ff.; Z 2.4.2, S. 79ff., Begründung zu Z 2.4.2, S. 82ff. *Im Folgenden: Regionalplan Stuttgart 2009.*

47 Vgl. Regionalverband Schwarzwald-Baar-Heuberg 2003, G 2.5, S. 9; Begrünung zu G 2.5, S. 10. *Im Folgenden: Regionalplan Schwarzwald-Baar-Heuberg 2003.*

48 Vgl. Planungsverband Region Oberland 2001, II Z 1.3, S. 1; Begründung zu II Z 1.3, S. 1f. *Im Folgenden: Regionalplan Oberland 2001.*

49 Vgl. Regionaler Planungsverband Main-Rhön 2008, Z 1.8, S. 2 B II; Begründung zu Z 1.8, S. 7 B II. *Im Folgenden: Regionalplan Main-Rhön 2008.*

50 Vgl. Regierungspräsidium Gießen 2010, Z 5.2-4, S. 46; Begründung zu Z 5.2-4, S. 47; Z 5.3-3, S. 55; Begründung zu Z. 5.3-3, S. 56f.; Z 5.2-7, S. 48; Begründung zu Z 5.2-7, S. 48ff. *Im Folgenden: Regionalplan Mittelhessen 2010.*

51 Vgl. Regionaler Planungsverband Mittleres Mecklenburg/Rostock 2011, 4.1 Z 2, S. 37; Begründung zu 4.1 Z 2, S. 38f. *Im Folgenden: Regionalplan Rostock 2011.*

52 Vgl. Planungsverband Region Rostock 2019, 3.1.2 Z 4, S. 3; Begründung zu 3.1.2 Z 4, S. 4f. *Im Folgenden: Laufende Teilfortschreibung Regionalplan Rostock Entwurf 2019.*

53 Vgl. Regionaler Planungsverband Mecklenburgische Seenplatte 2011, 4.1 Z 4 und Z 5, S. 62; Begründung zu 4.1 Z 4 und Z 5, S. 63. *Im Folgenden: Regionalplan Mecklenburgische Seenplatte 2011.*

54 Vgl. Region Hannover 2016, 2.1 Ziffer 07, S. 22; Begründung zu 2.1 Ziffer 07, S. 94ff. *Im Folgenden: Regionalplan Hannover 2016.*

55 Vgl. Landkreis Cuxhaven 2012, 2.1 07, S. 8; Begründung zu 2.1, S. 10; 2.1 06, S. 8 *Im Folgenden: Regionalplan Cuxhaven 2012.*

56 Vgl. Bezirksregierung Düsseldorf 2018, 3.1.1 Z 1, S. 49; Begründung zu 3.1.1 Z1, S. 49. *Im Folgenden: Regionalplan Düsseldorf 2018.*

- Rheinland-Pfalz: Laufende Teilfortschreibung des Regionalen Raumordnungsplans Rheinhessen-Nahe 2014, Entwurf 2016[58]; Regionaler Raumordnungsplan Westpfalz 2012[59];
- Sachsen-Anhalt: Regionaler Entwicklungsplan Harz Teilfortschreibung 2018 [60];
- Thüringen: Laufende Änderung Regionalplan Ostthüringen Entwurf 2018[61] [62].

Im Folgenden werden die Eigenentwicklungsfestlegungen der ausgewählten Regionalpläne anhand der Kriterien "Festlegung zur Eigenentwicklung", "Räumlicher Umgriff", "Maß der zulässigen Siedlungsentwicklung im Rahmen der Eigenentwicklung" und "Absicht des Normgebers" vergleichend analysiert.

4.1.1 Festlegung zur Eigenentwicklung[63]

Im Rahmen des ersten Untersuchungskriteriums "Festlegung zur Eigenentwicklung" werden die Bindewirkung der Festlegungen zur Eigenentwicklung der ausgewählten Regionalpläne und die verwendeten Begrifflichkeiten zur Be- bzw. Umschreibung von Eigenentwicklung vergleichend analysiert.

Die Analyse der **Bindungswirkung** der Festlegungen zur Eigenentwicklung in den ausgewählten Untersuchungsregionen ergibt, dass ein Großteil der zu untersuchenden Regionalpläne hierzu Ziele der Raumordnung aufweist (vgl. Regionalplan Stuttgart, Oberland, Main-Rhön, Mittelhessen, Rostock, Mecklenburgische Seenplatte, Hannover, Cuxhaven, Düsseldorf, Harz). Als Grundsätze der Raumordnung sind die Festlegungen zur Eigenentwicklung in vier der Untersuchungsregionen verankert (vgl. Regionalplan Schwarzwald-Baar-Heuberg, Münsterland, Rheinhessen-Nahe, Ostthüringen). In der Region Westpfalz ist die Regelung zur Eigenentwicklung im Regionalplan weder als Ziel noch als Grundsatz gekennzeichnet.[64] Auffallend ist, dass einige regionale Raumordnungspläne mehrere Festlegungen mit Bezug zur Eigenentwicklung mit unterschiedlichen Bindungswirkungen aufweisen. So beinhalten beispielsweise die Untersuchungsregionen von Rheinland-Pfalz einerseits eine Festlegung mit geringer Bindungswirkung, die qualitative Vorgaben zur Eigenentwicklung macht, und andererseits eine verbindliche Vorgabe, die quantitative Regelungen zur Eigenentwicklung beinhaltet (vgl. Regionalplan Rheinhessen-Nahe, Westpfalz). Im Regionalplan Mecklenburgische Seenplatte variiert die Verbindlichkeit je nach inhaltlichem Umgriff. Hinsichtlich der Wohnsiedlungsentwicklung besteht eine verbindliche Eigenentwicklungsregelung. In Bezug auf die gewerbliche Siedlungsentwicklung jedoch nicht.[65]

In den meisten der ausgewählten Regionalpläne wird der **Begriff** „Eigenentwicklung" verwendet (vgl. Regionalplan Stuttgart, Mittelhessen, Hannover, Cuxhaven, Düsseldorf, Rheinhessen-Nahe, Westpfalz, Harz). Darüber hinaus finden auch die Begriffe „organische Entwicklung" (vgl. Regionalplan Schwarzwald-Baar-Heuberg, Oberland, Main-Rhön), „Eigenbedarf" (vgl. Regionalplan Rostock, Mecklenburgische

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[57] Vgl. Bezirksregierung Münster 2014, III.1 G 8.4, S. 25; Begründung zu III.1 G 8.4, S. 27. *Im Folgenden: Regionalplan Münsterland 2014.*

[58] Vgl. Planungsgemeinschaft Rheinhessen-Nahe 2016, 2.2.1 G 13, S.16f; Begründung zu 2.2.1 G 13, S. 16; 2.2.4 Z 20, S. 19ff.; Begründung zu 2.2.4 Z 20, S. 22ff.; Anlage 1 und 2. *Im Folgenden: Laufende Teilfortschreibung Regionalplan Rheinhessen-Nahe Entwurf 2016.*

[59] Vgl. Planungsgemeinschaft Westpfalz 2012, II.1.2, S. 18; II.1.3 Z 8, S: 20f.; Begründung zu II.1.3 Z 8, S. 21f.; II.1.3 G 9, S. 21. *Im Folgenden: Regionalplan Westpfalz 2012.*

[60] Vgl. Regionale Planungsgemeinschaft Harz 2018, 3.2.4 Z 19, S. 21; Begründung zu 3.2.4 Z 19, S. 22; 3.2.4 G 20, S. 21; Begründung 3.2.4 G 20, S. 21. *Im Folgenden: Regionalplan Harz Teilfortschreibung 2018.*

[61] Vgl. Regionale Planungsgemeinschaft Ostthüringen 2018, G 2-3, S. 14; Begründung zu G 2-3, S. 14. *Im Folgenden: Laufende Änderung Regionalplan Ostthüringen Entwurf 2018.*

[62] Erfolgen im Folgenden vergleichende Aussagen zu Übereinstimmungen in mehreren Regionalplänen wird im Fließtext folgendermaßen zitiert: „(vgl. Regionalplan Stuttgart, Harz, Ostthüringen). Demnach werden die Regionalpläne zur besseren Lesbarkeit im Fließtext vereinfacht zitiert. In der Quellenangabe im Fließtext wird auf die Jahreszahl sowie die Angaben zu den Festlegungen und die Seitenzahl verzichtet. Zudem steht nur zu Beginn der Quellenangabe „Regionalplan" und nicht vor jedem genannten Regionalplan.

[63] Die folgende Vergleichsanalyse (4.1.1 bis 4.1.4) basiert auf eigenen Erhebungen der Regionalpläne der Untersuchungsregionen, Quellen s. Kapitel 4.1. Werden Erkenntnisse zusammenfassend dargelegt, wird u.a. aus Lesbarkeitsgründen auf eine detaillierte Aufführung der Quellen verzichtet und auf die Quellen in Kapitel 4.1. verwiesen.

[64] Vgl. Regionalplan Westpfalz 2012, II.1.2, S. 18.

[65] Vgl. Regionalplan Mecklenburgische Seenplatte 2011, 4.1 Z 4f. S. 62.

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Seenplatte), „Bedarf der ortsansässigen Bevölkerung" (vgl. Regionalplan Münsterland) und „gemeindebezogener Bedarf" (vgl. Regionalplan Ostthüringen) Eingang in die Regionalpläne.

4.1.2 Räumlicher Umgriff

In den Regionalplänen der Untersuchungsregionen variieren die Regelungsinhalte der Eigenentwicklungsfestlegung mit räumlichem Bezug. Neben der räumlichen Bezugsgröße unterscheidet sich auch, welche Gemeinden bzw. Gemeindeteile auf die Eigenentwicklung beschränkt werden und ob weitergehende Regelungen mit räumlichem Bezug beinhaltet sind.

In zehn der 15 Untersuchungsregionen beziehen sich die Eigenentwicklungsfestlegungen auf die **räumliche Bezugsgröße** Gemeinden (vgl. Regionalplan Stuttgart, Schwarzwald-Baar-Heuberg, Oberland, Main-Rhön, Rostock, Mecklenburgische Seenplatte, Rheinhessen-Nahe, Westpfalz. Ostthüringen). Auf Gemeindeteile beziehen sich die Eigenentwicklungsfestlegungen der restlichen fünf Untersuchungsregionen (vgl. Regionalplan Mittelhessen, Hannover, Düsseldorf, Münsterland, Harz). Der Begründung zweier Regionalpläne kann entnommen werden, dass sich die Eigenentwicklungsregelung auf Gemeinden und Gemeindeteile bezieht (vgl. Regionalplan Stuttgart, Cuxhaven).

Welche Gemeinden bzw. Gemeindeteile auf die Eigenentwicklung beschränkt sind, wird in den Raumordnungsplänen unterschiedlich gehandhabt. Eigenentwicklergemeinden bzw. -gemeindeteile können eine Restkategorie darstellen und sich im Umkehrschluss aus dem räumlichen Umgriff anderer positivplanerischen Festlegungen ergeben, also eine Negativdefinition dieser sein. Hierbei handelt es sich um positivplanerische, standort- oder flächenbezogene Festlegungen zur verstärkten (Wohn-)Siedlungsentwicklung, auf die sich die Eigenentwicklungsregelung bezieht, um einen räumlichen Umgriff zu definieren. Diese Variante der Bestimmung des räumlichen Umgriffs besteht in einem Großteil der untersuchten Raumordnungspläne (vgl. Regionalplan Schwarzwald-Baar-Heuberg, Oberland, Main-Rhön, Rostock, Mecklenburgische Seenplatte, Hannover, Cuxhaven, Düsseldorf Rheinhessen-Nahe, Westpfalz. Harz). Beispielhaft ist, dass Gemeinden und Gemeindeteile als Eigenentwickler festgelegt werden, die „nicht-zentrale Orte" bzw. „Gemeinden ohne zentralörtliche Einstufung" darstellen oder Gemeinden sind, für die keine Festlegung zur verstärkten Siedlungsentwicklung bestehen. Nur in wenigen Untersuchungsregionen werden die Eigenentwicklergemeinden und -gemeindeteile direkt bestimmt, ohne sich auf andere Festlegungen im Raumordnungsplan zu beziehen (vgl. Regionalplan Stuttgart, Münsterland). Auch besteht eine Eigenentwicklungsfestlegung, die keine weitere Erläuterung des räumlichen Umgriffs enthält (vgl. Regionalplan Ostthüringen).

Vorgaben zur Verortung der Eigenentwicklung sind ein unüblicher Regelungsinhalt der Festlegungen zur Eigenentwicklung der regionalen Raumordnungspläne der Untersuchungsregionen. Lediglich im Regionalplan Stuttgart sind Vorgaben zur Verortung der Eigenentwicklung innerhalb des Gemeindegebiets beinhaltet. So sind in diesem Regionalplan für einige Eigenentwicklergemeinden die empfohlenen Ortslagen für die Schwerpunktsetzung der Eigenentwicklung aufgeführt.[66] Darüber hinaus werden teilweise in der Festlegung zur Eigenentwicklung auch Hinweise zur vorrangigen Innenentwicklung integriert (vgl. Regionalplan Schwarzwald-Baar-Heuberg, Mittelhessen).

4.1.3 Maß der zulässigen Siedlungsentwicklung im Rahmen der Eigenentwicklung

Was wird unter Eigenentwicklung verstanden? Welche Entwicklungen sind im Rahmen der Eigenentwicklung zulässig? Diese Fragen lassen sich nach Durchführung der vergleichenden Analyse nicht generalisierend beantworten. Der Vergleich zeigt auf, dass **qualitative Vorgaben zum Maß der zulässigen Siedlungsentwicklung** der Eigenentwicklungsfestlegungen variieren. Demnach umfasst Eigenentwicklung in den Raumordnungsplänen unterschiedliche Komponenten, d.h. es sind im Rahmen der Eigenentwicklung unterschiedliche Bedarfe zu decken und Entwicklungen möglich, weswegen sich auch das Maß der zulässigen wohnbaulichen und gewerblichen Siedlungsentwicklung im Rahmen der Eigenentwicklung unterscheidet.

Zunächst sei darauf hingewiesen, dass sich der **inhaltliche Umgriff** in den Eigenentwicklungsfestlegungen unterscheidet. Ein Großteil der Eigenentwicklungsfestlegungen der Untersuchungsregionen bezieht sich sowohl auf die Wohnsiedlungsentwicklung als auch auf die gewerbliche Siedlungsentwicklung. Lediglich

66 Vgl. Regionalplan Stuttgart 2009, Z 2.4.1 S. 79ff.

die Festlegungen zur Eigenentwicklung in zwei Regionalplänen beziehen sich nur auf die Wohnsiedlungsentwicklung (vgl. Regionalplan Rostock, Cuxhaven)

Die **qualitativen Angaben** zum Maß der zulässigen Siedlungsentwicklung in den Festlegungen verdeutlichen, dass Eigenentwicklung im Großteil der Regionalpläne nicht als Eigenentwicklung im „engeren Wortsinn" definiert ist und auch exogene Entwicklungen zulässt bzw. exogene Bedarfe deckt. Demnach beschränkt sich die Eigenentwicklung, entgegen des Wortsinns, selten ausschließlich auf die örtlichen Bedürfnisse. Die Deckung der Bedarfe aus Wanderungen in Eigenentwicklergemeinden und -gemeindeteilen werden nur in den Regionen Rostock und Düsseldorf kategorisch ausgeschlossen (vgl. Regionalplan Rostock, Düsseldorf). Dahingegen wird in sechs der Untersuchungsregionen die Deckung der Bedarfe aus Zuwanderungen nicht gänzlich ausgeschlossen (vgl. Regionalplan Mecklenburgische Seenplatte, Oberland, Schwarzwald-Baar-Heuberg, Main-Rhön, Oberland, Münsterland). Hier ist die Zulässigkeit von Zuwanderungen in Eigenentwicklergemeinden bzw. -ortteilen an unbestimmte Rechtsbegriffe gebunden. Beispielhaft hierfür ist die Angabe zur „nicht unverhältnismäßigen Zuwanderung" im Regionalplan Main-Rhön oder zur „der Größe, Struktur und Ausstattung nach angemessenen Zuwanderung" im Regionalplan Oberland. Eine weitere beispielhafte Vorgabe beinhaltet der Regionalplan Mecklenburgische Seenplatte, welcher vorgibt, dass Eigenbedarf *vorrangig* den Bedarf der am Ort lebenden Menschen umfasst und demnach die Bedarfsdeckung aus Wanderungen nicht ganz ausgeschlossen zu sein scheint. In knapp der Hälfte der Untersuchungsregionen besteht in der Eigenentwicklungsfestlegung keine Angaben zur Zulässigkeit bzw. zum Ausschluss der Bedarfsdeckung über den örtlichen Wohnungsbedarf hinaus (vgl. Regionalplan Mittelhessen, Hannover, Cuxhaven, Rheinhessen-Nahe, Westpfalz, Harz, Ostthüringen).[67]

Die vergleichende Analyse zeigt darüber hinaus auf, dass in rund der Hälfte der untersuchten Regionalpläne auch **quantitativen Angaben** zur Bestimmung der maximal zulässigen Siedlungsentwicklung in Eigenentwicklergemeinden bzw. -gemeindeteilen bestehen (vgl. Regionalplan Stuttgart, Mittelhessen, Rostock, Hannover, Cuxhaven, Rheinhessen-Nahe, Westpfalz). Der Großteil der untersuchten Berechnungsmodelle ist strikt verbindlich und als Ziel der Raumordnung festgelegt (vgl. Regionalplan Mittelhessen, Rostock, Hannover, Rheinhessen-Nahe, Westpfalz). Jedoch bestehen, wie beispielsweise in der Region Stuttgart, auch Berechnungsmodelle, die lediglich als Grundsatz der Raumordnung ausgeformt sind und somit nur Orientierungswerte darstellen.[68] Berechnungsmodelle beziehen sich meist ausschließlich auf die Wohnsiedlungsentwicklung und nicht auf die gewerbliche Siedlungsentwicklung (vgl. Regionalplan Stuttgart, Rostock, Cuxhaven, Rheinhessen-Nahe, Westpfalz). Eine Ausnahme hierbei stellt der Regionalplan Mittelhessen dar.[69] Auch im Regionalplan Hannover besteht ein Berechnungsmodell, das neben der Wohnsiedlungsentwicklung auch die Entwicklung gemischter Bauflächen einbezieht.[70] Der Vergleich stellt heraus, dass grundsätzlich zwischen Berechnungsmodellen, die einen Flächenbedarfswert sowie Berechnungsmodellen, die eine zulässige Anzahl an Wohneinheiten vorgeben, unterschieden werden kann. Dementsprechend variieren auch die Sachbezüge. Es ist zu unterscheiden zwischen Berechnungsmodellen mit einem Bezug auf die vorhandene Siedlungsfläche (x % der vorhandenen Siedlungsfläche), die vorhandenen Wohneinheiten (x % des Wohnungsbestands) und Modellen, die einen bestimmten Flächenwert oder eine bestimmte Anzahl an Wohneinheiten pro 1.000 Einwohner (x Hektar oder x Wohneinheiten / 1.000 / Jahr(e)) vorsehen und demnach einwohnerbezogen ausgeformt sind. Im Regionalplan Mittelhessen besteht darüber hinaus ein absoluter maximaler Flächenbedarfswert für Eigenentwicklergemeinden.[71] Wesentlich ist zudem, dass die Berechnungsmodelle oftmals durch die Vorgabe von baulichen Dichtewerten ergänzt werden und dadurch beispielsweise die durch das Berechnungsmodell ermittelte Anzahl an Wohneinheiten, anschließend in einen Flächenwert umgerechnet werden kann.

Darüber hinaus bestehen Unterschiedlichkeiten hinsichtlich der Herleitung der Grundwerte „x" und der zeitlichen Bezüge. Ein Vergleich der Angaben zur Art und Weise der Ermittlung der Grundwerte „x" der Berechnungsmodelle verdeutlicht, dass hierbei insbesondere zwischen der Verwendung von

[67] Die Ausgestaltung der qualitativen Vorgaben hinsichtlich der gewerblichen Eigenentwicklung werden im Rahmen dieses Beitrags nicht aufgeührt.

[68] Vgl. Regionalplan Stuttgart 2009, G 2.4.0.5.1, S. 55

[69] Vgl. Regionalplan Mittelhessen 2010, Z 5.3-3, S. 55; Begründung zu Z. 5.3-3, S. 56f.

[70] Vgl. Regionalplan Hannover 2016, 2.1 Ziffer 7, S. 23.

[71] Vgl. Regionalplan Mittelhessen 2010, Z 5.2-7, S 48f.; Begründung zu Z 5.2-7, S. 48f.

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Erfahrungswerten und der Verwendung von Prognosewerten unterschieden werden kann. Wesentlich ist hierbei, dass entweder prognostizierte örtliche Bedarfe oder prognostizierte regionale Bedarfe die Grundlage der Herleitung der Grundwerte bilden. Hinsichtlich der zeitlichen Bezugsgröße der Berechnungsmodelle wird im Vergleich deutlich, dass auch hier Varianzen bestehen. Die Berechnungsmodelle können für eine bestimmte Anzahl an Jahren ausgestaltet sein oder aber auch für die Geltungsdauer des Raumordnungsplans.

Die Anwendung dieser Berechnungsmodelle auf einen Modellortsteil verdeutlicht, dass diese unterschiedlich viel Siedlungsentwicklung zulassen würden und dass die Vergleichbarkeit der Anwendung der Berechnungsmodelle auf den Modellortsteil aufgrund unterschiedlichster Faktoren erschwert wird. Hierzu zählt beispielsweise, dass einige Berechnungsmodelle einen Flächenwert vorgeben und andere eine Anzahl an zulässigen Wohneinheiten. Außerdem wird die Vergleichbarkeit durch unterschiedliche Handhabungen der Berechnungsmodelle bezüglich der Anrechnung bestehender Flächenpotenzialen im Innenbereich und in rechtskräftigen Bauleitplänen gemindert. Auch zusätzliche beschränkende Vorgaben, wie beispielsweise die Vorgabe eines gemeindlichen Wohnbauflächenbedarfs, in den sich in der Region Mittelhessen der 5-Hektar-Eigenbedarfswert der Ortsteile einfügen muss[72], sowie Lockerungen und Ausnahmeregelungen beeinträchtigen die Vergleichbarkeit der Rechenmodelle. Demnach besteht beispielsweise für die Stadt-Umland-Region Rostock eine abweichende und weniger restriktive quantitative Vorgabe[73] und somit nicht für die gesamte Region ein einheitliches Berechnungsmodell, wodurch die Vergleichbarkeit relativiert wird.

4.1.4 Angaben zur Absicht des Normgebers

Die vergleichende Plananalyse zeigt, dass hinsichtlich der Steuerungsintention des Planelements zwar eine große Bandbreite an Angaben in den Festlegungen besteht, aber nicht alle Eigenentwicklungsfestlegungen umfassende Erläuterungen hierzu aufweisen. Zu den Angaben zur Absicht des Normgebers, die in den Eigenentwicklungsfestlegungen der Raumordnungspläne am meisten genannt werden, gehören unter anderem die nachhaltige Raumentwicklung, die räumliche Konzentration der Siedlungsentwicklung, sowie der Freiraumschutz. Die Angaben zu den Steuerungsintentionen sind im Großteil der untersuchten regionalen Raumordnungspläne sehr lückenhaft. Nur in einzelnen Regionalplänen, wie beispielsweise dem Regionalplan Stuttgart, wird genauer dargelegt, was mit dem Planelement Eigenentwicklung intendiert wird.[74] Zudem besteht mit dem Regionalplan Ostthüringen ein Regionalplan, der sehr ausführliche Erläuterungen zur Absicht der Reduzierung der Flächenneuinanspruchnahme durch den Grundsatz zur Eigenentwicklung bzw. zum „gemeindebezogenen Bedarf“ aufweist[75].

4.2 Empfehlungen zur Optimierung der Festlegungen zur Eigenentwicklung

Auf Basis der Erkenntnis der vergleichenden Plananalyse der hohen Heterogenität der Regelungsinhalte der bestehenden Eigenentwicklungsfestlegungen werden Empfehlungen ausgesprochen, wie die Festlegungen zur Eigenentwicklung ausgestaltet bzw. optimiert werden können, um einen möglichst großen Beitrag zum Klimaschutz zu leisten.

Zunächst sollte in der **Begründung** der jeweiligen Eigenentwicklungsfestlegung besser herausgestellt werden, dass die Reduzierung der Flächenneuinanspruchnahme und damit auch der Klimaschutz eine zentrale Intention der Eigenentwicklungsfestlegung darstellt. Hierzu sollte in der Begründung insbesondere auf die Klimaschutzziele sowie das Ziel der Bundesregierung zur Reduzierung der Flächenneuinanspruchnahme eingegangen werden und auch die Flächenneuinanspruchnahme in der Planungsregion geschildert werden, ggf. mit Hinweisen zur Entkoppelung der Wohnsiedlungsflächen- und Bevölkerungsentwicklung und zur besonders hohen Flächeninanspruchnahme pro Kopf im ländlichen Raum. Ferner sollte im Zuge dessen hervorgehoben werden, dass Eigenentwicklung als Planelement zur Begrenzung der Siedlungsentwicklung in infrastrukturell schlecht ausgestatteten Gemeinden und Gemeindeteilen als zielführendes Instrument zur Reduzierung der Flächenneuinanspruchnahme gilt. Nicht zuletzt sollte deutlich gemacht werden, dass die Festlegung eine räumlichen Konzentration der Siedlungsentwicklung auf geeignete Standorte stützt und dadurch negativen Auswirkungen, wie einem

[72] Vgl. ebenda.
[73] Laufende Teilfortschreibung Regionalplan Rostock Entwurf 2019, 3.1.2 Z 4, S. 3.
[74] Regionalplan Stuttgart 2009, Begründung zu Z 2.4.2, S. 82.
[75] Laufende Änderung Regionalplan Ostthüringen Entwurf 2018, Begründung zu G 2-3.

erhöhten Verkehrsauskommen oder einer geringen Tragfähigkeit von Infrastrukturen und des ÖPNV, entgegengewirkt und auf diese Weise Treibhausgasemissionen reduziert und das Klima schützt.[76]

Empfohlen wird darüber hinaus, dass das Planelement als **Ziel der Raumordnung** in den Regionalplänen festgelegt wird. Verbindliche und abschließende Regelungsinhalte zum räumlichen Umgriff und zum Maß der zulässigen Siedlungsentwicklung (qualitative und quantitative Vorgaben) im Rahmen der Eigenentwicklung sind von Vorteil, da sich die nachgelagerte Bauleitplanung dann an diese Vorgaben strikt anzupassen hat und kein Abwägungsspielraum bleibt. Dadurch kann der Steuerungsintention der Reduzierung der Flächenneuinanspruchnahme und somit dem Klimaschutz bestmöglich Rechnung getragen werden.[77]

Um die Festlegung möglichst kompatibel mit deren Steuerungsintentionen der Reduzierung der Flächenneuinanspruchnahme und der räumlichen Konzentration der Siedlungsentwicklung auszugestalten, muss bei der **Festlegung des räumlichen Umgriffs** der Eigenentwicklungsfestlegung auf einige wesentliche Aspekte geachtet werden. Wichtig ist, dass in Abhängigkeit der jeweiligen Gemeindestruktur entweder die räumliche Bezugsgröße „Gemeinde" oder „Gemeindeteile" verwendet wird und dabei immer alle Siedlungen durch die Eigenentwicklungsfestlegung erfasst werden, die keine Eignung für eine verstärkte Siedlungsentwicklung aufweisen. Wären anderenfalls Gemeinden oder Gemeindeteile, die keine Eignung für eine verstärkte Siedlungsentwicklung aufweisen, nicht auf die Eigenentwicklung beschränkt, würde dies der Steuerungsintention des Planelements zuwiderlaufen. Bei der Festlegung der Gemeinden bzw. Gemeindeteile ohne Eignung für verstärkte Siedlungsentwicklung als Eigenentwickler ist des Weiteren darauf zu achten, dass geeignete Kriterien zur Festlegung, wie beispielsweise Mobilitäts- und Erreichbarkeitskriterien, die infrastrukturelle Ausstattung und Versorgungssituation, natürliche und naturräumliche Restriktionen und ggf. auch das Arbeitsplatzangebot, herangezogen werden. Zentral ist zudem, dass eine verbindliche Vorgabe zur Konzentration der Eigenentwicklung auf den Hauptort besteht, falls ganze Gemeinden mit mehreren Ortsteilen als Eigenentwickler festgelegt werden. Darüber hinaus sollte auch das Prinzip der Innen- vor Außenentwicklung für die Eigenentwicklergemeinden verbindlich vorgeschrieben werden, um eine kompakte Siedlungsentwicklung zu garantieren.[78]

Um auch die **Angaben zum Maß der zulässigen Wohnsiedlungsentwicklung** kompatibel mit der Steuerungsintention der Reduzierung der Flächenneuinanspruchnahme auszugestalten, sollten zum einen die **qualitativen Vorgaben zur Eigenentwicklung** klar und ohne Verwendung unbestimmter Rechtsbegriffe ausformuliert werden. Um einen möglichst großen Beitrag zum Klimaschutz leisten zu können, sollte die Festlegung die Deckung von Bedarfen aus Wanderungsgewinnen in Eigenentwicklerortsteilen strikt ausschließen. Zusätzlich zu diesen restriktiven qualitativen Angaben zum Maß der zulässigen Wohnsiedlungsentwicklung wird ein Berechnungsmodell zur **quantitativen Ermittlung der zulässigen Eigenentwicklung** als Ziel der Raumordnung empfohlen, damit das Maß der Wohnsiedlungsentwicklung für die Adressaten besser nachvollziehbar ist und auch ein verbesserter Vollzug der Angaben zum Maß der Wohnsiedlungsentwicklung in der Praxis gewährt werden kann. Quantitative Angaben sollten auf örtlichen Wohnungsbedarfsprognosen basieren, die sich aus dem Bedarf der natürlichen Bevölkerungsentwicklung und der ortsansässigen Bevölkerung (Ersatz-, Neu- und Nachholbedarf) zusammensetzen. Diese Berechnungsmodelle sollten in Kombination mit einem zusätzlichen Berechnungsmodell zur Wohnungsbedarfsdeckung der gesamten Region angewandt werden, um auch sicherzustellen, dass der Gesamtbedarf der Region trotz restriktiver Siedlungsentwicklung in den Eigenentwicklern erfüllt wird. Weiterhin sollte bei der Festlegung darauf geachtet werden, dass das Berechnungsmodell das Maß der Eigenentwicklung als Flächenwert vorgibt, denn durch eine reine Vorgabe von zulässigen Wohneinheiten wäre die Ressource "Fläche" nicht ausreichend geschützt. Um eine effiziente Nutzung der zur Verfügung stehenden Fläche zu erreichen, sollte darüber hinaus ein Dichtewert in Form von "x Wohneinheiten pro Hektar" für die Eigenentwicklergemeinden vorgegeben werden. Letztendlich wird auch empfohlen, die bestehenden Wohnsiedlungsflächenpotentiale im Innenbereich und im Bereich von rechtskräftigen Bebauungsplänen im Berechnungsmodell einzuberechnen, um der Intention der Reduzierung der Flächenneuinanspruchnahme ausreichend Rechnung zu tragen. Auch von zentraler Bedeutung ist die zeitliche Bezugsgröße. Diese sollte in Jahren vorgegeben werden, da der Zeitbezug „Planungshorizont des

[76] Vgl. Briegel 2020, S. 179.
[77] Vgl. ebenda, S. 180.
[78] Vgl. ebenda, S. 181.

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Regionalplans“ unbestimmt ist. Um eine reibungslose praktische Umsetzung des Berechnungsmodells sicherzustellen, sollte letztendlich auch ein Siedlungsflächenmonitoring auf Gemeindeebene verbindlich vorgeschrieben werden.[79]

Die verschiedenen, vorgestellten **Berechnungsmodelle** zur quantitativen Bestimmung der zulässigen Wohnsiedlungsentwicklung im Rahmen der Eigenentwicklung[80] können sich unterschiedlich auf die Qualität der Flächenneuinanspruchnahme, sprich die Bautypologie und auch die bauliche Dichte, auswirken. Legt die Regionalplanung fest, dass eine bestimmte Anzahl an Wohneinheiten in einem bestimmten Zeitraum in Eigenentwicklergemeinden zulässig ist, ohne zusätzliche Dichtewerte vorzugeben, ist davon auszugehen, dass dadurch insbesondere in kleineren Gemeinden in ländlichen Räumen Anreize geschaffen werden, dieses Kontingent an Wohneinheiten vornehmlich für Einfamilienhäuser zu nutzen. Diese Berechnungsmodelle, die der kommunalen Planung eine Anzahl zulässiger Wohneinheiten vorgeben, können folglich dem verfolgten Ziel der Reduzierung der Flächenneuinanspruchnahme nur sehr bedingt gerecht werden.[81] Dahingegen kann durch die Vorgabe eines Flächenwerts erreicht werden, „dass Gemeinden versuchen, die Fläche, die sie beplanen dürfen, möglichst effizient zu nutzen und möglichst viele Wohneinheiten auf dieser Fläche zu realisieren.“[82] Demnach kann festgehalten werden, „dass ein vorgegebener maximaler Flächenwert besser sicherstellt, dass flächensparend gebaut wird und somit der Steuerungsintention [des Planelements Eigenentwicklung der Reduzierung der Flächenneuinanspruchnahme] besser gerecht wird, als durch die Vorgabe von maximalen Wohneinheiten.“[83] Gleichwohl kann allein durch die Vorgabe eines Flächenwertes und die darausfolgende effiziente Nutzung dieser Fläche durch eine dichte Bebauung nicht sichergestellt werden, dass diese Bebauung in qualitativer Hinsicht auch anderen Kriterien einer klimagerechten und energieeffizienten Siedlungsentwicklung entspricht.

5 BEITRAG DER EIGENENTWICKLUNGSFESTLEGUNG ZUM KLIMASCHUTZ

Die restriktive Festlegung des Planelements Eigenentwicklung ist gerade deshalb von besonderer Bedeutung für die Reduzierung der Flächenneuinanspruchnahme und den Klimaschutz, da durch dieses Planelement Gemeinden und Gemeindeteile im ländlichen Raum in ihrer Siedlungsentwicklung begrenzt werden können. Diese weisen einerseits eine vergleichsweise hohe Flächeninanspruchnahme pro Kopf und somit ein hohes Flächeneinsparpotential und andererseits eine sehr deutliche Abkopplung ihrer Bevölkerungs- und Gebäudeflächenentwicklung auf. Die Begrenzung der Siedlungsentwicklung dieser Gemeinden und Gemeindeteile ist daher wesentlich, um den Zielen der Bundesregierung zur Reduzierung der Flächenneuinanspruchnahme annähernd gerecht werden zu können. Im Diskurs zu raumordnerischen Planelementen zur Steuerung der Siedlungsentwicklung und zum Schutz des Klimas sollte das Planelement Eigenentwicklung künftig demnach einen hohen Stellenwert einnehmen. Dabei geht die Argumentation, das Planelement „Eigenentwicklung“ würde zu einem weiteren „Ausbluten“ des ländlich-strukturschwachen Raumes und demnach zur Verstärkung der räumlichen Disparitäten zwischen ländlichen Räumen und Verdichtungsräumen beitragen, gänzlich ins Leere. Die Vorgabe der Eigenentwicklung fördert in eben diesen Räumen durch die Beschränkung der Wohnsiedlungsentwicklung auf bislang unbebauten Arealen vielmehr deren Innenentwicklung und damit die (Wieder-)Belebung verödeter Ortskerne in ländlichen Räumen.

Die Empfehlungen zur Optimierung des Planelements Eigenentwicklung zeigen, dass dieses so ausgestaltet werden kann, dass eine hohe Steuerungswirkung gegeben ist und ein wesentlicher Beitrag zur Reduzierung der Flächenneuinanspruchnahme und zum Klimaschutz leisten kann. Zweifellos kann sich die Steuerungswirkung des Planelements nicht voll entfalten, wenn dieses nicht verbindlich festgelegt wird, unbestimmte Angaben zum räumlichen Umgriff und zum Maß der Siedlungsentwicklung beinhaltet oder auch exogene Bedarfe zulässt.

Dabei ist klar, dass nicht nur die Siedlungsentwicklung der Eigenentwicklergemeinden eine derartige Steuerung bedarf, sondern ebenso die Siedlungsentwicklung der Siedlungsschwerpunkte einer Region. Daher wird neben der quantitativen Steuerung der Wohnsiedlungsflächenentwicklung der Gemeinden mit

79 Vgl. ebenda, S. 182ff.
80 Vgl. oben, S. 9.
81 Vgl. Briegel, S. 156f.
82 Ebenda, S. 158.
83 Ebenda.

Beschränkung auf die Eigenentwicklung auch empfohlen die Wohnsiedlungsentwicklung der gesamten Region bedarfsgerecht zu gestalten und flächenmäßig zu begrenzen.

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Rethinking Planning and Spatial Assessment from a Care Perspective

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1 ABSTRACT

The implementation of the New Urban Agenda in most cases focuses on one of the UN Strategic Development Goals (SDG2030), for example either on 5) Gender Equality or 11) Sustainable Cities & Communities. Nonetheless, a considerable body of knowledge exists [see references] that brings together gender and sustainability, and explains how strategies to achieve Gender Equality and Urban resilience can enhance each other. The empirical studies underlaying these insights demonstrate that implementation requires a radical transformation of planning processes and methodologies towards collaborative planning cultures and residents' involvement. While direct dialogue needs to have a structural place in planning, in practice, it is difficult to include residents in all steps of the planning process, particularly preparing structural development plans on a larger scale. Moreover, there are parts of planning processes that can, and should, be done by professionals, such as preparatory analyses and making synergies of local data and conditions.

In this contribution, we argue that this needs to be done with an understanding of gender-inequalities because gender-blindness will lead to reproducing gender stereotypes, and re-inforce the existing inequalities in its wake. However, gender competences are often not part of planning and urbanism curricula, and few planners have the necessary knowledge and skills to transfer knowledge from genderstudies into planning decisions. In this paper we argue for an approach that puts ‚care' in the heart of planning and studies its implications at different scale-levels. Our approach is based on the Austrian pilot project "Smart through Gender+" and builds on two decades of research and exchange amongst European Gender Planning Experts.

Keywords: Gender Mainstreaming, Care, Diversity, Planning Instruments, Smart Cities

2 INTRODUCTION

Planners often claim to be highly democratic and "plan for everyone" without exclusion. However, as long as not everyone has the same starting point in society, not making a diffence means certain groups or activities remain invisible with a high risk of being excluded. While collecting gender-segregated data for this purpose is a necessity, it also holds the risk of collecting findings based on given assumptions on gender roles- and develop strategies fixed on gender-typical roles. One of the consequences of stereotyping is, that it implicitly reproduces the established norms (see Damyanovic 2007) and puts different perspectives on how space works out of (the formal planning) order. A body of knowledge existst that brings Gender Equality and Urban resilience together, and explains how both strategies can enhance each other. The empirical studies underlaying these arguments, demonstrate that implementation requires a radical transformation of planning processes and methodologies; towards collaborative planning cultures and residents' involvement. However, in practice, it is difficult to include residents in all steps of the planning process, particularly when preparing spatial development plans on a larger (regional) scale. Moreover, there are parts of planning processes that can, and should, be done by professionals, such as preparatory analyses and making synergies of local data and conditions.

In our experience, planning and urban analyses needs to be done with an understanding of gender-inequalities because gender-blindness will lead to reproducing gender stereotypes, and re-inforce the existing inequalities in its wake. However, gender competences are often not part of planning and urbanism curricula, and few planners have the necessary knowledge and skills to transfer knowledge from genderstudies into planning decisions. For this reason, we as collaborating geographer and engineer, are developing practical tools that can support gender-aware planning.

The tool we discuss here, is a matrix from the users' and residents' perspective, integrating these principles in a differentiated urban analysis and spatial assessment. The matrix differentiates from the habitual definitions of "target" or "user" groups, in that it does not put the personal characteristics (such as age or gender) on the foreground, but looks at the determining conditions for the use of (semi)public urban space.

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Performing Urban Analyses based on the Gender Mainstreaming principles are a promising approach to avoid "stereotyping" or "victimising" certain user groups and advance towards equal rights to the city.

In this paper we explain the background of this approach, and how it can help a dynamic urban assessment, rather than static, role-confirming diagnosis. We depart from the main principles identified for Gender Mainstreaming as an officiel EU-strategie in line with SDG-5:

- Facilitating the reconciliation of home and job, to ensure economic independance
- The recognition of the diversity amongst social/user groups and
- Bodily integrity, the right to decide about one's own body andmove freely in public space.

(EIGE 2021 – https://eige.europa.eu/gendermainstreaming/concepts-and-definitions).

We illustrate a dynamic assessment by the example of the case study of the city of Linz (AT) from the research project SmartThrougGender+. The project Smart Through Gender+ involved developing and testing a set of analytical tools and planning instruments for inclusive urban planning, adressing diverse needs of residents in the city of Linz. The task of the two authors in the research project was, among others, the articulation of gender equality goals, their translation in planning guidelines for implementation, as well as the definition of gender+ groups for a differentiated recording and description of urban qualities and deficits.

We conclude the paper by summarizing the benefits and limitations of this approach, and give some recommendations on how it could be implemented elsewhere.

3 FRAMING – CONTEXT

3.1 Fresh view on spatial conditions: From feminist planning targets to core topics

Virtually all societal orders are informed to a large extent by a (bipolar, heterosexual) gender divide. However, the roles assigned to men and women and the relations between them vary through time and place. In gender studies the term "gender" is used to refer to social and cultural constructions of masculinities and femininities. Gender differences go beyond variations that may exist between individual men and women, and focus on systemic aspects such as the gender paygap which lead not only to "injustices" but also to economic loss (https://www.europarl.europa.eu/legislative-train/theme-deeper-and-fairer-internal-market-with-a-strengthened-industrial-base-labour/file-gender-pay-gap-action-plan). In this context Garber and Turner (1992) remind that "gender" in urban studies explicitly excludes reference to biological differences to focus on cultural differences. A ‚gender-differentiated planning approach" is about the societal aspects of activities or places perceived as "typically male and female for example: sport-facilities; production or manufacturing locations, playgrounds during the day or parks during the night. Gender Mainstreaming is concerned with this gender dynamic at policy level and legally binding within the European Union (eige.europa.eu/gender-mainstreaming). Gender Mainstreaming is a top-down strategy to embed equality policies in all sectors, including planning processes. Pursuant to Article 2, 3, and 13 of the Treaty of Amsterdam, all EU member states have adopted formal equal opportunity policies and anti-discrimination legislation.

Applying Gender Mainstreaming in Planning Processes thus involves looking at gendered differences in the use as well as in the production of space. In order to do so, the first impulse often is to ‚count male and female bodies' and set equality goals on this basis. In the production of space, this could for example mean an equal participation of both sexes in the decisionmaking institutes and positions. For the use of space, this could imply adapting bus-routes or time-tables to the needs of under-represented groups, or making public transport, parks and squares more "safe" for groups expressing a feeling of vulnerability or fear of going out (Knoll and Schwaninger, 2020). While these responses in themselves are locally useful, the trouble with this approach is that it often relies on pre-set images of activities and needs of female and male population groups.

Spatial planning decisions and the subsequent urban design proposals contain implicit gender-stereotyping and behavioural assumptions (Jarvis et al., 2012; Fainstein and Servon, 2005; Greed, 2005; etc.). The planning models for the CIAM functional city included elaborate guidelines for the domestic sphere, labelled this "dwelling" and departed on the model of the (male) breadwinner household unit with the other (female) partner performing the household (Tummers & Zibell, 2012). Since the womens' movement of the 1970s this concept based on unwaged ‚domestic labour‘ was subject to criticism, and household-units have beed diversifying. Nonetheless, these underlying assumptions are still reproduced in planning documents such as texts, maps, and images of structure visions, master plans, and technical briefings, which contain language and symbols with implicit models of gender roles. For example, a structural vision to enhance the competitiveness of a region may contain strategies for economic development without any reference made to unwaged (household) activities as part of the economic model. Planning documents inform planning decisions on, for example, density, mixed use, or road profiling, which in turn have an impact on the level of services that can be maintained and on user qualities such as safety and accessibility. Similarly the design for cyclist networks is based on a single speed assumption, usually 20 km/h, which can be very hard to achieve when accompanied by young children or elderly people. The effect of such decisions will be different for distinctive user groups (Sanchez de Madariaga and Roberts, 2014; Damyanovic et al., 2013).

This has led feminist scholars to criticise planning practice, as they have other applied sciences, for taking the “white middle-class male” as a normative standard (Wankiewicz & Tummers, 2020). Ignoring such differences and operating on out-dated social models leads to planning decisions that are not future-proof and do not respond adequately to societal trends and challenges. Transport Planning is relatively advanced in understanding for example that mobility is not only steered by displacements for waged work (commuting) or recreation (funshopping) but primarily by the care-responsabilities that residents have, or the care that they need (Knoll and Schwaniger, 2020). Not offering public transport that enables the socalled trip-chaining (for delivering children at school on the way to work, and picking up shopping during tthe return trip) obliges households to use a car, with as consequence increased presssure on the environment, the quality of urban space, and the household budget.

Many planning authorities acknowledge this by issuing guidelines for “special needs” groups, such as people with disabilities or child-friendly school routes. The SDG2030 Target 11.7 aims for example, by 2030 provide universal access to safe, inclusive and accessible, green and public spaces “in particular for women and children, older persons and persons with disabilities” (https://sdgs.un.org/goals/goal11). While seeing “women” as a “special needs group” can be strategically necessary, it also has some long-term disadvantages. In the first place, special budgets are temporary and in most cases do not lead to structural embedding or imrpovement. Second, the plans and documents of local authorities or planning departments issue for Gender Mainstreaming in planning mostly talk about the “needs and interests of women”, implicitly suggesting that women have something to “catch up with” without specifying which economic or decision-making injustice that is being addressed. Without such critical perspective, consultancies with local women are likely result in a strategy to improve access for people with prams and accompanied by small children, or improving the lightning in certain streets. The share (vulnerable) groups of men may have in the accessibility of public space thus remains out of sight. Most importantly: ‚care‘ thus remains a secondary category of activities, instead of being visible and prioritised in general planning activities.

3.2 Nurture vs. nature – avoiding stereotyps and sex counting

An important condition to implement Gender Mainstreaming is the availability of gender-segregated statistics. While gender-segregated data are indispensable, to distinguish between the condition of (for example) men and women, the difficulty with them is that it it makes

(1) homogeneous categories of (all) men and (all) women – despite crossvariables such as income or age; and

(2) appears to connect women structurally with ‚disadvantages‘ and implicitly building equality strategies towards a “catching up with the men” in other words the male-dominated forms of economy.

One example illustrates this dilemma: As can be seen in time-pattern statistics, men participate less in domestic tasks, such as child-care, cleaning, and washing (ec.europa.eu/eurostat/statistics-explained/index.php?title=Labour_market_and_household_statistics). This however does not mean that “men” per se are less “caring” as can be observed in societies and generations where men get the oppportunity to “take care”. Moreover, the growing amount of single-person households, especially in the western world and amongst senior citizens, implies that many more people have to combine waged work and care-tasks for themselves, in one -male or female- body. Consequently, if planners continue to perceive women (only) as the care-takers, it ignores other demographic developments that lead to a widening of the ‚interest group‘ (or target group in marketing terms) of gender-aware planning. It also ignores, that an increasing number of households with women interested in having a professional career "outsource" the care-work to nannies, cleaners, canteens and meal-caterers, laundry and other services. In spatial terms this outsourcing has implications in global migration, bringing in its wake different housing needs, in the best case extending the nuclear fmily home with appartments for staff, comparable to the "chambres de bonnes" in early modern Paris, so far only affordable for upper salary ranges (Sassen, 2009). The migration of domestic staff virtually always involving living in two locations for the personell involved, and while this is increasingly an issue for seasonal agricultural labourers, for domestic workers so far it is hardly cosidered. Here "gender" intersects with "class" and often "(ethnic) origin".

In order to advance Gender equality in and through planning, it is needed to address urban design, quality of place, and the planning process itself. Following the earlier mentioned principles of Gender Mainstreaming, the state of the art in gender-aware planning now presents considerable knowledge available for local implemetation, such as:

- Facilitating the reconciliation of home and job, which means to rethink the functional segregation of the CIAM urban model. The concept of the "city of short distances" also called "walkable city" or "15-minute city" has become a wide-spread reference. Where (low) densities do not allow the implementation of this concept, compensation needs to be found amongst others in transport planning and the re-organisation of services for example in space or time-sharing.
- The recognition of the diversity amongst social/user groups has lead to important innovations of participation methods, aiming for empowerment rather than for consultation;
- Bodily integrity involves the recognition of subjective experiences as imposing restrictions for moving freely in public space, such as fear of harrasment of uncomfort by sexist advertisement. Design criteria for "safe" parks and streets are available.

Based on this body of knowledge, particularly the analysis of Gender Planning handbooks, we have identified key dimensions which strongly influence the temporal and spatial flexibilty or rigidity of daily routines and the autonomy or dependency of persons/users from urban qualities and facilities. The next section zooms into these aspects and the experimental implementation in the case for Linz.

4 GENDER IN PLANNING – OUR APPROACH

4.1 Care-Work in focus: Rethinking user groups to spatial-temporal use patterns

As planners, we are committed to the goals and targets of the SDGs, in the first place target 5.4:

"recognize and value unpaid care work and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate".

One of the consequences to be considered within planning processes is the diversity and complexity of daily use patterns and need for care-work related infrastructures and spatial qualities. all EU countries surveys and statistics show strong inequalities in the distribution of these taks between women and men (e.g. Eurofounds 2012): since decades, women care for children, household and reproductive work. This generates another inequality in the share of part-time working arrangements, e.g. in Austria 47,7 % women, 10,7 % men in 2019 (Statistik Austria 2020). Another consequence of this gender bias is a big gap in income between women and men and a dramatic low income pension age (women have 50% less than men in 2020 – (Trapez 2020). This income gap has an impact upon, amongst others, achieving the targets of SDG 11.1 to "ensure access for all to adequate, safe and affordable housing and basic services" because less household income implies less tax-income thus reducing on two fronts the budgets for housing and basic infrastructure. The same can be said for 11.2 to 'provide access to safe, affordable, accessible and sustainable transport systems'.

However for analysing spatial qualities and the accessibility and quality of urban infrastructures it is not of primary importance if the accompanying person who brings a child to Kindergarden/creche, cooks meals and keeps the houshold has a male or female or hybrid body. We propose a tool for urban assessment that aims to integrate the users' & residents' perspective and at the same time avoiding stereotyping. The matrix differentiates from the habitual definitions of "target" or '"user" groups, in that it does not put the persona characteristics on the foreground, but looks at the determining conditions for the use of (semi-)public urban space. Gender studies has shown that this is not only steered by displacements for waged work (commuting) or recreation (funshopping) but primarily by the care-responsabilities that residents have, or the care that they need. Key condition which influence stongly the temporal and spatial flexibilty and the autonomy of persons to access urban ressources are:

- Care-responsibility: (single) parents, partners or daughters caring for old age care dependant people are higly dependant on location, accessibility and opening hours of care facilities, supportive infrastructures, shopping and leisure offers as well as the quality and reliability of mobility networks
- Care dependeny: babies, children and teenagers up to 15, adults with disabilities need other adults who care for them, need certain spatial qualities and a variety of everyday life infrastructures (playgrounds, meeting points, bike lanes, benches and
- Occupation /Employment: daily routines and spatial needs with fulltime, part time jobs or minor and informal jobs, as well as between office- industry- or service related occupations are very different.
- Physical presence/well-being: bodily or mental Mobility restrictions (visually & or mobility impaired persons): freedome to move within the city, accessibilty of infrastructures of children, young adults, families and old aged people need barrer-free public, semi-priate an private spaces. We include in this category also socially learned spatial use patterns: e.g. domination of playgrounds by male teenagers and avoiding strategies of girls at night-time ("imaginated" places of fear and danger).

Based on these relevant conditions we developed matrix to illustrate a diversity of spatial use patterns and daily routines by adding the dimension of income as financial ressourcces. We argue that deficits in urban infrastructures hit low income groups stronger, while higher income groups may compensate by buying a service privately (figure 1).

CARE-PROFILES	low income	medium income	high income
autonomous			
in need for support	eg peole with visual / mobility disabilities, children & teens, senior citizens		
dependent on nursing/care	eg very old people, wheelchair users, children and teens		
caring for children *(< 12 years)*			
caring for elderly (>75 years)			
standard activity schedule	eg. 5 - 8 office cleaner	eg '9-5' office 16-22 production	zB CEO's; top-athlete
irregular actitvity pattern	zB Busfahrer; communitycentre volunteer	eg self employed consultant; midwife; pensioner	eg. Pensioner, TV-Star
Legend of profiles:	less problematic		unproblematic
	highly problematic/urgent		mobilisierbar

Fig. 1: Types of daily routines and spatio temporal use patterns from a care perspective. Source: Working paper Tussen Ruimte/planwind.

With the matrix, we identify groups of users in the city whose daily routines are very rigid and who depend strongly on the offer, the quality and the reliability of public and private infrastructures and on the quality of public (and private) spaces. These legend colours are indicator for the distance to "Right to the City" and show the need for/urgency of planning-action/interventions & for co-design. As long as the "domestic labour" statistics remain un-equal, it can be expected that many women find themselves in the "red" categories. From a gender mainstreaming point of view, these than should become planning priorities.

4.2 Identifying spatial needs for daily routines to assess spatial qualities and deficits from a care perspective

For the next step to operationalizing these goals and targets for a city and quarter, it is necessary to define basic services and to assess spatial structures from the different perspectives of users. Based on the above described typologie of user profiles of the urban infrastructure, we strive to identify specific infastructures of everyday, required spatial qualities and offers. Only then, a digitally supported assessement of qualitys or deficits of spatial structures is possible. As relevant destinations for daily routines we identfy six groups:

(1) housing, residence

(2) services of proximity (e. g. shops, pharmacies and financial personal services),

(3) places to eat during the day,

(4) care facilities (children and adults)

(5) workplace for paid or voluntary jobs, including secondary school, training or eduation

(6) leisure: places of recreation, relaxation, culture.

The needs and preferences for different services and destinations generate trip chains of the users. Public transport and public space (sidewalks, streets and bikelanes, squares) are the linking network between the destinations and create a trip chain.

Based on this conceptualization of spatial needs, the analyses of spatial structures, qualities and deficits can start. The research team in the project SmartThroughGender+ used digitally available data for city-wide mapping, and in addition analogue mapping, interviews and walks for the spatial analysis at district/area level.

For more information on digital tool development and data see the paper of Gebetsroither, Bürbaumer & Fink (Real Corp 2020) and two manuals: one for the city-wide digital tool https://cities.ait.ac.at/projects/smtg/Gesamtstadtebene/SMTG+_Explorer.html and for the tools at district/quarter level https://cities.ait.ac.at/projects/smtg/Stadtteilebene/SmartThroughGender.html

In the next step, we connect the first matrix to the care-profiles, to elaborate a set of urban space-related criteria and indicators (figure 2). The income situation largely determines how autonomous or restricted people are in shaping their everyday lives, or how dependent they are on good open space quality, public transport quality and everyday infrastructures (local supply, playgrounds and sports facilities, childcare facilities, etc.). Evidently, people with higher financial resources have more opportunities to cater for their needs.

daily infrastructure	housing, residence	services of proximity	meals	care facilities (professional)	workplace	leisure	
N/A = non applicable	(Bound)	in/out of neighbourhood		in neighbourhood	in/out of neighbourhood	inside neighbourhood	outside neighbourhood
autonomous	X	in & out	job-related (Mensa, Canteen)	NA	in & out	green, sports, hobby	Culture
in need for support	XX	NA	mealservice at home/in neighbourhood	day-care	inside	playground, green (dogs)	specialised training, wellness
dependent on nursing/care	XXX	NA	mealservice at home/in care-accommodation	meal, housecleaning	NA	social/contact	hospital
caring for children *(< 12 years)*	XXX	inside neighbourhood	child-care, clubs	daycare, clubs	in & out	playground, media,- and hobby offers	sports, cinema, etc
caring for elderly (>75 years)	XX	inside neighbourhood	daycare; accommodation	daycare (care-accomm)	in & out	social/contact	excursions, wellness
standard activity schedule	location	fixed routes	regular routines	regular times	fixed time-space patterns	regular/team possible	
irregular actitvity pattern	equipment	variable routes	variable needs	variable time schedule	variable time-space patterns	individual schedule	
Basic infrastructure: (examples)	laundry privacy untilities	Grocery stores General Practitioner Open Market	fast-food take-away meal- grocerydelivery	Kindergarten Daycentre communitycentre Clubs	employer co-working space schools	Green areas playground Library/mediacentre Sports	

Fig. 2: Who needs what and where? Linking user profiles/use patterns to spatial structures (infrastructures of everyday life) in an urban neighbourhood. Source: Working paper Tussen Ruimte/planwind.

5 OPERATIONALIZATION CARE IN PLANNING: THE LINZ PILOT

5.1 Mapping based on care-work

We illustrate a care-based assessment by the example of the case study of the city of Linz (AT) from the research project SmartThrougGender+. The SMTG+ tool set can identify qualities and deficits with regard to criteria of a Gender+-responsive urban planning and identify the need for action.

At the overall city level, the assessment is carried out quantitatively in the form of a "gender score" (see fig 3). The gender-score for the city is based on demographic data (to establish potential demand); points of interest (here defined as everyday infrastructure) and the quality of green areas.

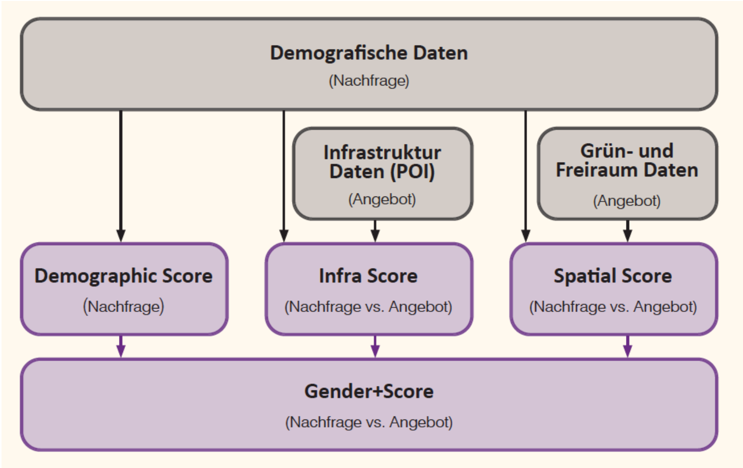

Fig. 3: Gender score for the city. Source: Autorinnen- und Autorenkollektiv SMTG+ (2021), AIT.

This shows where gender inequalities are located. The in-depth analyses at neighbourhood level make it possible to identify deeper inequality dynamics.

At the city level, the evaluation and identification of the need for action can be done by interpreting the results of the analysis with regard to the Gender+ criteria (figure 4).

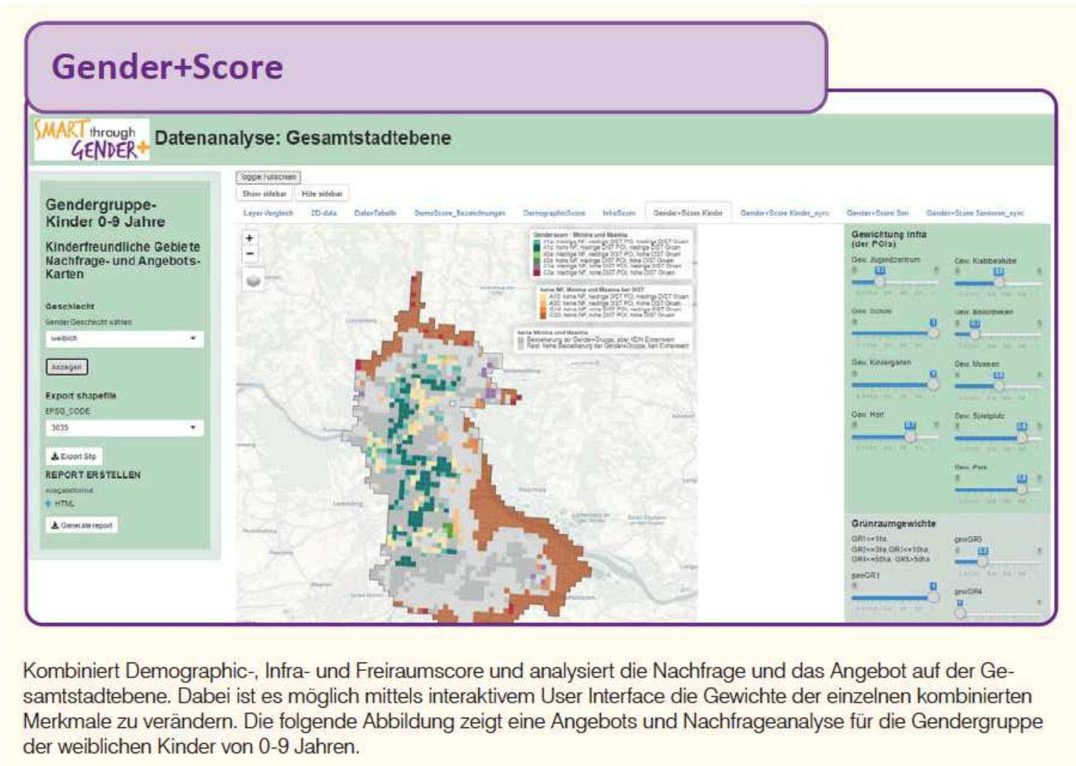

Fig. 4: The gender score for young girls in the city of Linz. Source: Autorinnen- und Autorenkollektiv SMTG+ (2021), AIT.

A look at common planning documents (such as urban development concepts, master plans or sectoral sectoral concepts), shows whether there is room for action such in areas for example upcoming actualisation of the zoning plan, empty buildings available for re-use or land. Ideally, the next step would be focussing on these areas. For the pilot, an urban district (Bulgariviertel) was pre-defined and analysed with a combination of qualitative and quantitative methods, both from social science and landscape/geographical mapping. The pilot in Linz mapped groups with ‚care responsibilities' through demographic statistics, and focussed on the everyday infrastructure and the accessibility and quality of green spaces (fig 5).

Ultimately, a gender-score on district-level could provide concrete planning information (fig 6).

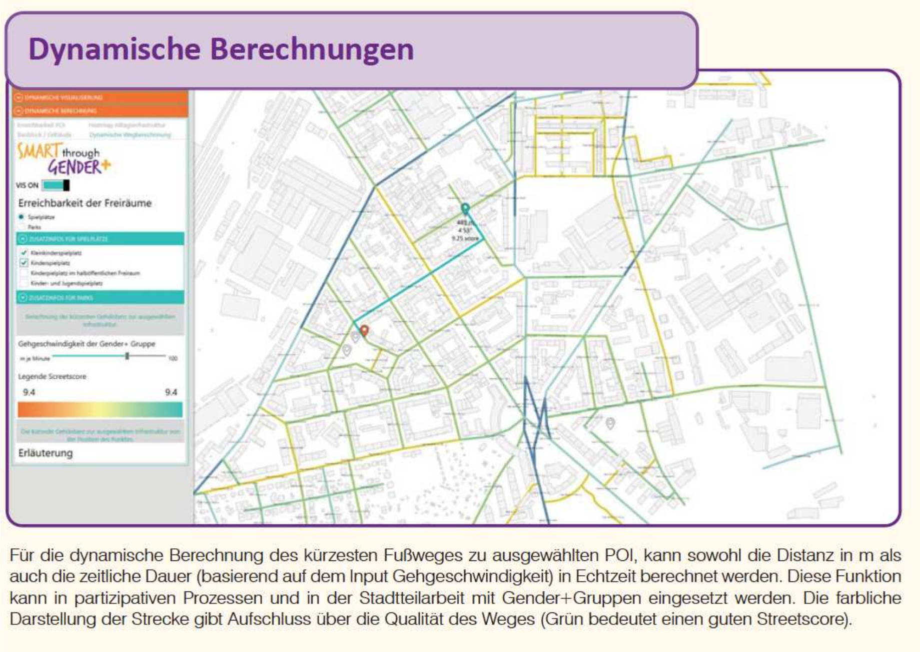

Fig. 5: The digital tools enables differentiating distances according to the speed of walking. Source: Autorinnen- und Autorenkollektiv SMTG+ (2021), AIT.

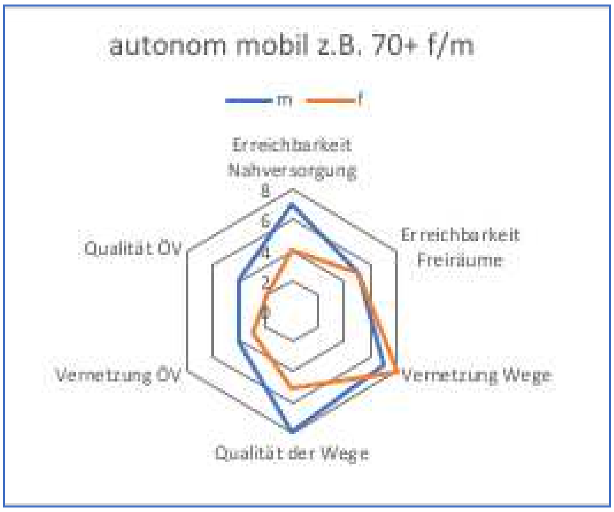

Fig. 6: visualisation of final scores to identify need ofr planning intervention. Source: planwind April 2020.

5.2 Reality check: experts' and residents views

In Bulgariviertel, the "external" view of experts, such as planners and professionals in care-sectors, was held against the "inside view" from diverse groups of residents. Between september 2019 and March 2020, professionals from care-institutions such as Kindergartens and senior-accomodation, as wel as from migrant organisations and Blinden- und Sehbehindertenverband OÖ –Verkehrsreferat were interviewed. The findings were compared with the observations from residents. How important this type of verification is, can be illustrated by a simple example: although the genderscore on the map of the central square was positive, amongst others due to the presence of public toilets, the wheel-chair dependent users indicated that the toilets where difficult to find, hard to access and often locked. Both perspectives are necessary and complementary for a well-founded spatial analysis. Gender+-differentiated statistics, different building structures, density and equipment of road networks, location and density of everyday infrastructures and green and open spaces as well as their different qualities are analysed from the outside. Digital methods can partially support these analyses in order to calculate key figures, distances or catchment areas. It is only through surveys and inspections with residents and experts – with the view from the inside – that group-specific usage preferences, the perception of building and open space structures and their changes can be recorded and made visible. The view from the inside provides information on group-specific (subjectively) perceived spatial structures, quality of services and deficits, as well as on which strategies result from this for everyday life. These include answers to planning-relevant questions such as: Where do groups move to? What is used as an alternative in the case of missing offers or lacking qualities (of footpaths and cycle paths, green and open spaces or everyday infrastructures)? What detours are accepted?

Particularly the analysis of “Physical Integrity” shows the different effects of sources of risk on the physical health and well-being of the residents. The view from the inside quickly provides specific information on danger spots or unsafe areas in the public open spaces from the residents' point of view. The view from the outside captures “objective” features that influence safety (e.g. lack of lighting, sightlines and features that obstruct vision such as furniture or parking in blind areas). A combination of a view from the outside and a view from the inside is absolutely necessary, as objective safety and subjective perception of safety must be analysed together. When identifying danger spots, unpopular places to avoid or areas of fear, the view from the inside provides more accurate results than the view from the outside. For a substantial analysis from the outside perspective, the data for urban spaces is usually not available in detail and not prepared in a gender-differentiated way. Statistics of crime-incidence, or accident frequency for example are organised in different categories. By looking from the inside, it is easier to capture group-specific differences and subjective perceptions.

6 DISCUSSION: OPERATIONALIZATION CARE IN PLANNING FOR GENDER JUSTICE

6.1 Towards operationalizing CARE in planning for gender justice: Potential

As long as the “domestic labour” statistics remain un-equal, it can be expected that many women find themselves in the “red” categories of figure 1, categories that should become planning priorities. By proposing to focus on the every-day needs rising out of gender roles, rather than on the gender-identity of the person involved we attempt both to put the care-economy on the planning agenda, and to discard with fixed gender roles. Doing so acknowledges the differences that exist amongst women, and men, for example between high-income career-professionals and low-income service-providers, or between well-off healthy grand-mothers and chronically ill young mothers. This is just one step in operationalising the theoretical notion of “intersectionality” (Lacey et all, 2013) thus placing “gender-equality” in a wider context of urban justice. It also acknowledges that any person or household can move from one category to another, since everyone is vulnerable for an unexpected crisis (such as loss of health or income) but also has potential to improve the conditions and quality of life.

The question whether “women” are natural care-takers and “men” are somewhere out conquering or hunting has more repercussions. It raises the question in how far a male-dominant profession has been “gender blind” because of the lack of representation of “female”/reproductive interests? Since (thus far) the initiatives for GM mostly come from female professionals, the absence of the care economy in planning was (and is) often related to the absence of female staffing in institutionalised planning entities (Greed, 2007). In some instances Gender Mainstreaming is even mistaken for human resource management. The composition of planning teams, as well as equal representation on all levels of decision-making, is therefore also a gender issue (Ortiz Escalante and Gutiérrez Valdivia, 2015). However, we (the authors) are not convinced that men are incapable of being agents of change towards gender equality. Planning for SDG5 is a competence that can be acquiered in much the same way as professionals are learning to plan for SDG11.

After the stage of data collection, important decisions have to be made for the further development of the tool. This concerns amongst other the question whether the tool includes a weighing of critieria, or leaves it to planners to validate the different aspects of gender-mapping that contribute to the general score. The latter option may produce a better match with local conditions, and advance a deeper understanding if discussed in an interdisciplinary team, but could also lead to untransparant results. Alternatively, the tool pre-sets values for the weight of specific factors in the final score, which is less adaptable to local conditions and does not enhance the understanding of gender-dynamic per se.

6.2 Towards operationalizing CARE in planning for gender justice: Limitations

Putting care at the heart of a planning method is ameans to get around fixed and polarised gender roles, but does not imply that the gender-inequalities are ignored. On the contrary, gender studies highlight time and again the vicious circle that the inequal division of waged work and unwaged domestic care means for many women. As long as the key-determinants of urban time-space patterns are based on gender-stereotypes, and not based on facts and figures, the systemic inequalities remain invisible. However, there are hardly any statistical records with accurate representation of these spatial use groups. For example- children according to age groups can be recorded as a statistical category, but not adults in need of care who are cared for by relatives, by mobile care teams or by 24-hour one-person companies (personal care-givers). Persons in employment with care responsibilities for minor children can be identified, eg as ‚single parent‘ but there is no information on the extent and rhythm of employment – e. g. marginally employed persons, persons working part-time. Consequences of repairing such gaps in data gathering are to be established, and frictions with for example privacy-issues can be expected.

At this stage, it means that urban analyses can not rely only on digital data and needs to be complemented by qualitative assessment methods such as field observation and focusgroups. The risk of gender bias is also present in such methods, for example when choosing the time and location for fieldwork, or who is considered an ‚expert‘ and invited to participate in a focus group.

A further methodological pitfall is to limit gender-analyses to the local qualities in neighbourhood and building block. The accessibility of green spaces, distance to bus-stops and cross-over facilities for pedestrians to schools and shops are part of urban networks of green spaces, transport– mobility, accomodations and provision of care etc.. The smarter through Gender+ digital assessment at city level would be capable of demonstrating different qualitites and deficits between neighbourhoods, based on data for daily infrastructure if these were available at the cities‘ (or regions) scale. Showing such differences, and comparing them to demographic trends and the availability of housing types can have consequentces for planning processes in that priorities can be shifted to equipping neighbourhoods with inadequate care-infrastructures.

7 CONCLUSIONS

This paper reports on our search for planning instruments that can unite SDG5 (gender equality) with SDG11 (sustainable cities). Democratic and sustainable cities need active and informed citizens, who are not only concerned with personal career and well-being but also care for others and the environment, as public authorities can not provide everything for everyone at all times. Being able to take care of one-self, other people and the environment requires access to urban resources such as decent housing, education and health care. Gender Mainstreaming breaks with the idea that societal roles such as “care” and “wage-earning” are a natural given for women or for men. Gender Mainstreaming in planning aims to overcome the idea that the biological sex defines spatial use patterns. A key issue is the reconciliation of waged work and care-work. If a person has to fulfill care responsibilities for children, or adults, and how intense these care responsibilities are, determines the dependency on urban infrastructures and spatial qualities. We departed from this premises to design a method for urban analyses that integrates care-work, and with it gender in-equalities, in the planning agenda. Concrete mapping is needed to understand in how far these care tasks and the daily routines are supported or hindered by lack of facilities or unsafe streets. Moreover, mapping can make visible Gender inequality through spatial indicators: for example about the amount of m² or EUR dedicated to spaces for daily routines or activities related to the re-defined user groups. The pilot revealed specific data-gaps that are needed in order to further develop such digital planing tools.

While faciltiating care-tasks is an urgent planning-action, is it not the only planning aspect that contributes to “gender-equal” access to urban resources. Besides the “functional accessibility” of public space, the symbolic accessibility is highly gendered. Illustrative is the idea that women are not safe at night (especially in parks or abandoned areas) while the incidence of violence against women is far more higher inside the home or private places. On the other hand, men are much at risk in public space in statistics of violence or accidents. The appropriation of public space in terms of what activities and presence are considered appropriate is gendered to a large extent. Studies of youth on public spaces for example show segragated activities, and different behaviours for female or male peer-groups. These differences ar not a “natural consequence” of being a girl or a boy, but the result of expectations and role-models presented in all stages of life. Not all girls prefer to sit and chat on the side-line (otherwise the Fridays For Futures movement would not have come into being), and not all boys prefer to be loud and competitive.

User groups are both passive “object” of analysis and active subject of collaborative planning and design. Both in urban analyses and in participatory planning dialogues, stereotyped gender-roles need to be addressed explicitly. Applying use-profiles that depart from the dependency on care, as well as the care-responsibilities of people, has the potential to embed “care” for others and for the environment structurally in the planning agenda and thus create urban conditions to facilitate active citizenship for all. Replacing stereotypes with concrete data on the activities connected to the care-economy, thus contributes to both SDG-5 and SCG-11 giving both a more durable perspective.

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Sicherheitsempfinden im öffentlichen Verkehr in Zeiten von COVID-19

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1 ABSTRACT

Die COVID-19-Pandemie hat die Mobilität in Deutschland stark verändert. Geltende Regeln und Einschränkungen sorgen nicht nur für drastische Mobilitätseinbrüche, auch alte Gewohnheiten werden aufgebrochen und Mobilitätsentscheidungen neu getroffen. Der Individualverkehr stellt eine attraktivere Alternative zum gemeinsam genutzten öffentlichen Verkehr dar, welcher von Bedenken bezüglich Hygiene und Ansteckungsrisiko gezeichnet ist. Hierbei besteht allerdings die Gefahr, dass sich eine entsprechende Gewöhnung an die Nutzung des Individualverkehrs auch auf die langfristige Verkehrsmittelwahl zu Lasten der Umwelt auswirken könnte. Um das Vertrauen in den öffentlichen Verkehr frühzeitig zurückzugewinnen, wird es relevant, passgenaue Hygienemaßnahmen zu finden und umzusetzen. So soll die Sicherheit objektiv erhöht, aber vor allem das subjektive Sicherheitsempfinden der Fahrgäste bestärkt werden.

In der vorliegenden Untersuchung wird dies anhand eines spezifischen Anwendungsfalls im ländlichen Raum behandelt: Ein Vereinsshuttle, welches Mitglieder gebündelt zuhause abholt und zum entsprechenden Angebot hin- und anschließend wieder zurückfährt. Mittels einer Befragung wird die Pilotzielgruppe, ältere Menschen, denen die Teilhabe am Sportangebot ermöglicht werden soll, näher untersucht. Die Erhebung liefert tiefergehende Erkenntnisse über das veränderte Mobilitätsverhalten der Seniorinnen und Senioren sowie deren Sicherheitsempfinden und die dahinterliegenden Ursachen bei der Mobilitätsnutzung. Daraus werden Hygienemaßnahmen für das Vereinsshuttle sowie Handlungsempfehlungen abgeleitet.

Keywords: Mobilität, Ländlicher Raum, Öffentlicher Verkehr, COVID-19-Pandemie, Sicherheitsempfinden, Hygienemaßnahmen

2 EINLEITUNG

Im Jahr 2019 nutzten in Deutschland etwa 28 Millionen Menschen täglich den öffentlichen Personennahverkehr (ÖPNV) (VDV, 2020a). Damit ist der ÖPNV ein entscheidender Pfeiler zur Mobilitätssicherung und Reduzierung verkehrsbedingter Emissionen. Seit Beginn des andauernden Ausbruchs der Infektionskrankheit COVID-19, die am 11. März 2020 von der Weltgesundheitsorganisation offiziell zu einer Pandemie erklärt wurde (WHO, 2020), steht das gesellschaftliche Leben in weiten Teilen still. Auch die Mobilität in Deutschland ist dadurch zeitweise um bis zu 40 Prozent eingebrochen (Statistisches Bundesamt, 2021). Neben geltenden Beschränkungen und wegfallenden Wegezwecken, die insgesamt zu einem geringeren Mobilitätsniveau führen, liegt die Hauptursache für die Nutzungsreduzierung des ÖPNV vorrangig im subjektiv wahrgenommenen Ansteckungsrisiko der Fahrgäste (ADAC, 2020). Obwohl die Sicherheit des ÖPNV in Bezug auf COVID-19 anhand mehrerer Studien belegt werden kann (siehe Kapitel 3.2), ist das Vertrauen der Kundinnen und Kunden teilweise enorm gesunken. Fast die Hälfte der ÖPNV-Nutzenden hat Angst vor einer Infektion im ÖPNV und auch die Hygienemaßnahmen werden als eher nicht ausreichend empfunden (DLR, 2020c). Neben kurzfristigen finanziellen Belastungen für die Verkehrsunternehmen besteht auch das Risiko fortwährender schwerwiegender Folgen. Bleibt die Unsicherheit bestehen, kann sich dies auch langfristig auf die Verkehrsmittelwahl auswirken (Henrich-Köhler et al., 2020). Dazu trägt auch bei, dass der Personenkraftwagen (PKW) als Form des Individualverkehrs als Schutzraum angesehen und aktuell neben dem Fahrrad und dem Zufußgehen, relativ gesehen, häufiger genutzt wird (Schelewsky, 2020). Die vermehrte Nutzung des PKW kann die Vorteile von diesem aufzeigen sowie zu einer Gewöhnung führen und ist teilweise an einen Kauf gekoppelt. Dies kann in einer Verstetigung der PKW-Nutzung resultieren. Auch eine verkehrspsychologische Theorie nach Fujii et al. (2001) besagt, dass Veränderungen im Mobilitätsverhalten, die durch temporäre strukturelle Änderungen induziert werden und an positive Effekte gekoppelt sind, dazu führen können, dass Gewohnheiten aufgebrochen und Verhaltensweisen langfristig geändert werden. Deshalb werden Forderungen an Strategien zur Erhöhung der objektiven und insbesondere der subjektiv wahrgenommenen Sicherheit im ÖPNV laut (Henrich-Köhler et al., 2020). Um passgenaue Hygienemaßnahmen entwicklen zu können, wird ein tiefgreifendes Verständnis für das subjektive Sicherheitsempfinden benötigt (Hagen et al., 2020).

Das Ziel dieser Untersuchung ist es, Maßnahmen zu erarbeiten, die das subjektive Sicherheitsempfinden der Fahrgäste erhöhen. Als Grundlage hierfür soll zunächst ein besseres Verständnis für die Mobilitätsnutzung und das Sicherheitsempfinden während der COVID-19-Pandemie gewonnen werden. Dazu werden die folgenden Forschungsfragen aufgestellt:

(1) Wie und aus welchen Gründen hat sich die Verkehrsmittelnutzung im Vergleich zu vor der COVID-19-Pandemie verändert?

(2) Wie wird die Sicherheit in verschiedenen Verkehrsmitteln in Bezug auf COVID-19 empfunden und aus welchen Gründen wird der ÖPNV als unsicher eingeschätzt?

(3) Welchen Einfluss haben verschiedene Hygienemaßnahmen auf die wahrgenommene Sicherheit hinsichtlich COVID-19?

Hierzu wird zunächst der Forschungsstand (Kapitel 3) vorgestellt und aufgezeigt, weshalb die genauere Betrachtung der älteren Zielgruppe als relevant erachtet wird. Den Untersuchungsgegenstand der empirischen Erhebung stellt das PROSMUS Vereinsshuttle als abgegrenztes Anwendungsbeispiel dar. Dieses soll die gesellschaftliche Teilhabe von älteren Menschen im ländlichen Raum über den Transport zu Sportangeboten verbessern. Das Vereinsshuttle ist eines der Pilotprojekte, das aus einem Ideenwettbewerb für kooperative Mobilitätskonzepte im ländlichen Raum, gefördert von den Ministerien für Wirtschaft, Arbeit und Wohnungsbau, für Verkehr und für Ländlichen Raum und Verbraucherschutz Baden-Württemberg (2020), hervorgegangen ist. Zur empirischen Untersuchung der Forschungsfragen wird eine Befragung von 36 Seniorinnen und Senioren mit einem standardisierten Fragebogen durchgeführt. Die Methodik wird in Kapitel 4 genauer vorgestellt. Im darauffolgenden Kapitel 5 werden die Ergebnisse der Erhebung berichtet und interpretiert. Daraus werden anschließend Handlungsempfehlungen für das Vereinsshuttle im Abgleich mit der Anbietersicht, die durch ein Interview vor der Befragung der Fahrgäste erfasst wurde, abgeleitet (Kapitel 6). Nach einem abschließenden Fazit (Kapitel 7) werden die Limitationen der Studie sowie Möglichkeiten zur weiteren Forschung innerhalb des Themenbereichs aufgezeigt (Kapitel 8).

3 FORSCHUNGSSTAND

Die folgenden Unterkapitel stellen den aktuellen Stand der Forschung zu dem veränderten Mobilitätsverhalten (3.1), dem Sicherheitsempfinden im ÖPNV (3.2) und Hygienemaßnahmen für den ÖPNV hinsichtlich COVID-19 dar (3.3). Aus den Unterkapiteln ergeben sich die oben genannten Forschungsfragen.

3.1 Mobilitätsverhalten im Wandel

Das Mobilitätsverhalten umfasst „die Entscheidungen, die Menschen einzeln, als Gruppen oder gesamtgesellschaftlich bezüglich ihrer Bewegung im Raum treffen“ (BMVI, 2019, Absatz 1). Bereits im Zuge früherer Pandemien wie der „Schweinegrippe“ oder der SARS-Pandemie 2002/2003 konnte eine Tendenz zur Vermeidung der ÖPNV-Nutzung als Präventionsmaßnahme beobachtet werden (Cowling et al., 2010; Goodwin et al., 2011; Jones & Salathé, 2009; Lau et al., 2003). Allerdings stellt die COVID-19-Pandemie eine Ausnahmesituation dar, in der das veränderte Mobilitätsverhalten neben individuellen Entscheidungen zur Risikominimierung auch auf geltende Einschränkungen der Freiheiten und des alltäglichen Lebens zurückgeführt werden kann (Anke et al., 2021). Die sich ergebenden Veränderungen des Mobilitätsverhaltens werden nachfolgend in Anlehnung an Drews et al. (2020) in distanzbasierte, wegezweckbasierte und verkehrsmittelbasierte Veränderungen unterschieden. Der Betrachtungsfokus liegt auf den Entwicklungen in Deutschland, um diese anhand des lokalen Pandemiegeschehens einordnen zu können.

Distanzbasiert zeigte sich, dass die Mobilität teilweise stark eingebrochen ist (Statistisches Bundesamt, 2021). Im Jahresverlauf 2020 wurde dabei deutlich, dass distanzbasierte Veränderungen stark mit den geltenden Einschränkungen und den Infektionszahlen zusammenhängen. So wurde circa Mitte April das Minimum an Mobilität erreicht (Follmer & Leppler, 2020), woraufhin die Mobilität, angetrieben durch die ersten Lockerungen Anfang Mai, stetig angestiegen ist und so schließlich Ende Juni wieder das gewohnte Mobilitätsniveau vorzufinden war (Follmer & Schelewsky, 2020). In den Sommermonaten des Jahres 2020 überstieg die Mobilität sogar teilweise das Vorjahresniveau (Statistisches Bundesamt, 2021). Ab Oktober ging das Mobilitätsniveau im Zuge steigender Infektionszahlen erneut zurück, noch vor den neuen Maßnahmen des „Lockdown light“ ab dem 02. November (Zehl & Weber, 2020).

Wegezweckbasierte Veränderungen beschreiben veränderte Häufigkeiten der Gründe zu denen Menschen Wege antreten (Drews et al., 2020). Der am häufigsten wegfallende Wegezweck war zu Pandemiebeginn die Freizeit, gefolgt von wegfallenden Wegen aufgrund von Homeoffice und Videokonferenzen (Anke et al., 2020). Ebenfalls wurden Wege zum Einkaufen sowie private Reisen seltener angetreten (DLR, 2020a). Im Verlauf von 2020 zeigte sich, dass wegezweckbasierte Veränderungen hauptsächlich von den geltenden Einschränkungen induziert werden (ADAC, 2020).

Die Veränderungen bezüglich der genutzten Verkehrsmittel sollen genauer betrachtet werden. Über verschiedene Studien hinweg zeigt sich das Bild, dass Wege in etwa gleich oft bis häufiger zu Fuß oder mit dem Fahrrad bestritten wurden, der PKW in etwa gleich bis etwas weniger häufig genutzt wurde, wobei der Anteil an Mitfahrenden gesunken ist, während die ÖPNV-Nutzung einen sehr großen Einbruch erfuhr (Anke et al., 2020; Follmer & Schelewsky, 2020; Hagen et al., 2020). Die Selbsteinschätzung der Nutzungsreduzierung des ÖPNV kann auch anhand Statistiken bestätigt werden, wonach die Nachfrage während der starken Einschränkungen im Frühjahr 2020 trotz fast vollständigem Angebot auf 20 Prozent gesunken ist (VDV, 2020b). Auffälligerweise hat sich die ÖPNV-Nutzung bei älteren Menschen nicht so stark reduziert wie bei jüngeren (Hagen et al., 2020; HORIZONT, 2020). Darüber hinaus nimmt die ÖPNV-Nutzung in ländlichen Regionen anteilig gesehen weniger stark ab als in Städten (Follmer & Schelewsky, 2020; Hagen et al., 2020). Über drei Erhebungswellen des DLR (2020a, 2020b, 2020c) konnte beobachtet werden, dass die ÖPNV-Nutzung Anfang April 2020 zu Gunsten der PKW-Nutzung eingebrochen ist. Im Jahresverlauf zeigte sich zunächst eine leichte Erholung des ÖPNV im Sommer 2020, wobei die ÖPNV-Nutzung nicht proportional zu dem teilweise sogar übermäßigen Mobilitätsaufkommen gestiegen ist. Zum Winter brach die Zahl der ÖPNV-Nutzenden, entgegen der gewöhnlichen witterungsbedingten Zunahme, wieder ein. Es lässt sich eine Gewöhnung der PKW-Nutzung als Schutzraum erkennen. Die Verringerung des Infektionsrisikos bestimmt während der COVID-19-Pandemie vorrangig die Verkehrsmittelwahl, mehr als beispielsweise die Fahrzeit oder -kosten (Heineke et al., 2020).

Da erste Hinweise gefunden wurden, dass sich diese Änderung der Verkehrsmittelwahl im ländlichen Raum anders verhält als in Städten, ebenso wie bei älteren Menschen im Vergleich zu jüngeren, soll die erste Forschungsfrage die Veränderung des Mobilitätsverhaltens bei der Kombination beider Aspekte beleuchten. Darüber hinaus soll offen untersucht werden, auf welche Gründe die Änderungen zurückzuführen sind.

3.2 Sicherheitsempfinden im ÖPNV

Verkehrsmittelbasierte Veränderungen, genauer gesagt die überproportional reduzierte ÖPNV-Nutzung, variieren weniger mit den Beschränkungen, sondern können vielmehr anhand des Sicherheitsempfindens der Fahrgäste als interner Grund erklärt werden. Daher wird dieses nachfolgend genauer beleuchtet.

Da kein allgemeingültiger Sicherheitsbegriff besteht, wird Sicherheit im Folgenden verstanden als Zustand, der sich „durch die Abwesenheit oder auch den Schutz vor den Auswirkungen wahrgenommener Gefahren, Bedrohungen oder auch Risiken“ (Gerhold, 2020, S. 10) kennzeichnet. Es kann dabei zwischen dem subjektiven Sicherheitsempfinden als Wahrnehmung durch das Individuum und der tatsächlichen, objektiven Sicherheit unterschieden werden (Köhn & Bornewasser, 2012).

Unabhängig von der COVID-19-Pandemie zeigt sich ein deutlicher Unterschied zwischen dem subjektiven Sicherheitsempfinden und der objektiven Sicherheit anhand Statistiken, wobei das subjektive Sicherheitsempfinden tendenziell schlechter bewertet wird (Bieck et al., 2013). Dies ist aus Sicht der Verkehrsunternehmen insofern kritisch, da empirisch eine Korrelation zwischen dem Sicherheitsempfinden und der ÖPNV-Nutzung nachgewiesen werden konnte. Dabei konnte allerdings auch gezeigt werden, dass das subjektive Sicherheitsempfinden durch Sicherheitsmaßnahmen erhöht werden kann, insbesondere bei Personen mit einem geringeren Sicherheitsempfinden (Gerhold, 2020).

In Bezug auf COVID-19 wird der ÖPNV objektiv anhand Studien zur Luft und Oberflächen in Fahrzeugen und Haltestellen (BBC News, 2020), zum Infektionsumfeld bestätigter COVID-19-Ausbrüche und der dazugehörigen Fälle (Buda et al., 2020) sowie in Clusteranalysen (AGES, 2020) als relativ sicher bewertet. Subjektiv stellt die COVID-19-Pandemie eine neuartige Bedrohung im ÖPNV dar. Diese Bedrohung ist der Haupterklärungsgrund für die Nichtnutzung des ÖPNV (ADAC, 2020; Anke et al., 2020; Follmer &

Schelewsky, 2020; Krämer et al., 2021). Im Verkehrsmittelvergleich wird deutlich, dass der Individualverkehr kaum bis gar nicht für Unbehagen sorgt, während sich die Fahrgäste des ÖPNV erheblich unwohler fühlen als vor der COVID-19-Pandemie (DLR, 2020a). In der Zeit niedrigerer Infektionszahlen und Lockerungen im Sommer 2020 fühlten sich dennoch weiterhin 50 Prozent der Befragten im ÖPNV unwohler oder deutlich unwohler als zuvor (vgl. 60 Prozent im Lockdown Anfang April) (DLR, 2020c). Eine bevölkerungsrepräsentative Studie betrachtete das allgemeine Sicherheitsempfinden im ÖPNV aufgrund der COVID-19-Pandemie und illustriert, dass sich zum Befragungszeitpunkt im November 2020 knapp die Hälfte der Befragten eher unsicher oder sogar sehr unsicher fühlten (vzbv, 2021). Dabei fühlten sich befragte Personen ab 60 Jahren deutlich unsicherer als junge Menschen. Die Studien zum Sicherheitsempfinden im ÖPNV in Zeiten von COVID-19 untersuchen dabei nicht, bzw. nur mittels geschlossener Fragen, wie die Sicherheitseinschätzung entsteht und welche Situationen oder Infektionsquellen den Befragten Sorgen bereiten.

Es wurde festgestellt, dass das Sicherheitsempfinden in verschiedenen Verkehrsmitteln unterschiedlich bewertet wird, wobei der ÖPNV am meisten Bedenken hervorruft. Vor allem ältere Menschen fühlen sich dort unsicher. Daher soll die vorliegende Untersuchung diese Gruppe näher beleuchten. Über den aktuellen Forschungsstand hinaus sollen mithilfe der zweiten Forschungsfrage insbesondere die Ursachen für die Bedenken beleuchtet werden.

3.3 Hygienemaßnahmen für den ÖPNV hinsichtlich COVID-19

Obwohl zum jetzigen Zeitpunkt davon ausgegangen werden kann, dass die objektive Sicherheit in Bezug auf COVID-19 im ÖPNV relativ hoch ist, besteht eine deutliche Diskrepanz zu der subjektiven Wahrnehmung durch die Fahrgäste, die es zu schließen gilt. Auch die reine Aussage, dass die Ansteckungsgefahr in den Fahrzeugen gering sei, gibt ÖPNV-Nutzenden nicht ausreichend Sicherheit (vzbv, 2021). Es wird ersichtlich, dass die Sicherheit nicht nur objektiv dargestellt, sondern auch durch den Fahrgast selbst empfunden werden muss. Hygienemaßnahmen sind ein Ansatz, um das subjektive Sicherheitsempfinden der Fahrgäste zu erhöhen.

Vergleichsweise wenig Studien haben bislang Hygienemaßnahmen aus Fahrgastsicht untersucht. Zunächst kann festgestellt werden, dass aus Nutzendensicht Handlungsbedarf für weitere Hygienemaßnahmen im ÖPNV gesehen wird (DLR, 2020c; Krämer & Hercher, 2021). Dementsprechend werden vorgeschlagene Maßnahmen auch zum großen Teil als hilfreich bzw. wichtig bewertet. Besonders viel Zuspruch erhalten die konsequente Umsetzung der Maskenpflicht, Reinigung und Desinfektion sowie die Erweiterung des Angebots auf häufigere Fahrten bzw. eine Limitierung der Auslastung (Adams et al., 2020; DLR, 2020b; Krämer & Hercher, 2021; vzbv, 2021). Als weniger relevant werden Abstandsmarkierungen auf dem Boden, die Kommunikation von Studien zum Ansteckungsrisiko, digitale Auslastungsanzeigen und der kontaktlose Ticketkauf angesehen (DLR, 2020b; Krämer & Hercher, 2021; vzbv, 2021). Die genauere Betrachtung der Maskenpflicht zeigt, dass sich weniger als die Hälfte der Befragten einer Umfrage bei einer Maskenpflicht im ÖPNV sicher fühlen (Krämer & Hercher, 2021). Dabei ist im Altersvergleich auffällig, dass sich ältere Menschen bei einer Maskenpflicht unterdurchschnittlich sicher fühlen.

Bei den aufgezeigten bisherigen Studien zu Maßnahmen wurde betrachtet, inwieweit die Maßnahmen als wichtig, hilfreich oder geeignet erachtet werden, um das Ansteckungsrisiko allgemein betrachtet zu verringern und so die Nachfrage im ÖPNV zu erhöhen. Es wurde mit Ausnahme von Krämer und Hercher (2021), die als Maßnahme die Maskenpflicht näher beleuchteten, nicht untersucht, wie sich die Maßnahmen auf das subjektive Sicherheitsempfinden auswirken. Daher soll die dritte Forschungsfrage, aufbauend auf den ersten positiven Beurteilungen der Hygienemaßnahmen, genauer beleuchten, inwieweit verschiedene Maßnahmen, über die bisherige allgemeine Betrachtung hinaus, einen Einfluss auf die kritische Größe, das subjektive Sicherheitsempfinden der Fahrgäste, haben. Dies wird für den spezifischen Anwendungsfall des Vereinsshuttles untersucht. Da sich ältere Personen im ÖPNV trotz Maskenpflicht unsicherer fühlen, wird es besonders relevant, die geeignetsten Maßnahmen für diese Zielgruppe zu identifizieren.

4 FORSCHUNGSANSATZ UND STICHPROBE

Untersuchungsgegenstand der vorliegenden Studie ist das veränderte Mobilitätsverhalten und das Sicherheitsempfinden von Seniorinnen und Senioren im ländlichen Raum während der COVID-19-Pandemie sowie die Beeinflussung des Sicherheitsempfindens durch Hygienemaßnahmen. Untersucht wird dies anhand des PROSUMUS Vereinsshuttles als Fahrdienst in Oftersheim (Baden-Württemberg). In einem Großraumtaxi, zukünftig auch einem Kleinbus, werden Vereinsmitglieder gebündelt zuhause abgeholt und nach den Angeboten wieder nach Hause gefahren. Die Pilotzielgruppe der Seniorinnen und Senioren ab 60 Jahren stellt die Zielgruppe bzw. Grundgesamtheit dieser empirischen Erhebung dar.

Zur Erarbeitung der Hygienemaßnahmen, die in den Fragebogen aufgenommen werden, wurde zunächst ein vollstrukturiertes Interview entlang eines Maßnahmenkatalogs, welcher aus einer Literaturrecherche hervorgegangen ist, mit dem Projektleiter des Vereinsshuttles durchgeführt. Darin bewertete der Projektleiter die Maßnahmen bezüglich ihrer Umsetzbarkeit und dem finanziellen Aufwand. Diese Beurteilung fließt neben der Sicht der Nutzenden in die Entwicklung der Handlungsempfehlungen ein.

Zur Erhebung wurde ein standardisierter Fragebogen verwendet. Nach einem Pretest mit zehn älteren Personen folgte die Feldphase im Zeitraum vom 30.03.2021 bis 16.04.2021. Der Fragebogen wurde vorwiegend in Papierform sowie von wenigen Teilnehmenden über das Online-Umfragetool Unipark ausgefüllt. Im ersten, allgemeinen, Teil wurde das veränderte Mobilitätsverhalten und das Sicherheitsempfinden in Bezug auf COVID-19 für verschiedene, lokal vorhandene, Verkehrsmittel abgefragt sowie das Sicherheitsempfinden im ÖPNV näher betrachtet. Im zweiten Teil folgten Fragen zum Sicherheitsempfinden, der Nutzungswahrscheinlichkeit und den Hygienemaßnahmen spezifisch für das Vereinsshuttle. Abschließend wurden demographische Daten erhoben.

Über geschlossene Fragen mit festen Antwortkategorien wurden die Veränderung der Verkehrsmittelwahl („Inwiefern hat sich Ihre Nutzung der folgenden Verkehrsmittel im Vergleich zu der Zeit vor der Corona-Krise verändert?“; 0 = auch vor der Corona-Krise nicht, 1 = gar nicht mehr – 6 = deutlich häufiger) und das Sicherheitsempfinden („Wie sicher fühlen Sie sich – oder würden Sie sich - aktuell bei der Nutzung der folgenden Verkehrsmittel in Bezug auf das Coronavirus fühlen?“; 1 = sehr unsicher – 6 = sehr sicher) erhoben. Außerdem wurden in Bezug auf das Vereinsshuttle die bisherige Nutzung („Wie häufig haben Sie das Vereinsshuttle bereits genutzt?“; 1 = noch nie, 2 = 1-3 Mal, 3 = mehr als dreimal), die Nutzungswahrscheinlichkeit während der COVID-19-Pandemie („Wie wahrscheinlich ist es, dass Sie das Vereinsshuttle auf dem Weg zu dem Sportangebot trotz des Coronavirus nutzen?“; 1 = sehr unwahrscheinlich – 6 = sehr wahrscheinlich), das Sicherheitsempfinden und der Einfluss der Hygienemaßnahmen auf das Sicherheitsempfinden („Bitte geben Sie für alle Maßnahmen an, inwieweit diese einen Einfluss darauf haben bzw. hätten, wie sicher Sie sich bei der Nutzung des Vereinsshuttles in Bezug auf das Coronavirus fühlen würden.“; 1 = deutlich sicherer – 6 = überhaupt nicht sicherer) erhoben.

Mittels offener Fragen wurden das veränderte Mobilitätsverhalten („Aus welchen Gründen hat sich Ihre Verkehrsmittelwahl und -nutzungshäufigkeit seit Beginn der Corona-Krise verändert?“) und das Sicherheitsempfinden der Fahrgäste allgemein („Welche allgemeinen Sorgen und Bedenken haben bzw. hätten Sie in Bezug auf das Coronavirus?“) sowie in verschiedenen Phasen der Fahrt (Fahrtbeginn, die Fahrt an sich und das Ein- und Aussteigen) untersucht, um unbeeinflusste Meinungen der Befragten zu erfassen. Somit wurde ein Mixed-Methods-Design in den Fragebogen integriert. Dies bedeutet die Kombination qualitativer und quantitativer Methoden (Mey & Mruck, 2010). Da dies zeitgleich, in diesem Fall innerhalb eines Erhebungsinstruments stattfindet, handelt es sich um ein within-method Triangulationsdesign (Flick, 2011). So können mehr Erkenntnisse als mit nur einem der beiden Ansätze erlangt werden.

Die Stichprobe umfasste nach dem Ausschluss von zwei Teilnehmenden 36 Seniorinnen und Senioren. Das Alter der Befragten reichte von 60 bis 87 Jahren und lag im Durchschnitt bei 69.22 Jahren (SD = 6.90). Die Stichprobe bestand aus gleich vielen Seniorinnen wie Senioren. 55.56 Prozent der Befragten gaben an, zum Zeitpunkt der Befragung, bereits eine COVID-19-Impfung erhalten zu haben, 13.89 Prozent wurden zweimal geimpft, wohingegen 30.56 Prozent noch keine Impfung erhalten hatten. Da es sich beim Vereinsshuttle um ein Pilotprojekt handelt, das coronabedingt bisher kaum getestet werden konnte, zählte zu den 36 Befragten nur eine Person, die das Vereinsshuttle bereits genutzt hatte. Daher konnten keine Gruppenvergleiche zwischen Nutzenden und Nichtnutzenden angestellt werden.

5 ERGEBNISSE UND DISKUSSION

Die Unterkapitel 5.1 bis 5.4 stellen die Ergebnisse zu den aufgestellten Forschungsfragen dar, worauf in Unterkapitel 5.5 die Diskussion der Ergebnisse unter Rückbezug zum Forschungsstand folgt.

5.1 Verändertes Mobilitätsverhalten

Die erste Forschungsfrage beschäftigt sich mit der veränderten Verkehrsmittelnutzung der Seniorinnen und Senioren im ländlichen Raum im Zuge der COVID-19-Pandemie und den dahinterliegenden Gründen. Es zeigte sich, dass das Fahrradfahren und insbesondere das Zufußgehen während der COVID-19-Pandemie häufiger als Fortbewegungsmittel verwendet wurden, während der ohnehin von Wenigen aus der Zielgruppe genutzte ÖPNV weiter an Nutzenden verlor (Abbildung 1).

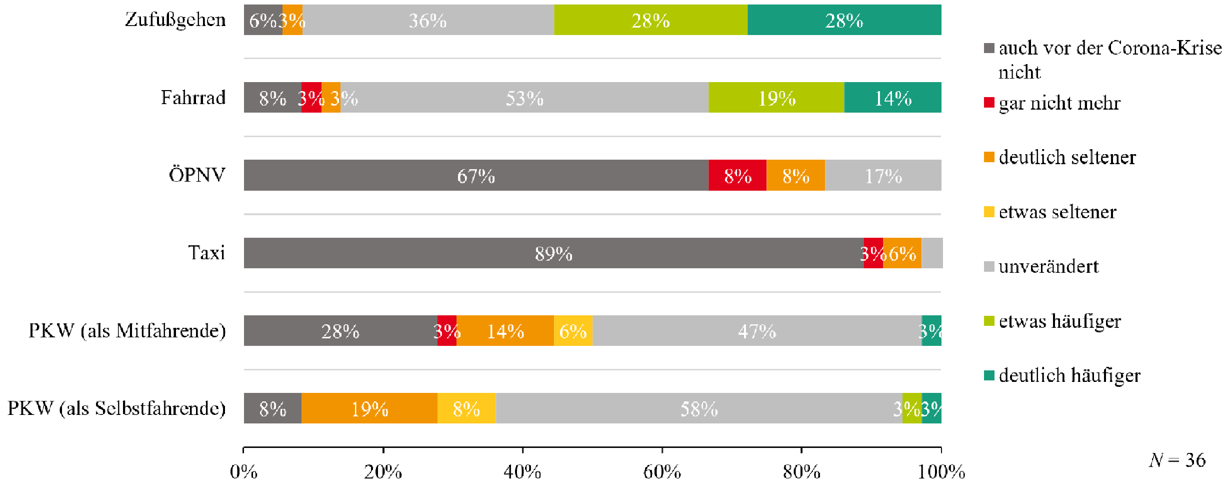

Abb. 1: Veränderte Verkehrsmittelnutzung aufgrund der COVID-19-Pandemie

Die genauere Betrachtung der Nutzenden der jeweiligen Verkehrsmittel und deren veränderte Verkehrsmittelnutzung während der COVID-19-Pandemie zeigte für den PKW als Selbstfahrende, dass der Großteil (63.63 %) der 33 Nutzenden diesen unverändert und 30.30 Prozent diesen etwas oder deutlich seltener nutzten. Als Mitfahrende verhielt sich die Veränderung ähnlich, 63.64 Prozent der 26 Nutzenden nutzten den PKW unverändert, während 26.92 Prozent ihn etwas oder deutlich seltener nutzten. Von den ÖPNV-Nutzenden, zu denen zwölf der Befragten gehörten, nutzten 50 Prozent den ÖPNV während der COVID-19-Pandemie unverändert, 25 Prozent deutlich seltener und weitere 25 Prozent nutzten ihn gar nicht mehr. Aufgrund der geringen Aussagekraft der kleinen Stichprobe von vier Taxi-Nutzenden wird die Veränderung dieses Verkehrsmittels nicht berücksichtigt. Das Fahrrad wurde von dem überwiegenden Anteil (57.58 %) der 33 Teilnehmenden, die das Fahrrad allgemein nutzen, während der COVID-19-Pandemie gleich häufig genutzt und von circa einem Drittel (36.36 %) etwas oder deutlich häufiger zur Fortbewegung verwendet. Das Zufußgehen war die Fortbewegungsart mit dem höchsten Anstieg seit Beginn der COVID-19-Pandemie. Von 34 Personen gingen mehr als die Hälfte (58.82 %) deutlich oder etwas häufiger zu Fuß.

Die ÖPNV-Nutzungsveränderung korrelierte positiv mit der PKW-Nutzung als Selbstfahrende, $r_s(11) = .36$, $p = .284$, und als Mitfahrende, $r_s(8) = .39$, $p = .339$, während die Korrelationen mit dem Fahrrad,

$r_s(11) = -.49$, $p = .125$, und dem Zufußgehen, $r_s(12) = -.18$, $p = .585$, negativ ausfielen. Auch das Alter der Teilnehmenden korrelierte negativ mit der veränderten ÖPNV-Nutzung, $r_s(10) = -.45$, $p = .140$. Ausgehend von der Codierung bedeutet diese Korrelation, dass ein steigendes Alter eher mit einer Nutzungsreduzierung einhergeht.

Die Seniorinnen und Senioren wurden außerdem offen nach den Gründen für ihre veränderte Verkehrsmittelwahl und -nutzungshäufigkeit befragt. Von 29 Befragten, die offene Nennungen machten, gaben sieben Personen an, dass es bei ihnen keine Veränderung gibt. Am häufigsten, zwölfmal, wurde genannt, dass mehr Wege zu Fuß und mit dem Fahrrad zurückgelegt werden. Hier wurden explizit die Bewegung und der Freizeitausgleich, mehr verfügbare Zeit und die frische Luft angesprochen. Wegfallende Ziele und Zwecke wie Freizeitaktivitäten und Reisen wurden von elf Befragten als Grund angegeben. Auch die Ansteckungsgefahr wurde von neun Befragten genannt, davon zweimal explizit im ÖPNV. Die Ablehnung der ÖPNV-Nutzung wurde von fünf weiteren Personen genannt, hierfür wurde allerdings kein Grund angegeben. Beschränkungen wie Ausgangssperren und Kontaktbeschränkungen spielten für fünf Seniorinnen und Senioren eine Rolle sowie eine gewisse Nahraumorientierung für zwei Befragte.

5.2 Subjektives Sicherheitsempfinden

Des Weiteren wurden das subjektive Sicherheitsempfinden bezüglich COVID-19 in verschiedenen Verkehrsmitteln sowie die Bedenken der Seniorinnen und Senioren bei der ÖPNV-Nutzung, zur Beantwortung der zweiten Forschungsfrage, erhoben. Das Sicherheitsempfinden unterschied sich zwischen den Verkehrsmitteln. Auf einer Skala von sehr unsicher (1) bis sehr sicher (6) wurde das Zufußgehen mit einem Mittelwert von 5.53 als am sichersten eingeschätzt. Darauf folgten der PKW als Selbstfahrende, das Fahrrad sowie der PKW als Mitfahrende. Als eher unsicher wurde das Taxi eingeschätzt. Mit einem Mittelwert von 2.14 wurde der ÖPNV mit Abstand als am unsichersten bewertet. Diese deskriptiven Unterschiede sind in Abbildung 2, unter Angabe der jeweiligen 95%-Konfidenzintervalle, dargestellt.

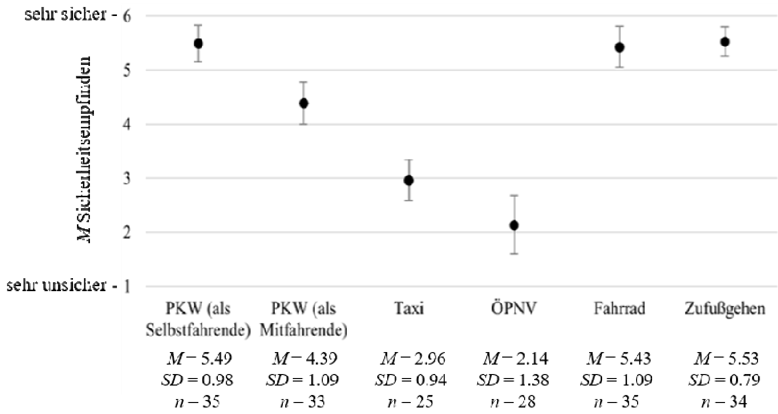

Abb. 2: Subjektives Sicherheitsempfinden in verschiedenen Verkehrsmitteln

Über alle Verkehrsmittel hinweg zeigte sich die Tendenz, dass die wahrgenommene Sicherheit mit zunehmendem Alter sinkt. Die genauere Betrachtung des Sicherheitsempfindens im ÖPNV ergab keine Geschlechterunterschiede, ebenso wenig wie zwischen geimpften und ungeimpften Personen. Darüber hinaus konnte den Daten entnommen werden, dass das Sicherheitsempfinden im ÖPNV von ÖPNV-Nutzenden höher bewertet wurde (M = 2.64, SD = 1.03, n = 11) als von Personen, die angaben, den ÖPNV generell nicht zu nutzen (M = 1.82, SD = 1.51, n = 17).

Da der ÖPNV von dem Großteil der Seniorinnen und Senioren (85.72 %) als eher unsicher, unsicher oder sehr unsicher eingeschätzt wurde, werden nachfolgend die Bedenken anhand der offenen Nennungen beschrieben. Neben der achtmaligen allgemeinen Nennung der hohen Ansteckungsgefahr bezogen sich die Bedenken vorwiegend auf die Situation, dass zu viele Personen (13 Nennungen) auf einem zu engen Raum zusammenkommen, in dem kein Abstand gehalten werden kann (19 Nennungen). Sieben Mal wurde das Verhalten der Mitreisenden angesprochen, wobei eine der Nennungen auf Erkältungssymptome dieser Bezug nahm und sechs Nennungen undisziplinierte Verhaltensweisen, wie das Nichttragen von Masken, adressierten. Drei Teilnehmende gaben an, keine allgemeinen Bedenken zu haben. Die genauere Betrachtung entlang der Fahrtabschnitte ergab, dass die Befragten wenig Bedenken bezüglich der Situation vor Fahrtbeginn hatten (17 Nennungen), da sie besser Abstand halten können, obwohl auch hier das undisziplinierte Verhalten von Mitreisenden angesprochen wurde (sechs Nennungen). Beim Ein- und Aussteigen wurde besonders häufig der zu enge Kontakt mit anderen Fahrgästen genannt (21 Nennungen). Neben Fahrgästen, die sich undiszipliniert verhalten (sechs Nennungen), wurden auch Bauteile als Übertragungsweg genannt (vier Nennungen). Zweimal wurde angegeben, dass das Ansteckungsrisiko beim Ein- und Aussteigen besonders hoch ist, wohingegen vier Befragte eine geringere bzw. keine Gefahr sahen, da die Dauer sehr kurz ist.

Das Sicherheitsempfinden im Vereinsshuttle wurde auf der Skala von sehr unsicher (1) bis sehr sicher (6) im Durchschnitt mit 3.57 (SD = 1.45, n = 30) bewertet. Damit wurde es höher eingeschätzt als das Sicherheitsempfinden im Taxi und im ÖPNV.

5.3 Einfluss der Hygienemaßnahmen auf das Sicherheitsempfinden

Zur Untersuchung der vierten Forschungsfrage bewerteten die Seniorinnen und Senioren verschiedene Hygienemaßnahmen im Hinblick auf den Einfluss, den diese auf ihre wahrgenommene Sicherheit bezüglich COVID-19 im Vereinsshuttle haben. Die Mittelwerte aller Maßnahmen sind in aufsteigender Reihenfolge, das heißt abnehmendem Einfluss, in Tabelle 1 aufgeführt. Mit Ausnahme von vier Maßnahmen lag der Mittelwert aller Maßnahmen auf einer Skala von deutlich sicherer (1) bis überhaupt nicht sicherer (6) unterhalb von 3, was dem Skalenpunkt eher sicherer entspricht. Als Maßnahme, die am meisten Sicherheit gibt, wurde die Pflicht zum Tragen einer FFP2-Maske bzw. medizinischen Maske eingeschätzt. Darauf folgten die Auslastungsbeschränkung auf den Einzeltransport von Fahrgästen und die verstärkte Reinigung und Desinfektion.

Maßnahme	***n***	***M***	***SD***
Maskenpflicht: FFP2-/medizinische Maske	35	1.80	0.80
Auslastungsbeschränkung: Fahrgäste einzeln	35	1.83	1.20
Verstärkte Reinigung und Desinfektion des Innenraums	36	2.08	1.00
Herstellung von Individuellen Zonen in den Fahrzeugen, z.B. über Trennwände zwischen den Fahrgästen	36	2.22	1.25
Desinfektionsmöglichkeit	35	2.23	1.11
Lüftung über geöffnete Fenster	34	2.24	0.92
Luftreinigung über einen Virenfilter	36	2.33	1.29
Kontaktloses Zahlen, z.B. über Karte, Körbchen, Sparschwein o.Ä.	36	2.33	1.12
Schutzscheibe zwischen Fahrenden und Fahrgästen	36	2.44	0.97
Fahrende machen täglich einen Corona-Schnelltest	36	2.64	1.22
Auslastungsbeschränkung: Hälfte der Fahrgäste	36	2.72	1.11
Pflicht, den Fahrpreis passend zu entrichten	35	2.83	1.32
Gesprächsverbot	35	2.97	1.15
Kontaktnachverfolgung	36	2.97	1.48
Maskenpflicht: Stoff-/Alltagsmaske	36	3.03	1.21
Vorderer Sitzplatz neben den Fahrenden wird nicht besetzt	36	3.25	1.38
Keine Hilfestellungen beim Ein-/Aussteigen oder Verladen von Rollatoren	35	3.31	1.41
Kommunikation zum Ansteckungsrisiko auf Basis von Studien	36	3.58	1.18

Tabelle 1: Mittelwerte des Einflusses unterschiedlicher Hygienemaßnahmen auf das Sicherheitsempfinden

Um zu untersuchen, ob die Maßnahmen bei unterschiedlichen Personengruppen verschieden stark wirken, wurde für jede Person eine Mittelwertsvariable über alle Maßnahmen hinweg berechnet. Diese zeigte keinen Zusammenhang mit demographischen Variablen. Allerdings gaben Befragte mit einem höheren Sicherheitsempfinden im Vereinsshuttle eher an, dass die Maßnahmen zu einer Erhöhung ihres Sicherheitsempfindens führen könnten als Personen mit einem niedrigen Sicherheitsempfinden, $r(27) = -.12$, $p = .531$.

5.4 Diskussion

Die Ergebnisse der veränderten Verkehrsmittelwahl der Seniorinnen und Senioren während der COVID-19-Pandemie ähneln denen bisheriger Studien, die in Kapitel 3.1 vorgestellt wurden. Die ÖPNV-Nutzung wurde von der Hälfte der Nutzenden reduziert, was als vergleichsweise geringer Einbruch angesehen werden kann. Dies deckt sich mit der in Kapitel 3.1 angesprochenen Tendenz, dass die ÖPNV-Nutzung von älteren Menschen sowie im ländlichen Raum weniger reduziert wurde. Bei der Interpretation sollte allerdings die geringe Anzahl an ÖPNV-Nutzenden beachtet werden. Gleichzeitig spiegelt dies das auf dem Land vorherrschende Bild der Dominanz des PKW (ADAC, 2016) adäquat wider. Es könnte demnach postuliert werden, dass der ÖPNV im ländlichen Raum unter älteren Menschen wenige, aber dafür loyale Kundinnen und Kunden, hat. Anhand der offenen Nennungen kann das Ansteckungsrisiko, entgegen bisheriger Studien, nicht als überwiegendes Motiv der Mobilitätsveränderung angesehen werden. Vielmehr steht das Bedürfnis nach Bewegung im Vordergrund. Wobei auch hier beachtet werden muss, dass der ÖPNV allgemein eine untergeordnete Rolle spielt und die Ansteckungsgefahr daher seltener genannt worden sein könnte.

Die vorliegende Untersuchung unterstützt ebenfalls bisherige Erkenntnisse zu dem Sicherheitsempfinden in verschiedenen Verkehrsmitteln. Über den bisherigen Forschungsstand hinaus konnten Erkenntnisse zu konkreteren Bedenken der Seniorinnen und Senioren im ÖPNV gewonnen werden. Am meisten Bedenken werden dadurch hervorgerufen, dass Abstände zu Mitreisenden nicht eingehalten werden können. Zu der Situation vor Fahrtbeginn werden weniger Bedenken geäußert, die Fahrt selbst wird am problematischsten wahrgenommen und auch für das Ein- und Aussteigen werden klare Regelungen benötigt. Dabei stellen vorrangig andere Fahrgäste und teilweise der oder die Fahrende ein Risiko dar; Bauteile und Zahlungsmittel spielen eine untergeordnete Rolle.

Die Untersuchung zeigt den potenziellen Einfluss vieler Maßnahmen auf das Sicherheitsempfinden der Seniorinnen und Senioren im Vereinsshuttle während der COVID-19-Pandemie. Auch hier werden die stärkeren Bedenken in Bezug auf Mitreisende sichtbar, da dementsprechende Maßnahmen den größten Effekt aufweisen. Die Einschätzung der Maßnahmen bezüglich des Sicherheitsempfindens deckt sich in weiten Teilen mit den Erkenntnissen bisheriger Studien aus Kapitel 3.3. Die Maskenpflicht, die Reinigung und eine Auslastungsbeschränkung erhalten am meisten Zustimmung, während das Gesprächsverbot und die Kommunikation zum objektiven Ansteckungsrisiko einen geringeren Effekt versprechen. Obwohl Bauteile und Flächen anhand der offenen Bedenken nicht als primärer Übertragungsweg angesehen werden, ist die Reinigung des Fahrzeuges wichtig für ein grundsätzliches Sicherheitsgefühl der Fahrgäste. Entgegen des allgemeinen Forschungsstandes hinsichtlich Maßnahmen zur Erhöhung des Sicherheitsempfindens im ÖPNV, konnte in der vorliegenden Untersuchung beobachtet werden, dass die Maßnahmen bei Personen, die sich bereits sicherer fühlen eher einen Effekt auf das Sicherheitsempfinden haben.

6 HANDLUNGSEMPFEHLUNGEN

Nachdem die Relevanz von Maßnahmen zur Steigerung des subjektiven Sicherheitsempfindens anhand des Forschungsstandes sowie empirisch aufgezeigt wurde, werden in diesem Kapitel unter Berücksichtigung der Anbietersicht, in diesem Fall des Projektleiters, Handlungsempfehlungen für das Vereinsshuttle generiert.

Ausgehend von den Befragungsergebnissen sollten jene Maßnahmen, die dem Schutz der Fahrgäste untereinander dienen, prioritär umgesetzt werden. Dazu zählt die Maskenpflicht, wobei die FFP2- bzw. medizinische Maske im Vergleich mit der Alltagsmaske deutlich mehr zur Erhöhung des subjektiven Sicherheitsempfindens beitragen kann. Diese war zum Erhebungszeitraum gesetzlich vorgegeben. Es kann empfohlen werden, auch nach einer eventuellen zukünftigen Aufhebung der gesetzlichen FFP2-Maskenpflicht über die Beibehaltung dieser nachzudenken. Die Auslastungsbeschränkung in Form von Einzeltransporten gibt den Seniorinnen und Senioren viel Sicherheit, während die Reduzierung auf den Transport der Hälfte der möglichen Fahrgäste merklich weniger Sicherheit gibt. Da beide Formen mit ähnlich hohen Kosten verbunden sind, sollte analog der Maskenpflicht je nach Pandemielage entschieden werden. Die Bündelung von Fahrten könnte über die Sportgruppen hinaus so geplant werden, dass immer dieselben Personen miteinander transportiert werden, die auch privat oder während des Sportangebots mehr Kontakt haben. Alternativ bietet die kostenaufwendige Herstellung von individuellen Zonen, beispielsweise über Trennwände zwischen Fahrgästen, die Möglichkeit, mehrere Passagiere zu transportieren und gibt den Seniorinnen und Senioren fast so viel Sicherheit wie der Einzeltransport. Ein Gesprächsverbot wird ausgehend von den Daten nicht empfohlen, da es einen vergleichsweise geringen Einfluss auf das Sicherheitsempfinden hat und laut des Projektleiters schwierig umzusetzen wäre.

An zweiter Stelle sollten Reinigungs- und Desinfektionsmaßnahmen realisiert werden, da diese relevant für das Sicherheitsgefühl der Seniorinnen und Senioren sind. Auch Desinfektionsmöglichkeiten, die mit moderatem Aufwand umzusetzen sind, sollten zur Verfügung gestellt werden. Weiterhin spielt die Belüftung des Vereinsshuttles eine wichtige Rolle. Es kann beobachtet werden, dass die einfach umsetzbare Lüftung über geöffnete Fenster marginal mehr Sicherheit gibt als ein kostenaufwendiger Virenfilter. Deshalb ist die Lüftung über geöffnete Fenster vorzuziehen, wobei ein zusätzlicher Effekt eines Virenfilters nicht auszuschließen ist. Der Bezahlvorgang stellt für manche Befragte eine risikoreiche Situation dar. Die kontaktlose Zahlung gehört laut der Einschätzungen zu den effektiveren Maßnahmen. Diese könnte im Vereinsshuttle in einer simplen Form wie einem Körbchen realisiert werden. Anhand der Einschätzungen haben jene Maßnahmen in Bezug auf die oder den Fahrenden zwar einen Einfluss auf das Sicherheitsempfinden, können aber im Vergleich zu anderen Maßnahmen eher als optional eingestuft werden. Da diese teilweise mit höheren Kosten verbunden sind, ist eine nähere Kosten-Nutzung-Analyse zu empfehlen. Statt der Abtrennung des Fahrenden sollte allgemeiner darauf geachtet werden, die Abstände zwischen den Fahrgästen zu maximieren. Die Kontaktnachverfolgung gibt nur etwas Sicherheit für die Mitfahrenden. Da diese durch die Buchungen automatisch gegeben ist, sollte sie dennoch beibehalten

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werden. Keine Hilfestellungen beim Ein- und Aussteigen anzubieten, gibt insgesamt wenig Sicherheit. Dies ist allerdings eine Maßnahme, die stark mit dem Alter sowie der Nutzungsmöglichkeit des Angebots zusammenhängt. Hierbei empfiehlt sich eine individuelle Handhabung. Die Kommunikation von Studien zum Ansteckungsrisiko zeigt den geringsten Effekt und ist demnach nicht zu forcieren.

Abgesehen von den konkreten Empfehlungen zu Maßnahmen soll hervorgehoben werden, dass es besonders relevant ist, diese konsequent umzusetzen und zu kontrollieren. Weiterhin wurden die Empfehlungen auf Basis der aktuellen Einschätzungen getroffen, hierbei sollte eine regelmäßige Reevaluierung stattfinden. Generell empfiehlt es sich, Maßnahmen, die viel Sicherheit geben, möglichst lange beizubehalten. Gleichzeitig sollten diese im Vergleich zu der aktuellen Gesetzeslage nicht unverhältnismäßig erscheinen.

7 ZUSAMMENFASSUNG

Die vorliegende Untersuchung beabsichtigte, aufbauend auf einem weitreichenderen Verständnis für die veränderte Mobilitätsnutzung und dem damit einhergehenden subjektiven Sicherheitsempfinden von Seniorinnen und Senioren während der COVID-19-Pandemie, Hygienemaßnahmen zur Steigerung der wahrgenommenen Sicherheit im Vereinsshuttle zu entwickeln. Dazu wurde eine Befragung mit einem standardisierten Fragebogen mit 36 älteren Personen durchgeführt. Es zeigt sich, dass das Zufußgehen während der COVID-19-Pandemie die größte Steigerung erfuhr, gefolgt vom Fahrradfahren. Dahinter verbirgt sich das Bedürfnis nach mehr Bewegung als zentrales Motiv der Mobilitätsveränderung. Der PKW wurde weitestgehend gleich häufig bis etwas seltener genutzt. Die grundsätzlich geringe ÖPNV-Nutzung reduzierte sich während der COVID-19-Pandemie, verglichen mit anderen Studien erscheint diese Entwicklung jedoch moderat. Während Verkehrsmittel des Individualverkehrs als sehr sicher eingeschätzt werden, ist das Sicherheitsempfinden im ÖPNV niedrig. Das größte Ansteckungsrisiko geht aus Sicht der Befragten von dem zu engen Kontakt mit anderen Fahrgästen aus. Daraus ergibt sich die Priorisierung von Maßnahmen, die dem Schutz der Fahrgäste untereinander dienen. Auch die Potenziale und die Umsetzbarkeit weiterer Maßnahmen wurden für den Anwendungsfall des Vereinsshuttles auf Basis der Einschätzungen zu spezifischen Hygienemaßnahmen und den zum ÖPNV geäußerten Bedenken evaluiert. Die Umsetzung der Hygienemaßnahmen, basierend auf den Handlungsempfehlungen, kann entscheidend dazu beitragen, das Sicherheitsempfinden der Fahrgäste zu erhöhen und so die Beförderung im Vereinsshuttle während der COVID-19-Pandemie zu ermöglichen.

8 LIMITATIONEN UND AUSBLICK

Die Relevanz der Untersuchung des Einflusses von Hygienemaßnahmen auf das Sicherheitsempfinden konnte in einem kleinen Maßstab gezeigt werden. Der spezifische Anwendungsfall des Vereinsshuttles ist allerdings mit Limitationen verbunden. Der Stichprobenumfang ist relativ gering, die Seniorinnen und Senioren sind als Sportvereinsmitglieder möglicherweise in einer überdurchschnittlichen körperlichen Verfassung und konzeptionelle Unterschiede zwischen dem Vereinsshuttle und dem ÖPNV, beispielsweise die vorherige Buchung, schränken die Übertragbarkeit der Ergebnisse ein. Daher wird der Ansatz für breitere Untersuchungen empfohlen, in denen die Verallgemeinerbarkeit der Handlungsempfehlungen überprüft werden sollte. Dabei empfiehlt sich ausgehend von der Reflektion der vorliegenden Studie die Abstimmung mit dem Mobilitätsanbieter, um die praktische Anwendbarkeit der bewerteten Hygienemaßnahmen sicherzustellen. Außerdem ermöglichen Befragungen für spezifische Verkehrsmittel im Vergleich zu einer Grobbetrachtung des gesamten ÖPNV eine einheitliche Vorstellung und somit präzisere Einschätzungen. Mehrere Messzeitpunkte helfen die Dynamik der COVID-19-Pandemie zu erfassen. Auch ein Mix-Methods-Design kann befürwortet werden, wobei sich insbesondere ein sequenzielles, erklärendes Design anbietet. Aufbauend auf quantitativen Daten, die analog der vorliegenden Studie einen guten Überblick geben, kann die Vertiefung anhand qualitativer Methoden detailliertere Erkenntnisse liefern.

Die vorliegende Studie untersucht den Einfluss einzelner Hygienemaßnahmen auf das Sicherheitsempfinden, kann allerdings keine Aussagen zu der Kombination von Maßnahmen treffen. Darüber hinaus wurde lediglich der positive Aspekt des höheren Sicherheitsempfindens der Maßnahmen erfasst. Zukünftige Forschung sollte ebenfalls negative bzw. einschränkende Wirkungen von Hygienemaßnahmen adressieren und das Verhältnis der entgegengesetzten Effekte untersuchen. Dazu sollte auch beleuchtet werden, ob zu viele Maßnahmen abschreckend wirken. Unbeantwortet bleibt außerdem die Frage, wie die Maßnahmen nach der Umsetzung effektiv kommuniziert werden können. Eine Limitation dieser Untersuchung stellt außerdem der mögliche Einfluss der COVID-19-Lage im Erhebungszeitraum dar. Generell unterliegen die Erkenntnisse aufgrund der Aktualität der Themen der großen Dynamik des Pandemiegeschehens und müssen unter Berücksichtigung dieser interpretiert werden. Aufgrund der andauernden COVID-19-Pandemie werden auch fortwährend Untersuchungen zu den adressierten Themen notwendig sein, in denen sich verändernde Umweltbedingungen, beispielsweise eine zunehmende Impfquote, relevant werden.

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Simulation and Analysis of Urban Green Roofs with Photovoltaic in the Framework of Water-Energy Nexus

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1 ABSTRACT

Urban green infrastructures such as green roofs can reduce building energy demand, mitigate rainfall run-off and improve urban air quality. On the other hand, decentralized renewable energy systems such as rooftop photovoltaics (PV), are one of the key actions towards reducing a building's energy dependence and greenhouse gas emissions. This study assesses the technical and economic benefits of a combination of green roofs and PV systems and thereby considers increased PV yields, decreased building heat demands, and reduced rainwater runoff mitigation, that can stem from this combination. For this, two workflows within an urban simulation environment, SimStadt, were applied and extended for two city quarters in Stuttgart, Germany. The results show that by installing green roofs with PV systems where possible, annual PV yields increase by about 0.3%, annual space heating demands decrease by 0.1 %, and 30 % of rainwater runoff can be avoided in the case study areas. The economic cost-benefit analysis, however, shows that only around 31% of the initial investment can be recurred over the assets' lifetime.

Keywords: Simulation, Urban green infrastructure, Analysis, Water-Energy Nexus, Green roof with PV

2 INTRODUCTION

Globally, more and more people live in urban areas (Kotzeva and Brandmüller 2016). Next to its multiple benefits, increased urbanisation and densification pose problems such as pollution or urban heat island effects(McMichael 2000). Urban green infrastructure, i.e., parks, trees, lawns, and green roofs, can dampen these impacts by, for example,improvingpublic health (Lee and Maheswaran 2011), reducingbuilding energy demands(Castleton et al. 2010),mitigatingwater runoffs through water harvesting, and enhancing infiltration and evapotranspiration(Silvennoinen et al. 2017). In particular, green roofs improve stormwater management (Stovin 2007; Mentens et al. 2006), water run-off quality (Berndtsson et al. 2009), urban air quality (Yang et al. 2008), roof lifetimes(Teemusk and Mander 2009), and reduce the urban heat island effect (Doug et al. 2005) as well as building energy consumption(Lamnatou and Chemisana 2015; Movahhed et al. 2019; Wong et al. 2003)through reduced heat fluxes, increased solar reflectivity (Gaffin 2005) and increasedbuilding thermal masses(Niachou et al. 2001). Furthermore, the building's architectural interest and its rooftop biodiversity increase (Koehler 2003).

There are two types of green roofs, extensive and intensive, defined by the depth of the substrate layer (Speak et al. 2013). Extensive green roofs have a thin substrate layer (less than 150 mm) with low-level planting, typically sedum or lawn, and can be comparably lightweight in structure. Intensive roofs have a deeper substrate layer to allow deeper-rooting plants such as shrubs and trees to survive. Extensive green roofs are relatively maintenance-free and readily survive in European climates(Castleton et al. 2010). However, in regions with hot arid climates(annual temperature≥18°C; annual precipitation≥5×threshold for dryness as defined by (Peel et al. 2007)), irrigation of up to9 mm per day(drip irrigation)can be required (van Mechelen et al. 2015).

On the other hand, the implementation of energy systems that produce heat and electricity from renewable energy sources is one of the key actions towards reducing a building's energy dependence and greenhouse gas emissions.Electricity production from photovoltaic (PV) panels is one option ofutilising a building's roof. To maximise electricity output, PV module efficiency should be as high as possible. It is generally characterised by material limitationanddecreases with increasing ambient temperature. Furthermore,PV cells exhibit long-term degradation if their surface temperature exceeds a certain limit(Rahman et al. 2015). Green roofs can reduce this effect since the evapotranspiration of the plants reduces ambient air temperatures.Simulations and experimental works show that there is a relative increase in annual PV output on green surfaces that ranges from 0.08% (Witmer 2010) to 8.3%(Hui and Chan 2011).

The benefits of a combination of PV and a green roofon a single building have beenstudied before (Baumgartner et al. 2016; Silvennoinen et al. 2017; Hui and Chan 2011; Movahhed et al. 2019).The work ofCarter and Keeler (2008), for example,conducteda cost analysis of green roofs plus PV at the urban watershed level. However, it appliedaverage PV yield gains and heating energy cost savings across all buildings. To the knowledge of the authors, there is no existing tool that assessesa building'sheating demand, rooftop PV yield,and rooftop water run-off in an integrated way, on a single-building level, with the option of scalability to city quarter or city level. To fill this gap, this study appliedthe urban simulation platform SimStadtthat allows simulating building heating and cooling demands (Weiler et al. 2019) and rooftop PV yields (Rodríguez et al. 2017)on a single building level.The goal of the presented method is not to simulate PV yields of green roofs in very high detail as in Zheng and Weng (2020) andScherba et al. (2011), but to contribute to research on the water-energy nexus in urban areas andprovide guidance to urban planners.

Theenergetic impact simulation methods, includingheating demand simulation workflow and roof PV simulation workflow, are introduced in section 2.1., whilesection 2.2 introduces the method to quantify thebenefits of reduced water run-offs.The cost-benefitanalysis method of green roofsplus PV is introduced in section 2.3. A case study is introduced in section 2.4, followed by results (section 3), and a discussion (section 4).

3 MATERIAL AND METHOD

3.1 Energetic impacts of PV-green roof

This work considers two aspects of the energetic impact of green roofs with PV: (i) higher PV module conversion efficienciesdue to the evaporative cooling effect of rooftop green, and (ii) heating and cooling demand reductions due to lower U-values (better insulation of green roofs compared to conventional roofs).

Rooftop PV potentialsand hourly yields can be simulated by the appropriate workflow in SimStadt(Rodríguez et al. 2017). It uses 3D building models in the CityGML data modelas basic input(Open Geospatial Consortium 2021). Besidesthe CityGML model, one of theinput parametersis PV module efficiency, with a value of 15% taken as a base case for non-green roofs(Rahman et al. 2015). The output of the workflow is a CSV file including PV potential in MWh/a and monthly irradiance in W/m2. The PV module efficiency difference is the decisive factor in electricity yields between non-green roofs and green roofs. The efficiency changes of PV modules on green roofsare not only a result of a drop in ambient temperaturebut also of the reflectionalbedo factorof the plants, which is higher than a non-greened roof(Lamnatou and Chemisana 2015). Amonthly average PV module efficiency changewas applied based on previous research byNagengast et al. (2013) to align better with the existing workflow output . Linear regression equations were used to find the relationships between ambient temperature, PV back-surface panel temperature (equation 1), and hence PV module output (equation 2) for both roof types (Nagengast et al. 2013). In this paper, the module cell temperature is equal to the back-surface panel temperature.

$$T_{module} = \beta_0 + \beta_1 T_{ambient} \tag{1}$$

$$P = \beta_2 + \beta_3 T_{module} + \beta_4 I \tag{2}$$

Where T_{module} is the PV module cell temperature in °C, $T_{ambient}$ is the ambient air temperature in °C, P is the PV output in kW, and T_{module} is the solar irradiance on PV module in W/m2. The power data was collected over one year in Pittsburg, USA. of the same polycrystalline 275 W PV modules tiled at 15°. The power modules were 1.96 m by 0.99 m, mounted faced south.The coefficients for both roof types are subsumed in table 1:

Coefficient	Non-green roof	Green roofs
β_0	1.2	1.3
β_1	1.5	1.3
β_2	0.17	0.1

β_3	-2.4E-03	5.6E-04
β_4	0.013	0.013

Table 1: Regression values for non-green and green roofs(Nagengast et al. 2013).

Monthly average irradiance on PV panels from SimStadt, and monthly average ambient temperature from Meteonorm (2021) were the monthly inputs for equations 1 and 2.Multiplied by the hours per month, PV potential on two types of roofs could be calculated.

The building's heating and cooling demand with and without green roofs, driven by a decreaseof the roof's U-value in the latter case, will be simulated with the heating-demand-with-refurbishment-scenariosworkflow in SimStadt(Weiler et al. 2019; Zirak et al. 2020).The heating demand simulation workflow also used a CityGMLfile as themain input. Furthermore, buildings were classified based on their function and year of construction. A building physics library in SimStadtthen applied relevant physical properties such as U-values for walls, roofs, and windows to each class of buildings. These properties were subsequently applied to the actual building geometries of a given case study [11]. Similar to a building physics library, a usage library was based on several German norms and standards, focusing on heating setpoint temperatures, occupancy schedules, and internal gains that are different according to the usage (residential, office, retail, etc.) of each building. The U-value of green roofs could be set for roof-only refurbishment scenarios in SimStadt.

According to the German Building Energy Act of 2020 ("Gebäudeenergiegesetz", GEG), the required U-value is 0.24 W/(m2K) for new buildings(GEG). Green roofs have a U-value between 0.24 to 0.34 W/(m2K)(Niachou et al. 2001). From an energy standpoint, savings were thus limited by installing a green roof on a new building. However, for non-insulated roofs, the U-value couldbe reduced up to 92% by applying green roofs (Niachou et al. 2001). It is assumed here that only flat roofs, i.e.with a tilt of less than 10°, can be retrofitted intogreen roofs.

3.2 Rainfall mitigation

In addition to energetic aspects, the reduction in rainwater runoff from green roofs was investigated. The share of rainwater runoff of total precipitation can be as high as 91% for a non-greened roof and as low as 15% for an intensive green roof. Main influencing factors include the depth of the substrate layer, rain duration, rainintensity, and the antecedent dry weather period, while the age of the green roof, slope angle, and length are not measurably correlated to yearly run-offs(Mentens et al. 2006; Garofalo et al. 2016). On a roof with solar PV panels, a green "upgrade" should be restricted to extensive or low-profile vegetation to avoid shading of the PV panels(Hui and Chan 2011).Based on the previous observations, a relationshipwas obtainedbetween the runoff depth (RD) in mm, i.e., the amount of rainfall turns into the ground surface runoff, or precipitation depth (PD) in mm,and the antecedent dry weather period (ADWP), i.e. the period between two independent rainfall events in hours(Garofalo et al. 2016). The relation is shown in equation 3, which exhibits an R2of 0.99. The assumed substrate layer was 80 mmbelonging to an intensive green roof:

$$RD = -0.24 + 1.01\,PD - 0.27\,lnADWP \tag{3}$$

The hourly precipitation data over a year was a part of the climate data package used in SimStadt for energetic simulation in section 2.1. Based on this information the PD and ADWP of each rainfall event in the year were identified. Combined with equation 3, the RD of the rainfall events could be calculated.

3.3 Economic analysis of green roofs

Apart from the technical benefits of PV plus green roofs, favourite economic factors are crucial toachieve relevant penetration rates. A cost-benefitanalysis is widely recognised as a useful framework for assessing the positive and negative aspects of prospective actions and policies, and for making the economic implications alternatives an explicit part of the decision-making process (Kenneth J. Arrow et al. 1996). One approach to cost-benefit analysis is to use the net present value (NPV) to compare alternative approaches with possibly different lifetimes, investments, and operating costs(Carter and Keeler 2008).

The incremental green roof construction costis 36.5€/m2 to 60.0€/m2compared to non-green roofs (Carter and Keeler 2008). In the following, an average cost of 48.25 €/m2was used. For rooftop PV systems of less than 100kWp that were put into operation before January 2021, the feed-in tariff in Germany is 8,16

€cent/kWh for 20 years (Wirth 2021). Based on the energy carrier mix in the heating sector (Eichhammer et al. 2019) and average heating cost for individual heating technologies(VerbraucherzentraleRheinland-Pfalz e.V. 2017), the average heating cost in Germany wasaround 10 € cent/kWh in 2019.

The prevailing German caselaw calls for separate stormwater fees based upon estimates of the actual contribution of a parcel to the total stormwater burden (Nickel et al. 2014). Stormwater fees in Germany are based upon individual parcel assessments and are determined by the surface area which drains to the central conveyance system, with an average annual stormwater charge of 0.89€ per m2 impermeable surface. Green roofswere rewarded with a discount, typically 50%(Ansel et al. 2011). The economic benefits of stormwater mitigation werethus set at 0.45 €/m2of impermeable surface annually.

The parameters for the cost-benefit analysiswere summarised in table2.

Parameters	Green roof investment cost	Green roof lifetime	Feed-in electricity price	Heating cost	Discount rate (KfW 2021)
Unit	€/m^2	Years	€/kWh	€/kWh	%
Value	48.25	60	0.086	0.098	2.3%

Table 2: Cost and benefit of integrated PV green roof.

3.4 Case study and input data

A major part of the city center of Stuttgart, Germany, currently undergoes significant redevelopment in the context of the construction of a new underground central rail station.The two case study areas in Stuttgart's city center include an area with existing buildings that could be retrofitted with green roofs and PV systems, and an area still covered with railway tracks that will develop into a new neighborhood. The two areas are thus representative for two common situations faced by urban planners, architects, project developers, and city authorities. The developed tools can thus contribute to improvingthe planning of so-called technical master plans(Grassl 2013).

The area defined here as Hauptbahnhofviertelis covered with buildings (red in figure 1). As mentioned in section 2.3.,a flat roofwith a slopeof less than 10° was assumed to be convertible into a green roof. It is thus important to have detailed knowledge of building envelopes, provided in our case by the 3D building model in the CityGML data format. Generally, building models in CityGML format are available in five Levels of Details (LoD), with LoD 0 relating to a planar shape representing a building's floor plan, LoD1 relating to buildings as blocks with average building height and a flat roof, LOD2 to models with additional information on building heights and particularly roof shapes, while LoD3 introduces windows and LoD4 information on (interior) ground plans and wall thicknesses as further information (Weiler et al. 2019). Furthermore, building functions, e.g., residential, office, etc., and year of construction (Zirak et al. 2020)can be attached. The LoD2 data model of great Hauptbahnhofviertel areaswas provided by the City of Stuttgart Measurement Office(Landeshauptstadt Stuttgart 2021). According to satellite images(BKG 2021), most of the existing flat roofs in the investigated area already covered with green roofs. To reduce complexity, it was assumed that 10% of flat roofs in the area still non-green roofs.

Fig. 1:Illustration of city quarter great Hauptbahnhofviertel (red) and Rosensteinviertel (blue). Source: Landeshauptstadt Stuttgart, Stadtmessungsamt

The other area studied here, Rosensteinviertel, is to date covered with railway tracks and rail-related buildings (blue in figure 1). After 2025, it will be converted into a mixed-useblockwith offices, retail space,and residential areas. As all the buildings in the Rosenstein quarter will be new-built, thusadhering to the latest energy efficiency standards, this part of the case study aimed to demonstrate an integrated rooftop approach, i.e. featuring green covers and PV panels, in new-built areas.For this area, a 3D building model inLoD 1 CityGMLformatwas created based on the current state of planning (ASP ARCHITEKTEN 2019), shown in figure 2. A further assumption thus was that all newly constructed buildings will feature flat roofs, supported by the available planning material.

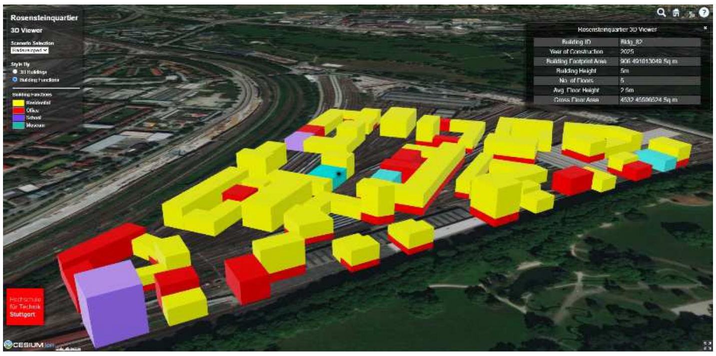

Fig. 2: LoD1 building data model of to-be-constructed buildings in Rosensteinviertel. Source: HFT Stuttgart

Besidesthisgeoinformaticsdata, climate data (precipitation, temperature, irradiation, etc) of the last 10 years as well as for 2030, 2040, and 2050 in Stuttgart was sourced from Meteonorm (Meteonorm 2021).

4 RESULTS

4.1 Energetic benefits

Table 2 shows the energetic benefits, including electricity generation potential and heating demand, for thetwo case study quarters.

In the great Haupfbahnhofviertel area (red in figure 1), electricity generation potentialsfrom rooftop PV systems were180 GWh/a, including 2,7 MWh from angled roofs.Due to better thermal insulation, the buildings with green roofs had lower heating demands. For LoD1 buildings without roof details, the decrement amount of heating demand is 0.1%; while all LoD2 buildings with flat roofs consumed 0.04% less heating energyaccording to simulation. This difference was brought by the missing information on the shape and its heating situation of attics of the LoD1 model (Nouvel et al. 2017). As all the buildings in Rosensteinviertel were assumed to be constructed with a U-value of 0.24 W/(m2 K), there is no additional benefit in terms of heating demand savings. PV systems can nevertheless be installed, also in combination with green roofs, with a yearly PV yield increase of 0.3%.

Building model	Roof angle	Roof condition	Hauptbahnhofviertel		Rosensteinviertel	
			PVgeneration [MWh/a]	Heating demand [MWh/a]	PVgeneration [MWh/a]	Heating demand [MWh/a]
LoD1	Flat	Status Quo	768	2,450	1,734	14,933
		Green Roof	770	2,447	1,740	14,933
		Difference	0.3%	-0.1%	0.3%	0.0%
LoD2	Flat	Status Quo	14,801	160,844	0	0
		Green Roof	14,855	160,775	0	0
		Difference	0.3%	-0.04%	0	0
	Angled		2,721	27,671	0	0

Table 2: Energetic benefits, including electricity generation potential and heating demand, in Hauptbahnhofviertel and Rosensteinviertel.

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Energetic benefits of green roofs werealso simulated in 10-year intervals until 2050, thus integrating changing climatic conditions:[1] In 2050, PV systems on green roofs would produce on average 0.31% more electricity than on non-green roofs per year. However, heating demands regardless of the roof types experienced a more pronounced drop of 5% till 2050.Nevertheless despite the warmer climate in winter, by retrofitting them into green roofs, the heating demands of existing buildings with non-green roofs could decrease by around 0.7 %.

The annualspecific PV yields of buildings with various geometries are only determined by the available roof area, as it is assumed that irradiance is constant within a city quarter. However, a building's geometryhas a decisive impact on its space heating demand: the larger the ratio between a building's volume and its ground area, the less heat dissipates through the roof. Figure 3 gives an example: the slim high-rise building (blue) has a smaller footprint than the lower building (yellow) of similar volume. In this case, upgrading the roof would be more important for the yellow building.

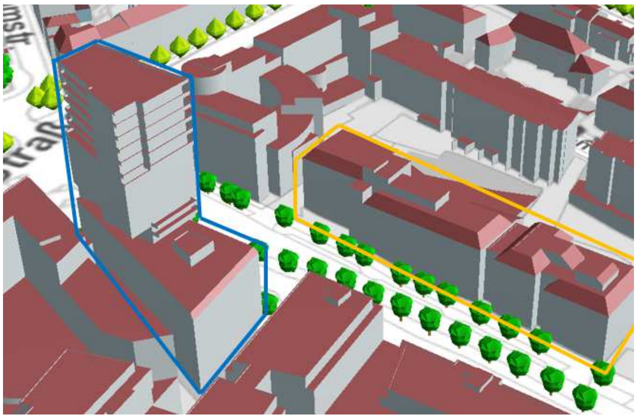

Fig. 3: Buildings from case study area of different geometry with similar volume to ground area ratio. Source: Source: LHS Stuttgart, Stadtmessungsamt

4.2 Rainfall-runoffmitigation benefit

In the Haupbahnhofviertel, flat roofs make up 87% of the total roof area of 4.1 million m2. As mentioned in section 2.4., 10% of this area hadthe potential to be converted into green roofs with the ability to better mitigate stormwater events and to decrease rainwater run-offs, while in Rosensteinviertelthe whole roof area of 76,000 m2is assumed to be flat roofs (ASP ARCHITEKTEN 2019).

In 2020, annual precipitation in Stuttgart was 711 mm andwasforecasted to increase by about 2 mm/a every 10 years until 2050. Without green roofs,theprecipitation would be collected in the tank, orredirected to the garden, or go directlyto the sewage system in the absence of rainwater storage systemsor ground-based percolation systems (Ansel et al. 2011). Green roofs can absorb and store around 30% (table 3) of the rainfall on an annual basis according to equations 1 and 2. The study by (Uhl and Schiedt 2008) shows that the rainfall run-off of green roofs can be reduced by 32% in Münster, Germany, which shares a similar precipitation amount and pattern as in Stuttgart. The aligned results confirmed the accuracy of the method.

City quarter	Precipitation	Flat roof area	Run-off of non-green roofs	Run-off of green roofs	Difference
Unit	mm/a	1,000 m^2	1,000 m^3/a	1,000 m^3/a	%
Hauptbahnhof	711	359	256	179	-29.9%
Rosenstein		77	55	38	

Table 3: Total run-off on normal roofs and green roofs with precipitation amount in the year 2020.

Figure 4 shows the ratio betweenmitigated runoff and precipitation on green roofs in 2020 (left) and 2050 (right)in rainfall events of differing precipitation and ADWPs of differing lengths.Generally, green roofs absorbed 100%of the rainfall if the precipitation amount per event was <1 mm and ADWP >100 h. Although the total 2050 precipitation does increase by 6 mm/a from 2020 to 2050, the rainfall pattern became more extreme, with (1) increased precipitation per rainfall event, indicated by more raster blocks with precipitation

[1] According to meteonorm data, average winter temperatures in Stuttgart (November to February) increase from 3.4°C to 4°C, while average summer temperatures (June to August) increase from 19.1°C to 19.9°C between 2020 and 2050.

amount to more than 5 mm, (2) a longer dry period between two rainfall events, indicated by an ADWP valueofup to 300 h compared to 250 h in 2020. The positive relation between rainwaterretention of green roofs and ADWP according to equation 3 roughly compensated for the reduced retention with the increased precipitation amount per rain event.Green roofs were predicted to mitigate 30.2% of annual precipitation in the year 2050 comparing with 29.9% in the year 2020.

As indicated in section 3.2, the area, tilt, and orientation of roofs have only limited impacts on rainfall run-off mitigation and are thus not included in equation 3. Therefore, the rainfall mitigation efficiency is similar between city quarters with similar rainfall patterns. The amount of mitigated rainfall should thus be similar for quarters with similar values of roof area per ground area.

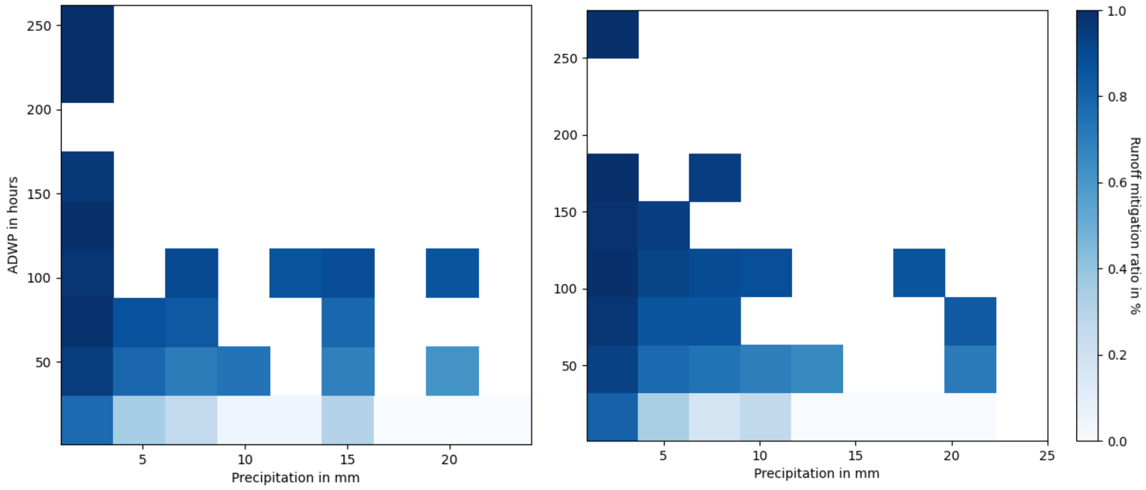

Fig. 4: Ratio between mitigated runoff in relation to ADWP (the period between two independent rainfall events) in hours,and precipitation per rainfall event in mm on green roofs in the year 2020 (left) and in the year 2050 (right).

4.3 Cost-benefit analysis

Economic benefits of green roofs were estimated for both city quartersareshown in table 4. The results are based on the assumption that (1) all green roofs were installed with PV modules; (2) 10% of all the current flat roofs werenon-green roofs; (3) no stormwater management solutions were applied today, (4) the lifetime of green roofs is 60 years, (5) the annual discount rate is 2.3% (KfW 2021).The annual benefits over the lifetime were discounted to the present value in the same year with the investment. In great Haupfbahnhofviertel, a0.3% increase of PV module efficiency increases revenues through feed-in to the grid by 0.66 million €, which compensatedabout 1% ofthe area's green roof renovation cost of 17.3 million €. The benefit of heating savings over 60 years of around 23,000 € wasthe leastsignificant factor (< 0.1 million €). Mitigation of rainwater runoff brought the largest benefit, with5.3 million €. Overall, all the benefits brought by green roof renovationwere not sufficient for a positive NPV for green roof investment, as the total lifetime NPV is negative.

Similar to Europaviertel, in Rosensteinviertelthe NPV of the benefits and the cost was -2.6 million €, which was not sufficient to initiate the green roof transition. The total energetic benefits accounted for 0.014 million €, which is much lower than inHauptbahnhof, as there was no heating saving potential for new-built.

		Hauptbahnhof	Rosensteinviertel
Green roof renovation cost	10^6 €	17.34	3.71
Benefits from feed-in tarrif	10^6 €	0.13	0.014
Benefits from heating saving	10^6 €	0.023	0
Benefits from stormwater mitigation	10^6 €	5.30	1.13
NPV	10^6 €	-11.89	-2.60

Table 4: Comparison of green roofs' benefits in Europaviertel and Rosensteinviertel in NPV of the whole lifetime.

5 DISCUSSION

This paper applied validated energy simulation workflows in the urban energy simulation platform SimStadt to assess the energetic and stormwater mitigation benefits of green roofs. The use of one unified single input of building model data in CityGML format ensured compatibility and comparability of results between PV yields, and heating demands.Greening all roofs in the newly built Rosensteinviertel and retrofitting 10% of roofs in the Hauptbahnhofviertel quarter would increase yields by about 0.3%. In addition, heating demandsin the Hauptbahnhofviertel quarter might be reduced marginally by 0.1% through retrofitting 10% of buildings without green roofs. Looking at the retrofit-demanded buildings alone, about 0.7 % of the heating demands could be saved by improving the roof thermal characteristics alone. Furthermore, about 30% of the yearly rainwater run-off could be avoided through green roofs. More importantly, runoff during extreme rainfall events of > 20 mm could be reduced by more than 50%, reducing pressure on existing sewage systems in great Hauptbahnhofvierteland reducing infrastructure costs in the new-built Rosensteinviertel.To the knowledge of the authors, the study on how rooftop PV systems affect the extensive green roof rainfall mitigation ability is still missing. For future research, it is meaningful to quantify this effect.

In terms of a cost-benefits analysisthe economic benefits of green roofs, namely increased PV yields, rainwater retention, and reduced heating demands were by far not sufficient to finance initial investments: over a lifetime of 60 years, only about 30% of investments could be recovered through operational savings in both city quarters. This was in line with results from (Carter and Keeler 2008), who showed that in a conventional setup (no reduction in green roof investments, no increase of heating cost, external factors such as improved air quality not included), green roofs were 19% more expensive than the normal roofs over the lifetime. For older buildings with high heating demands, e.g., the heating demands could be saved up to 2.5% in buildings built before 1950 and this resulted in a positive NPV over the lifetime.

The increasingly milder climate bringsless heating demands: in Stuttgart, Germany, annual heating demands are expected to decrease by around 1.5% every 10 years until 2050.Therefore, in regions where heating in winter is the dominant use of energy, heating energy saving through the green roof are becoming even less attractive in the future; while green roofs in regions with cooling in summer as the more important source of energy use, green roofs can play an increasingly important role in energy savings, at least as long as irrigation demands can be restrained(Lamnatou and Chemisana 2015).

The proposed method can be applied to any location in Germany. It is also possible to apply the method internationally, whena local building physics library exists or can be created, i.e., information on typical U-values of building envelope componentsin different construction years. Generally, city quarters are expected to show similar characteristics if they (i) share a similar share of flat roof buildings (ii) have buildings with similar building physics properties, (iii) have similar building geometries,and (iv) similar precipitation patterns.

6 CONCLUSION

This work established a workflow that quantifies the benefits of green roofs on building heating demand, rainfall run-off mitigation, and electricity yield of roof PV systems at the city quarter or regional level. The 3D building modelthat serves as the main input and the structured process ensure flexibility, i.e., from buildings in a pre-planning stage to existing buildings for retrofitting, scalability, i.e., from a single building to the whole region, and transferability, i.e., to any location in Germany or possibly globally.This work can thus support architects, urban planners,and city authorities in the decision-making process concerning the nexus between green roofs and PV systems and the development of technical master plans for urban planning.

7 ACKNOWLEDGEMENT

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Smart City Developments in Graz: Coming up against the Limits of Planning

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1 ABSTRACT

To deal with a significant increase in population in the last decade, the City of Graz has decided to activate its former industrial areas and develop new city quarters under a “smart city” paradigm, focusing on resource efficiency and quality of life.

There has been a wide array of critical issues identified in smart city developments around the world, amongst them the tendency to interpret urban issues and problems as technical problems, to frame them in technical terms and to offer technical solutions (Bauriedl and Strüver, 2019; McFarlane and Söderström, 2017; Söderström et al., 2014). In this paper, we acknowledge and seek to build upon this critical literature but want to expand on it by focusing on the challenges of dealing with smartness in planning policies, instruments and frameworks. Using qualitative content analysis, the research presented in this paper looks back at 10 years of project development and accompanying research, through which the city’s planning department has tried to reduce resource consumption and develop smart neighbourhoods with a high quality of life. While a narrowing scope of research can be observed, centering on the built object and the efficiency of its heating/cooling system, it becomes increasingly clear that the full potential of smartness comes up against limits that are to be found in the regulatory and planning system; thus, hindering increased resource efficiency on a structural level.

Through our analysis of local smart city research projects, five topics emerged that are considered relevant for a successful further development and practical implementation of the smart city concept, highlighting system boundaries as a central challenge. The integrative character of the smart city necessitates a changed spatial focus within the planning system (and its existing instruments) - entailing a needed shift from traditional decision making at the scale of the block to the entire neighborhoods and even city districts and their connection to resource circles of wider regions. This upends established legal procedures and responsibilities, established planning instruments and timeframes, as well as established protocols of data management among different disciplines. These issues have shown particularly influential for the successful organizational, structural and economic implementation of more resource efficient urban quarters in Graz.

Drawing on the concrete case of Graz, this paper highlights the challenges of planning for smartness and resource efficiency and discusses possibilities for improvement.

Keywords: Planning Instruments, System Thinking, Smart City, Smartness, Graz

2 GRAZ IN THE CONTEXT OF SMART CITIES

Graz is Austria’s second largest city with a population of roughly 300.000 inhabitants; growing rapidly with approximately 3000 inhabitants per year (Land Steiermark, 2020; Stadt Graz, 2019). Besides population growth and demographic changes manifesting in growing demands of resource consumption (energy, soil, material, infrastructure), and often leading to urban sprawl in the peripheries, Graz is facing pressing issues with regards to the climate emergency. Changing microclimates through urban heating, heat island effects, an increase in CO_2 emissions and ground sealing of areas due to demographic pressure, as well as its topographical location in a basin has led and will continue to lead to drastic temperature and wind speed increases over the course of the next decades (Lange, B., et al. 2010; Lazar and Sulzer, 2020; Stadt Graz, 2019; ZAMG, 2021)

Aiming for an integrative approach to tackle these concerns in its urban development strategies, the city of Graz has decided to activate its former industrial areas and develop new city quarters under a “smart city” paradigm, by focusing on resource efficiency and quality of life.

Since the start of Graz’ smart city initiative in 2010, the planning departments of the city of Graz have carried out numerous research projects. Addressing topics such as spatial-energy planning, smart building and climate technologies as well as material cycle concepts, led to a centering on the built object and the efficiency of its heating/cooling system, neglecting the necessity of the urban scale.

The research project presented in this paper (ECR 2020, funded by the Province of Styria and the planning departments of the City of Graz, and carried out by the Institute of Urbanism in cooperation with the Institute of Thermal Technology at Graz University of Technology) can be seen as a critical reflection of existing planning and regulation devices implemented within the development of the "Smart City Graz" with the aim of developing further integral measures for the implementation of sustainable urban development in the entire city of Graz.

3 GRAZ GOES SMART

As a rapidly growing city with limited building areas, Graz aims at densifying inner-city locations, and at the transformation of urban brownfields and former industrial areas.

The "Smart City Graz" - as referred to from the planning departments of the city of Graz - describes a former industrial and commercial area, situated at the western part of the city in close proximity to the main train station and to the city's centre. It is an area which has been in a state of upheaval for about 30 years and has been connotated and referred to as an industrial district with little quality of urban life.

The city of Graz is convinced that the transformation of those brownfields and former industrial areas into energy and resource-optimised urban developments - in the means of "smart city criterias" - offer solutions to the upcoming challenges faced by the city.

The planning departments of Graz and in particular the city planning directorate and its unit dedicated to smart city development, has established not only a definition of what the smart city development shall embody, but also a catalogue of criterias and objectives. Measures and indicators for the Smart City Graz have been defined for several fields of action, such as economy, society, ecology, mobility, energy as well as supply and disposal chains of the neighbourhoods in order to initiate the transformation of Graz to a climate neutral city (Stadtbaudirektion Graz b and Hoffer, 2018; Stadtbaudirektion Graz and Hoffer, 2012).

Lively urban neighbourhoods with a high quality of living space, attractive public spaces which offer diversity in programmes and uses, a neighbourhood of proximities and short distances, an increase in active mobility, efficient public transport systems, eco-efficient and recyclable materials, as well as an energy efficiency within the building are just few criteria to name (Stadtbaudirektion Graz a, 2018). Through their implementation a pioneering role in the field of integrated spatial, urban, transport and energy planning is envisioned, and the creation of synergies in the fields of energy, ecology, infrastructure, mobility, urban planning, and economy is desired (ibid.)

The implementation of these goals, however, is met with an (institutional) reality that separates different uses and levels, thus making the desirable diversity of these qualities impossible, mainly due to an aim of avoiding conflicts between economic profits and urban quality (Fellner et al., 2020).

Consequently, the laid out criterias and objectives for the development of a smart city do face a different reality, countering inhabitants' needs and advising actions with economic and technological as well as political interests (McFarlane and Söderström, 2017).

Additionally, the set-out criteria within the smart city framework catalogue (Stadtbaudirektion Graz and Hoffer, 2012), often imply the need for actions across a meta level, operating on the scale of the neighbourhood or a city's district. Actual measures, however, are often set on the level of a building plot and being hindered through limitations of planning and its existing instruments.

So instead of offering innovative approaches through technological innovations to implement the above mentioned, smart technologies seem to come to their limits if confronted with issues of planning and governance.

4 COMING UP AGAINST LIMITS OF SMARTNESS

Cities have to cope with complex and interdependent challenges such as the climate emergency, population growth, environmental problems, increasing resource consumption and processes of social change. Within the last decade the approach of facing these issues through the planning concept of a smart city has become a popular strategy and tool. Since the vision of a smart city kept promising sustainable economic growth, high quality of life and environment, and sustainable management of resources through investments in information and communication technologies, human and social capital, new demographic decision-making mechanisms, and future-oriented urban management, many cities started to implement its development (Sassen, 2014; Sennett, 2012).

For some, the smart city seems to be the realisation of a long-held desire for a fully integrated, efficient planning of urban spaces and supply systems based on digitalisation that permeates all structures and usage practices (Chambers and Elfrink, 2014). For others, it visualizes the nightmare of transparent citizens and digitalised surveillance in favour of neo-liberal control fantasies (Kropp, 2018).

In both cases, the concept of a "master plan" in order to control urban decision making through an engineering-technological rationality (Kropp, 2018; Sassen, 2011), which was thought to have been overcome, returns: It is imagined that technological data and its comprehensive collection and evaluation will now bring about the control on a meta level, that urban planning had failed to achieve so far and that had therefore been abandoned in theory and practice in favour of pragmatic decision-making (Sassen, 2014; Sennett, 2012). As Zhou et al. argue, in fact, however, the future of high-quality urban spaces will depend much more on strategic planning and governance as on technology (Zhou et al., 2018).

A problematic key feature of smart city developments is the tendency to interpret urban issues and problems as technical problems, to frame them in technical terms and to offer technical solutions (Bauriedl and Strüver, 2019; McFarlane and Söderström, 2017; Söderström et al., 2014). In this form of smart urbanism, social characteristics of urbanity and urban socialisation, as well as forthcoming and state of the art approaches to urban planning, which inspire to analyse planning assemblages beyond the scale of the local and the agency beyond the role of human actors and their interactions are lost from view (Bauriedl and Strüver, 2018; Latour, 2009). The need of understanding the social crisis occurring in our cities inherently connected to the climate crisis and the challenges the cities are facing seems to have taken on a secondary role, leaving technical solutions for one specific issue at the forefront (Latour, 2018; McFarlane and Söderström, 2017).

Even if projects are successful at the pilot stage, it can often be witnessed that once rolled out across the broader city, challenges - mainly with regards to adapting the organizational structure and requirements to the new system - occur (Fellner et al., 2020).

This proofes once more that technology can't be an immediate fix. Instead, an understanding on how technology can address social and ecological needs is of essential means (Latour, 2018, 2009). That is to say, an inclusive approach to urban planning is essential - one that integrates notions of technology to enable wider system thinking.

5 POLITICAL INTERFERENCES WITHIN PLANNING

Smart City concepts - depending upon the basis of a wider system thinking - see their limits in planning not only as in the above-mentioned paragraph within technological constraints, but merely also within planning instruments and their level of intervenency. Thus, it is essential to understand the political implications of planning instruments and processes and their spatial, social, and ecological effectuality (Fainstein & Fainstein, 1971). Political interferences in planning processes, structural differences within the organization of a city's apparatus, as well as the level where planning instruments can intervene, are decisive for wider system thinking and inherently for smart city concept implementations (Fellner et al., 2020). Understanding these relationships reveals the range of political influence upon the role of planning and its objectives and ultimately at which level of the political-administrative system the responsibility for an area of action is located and the consequences for spatial development (Schindegger, 1999).

In the case of Austria this is visible within spatial policies and their implication levels. As in the sense of a federal state structure, the Austrian counties possess a high degree of autonomy and are responsible for spatial planning. However, the planning competence is not matched by much enforcement power, as actual zoning is carried out by the municipalities (ibid.). Contrary to Switzerland and Germany who have spatial - and often also building policies regulated on a national, supra-regional and regional scale; Austria and in particular Styria leaves zoning and primarily building policy implementations at the municipal level – leading often to politically biased and short-visioned decisions (see Fig.1) (Lang, 2003; Stadt Wien, 2018; ARE, 2021; Stadt Graz, 2020). However, the city of Graz seems to take on a particular role within this

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paradoxon. While urban planning policies – compared to Switzerland (ARE, 2021) or Germany (BBSR, 2021) - are often regulated within zoning plans or regional policies, Graz seems to lack certain planning devices within this meta-level.

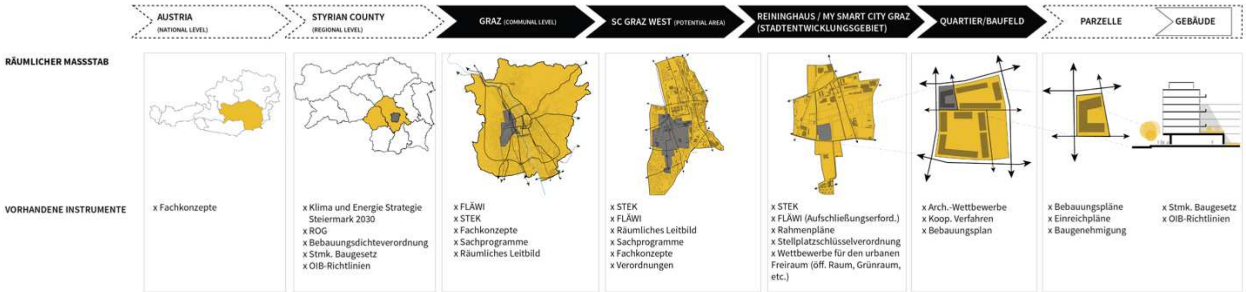

Fig. 1: Spatial matrix of planning instruments and levels in Austria

Particularly, decisions which need to be taken on the level of an urban quarter are currently either regulated within the building plan – or sheer not existent (Gruber et al., 2018). Contrary to other cities (Stadt Wien, 2018; Stadt Zürich, 2021; Freie Hansestadt Hamburg, 2020) Graz additionally finds itself in a standalone position, as all planning departements are mandated not through a city's senates member as usually systematized within cities of such size, but rather through the mayor and its deputy (see Fig.2) (Stadt Graz, 2020; Land Steiermark, 2021).

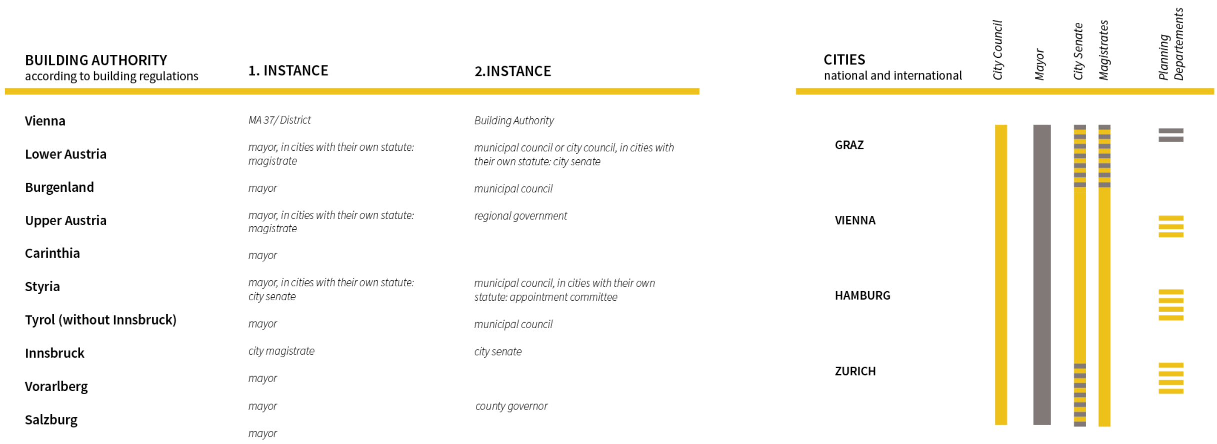

Fig. 2: Building authorities within Austria's countys and political interconnectivity of planning departements, city senates and mayors, grey colour indicating mayors' areas of responsibility (Stadt Zürich, 2021; Freie Hansestadt Hamburg, 2020; Stadt Wien, 2018; Stadt Graz, 2020).

6 PROJECT DESCRIPTION

The research project ECR Smart City 2020 (05/2018 – 12/2021) is based on the results of previous research projects in the Smart City Graz context. It is carried out by the Institute of Urbanism in cooperation with the Institute of Thermal Technology at Graz University of Technology and funded by the Province of Styria and the planning departments of the City of Graz.

Offering a critical reflection of existing planning and regulation devices at the Smart City Graz, the aim is the further development of integral measures for a sustainable future development of the City of Graz. The undertaken research of the Institute for Urbanism consists of two main parts. On the one hand the evaluation of past research in order to improve further planning measures is placed in focus and on the other hand the modelling of scenarios for a future urban transformation towards resource efficiency and climate neutrality is undertaken.

6.1 Methodological considerations

This paper presents parts of this much wider, aforementioned research project, dealing with the evaluation and contextualisation of past Smart City research in Graz. After a pre-selection, 18 local smart city projects were selected and analysed in order to derive recommendations for further actions. For that end, final reports were analysed through the means of qualitative content analysis, supported through the analysis software MaxQDA (Mayring and Brunner, 2009).

The selected projects were examined in depth with regards to topics such as structural similarities, forthcoming solutions and issues, timeframes and implementation processes, stakeholders, content correlations, main topics and primary targets of the research. Measures and recommendations for actions were established upon findings of the undertaken qualitative analysis and good practice examples.

6.2 Findings

Overall a narrowing scope of research can be observed, manifesting in a centering on the built object and the efficiency of its heating/cooling system. While this brings about technological innovation, it becomes increasingly clear that the full potential of smartness comes up against limits that are to be found in the regulatory and planning system; thus, hindering increased resource efficiency on a structural level.

This becomes imminent through the analysis of the main targets of the research projects. While most of the analysed projects deal with energy efficiency in buildings, use of waste heat and questions of energy efficiency zoning - mainly focusing on technological innovations on an object or plot scale, only three of the analysed projects touch upon social, ecological or qualitative spatial concerns. Considering that the creation of energy efficient districts - which should inherently take the design of its non-built environment into consideration - was just one of the many aims set out for the Smart City Graz, it seems that the holistic objectives of the smart city criteria are not reflected.

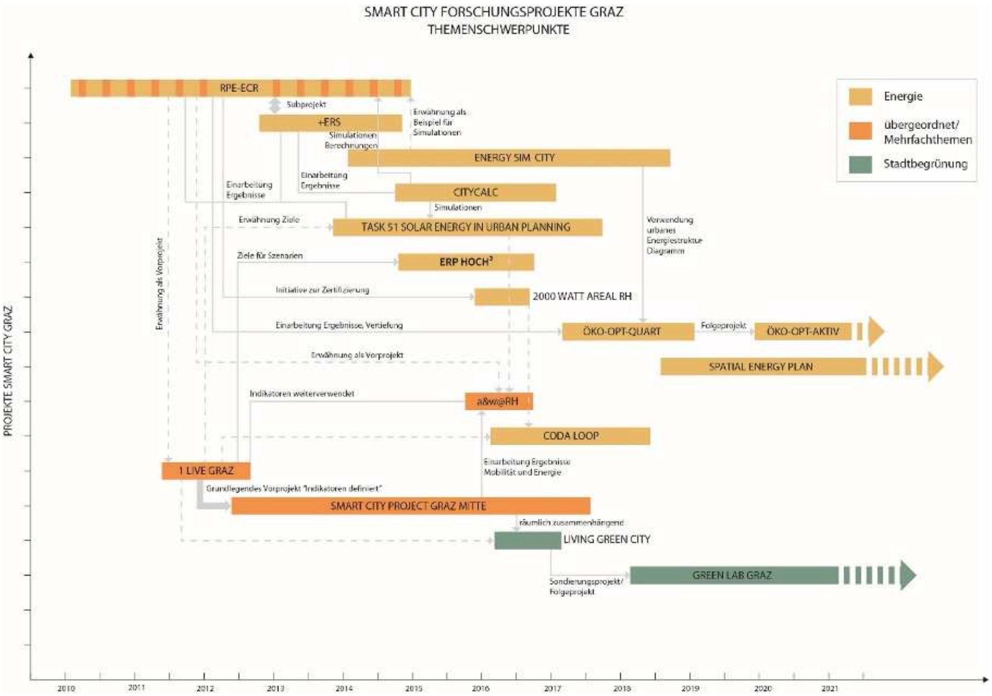

Fig. 3: Pert chart diagram depicting main focal points of analysed research project. A clear lean towards energy as a central research topic is visible.

Moreover, five overarching themes of challenges emerged. The acquisition of data, the monitoring and evaluation of those, the establishment of mobility concepts, mixed-use as well as system boundaries. It became apparent that the latter seems to be of central concern, overarching and determining the successful solutions of the other challenges.

While for example structured data management and acquisition is particularly necessary for the successful organisational, constructional as well as economic implementation of solution approaches for an energy and mobility optimisation of urban districts, limits mainly occured in connection with a lack of system thinking. The evaluation and monitoring of this hitherto (often not) acquired data represent a central way of probing solutions adopted so far. Not only is the discovered lack of these measures critical for the ongoing; but also for future smart city developments and strategies for the city as a whole. At the same time the need of mobility concepts and the implementation of a mix of uses within the urban districts long for concepts which consider a wider system; rather than the existing concepts which consider, if even, just the direct neighbourhoods.

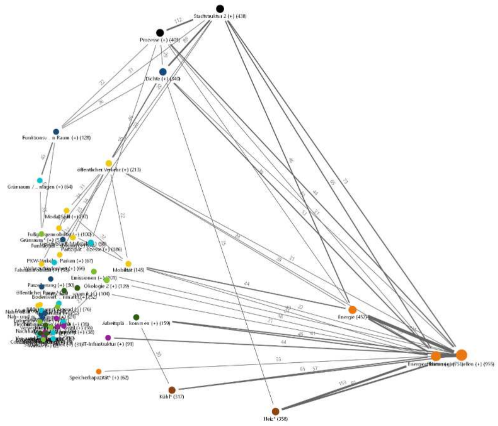

Fig. 4: Visualisation of qualitative content analysis through MaxQDA software. While topics linked to energy are considered and discussed within research projects mostly, smart city concept criterias are sparsely noted.

6.2.1 Data acquisition

Most of the analysed projects display issues with data collection especially at the scale of urban planning, needed in order to make recommendations or take actions. Predominantly these are either not recorded in a standardised way or only accessible with difficulty or for fees. Due to individual solutions and applications for single plots, data is often not compatible with one another. Additionally, databases are often not integrated into the cities geo-reference system. Consequently, the data is often useless for a distillation of measures and actions. This brings up front that systematic, standardised, interdisciplinary data collection (e.g. energy data, mobility, climate data, urban geographic data, zoning, vacancies, brownfields) and central administration are essential for real "smart" services, in order to research, monitor and later optimise methods and approaches.

6.2.2 Monitoring and evaluation

The current stage of the development of the Smart City Graz would essentially profit from feedback loops of already implemented systems. However, monitoring and especially the essential evaluation is often absent, mainly through a non-existence of data. Besides the importance of feedback loops within the Smart City Graz development, monitoring and evaluation processes seem extremely important for an international applicability for Smart City developments, considering that long-term evaluation and publications of findings are still of scarcity (Fellner et al., 2020). In general, an overall tendency of loose ends and unanswered questions was noticeable across all analysed projects. New urban development agreements and urban planning processes were implemented, but a monitoring or an evaluation if intended goals were achieved never occurred. Same holds true for the evaluation of spatial and economic qualities, as well as the monitoring of implemented projects according to mobility or energy measures. For most research projects, no statements could be made regarding the success of the desired effects due to discontinued or non-existent evaluation.

6.2.3 Mobility

While smart transport technologies would have the potential to offer solutions for old governance and planning problems, such as the avoidance of traffic jams and other infrastructure bottlenecks, the establishment of a transparent administration and, in general, a resource-efficient, fully plannable and demand-oriented management of public services and large-scale projects for a wide range of uses in urban development (Bauriedl and Strüver, 2019, 2018), the undertaken analysis clearly showed that this is not the case in the smart city development of Graz so far.

Although mobility has often been mentioned in conjunction with implementation processes of spatial-energy planning in the analysed project reports, so far, no mobility-focused research projects have been undertaken nor an evaluation of existing efforts. Whilst cooperations between urban development and transport planning is demanded in contracts and most of the measures and criterias are set up in coordination with the surroundings of the entire urban area, the implementation mostly fails due to non-existent policies and planning instruments which regulate the interests of stakeholders and the public.

6.2.4 Mixed use

One of the main aims of the city's vision for the development of the Smart City Graz is the implementation of concepts for a city of short distances (Moreno, 2020; Stadtbaudirektion Graz and Hoffer, 2012). This positions the concept of mixed use not only as a central element with regards to the aims for the development of the smart city, but also functions inherently as a dependency factor for reducing CO2 emission via primary energy-saving networks and soft mobility concepts.

However, within the built urban quarters of the smart city, it is evident that the envisioned mix of uses layed out in the development criterias and framework plan has only been implemented to a limited extent, entailing the loss of urbanity and vitality of open space (Jacobs, 2011). Corporate interests and economic profits of private developers lead to monofunctional uses on the ground floor level, as seen in several implemented developments (Dumke et al., 2017). Similarities in structural challenges can be seen with the topic of mobility and therefore necessitates concepts where the city, as well as a third party can cooperate as strategic partners in order to overcome monopolitcal interests.

6.2.5 System boundaries as overarching theme

The integrative character of the Smart City confronts us with completely new challenges. It is no longer the traditional individual building on a plot that has to be considered but rather entire neighbourhoods up to city districts. This leads to major challenges at many levels, which were previously oriented towards the scale of the parcel / property and retrospectively to their owners. The importance of a paradigm shift within the meta level is essential to overcome the predominant limits and establish a system of thinking dedicated to symbiotic connections.

Although dense urban settlements are predestined for systemic energy solutions, concepts must be thought beyond system boundaries in order to contribute to a significant increase in the efficiency of society as a whole. However, this can only succeed if smart cities also develop correspondingly smart business models (Rainer et al., 2014). Especially since balancing the interests of all actors in the energy system seems to be very complex. Central to this is the creation of a clear regulation of responsibility and risk compensation. Here, the importance of a legal basis must be emphasised once again.

Besides, it is important to note that newly interdisciplinary technical planning and simulation tools for energy, mobility, supply and data networks (Moser et al., 2020; Staller et al., 2018), often only operate at the level of implementation planning, and dismiss the importance of urban planning phases. Here, the development of new, integrative models for energy planning at neighbourhood and urban districts, but even on a regional level would also be necessary (Dumke et al., 2017), since decisions made on a building plot level are also space effective on a regional scale and vice versa. Exemplary therefore is the cross-energy hybrid grid integration, which requires diverse conversion technologies and storage solutions that need to be embedded in urban living spaces.

As seen in various smart city related projects undertaken in Graz, current legal frameworks are limiting the successful implementation of networks and alliances with regards to energy and resource consumption as well as production due to the predominant focus on an individual building plot (Stadtbaudirektion Graz b and Hoffer, 2018) This resulted for example in the discarding of a sustainable spatial energy and power supply concept developed for a neighbourhood in the Smart City Graz, which would have offered 100% locally produced energy consumption (ibd., 2018). Consequenting on this, spatial energy and resource planning across neighbourhoods require a format of inter-municipal associations and legal frameworks by addressing contracts of economically monopolistic agents such as in this case the power supplier. In general, policy needs to be a prime part at the meta level, deviating from silo thinking towards crossdisciplinary approaches.

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Only if a legal basis is developed, a “smart” integration of new economically and resource efficient smart city models is possible. Exemplary therefore are collectively operating networks or the often-proposed new economic evaluation models (Greencity Zürich, 2020).

Moreover, requirements of new systematized and holistic, as well as interdisciplinary planning processes with regards to societal, ecological, sustainable and resource related as well as spatial aims for the vision of a neighbourhood / district are needed. Not only can these planning processes be an actant for ensuring the above mentioned aimed qualities; but especially with regards to new complexities stemming from an interdisciplinary approach, the currently often enormous time resources required for decision-making processes can be eased. The oblivion of such processes in Graz can currently be observed in numerous spatial and resource related errors.

7 CONCLUSION

Through our analysis, the above discussed topics emerged and were considered essential for a successful further development and practical implementation of the smart city concept. As illustrated, the central challenge among these is that of systems thinking. Overcoming system boundaries seems to be the pivoting point for reaching set aims. The integrative character of the smart city necessitates a changed spatial focus within the planning system (and its existing instruments). Where traditionally decisions were taken at the scale of the block or the individual parcel of land, now entire neighborhoods and even city districts and their connection to resource circles have to be considered, transgressing boundaries of ownership, competencies and responsibilities. Instead of offering an immediate fix, technological innovation is often used as an evading mechanism in order to cover up structural issues of planning and governance (Marvin et al., 2016; Shelton and Lodato, 2019). This can be clearly illustrated within the development of the Smart City Graz.

Although clear legal responsibilities at the scale of urban quarters, development axes or even regions exist (spatial planning laws or building regulations at the federal state level), essential cooperation processes for developments on this scale are not standardised and even less institutionalised. Despite the establishment of binding law- agreements with landowners, the anchoring of aims according to sustainability, ecology, energy efficiency and reduction of MIV in the zoning plan in order to allow mixed uses, soft mobility, and sufficient open spaces was pushed, the actual implementation of a neighbourhood wide energy or mobility concept in the smart city development in Graz partially failed.

Meanwhile, innovative and smart use of planning processes and instruments such as an anchoring of a cooperative development and planning structure through development agreements between landowners, stakeholders and actors of the city in the zoning plan, gave way for the successful implementation of district wide implementations of energy concepts in the Green City Zurich (Greencity Zürich, 2020). A similar approach to planning instruments was applied at the Kalkbreite in Zurich. Economic networking and lifespan models for investors and property owners were established at the level of the neighbourhood, offering legal certainty and planning security, as well as insuring fulfillment of important aspects of urban planning (such as mixed use on the ground floor level, mobility concepts, qualitative open green spaces) (Genossenschaft Kalkbreite, 2019, 2014).

As most of the measures need to be implemented in coordination with the surroundings of the entire urban area - rather than an isolated consideration of a neighbourhood - cooperations between private and public actors are often concluded through the aforementioned urban development agreements. However, Germany and in particular the city of Hamburg uses urban development measures set out in zoning plans as a tool to influence and guide developments from an early competition stage onwards, up to building phases (Freie Hansestadt Hamburg, 2013). Mobility as well as energy concepts and their implementation in the resource efficient district Neue Mitte Altona profited from the set out urban development measures, as economical interests and challenges of system boundaries were evaded (Freie und Hansestadt Hamburg, 2012). Besides, it offers possibilities to rethink and implement transit-oriented development on an urban scale. The establishment of mobility funds on the level of an urban quarter through a third party, as implemented in the Seestadt Aspern[1], is an additional approach to push agreements and cooperations between individual developers (Hinterkörner et al., 2015).

[1] “The business model of the Mobility Fund is based on the use of levies in connection with revenues from motorised private transport to support sustainable mobility. In concrete terms, the fund is fed by the levying of charges on the

The analysis showed that other than system boundaries as an overarching theme, mixed use seems to be a prerequisite for fulfilling smart city aims. Furthermore, the reaching of CO2 emission goals, energy efficiency as well as urban spatial quality results from a diverse mix of functions (Dumke et al., 2017; Stadtbaudirektion Graz and Hoffer, 2012). In order to increase mixed use, to establish a certain quality to ground floor zones and consequently dismiss speculative usage through private developers, a special-purpose entity was founded throughout the development process in Seestadt Aspern (Hinterkörner et al., 2015).

Other challenges seemed to be of the acquisition of data, the monitoring and their evaluation. A central way of probing adopted solutions so far is the action of monitoring and evaluating the development in all stages. However, a successful evaluation and monitoring is dependent on the completeness and accuracy of the previously obtained data. Especially in the field of energy planning, early feedback loops could have counteracted shortcomings of implemented solutions. The need for an interdisciplinary data platform for the increasing flood of data from ever new sensors and end devices is once more highlighted within the outcomes of the analysis. The establishment of a Smart City data platform Graz at the Digital Agenda Graz[2] would be the aim - a district-specific data platform in the smart city district that can be expanded and subsequently used as a smart city platform for the whole of Graz.

In order to facilitate this, the establishment of a Smart City Graz innovation team would be fruitful, following the example of Salzburg (SIR) and Vienna (TINA Vienna) (SIR and Land Salzburg, 2021; Wien Holding, 2021). The aim would be to monitor the energy performance of urban developments, as well as the sustainable programming of the architectural competitions, the continuation of the international exchange of experience and the transfer of the findings to other Smart City developments in Graz.

Overall, a shift towards system thinking is central to the Smart City development process. This calls for targeted cooperation between the city administration, the province of Styria, research, investors and leading companies, inherently also aiming for a restructuring of current planning instruments, to bridge the gap between the individual plot and a city’s wider fabric.

Long-term systemic thinking and planning are imperative in order to avoid temporary paths such as shortcuts by means of supposedly cheaper and quicker solutions.

Technological data and its comprehensive collection and evaluation will only be able to offer support on a meta level, if urban planning doesn’t dismiss the importance of strategic planning and governance, through necessitating adaptations in planning instruments and processes.

Moreover, an understanding on how technology can address social and ecological needs is of essential means (Latour, 2009) implying that only if urban planning offers a comprehensive approach, the incorporated technology can facilitate broader solutions and system thinking to meet the upcoming challenges.

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construction of garages (a one-time charge of 1,000 euros per garage space) and their operation (2% of the garage rental income, after the 6th year of use)” (Hinterkörner et al., 2015).

[2] The „Digital Agenda Graz“ forms a platform established through Graz Holding to implement and discuss the digital transformation of the city through evaluating, testing and monitoring of research visions and guidelines (ITG Informationstechnik Graz GmbH, 2021).

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Smarte Lösungen statt „Lockdown“? Der „Tübinger Weg“ in der Corona-Pandemiebekämpfung auf dem Prüfstand

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1 ABSTRACT

Die baden-württembergische Universitätsstadt Tübingen verfolgte in der „zweiten Welle“ der Corona-Pandemie ein eigenes Interventionsprogramm („Tübinger Weg“), das insbesondere auf den Schutz von Risikogruppen (u. a. Corona-Tests in Alten-/Pflegeheimen, Ausgabe von FFP2-Masken) sowie auf freiwillige Verhaltensänderungen (u.a. niedrigschwellige Testangebote, Einkaufszeiten für Ältere) setzte. Vor diesem Hintergrund wurde geprüft, ob dieses Maßnahmenpaket messbare Erfolge im Hinblick auf den Verlauf der Pandemie in der Herbst- und Wintersaison 2020/2021 gezeigt hat. Hierzu wurde eine vergleichende statistische Analyse des Landkreises Tübingen mit dessen fünf Nachbarkreisen vorgenommen, da in diesen grundsätzlich ein ähnlicher zeitlicher Verlauf der Infektionen sowie identische allgemeine „Lockdown“-Maßnahmen bestanden. Der untersuchte Zeitraum umfasst sechs Monate (01.09.2020-28.02.2021). Als Indikatoren fungieren allgemeine und altersspezifische Inzidenzen, tödliche Infektionen, effektive Reproduktionszahlen und die Auslastung der Intensivstationen. Als „Stichtag“ zum Vergleich der Entwicklung wurde der 02.11.2020 verwendet, da hier bundesweit der sog. „Lockdown light“ begann und zugleich der „Tübinger Appell“ veröffentlicht und vor Ort mit einer Reihe von Maßnahmen begonnen wurde. Tatsächlich zeigt sich, dass der Kreis Tübingen bei zunächst gleichen oder sogar ungünstigeren Ausgangsbedingungen bei den meisten Indikatoren signifikant bessere Ausprägungen zeigt als die Nachbarregionen. Dies betrifft vor allem eine deutlich geringere Dichte an tödlichen Infektionen, aber auch geringere Inzidenzwerte bei Risikogruppen. Zumindest aus dem Blickwinkel dieser statistischen Analyse lässt dies den Schluss zu, dass die Maßnahmen des „Tübinger Wegs“ wirkungsvoll waren. Es lässt sich jedoch nicht kausal nachweisen, auf welche der einzelnen getroffenen Maßnahmen dies zurückzuführen ist.

Keywords: Lockdown, Nichtpharmazeutische Interventionen, Pandemie, Corona, Risikogruppenschutz

2 HINTERGRUND

Seit Januar 2020 ist Europa von der Verbreitung des neuartigen Coronavirus (SARS-CoV-2) bzw. der dadurch in manchen Fällen ausgelösten Lungenerkrankung COVID-19 betroffen. Die meisten Staaten reagierten darauf mit „Lockdowns“, die u.a. Grundrechtseinschränkungen (z.B. Kontaktbeschränkungen, Ausgangssperren), die Schließung von Einrichtungen (z.B. Einzelhandel, Freizeiteinrichtungen, Schulen) und das Verbot von Veranstaltungen umfassen, um so Kontakte zwischen Menschen zu reduzieren. Während kein Zweifel daran besteht, dass die Reduzierung (naher) physischer Kontakte prinzipiell auch Infektionen senkt, ist die Effektivität einzelner Maßnahmen – der sog. *nichtpharmazeutischen Interventionen* (*NPI*) – nicht eindeutig geklärt, was sich an sehr unterschiedlichen Ergebnissen in international angelegten Studien (z.B. Chaudhry et al., 2020; Flaxman et al., 2020; Sharma et al., 2021) und Studien zu einzelnen Ländern (z.B. Baier et al., 2020; Berlemann/Haustein, 2020; Bourdin et al., 2021; Dehning et al., 2020; Donsimoni et al., 2020; Gibson, 2020; Kosfeld et al., 2021; Santamaría/Hortal, 2020; Küchenhoff et al., 2021; Wieland, 2020a; 2020b; Wood, 2021) zeigt. Viele empirische Studien, die auf Zeitreihenanalyse basieren bzw. Infektionskurven auf Brüche untersuchen, finden Rückgänge an Infektionen, die mit der Einsetzung von Maßnahmen koinzidieren, jedoch keinen zusätzlichen Effekt besonders strikter Maßnahmen (z.B. Berlemann/Haustein, 2020; Santamaría/Hortal, 2020; Küchenhoff et al., 2021; Wieland, 2020a, 2020b). Weiterhin gibt es für schwere bzw. potenziell tödlich verlaufende COVID-19-Erkrankungen recht klar definierte Risikogruppen; z.B. gilt in Deutschland eine Person ab 65 Jahren per Definition zur „Risikogruppe“ (Rommel et al., 2021). Mehrere empirische Studien zeigen jedoch, dass zumindest COVID-19-Todesfälle und schwere Krankheitsverläufe durch besonders einschneidende Maßnahmen (z.B. Ausgangssperren) nicht signifikant beeinflusst werden (z.B. Chaudhry et al., 2020; Sharma et al., 2021).

Der erste deutsche „Lockdown“ bestand im Frühjahr 2020, wobei schrittweise Öffnungen bis zum Sommer hin erfolgten. In der „zweiten Welle“ (Herbst/Winter 2020/2021) begann ein neuer „Lockdown“ mit der als „Teil-Shutdown“ (bzw. „Lockdown light“) bezeichneten Schließung von Gastronomiebetrieben, Bars und Freizeiteinrichtungen, die bundesweit ab 02.11.2021 in Kraft trat. Ab dem 16.12.2020 folgte ein bundesweit

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abgestimmter vollständiger „Lockdown“, der die Schließung von Schulen sowie der meisten Einzelhandels- und Dienstleistungsbetriebe beinhaltete. Weiterhin wurden bundeslandspezifisch Kontaktbeschränkungen verschärft (z.B. Treffen von nur zwei Haushalten ab Anfang Dezember 2020). Zudem führten mehrere Länder (u.a. Bayern, Sachsen, Thüringen) parallel zur Schließung der Handels- und Dienstleistungsbetriebe erstmals eine landesweite „nächtliche“ Ausgangssperre ein; das Land Baden-Württemberg installierte diese bereits vor dem bundesweiten „Lockdown“ (12.12.2020), während andere Bundesländer komplett darauf verzichteten bzw. den jeweiligen Landkreisen die Entscheidung zu ihrer Umsetzung überließen.

Die o.g. Studien zur Effektivität von Maßnahmen beziehen sich auf das Frühjahr 2020. Zur Wintersaison in Deutschland fehlt bisher eine systematische Evaluation der NPI im o.g. Sinne. Bisherige Analysen haben allerdings gezeigt, dass eine Stabilisierung der Infektionszahlen bereits vor dem „Lockdown light“ einsetzte (Küchenhoff et al., 2020) und dass sich die o.g. Maßnahmenpakete nicht unmittelbar in der effektiven Reproduktionszahl der Corona-Infektionen niedergeschlagen haben (Hoyer et al., 2021). Auch der Effekt von Ausgangssperren wurde für hessische Landkreise untersucht, wobei kein signifikanter Einfluss auf das Infektionsgeschehen ermittelt werden konnte (de Haas et al., 2021). Die mit vielen Maßnahmen verbundenen „Kollateralschäden“ (z.B. Betriebsaufgaben, psychosoziale Folgen) sind aber im Wesentlichen unumstritten (Miles et al., 2021). Daher erscheint es geboten, alternative oder zumindest ergänzende Maßnahmen zu diskutieren, die – wie zu Beginn der Pandemie unter dem Aufruf „Flatten the curve!“ proklamiert – darauf abzielen, eine Überlastung der Kapazitäten des Gesundheitssystems sowie Todesfälle zu verhindern.

Im Herbst/Winter 2020 begann in Deutschland eine Diskussion zum sog. „Tübinger Weg“ (auch: „Tübinger Modell“) der Pandemiebekämpfung, was sich auf eigene, ergänzende Schutzmaßnahmen in der baden-württembergischen Universitätsstadt Tübingen (rd. 91.000 Einwohner) und zum Teil im umgebenden Landkreis Tübingen bezieht. Der „Tübinger Weg“ ist jedoch nicht von Anfang an ein einheitlich konzipiertes Maßnahmenpaket gewesen, sondern beruht auf *zunächst* individuellen Interventionen, die auf einzelne Akteure zurückgehen, vor allem auf den Tübinger Oberbürgermeister Boris Palmer und die Tübinger DRK-Präsidentin Lisa Federle, deren Kooperation im Zuge der sich aufbauenden „zweiten Welle“ intensiviert wurde. Am 01.11.2020 erschien in diesem Zusammenhang der sog. „Tübinger Appell“, der einerseits die getroffenen Maßnahmen zusammenfasste und andererseits auf deren Inanspruchnahme sowie eigenverantwortliches Handeln im Zuge der Pandemie hinwies; neben der Stadt Tübingen und dem DRK waren das Universitätsklinikum Tübingen und der Kreis- und Stadtseniorenrat Unterzeichner des Aufrufs (Universitätsstadt Tübingen, 2020). Die Maßnahmen – von denen einige später in ganz Deutschland installiert wurden – umfassten folgende Punkte (Auskunft OB Palmer, 2021; Deutsche Welle, 2020; Südkurier, 2020; Universitätsstadt Tübingen, 2020):

Corona-Schnelltests in Alten-/Pflegeheimen für Beschäftigte (seit September 2020) und Besucher (seit Oktober 2020); zunächst nur Stadt Tübingen, schrittweise auch in Heimen im Kreis Tübingen

(Wieder-)Eröffnung der PCR-Teststation auf dem Tübinger Festplatz (ab 17.08.2020) und Eröffnung eines Schnelltestzentrums für kostenlose Schnelltests (ab 26.11.2020); nur Stadt Tübingen

Kostenloser Versand von FFP2-Masken an alle Personen ab 65 Jahren (ab 02.11.2020); nur Stadt Tübingen

Anrufsammeltaxis zum gängigen ÖPNV-Tarif für alle Personen ab 60 Jahren; nur Stadt Tübingen

Appell zur Freihaltung bestimmter Zeitfenster beim Einkauf für ältere Personen

Im vorliegenden Fall wurde geprüft, ob die o.g. NPI („Tübinger Weg“) im Herbst/Winter 2020/2021 einen signifikanten Beitrag zur Reduktion von Infektionen – vor allem in Risikogruppen bzw. hinsichtlich tödlicher Infektionen und schwerer Krankheitsverläufe – beigetragen hat. Der gewählte Ansatz ist regional und orientiert sich an Studien zur Analyse von räumlich differenzierten Infektionsverläufen über die Zeit (z.B. Kosfeld et al., 2021; Wieland, 2020a) sowie an einer Arbeit zum Effekt einer singulären regional eingeführten NPI, der „Jenaer Maskenstudie“ (Mitze et al., 2020). Hierbei wurde das Infektionsgeschehen im Landkreis Tübingen – was die kleinste mögliche Raumeinheit darstellt, für die vollständige Daten vorliegen – mit dem in einer „Kontrollgruppe“ verglichen. Als Vergleichsmaßstab wurden jedoch keine zufällig oder nach bestimmten Homogenitätskriterien ausgewählte Landkreise verwendet, sondern die fünf Nachbarkreise (Böblingen, Calw, Freudenstadt, Reutlingen, Zollernalbkreis). Hintergrund dessen ist einerseits, dass das Infektionsgeschehen räumlich autokorreliert ist, d.h. statistisch signifikante Ähnlichkeiten z.B. hinsichtlich Inzidenz und Mortalität zwischen benachbarten Regionen bestehen, was bezüglich der „ersten Welle“ für deutsche Landkreise gezeigt werden konnte (Wieland, 2020a). Andererseits gehören die sechs Kreise zum selben Bundesland (Baden-Württemberg), weshalb dort – von den Maßnahmen des „Tübinger Wegs“ abgesehen – gleiche Ausprägungen sonstiger NPI bestanden. Weiterhin war der Anspruch, mehrere Indikatoren zu verwenden, da epidemiologische Maßzahlen – auch in Anbetracht unentdeckter Infektionen („Dunkelziffer“) – unterschiedlich große Aussagekraft besitzen (Brinks et al., 2020; Wieland, 2020b).

3 DATENGRUNDLAGE UND METHODIK

Um Einflüsse von NPI auf das Infektionsgeschehen identifizieren zu können, ist es notwendig, den Verlauf der Infektionen in Echtzeit nachzuvollziehen. Hierbei ist demnach nicht das Meldedatum der SARS-CoV-2/ COVID-19-Fälle, sondern deren Infektionsdatum – d.h. der Tag, an dem die jeweilige Infektion stattfand – entscheidend. Dieses Datum ist aber i.d.R. unbekannt bzw. wird in den offiziellen Fallstatistiken nicht dokumentiert, so dass es anhand der vorliegenden Daten geschätzt werden muss (Küchenhoff et al., 2021; Wieland, 2020a; 2020b; Wood 2021). Der hier zu Grunde gelegte Datensatz beinhaltet die täglichen Infektions-Fallmeldungen in Deutschland beim Robert-Koch-Institut (RKI, 2021a). Jede Meldung umfasst mindestens eine beim jeweiligen Gesundheitsamt als mit SARS-CoV-2 infiziert (d.h. positiver PCR-Test) gemeldete Person sowie u.a. Angaben zu Altersgruppe, Geschlecht und Wohnort (Landkreis). Außerdem ist erfasst, ob ein SARS-CoV-2/COVID-19-Todesfall vorliegt (was in diesen Fällen nachgemeldet wird). Zudem enthält der Datensatz das *Meldedatum* (Tag der Meldung des Falls beim örtlichen Gesundheitsamt) sowie, für einem Teil der Fallmeldungen, auch den *Erkrankungsbeginn*, d.h. das Datum, an dem die ersten Erkrankungssymptome begannen (Erläuterung siehe an der Heiden/Hamouda, 2020; Datensatzbeschreibung siehe RKI, 2021b). Der hier verwendete Datensatz (Stand: 18.05.2021) enthält 3.602.668 SARS-CoV-2-Fälle und 86.379 zugehörige Todesfälle. Für 1.887.836 Fälle (52,4 %) ist ein Erkrankungsbeginn bekannt.

Um auf dieser Grundlage das Infektionsdatum zu schätzen, wird analog zu Wieland (2020b) vorgegangen: Der erste Teil der Zeitspanne zwischen Infektion der betroffenen Person und deren Fallmeldung ans Gesundheitsamt ist die Zeit zwischen Infektion und Erkrankungsbeginn, d.h. die *Inkubationszeit*. Für jeden Infektionsfall i, bei dem das Datum des Symptombeginns, DO_i, bekannt ist, wird vom Erkrankungsbeginn die Inkubationszeit, IP, subtrahiert, um das ungefähre Infektionsdatum, DI_i, zu erhalten: $DI_i = DO_i - IP$. Hierbei wird, unter Rückgriff auf die epidemiologische Fachliteratur, eine mittlere Inkubationszeit von $IP = 5$ (Tagen) angenommen (Backer et al., 2020; Linton et al., 2020). Für die 1.714.832 Fälle, in denen kein Erkrankungsbeginn bekannt ist, wird der zweite Teil der Zeitspanne zwischen Infektion und Fallmeldung berücksichtigt, nämlich die Zeit zwischen Erkrankungsbeginn und Meldung, d.h. der *Meldeverzug*. Dieser lässt sich aus den Fallmeldungen, bei denen sowohl das Meldedatum als auch der Symptombeginn vorliegen (1.887.836 Fälle), empirisch ermitteln. Der Meldeverzug für Fallmeldung i lässt sich nicht sinnvoll mit einem Lageparameter annähern, da eine große und, was wichtiger ist, systematische Streuung vorliegt. Im Folgenden wird daher berücksichtigt, dass der Meldeverzug von Fallmeldung i, $RD_{i,agcwt}$, von der Altersgruppe a, dem Geschlecht g, dem Landkreis c und dem Wochentag w sowie der Zeit t abhängt. Anhand der Fälle mit bekanntem Erkrankungsdatum wurde folgendes Dummy-Regressionsmodell geschätzt:

$$RD_{i,agcwt} = \alpha + \sum_{a}^{A-1} \beta_a D_{agegroup_a} + \sum_{g}^{G-1} \gamma_g D_{gender_g} + \sum_{c}^{C-1} \delta_c D_{county_c} + \sum_{w}^{W-1} \zeta_w D_{weekday_w} + \varphi\, t + \varepsilon_{i,agcwt}$$

wobei α, β_a, γ_g, δ_c, ζ_w und φ die zu schätzenden Regressionsparameter sind und $\varepsilon_{i,agcwt}$ der stochastische Störterm (bzw. Residuum) ist. Mit Hilfe dieses Modells wurde der Meldeverzug für die Fallmeldungen, bei denen kein Erkrankungsbeginn bekannt ist, interpoliert, und so der Erkrankungsbeginn geschätzt. Bei diesen Fällen ergibt sich das ungefähre Infektionsdatum, DI_i, aus dem Meldedatum des Falls, DR_i, dem geschätzten Meldeverzug und der Inkubationszeit: $DI_i = DR_i - RD_{i,agcwt} - IP$.

Aus den Infektionsdaten wurden im nächsten Schritt alle Infektionen extrahiert, die – ausgehend vom geschätzten Infektionsdatum (s.o.) – im Untersuchungszeitraum („Zweite Welle“; 01.09.2020-28.02.2021) stattfanden. Nach diesem ersten Extraktionsschritt wurde ein Sub-Datensatz für das Untersuchungsgebiet (6 LK: Böblingen, Calw, Freudenstadt, Reutlingen, Tübingen, Zollernalbkreis) erstellt. Die Infektionsfälle wurden nun anhand des Infektionsdatums und nach Landkreisen aufsummiert. Für die Ermittlung der tödlichen Infektionen wurde analog verfahren, wobei nur die Infektionen berücksichtigt wurden, die als Todesfall gekennzeichnet sind. Um Infektionen der (altersbedingten) Risikogruppen abzubilden, wurden zudem landkreisspezifische Infektionszeitreihen nach Altersgruppen berechnet.

Im vorliegenden Fall wurden *7-Tage-Inzidenzen* auf der Basis der geschätzten Infektionsdaten berechnet (Porta, 2008; RKI, 2021c). Für Landkreis *c* an Tag *t* wurde für die Infiziertengruppe *s* (1. Alle Infektionen, 2. Tödliche Infektionen) bzw. für die Altersgruppe *a* (1. 60-79 Jahre, 2. 80 Jahre und älter) die Inzidenz, Inc^{s}_{ct} bzw. Inc^{a}_{ct}, wie folgt berechnet:

$$Inc^{s}_{c_t} = \frac{\sum_{t}^{t-6} I^{s}_{c_t}}{POP_{c_t}} * 100.000 \quad \text{bzw.} \quad Inc^{a}_{c_t} = \frac{\sum_{t}^{t-6} I^{a}_{c_t}}{POP^{a}_{c_t}} * 100.000$$

wobei I^{s}_{ct} bzw. I^{a}_{ct} die Neuinfektionen in Infiziertengruppe *s* bzw. Altersgruppe *a* in Landkreis *c* an Tag *t* darstellen. Zur Normierung wurde die Bevölkerung in Landkreis *c*, POP_{ct}, bzw. die altersgruppenspezifische Bevölkerung für Altersgruppe *a*, POP^{a}_{ct}, verwendet. Hierdurch werden Unterschiede in den Anteilen der Altersgruppen an der Bevölkerung zwischen den Landkreisen ausgeglichen. Die Bevölkerungsdaten entstammen der Regionaldatenbank des Statistischen Bundesamtes (2021), Stand: 31.12.2019.

Weiterhin wurde aus den Infektionszeitreihen die *effektive Reproduktionszahl* berechnet. Dieser in der Epidemiologie etablierte Indikator beschreibt die durchschnittliche Zahl von Sekundärinfektionen, die von einem infizierten Individuum ausgehen, zum Zeitpunkt *t*. Die effektive Reproduktionszahl, R_t, trifft eine Aussage über die Ausbreitungsgeschwindigkeit von Infektionskrankheiten im zeitlichen Verlauf; ein Wert oberhalb von eins bedeutet eine überproportionale Zunahme von Infektionen, während ein Wert gleich eins linearem Wachstum und ein Wert unter eins einem Rückgang an Infektionen entspricht (Nishiura/Chowell, 2009). Hier wurde die Reproduktionszahl für Infiziertengruppe *s* (1. Alle Infektionen, 2. Tödliche Infektionen) in Landkreis *c* zum Zeitpunkt *t*, R^{s}_{ct}, als Quotient der Neuinfektionen in zwei aufeinander folgenden Zeitabschnitten von jeweils vier Tagen berechnet (an der Heiden/Hamouda, 2020):

$$R^{s}_{c_t} = \frac{\sum_{t}^{t-3} I^{s}_{c_t}}{\sum_{t-4}^{t-7} I^{s}_{c_t}}$$

Da das o.g. Interventionsprogramm vorrangig auf den Schutz von Risikogruppen abzielt, deren Angehörige eine erhöhte Wahrscheinlichkeit eines schweren Krankheitsverlauf haben, wurden ergänzend Indikatoren zur COVID-19-Intensivbettenauslastung berechnet. Als Datengrundlage dienten hierbei die Tagesreports des DIVI-Intensivregisters (DIVI, 2021a), in denen die DIVI (Deutsche Interdisziplinäre Vereinigung für Intensiv- und Notfallmedizin e.V.) tagesaktuelle Daten zur COVID-19-Intensivbettenbelegung (1. COVID-19-Intensivfälle insgesamt, 2. COVID-19-Intensivfälle mit invasiver Beatmung) sowie zur Gesamtauslastung (Freie und belegte Intensivbetten) bereitstellt. Die Daten sind auf Landkreisebene verfügbar und umfassen nur „betreibbare“ Betten (d.h. jene, für die auch Pflegepersonal verfügbar ist). Berücksichtigt wurden Intensivbetten für Erwachsene und Kinder (Datensatzbeschreibung siehe DIVI, 2021b). Aus den freien und belegten Betten wurden für die sechs Landkreise einerseits der Besatz (ITS-Betten pro 100.000 Einwohner) und andererseits die Belegungsquote (freie Betten in % aller Betten) berechnet. Unter Zuhilfenahme der o.g. Bevölkerungsdaten wurde je Landkreis *c* an Tag *t* für die Behandlungsgruppe *b* (1. Alle Intensivfälle, 2. Invasiv beatmete) die *COVID-19-Intensivbettenbelegung*, IOC^{b}_{ct}, wie folgt berechnet:

$$IOC^{b}_{c_t} = \frac{ICU^{b}_{c_t}}{POP_{c_t}} * 100.000$$

Um einen möglichen Effekt des „Tübinger Wegs“ zu überprüfen, wurde die Entwicklung im Landkreis Tübingen der in den fünf Nachbarkreisen gegenübergestellt, wobei der Untersuchungszeitraum in zwei Abschnitte unterteilt wurde. Als Trennwert zwischen Zeitabschnitt I und II wurde der 02.11.2020 gesetzt, da an diesem Datum einerseits der „Lockdown light“ in Kraft trat und andererseits der „Tübinger Appell“ veröffentlicht und mit der Umsetzung von Vor-Ort-Maßnahmen begonnen wurde. Als Kriterium der Wirksamkeit wurde definiert, dass die o.g. Indikatoren (z.B. Inzidenz) in Zeitabschnitt II (02.11.2020-28.02.2021) im Landkreis Tübingen durchschnittlich signifikant geringer sein müssen als in den Nachbarkreisen. Um das Baseline-Niveau zu überprüfen, wurde derselbe Vergleich auch für Zeitabschnitt I (01.09.-01.11.2020) vollzogen. Da nicht für alle Indikatoren eine Normalverteilung angenommen werden kann, wurden zwecks Gruppenvergleich ein parametrischer und ein nichtparametrischer Test durchgeführt, nämlich 1.) ein *t-Test* für zwei Gruppen unter Annahme ungleicher Varianzen (*Welch-t-Test*) und 2.) ein *Mann-Whitney-U-Test*. Weiterhin wurden die Infektionsindikatoren noch zwecks Vergleich über die Zeitabschnitte kumuliert.

4 ERGEBNISSE UND DISKUSSION

Die Abbildungen 1 bis 5 zeigen jeweils die Verläufe der einzelnen o.g. Indikatoren über den Untersuchungszeitraum (01.09.2020-28.02.2021) für die sechs berücksichtigten Landkreise. Hierbei ist zur Orientierung der 02.11.2020 markiert, der im vorliegenden Fall als Trennwert der beiden betrachteten Teilzeiträume (s.o.) fungiert. Tabelle 1 zeigt die Ergebnisse der Signifikanztests für die betrachteten Indikatoren für beide Zeitabschnitte. Sofern mittels Welch-t-Test oder Mann-Whitney-U-Test signifikante Unterschiede ($p < 0{,}05$) zwischen Tübingen und dem Mittel der benachbarten Landkreise festgestellt wurden, sind diese fett markiert. Tabelle 2 zeigt den Vergleich der kumulierten Werte der Infiziertengruppen, d.h. die Werte der Vergleichsgruppe sind hier nicht die Mittelwerte der Nachbarkreise, sondern die Summen.

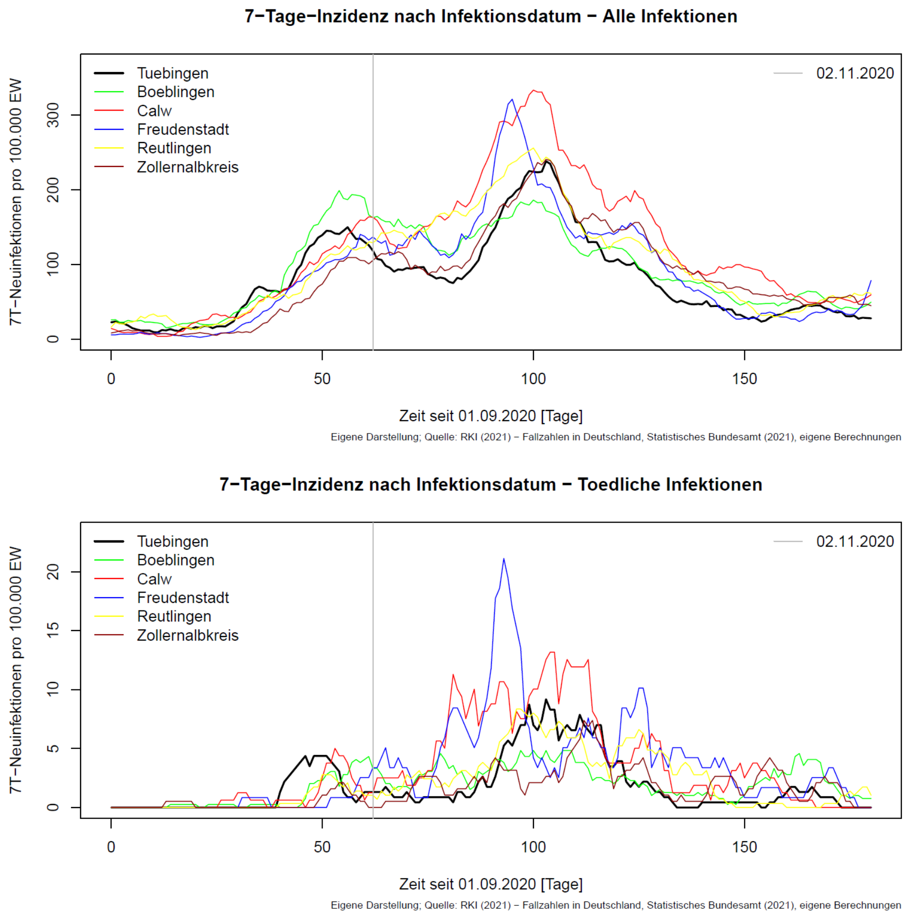

Abb. 1: Zeitverlauf der 7-Tage-Inzidenz für alle Infektionen (oben) bzw. tödliche Infektionen (unten) nach Landkreisen

Die 7-Tage-Inzidenzen für unterschiedliche Infiziertengruppen (alle Infektionen, nur tödliche Infektionen, Altersgruppe 60-79, Altersgruppe 80+; Abb. 1 und 2) zeigen zunächst einen vergleichbaren zeitlichen Verlauf: Die Infektionen – ausgehend vom geschätzten Infektionsdatum – steigen Ende September/Anfang Oktober 2020 erkennbar an, stabilisieren sich etwa ab Mitte Oktober, gefolgt von einem weiteren Wachstum ab Mitte November. Das Maximum („Peak“) der Infektionen liegt, je nach Indikator und Landkreis leicht abweichend, in der ersten Dezemberhälfte 2020. Im ersten Abschnitt des Untersuchungszeitraums (01.09.-01.11.2020) unterscheidet sich die 7-Tage-Inzidenz für alle Infektionen, tödliche Infektionen und Infektionen in der Altersgruppe der 60-79jährigen nicht signifikant zwischen dem Kreis Tübingen und dem Mittelwert der angrenzenden fünf Landkreise (siehe Tab. 1). Die mittlere Inzidenz bei mindestens 80-jährigen ist im Kreis Tübingen in Zeitabschnitt I signifikant höher, was die Ergebnisse sowohl des parametrischen (Welch-t-Test) als auch den nichtparametrischen Tests (Mann-Whitney-U-Test) aufzeigen. Ein ähnliches Bild zeigt sich auch für die kumulierten Infektionen (siehe Tab. 2); diese Werte sind für den ersten Zeitabschnitt im Kreis Tübingen (zum Teil deutlich) höher als in den Vergleichsregionen. Diese Ergebnisse weisen darauf hin, dass die „Ausgangsbedingungen“ des Infektionsschutzes, insbesondere für Ältere, im Kreis Tübingen keinesfalls günstiger gewesen sind als in den Nachbarkreisen (z.B. durch eine mögliche stärkere räumliche Segregation der Altersgruppen o.ä.); wäre dies nämlich der Fall, müssten besagte Indikatoren in Tübingen bereits vor Inkrafttreten der Maßnahmen des „Tübinger Wegs“ geringere Werte aufweisen. In Zeitraum II

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(02.11.2020-28.01.2021) zeigt sich hingegen, dass alle vier Inzidenzindikatoren in den Vergleichskreisen signifikant höher liegen als im Kreis Tübingen, was durch den Mann-Whitney-U-Test und, bis auf eine Ausnahme, auch durch den Welch-t-Test bestätigt wird. In der Altersgruppe 60-79 beträgt beispielsweise die mittlere altersgruppenspezifische 7-Tage-Inzidenz im Kreis Tübingen 75,56 und in den benachbarten Kreisen 87,76 (t-Test: p = 0,03; Mann-Whitney-U-Test: p < 0,01). Die mittlere Inzidenz tödlicher Infektionen ist in den Vergleichskreisen um den Faktor 1,52 erhöht (3,41 vs. 2,25; t-Test: p < 0,01; Mann-Whitney-U-Test: p < 0,01). Die altersspezifischen Inzidenzwerte für die Altersgruppe 80+ liegen in allen Landkreisen deutlich über den Inzidenzwerten für die anderen Subgruppen, in den Vergleichskreisen gegenüber Tübingen jedoch im Mittel um den Faktor 1,15 erhöht (194,84 vs. 168,99; t-Test: p = 0,11; Mann-Whitney-U-Test: p = 0,03). Auch die kumulierten Infektionen liegen im Kreis Tübingen für Zeitraum II unterhalb der benachbarten Landkreise, wenngleich sich der Unterschied vorrangig bei den tödlichen Infektionen bemerkbar macht, die in den Vergleichsregionen gegenüber Tübingen um den Faktor 1,38 erhöht sind (52,06 vs. 37,61). Es lässt sich demnach festhalten, dass im Kreis Tübingen im Zeitraum der Interventionen des „Tübinger Wegs“ a) weniger Infektionen, b) weniger tödliche Infektionen, c) weniger Infektionen in der Altersgruppe 60-79 und d) weniger Infektionen in der Altersgruppe 80+ als in den Vergleichslandkreisen zu verzeichnen waren. Dies zeigt sich sowohl an den durchschnittlichen Inzidenzwerten als auch an den kumulierten Indikatoren.

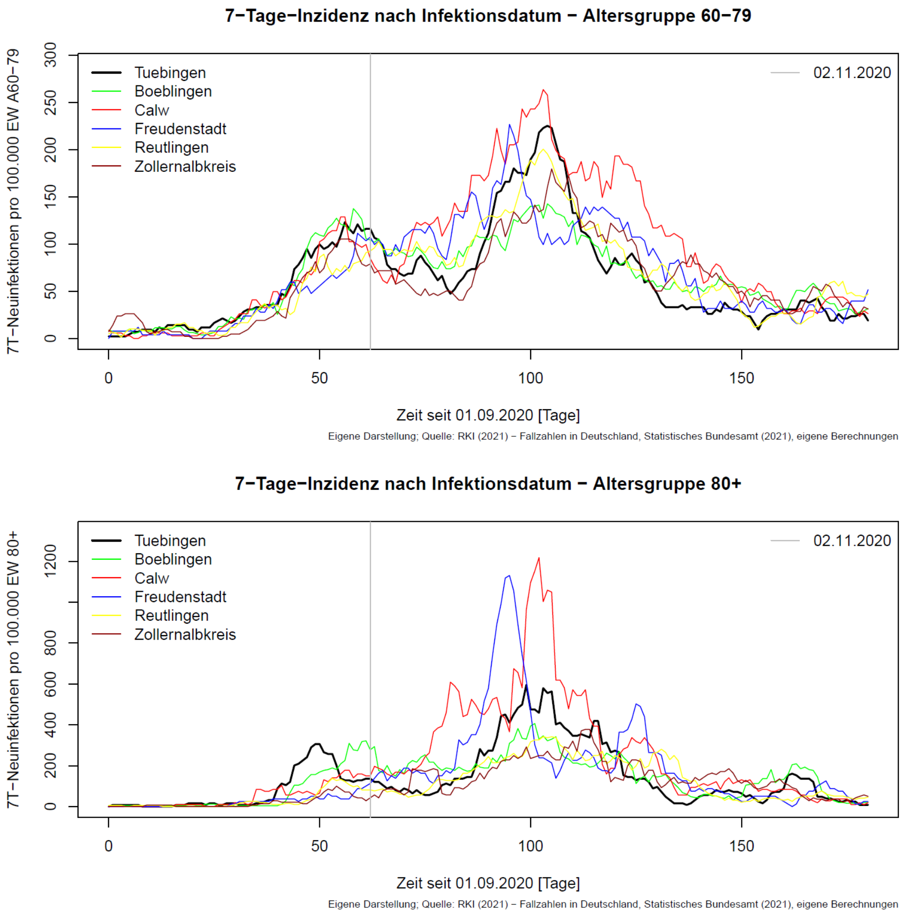

Abb. 2: Zeitverlauf der 7-Tage-Inzidenz für Altersgruppe 60-79 (oben) bzw. 80+ (unten) nach Landkreisen

In Bezug auf die effektive Reproduktionszahl (Abb. 3) zeigen sich für beide Zeiträume keine signifikanten Unterschiede zwischen dem Kreis Tübingen und seinen benachbarten Vergleichslandkreisen; in beiden Gruppen liegt R_t in Zeitraum I im Mittel über eins und in Zeitraum II im Mittel unter eins. Allerdings ist R_t für tödliche Infektionen in Zeitraum II im Kreis Tübingen signifikant geringer und unter eins, während die mittlere Ausprägung dieses Indikators in den Vergleichsregionen über eins bleibt (1,19 vs. 0,91; t-Test: p = 0,01; Mann-Whitney-U-Test: p = 0,09).

Eine grundlegend andere Entwicklung zeigen allerdings die Indikatoren, die sich auf die Intensivstationen der Kliniken beziehen (s. Abb. 4 und 5): Sowohl die durchschnittliche Zahl der COVID-19-Intensivfälle als auch die der invasiv beatmeten Intensivfälle ist im Kreis Tübingen in beiden Zeiträumen deutlich höher. In

Zeitraum II waren auf Intensivstationen im Kreis Tübingen mehr als doppelt soviele COVID-19-Fälle (5,03 vs. 2,24; t-Test: $p < 0{,}01$; Mann-Whitney-U-Test: $p < 0{,}01$) und etwa dreimal soviele beatmete Fälle (4,55 vs. 1,43; t-Test: $p < 0{,}01$; Mann-Whitney-U-Test: $p < 0{,}01$) zu verzeichnen als in den Vergleichslandkreisen. Es ist hierbei allerdings zu berücksichtigen, dass die genutzte DIVI-Statistik zur Intensivbelegung auf den belegten Intensivbetten basiert, ohne dass die Herkunft der Patientinnen und Patienten berücksichtigt wird; die o.g. Infektionsdaten beziehen sich hingegen auf den Wohnort der infizierten Personen. Im Kreis Tübingen ist auch das Universitätsklinikum Tübingen ansässig, dessen Einzugsgebiet – nicht nur für COVID-19-Fälle – weit über den Landkreis hinausgeht (Universitätsklinikum Tübingen, 2017) und dort zudem, wie auch in anderen Unikliniken, besonders schwere COVID-19-Erkrankungsfälle konzentriert werden (Schwäbisches Tagblatt, 2021). Dies zeigt sich auch an der wesentlich besseren Intensivbettenausstattung und der höheren durchschnittlichen Belegung im Landkreis Tübingen, die sich beide signifikant von den Umlandkreisen unterscheiden (siehe Abb. 5 und Tab. 1): Durchschnittlich betrug der Intensivbettenbesatz im Kreis Tübingen in Zeitraum I 46,92 und in Zeitraum II 47,25 Betten je 100.000 Einwohner. In den Vergleichskreisen lag dieser Indikator bei 15,65 bzw. 14,16 Betten. Auch die durchschnittliche Bettenauslastung hat sich in Tübingen kaum verändert (88,54 bzw. 88,42 %), während sie in den Nachbarkreisen angestiegen ist (70,47 bzw. 78,74 %). Diese Indikatoren lassen demnach keinen Schluss auf die tatsächliche Infektionslage im Vergleich der Landkreise zu, sondern dokumentieren stattdessen ein deutlich erhöhtes Ausstattungsniveau bei gleichzeitig höherer Auslastung der Intensivstationen im Kreis Tübingen.

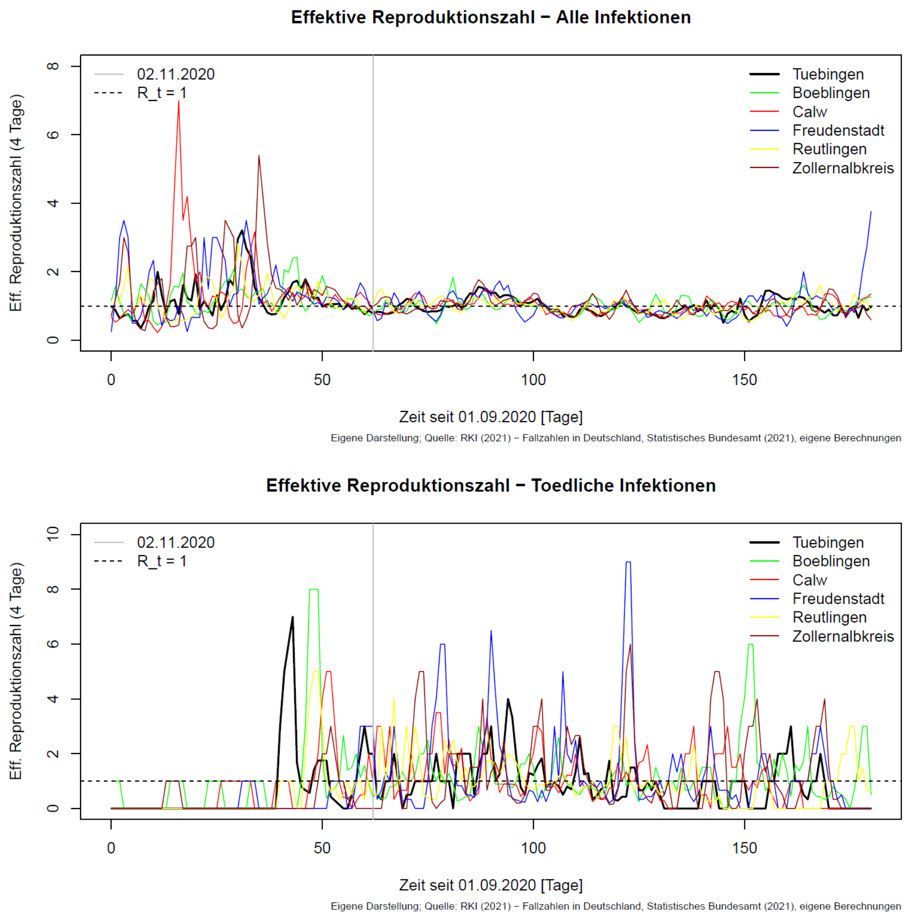

Abb. 3: Zeitverlauf der effektiven Reproduktionszahl für alle Infektionen (oben) bzw. tödliche Infektionen (unten) nach Landkreisen

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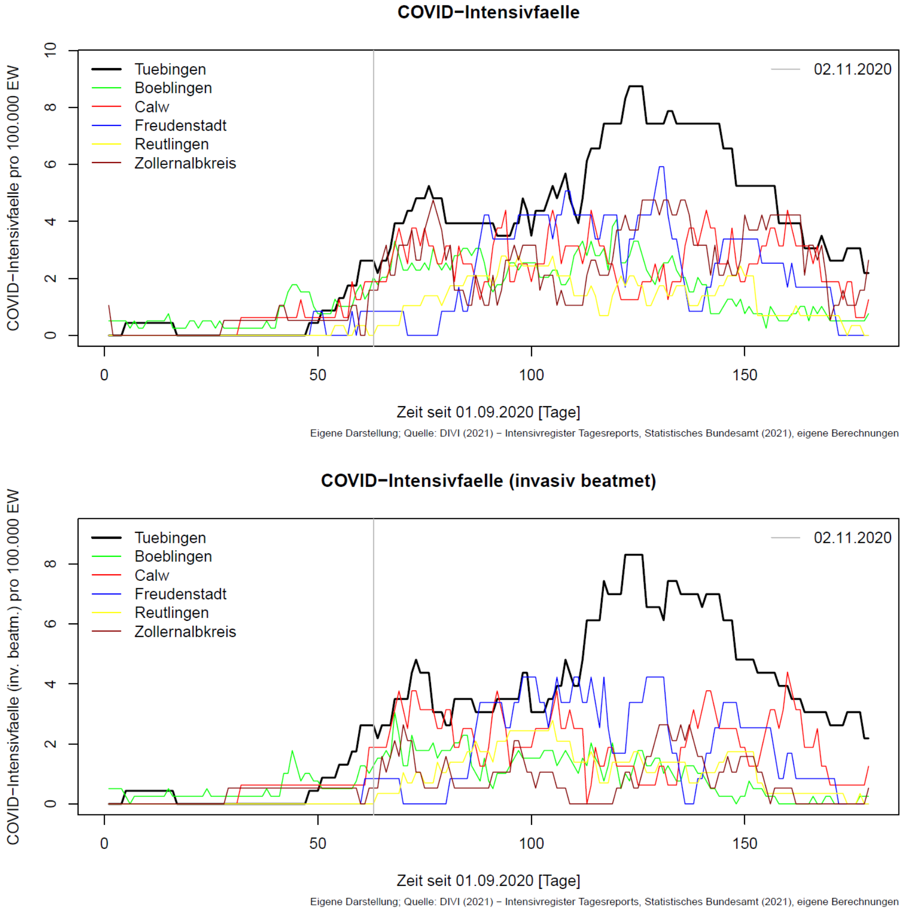

Abb. 4: Zeitverlauf der COVID-Intensivfälle (oben) bzw. invasiv beatmeten COVID-Intensivfälle (unten) nach Landkreisen

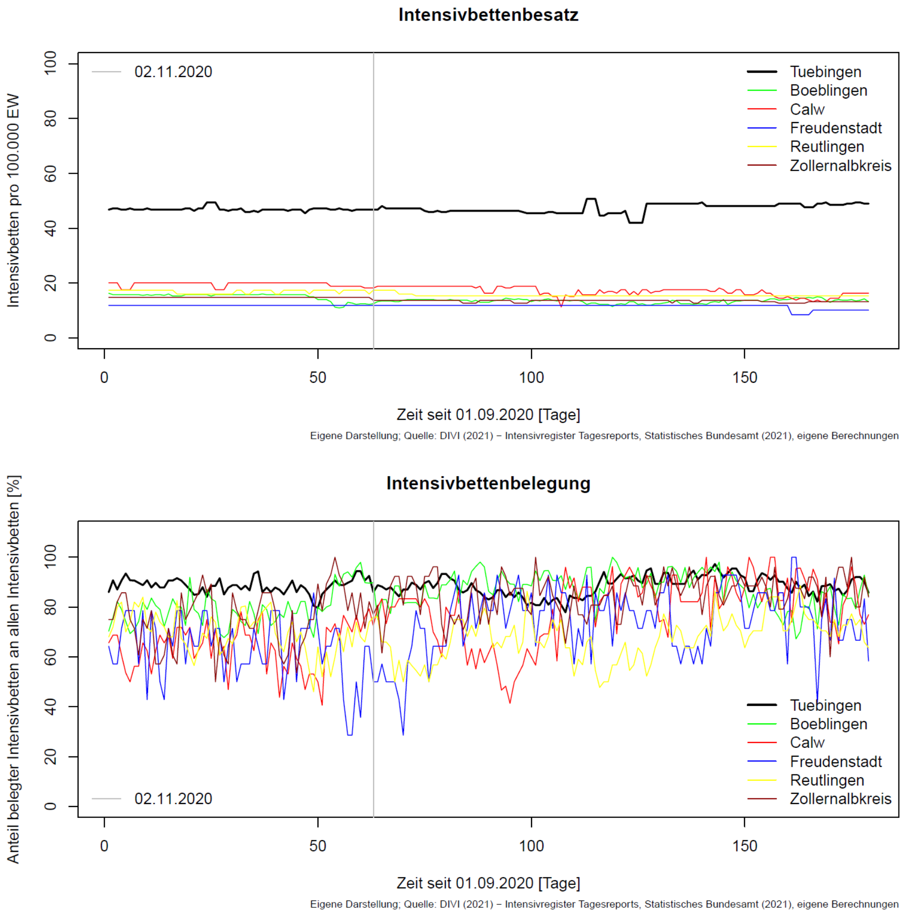

Abb. 5: Zeitverlauf des Intensivbettenbesatzes (oben) bzw. der Intensivbettenbelegung (unten) nach Landkreisen

Indikator	Zeitraum I 01.09.-01.11.2020				Zeitraum II 02.11.2020-28.02.2021			
	Arithm. Mittelwert		Signifikanztest (p)		Arithm. Mittelwert		Signifikanztest (p)	
	LK TUE	Andere	W-t-Test	M-W-U-Test	LK TUE	Andere	W-t-Test	M-W-U-Test
Inzidenz alle Infektionen	59,71	51,58	0,25	0,13	**91,41**	**121,51**	**< 0,01**	**< 0,01**
Inzidenz tödliche Infektionen	0,95	0,56	0,05	0,73	**2,25**	**3,41**	**< 0,01**	**< 0,01**
Inzidenz AG 60-79	42,17	35,09	0,20	0,09	**75,56**	**87,76**	**0,03**	**< 0,01**
Inzidenz AG 80 und älter	**72,55**	**36,03**	**0,01**	**0,01**	**168,99**	**194,84**	0,11	**0,03**
Effektive Reproduktionszahl Infektionen	1,21	1,35	0,08	0,22	0,97	0,99	0,28	0,37
Effektive Reproduktionszahl tödliche Infektionen	0,66	0,53	0,50	0,98	**0,91**	**1,19**	**0,01**	0,09
COVID-Intensivfälle je 100.000 EW	0,42	0,32	0,27	0,86	**5,03**	**2,24**	**< 0,01**	**< 0,01**
Invasiv beatmete COVID-Intensivfälle je 100.000 EW	**0,40**	**0,22**	**0,04**	0,44	**4,55**	**1,43**	**< 0,01**	**< 0,01**
Intensivbetten je 100.000 EW	**46,92**	**15,65**	**< 0,01**	**< 0,01**	**47,25**	**14,16**	**< 0,01**	**< 0,01**
Anteil belegter Intensivbetten	**88,54**	**70,47**	**< 0,01**	**< 0,01**	**88,42**	**78,74**	**< 0,01**	**< 0,01**

Tab. 1: Vergleich der Indikatoren jeweils für Zeiträume I und II (Mittelwerte, Welch-t-Tests, Mann-Whitney-U-Tests)

Indikator	Zeitraum I 01.09.-01.11.2020		Zeitraum II 02.11.2020-28.02.2021	
	Kumulierte Inzidenz		Kumulierte Inzidenz	
	LK TUE	Andere	LK TUE	Andere
Alle Infektionen	567,61	546,64	1.517,85	1.980,03
Tödliche Infektionen	9,18	6,28	37,61	52,06
Infektionen Altersgruppe 60-79	419,57	358,66	1.244,49	1.417,07
Infektionen Altersgruppe 80 und älter	708,14	410,97	2.808,40	3.036,27

Tab. 2: Vergleich der kumulierten Indikatoren jeweils für Zeiträume I und II

5 SCHLUSSFOLGERUNGEN

Die Ergebnisse der Analyse zeigen, dass der Kreis Tübingen bei zunächst gleichen oder sogar ungünstigeren Ausgangsbedingungen im Herbst/Winter 2020/2021 signifikant positivere Ausprägungen der verwendeten Infektionsindikatoren zeigt als die Vergleichsregionen; dies betrifft vor allem tödliche SARS-CoV-2-Infektionen und Infektionen in (Alters-)Risikogruppen. Zumindest aus einer statistischen Perspektive lässt dies den Schluss zu, dass die Maßnahmen des „Tübinger Wegs“ – die vor allem auf den Risikogruppenschutz abzielten – wirkungsvoll waren. Dies ist insbesondere deshalb beachtlich, weil bisherige Analysen zu den zeitgleichen „Lockdown“-Maßnahmen in Deutschland die Effektivität zumindest einzelner NPI in Frage stellen (z.B. de Haas et al., 2021; Hoyer et al., 2021; Küchenhoff et al., 2020).

Gleichwohl konnten in Tübingen weder Infektionen bei Risikogruppen noch Corona-Todesfälle gänzlich verhindert, sondern nur *reduziert* werden.

Die Aussagekraft dieses Ergebnisses ist aus mindestens drei Gründen eingeschränkt: *Erstens* betreffen viele Maßnahmen nur die *Stadt* Tübingen (z.B. Ausgabe Masken) oder wurden erst sukzessive im Kreis Tübingen eingeführt (Tests in Altenheimen). Die Regionalanalyse bezieht sich jedoch auf den *Landkreis*, da die genutzten Rohdaten nur auf Kreisebene verfügbar sind. *Zweitens* lässt sich nicht klären, ob im Landkreis oder der Stadt Tübingen – *aufgrund* der frühen Schnelltestangebote – möglicherweise anders bzw. mehr auf Corona-Infektionen getestet wurde, was sich in einer mangelnden Vergleichbarkeit der gemeldeten Infektionen – nicht jedoch der *tödlichen* Infektionen (!) – niederschlagen könnte. *Drittens* ist es nicht möglich, kausal nachzuweisen, ob eine *einzelne* Maßnahme zur Reduktion des Infektionsgeschehens beigetragen hat und, wenn ja, wie groß dieser Beitrag ist; dies ist der Tatsache geschuldet, dass die Corona-Infektionsketten in Deutschland weitgehend unbekannt sind (RKI, 2021c). Zudem basierten viele Maßnahmen auf Freiwilligkeit, so dass ihre faktische Umsetzung kaum überprüft werden kann. Dies betrifft z.B. die Frage, ob kostenlos verteilte FFP2-Masken auch wirklich getragen oder in welcher Intensität Schnelltestangebote tatsächlich genutzt wurden (Anm.: Zwischen Eröffnung des Schnelltestzentrums am 26.11.2020 und dem 17.03.2021 wurden 20.000 Schnelltests vollzogen, wobei nur asymptomatische Personen getestet wurden. 350 Tests fielen positiv aus, was einer Positivquote von 1,75% entspricht; Auskunft OB Palmer, 2021). Weiterhin ist zu bedenken, dass zum Jahreswechsel 2020/2021 die Corona-Schutzimpfungen begannen, was viele schwere Erkrankungen bzw. Todesfälle verhindert haben dürfte, jedoch müsste dieser Effekt in allen sechs Landkreisen auftreten.

Es ist jedoch zumindest naheliegend, dass die Schutzmaßnahmen für Heime einen Effekt hatten. Dass ein wesentlicher Teil, zum Teil eine große Mehrheit, der an und mit COVID-19 verstorbenen Bewohnerinnen und Bewohner dieser Einrichtungen waren, ist sowohl international (Comas-Herrera et al., 2021) als auch in Deutschland nachweisbar (Ärzteblatt, 2021). Weiterhin weisen zwei deutsche Regionalstudien auf die Wirksamkeit von Masken im Einzelhandel bzw. ÖPNV hin (Kosfeld et al., 2021; Mitze et al., 2020), wobei FFP2-Masken überwiegend eine erhöhte Schutzfunktion zugesprochen wird (z.B. Hemmer et al., 2021). Sofern diese real genutzt und dabei korrekt angewendet wurden, ist es naheliegend, dass auch die Verteilung kostenloser FFP2-Masken an Ältere einen Anteil an der Reduktion der Infektionen in diesen Altersgruppen hatte.

6 LITERATUR

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Spatial Navigation Modelling Technology in Urban Planning Project

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1 ABSTRACT

This article discusses the author's concept of a spatial navigation modeling method under the conditional name "ART-space", which can be considered as a design and analytical technology for assessing the degree of readability and diversity of the structure of a developed or implemented urban planning project in the process of imaginary or real navigation. To demonstrate the analytical capabilities of the proposed technology of mental navigation, we have chosen an outstanding project of the city-district Seestadt Aspern in Vienna (designed by Tovatt Architects & Planners AB), which is underway and has a complex expressive master plan.

Keywords: Spatial navigation, Mental space, Cognitive linguistics, Urban planning, Topology

2 BACKGROUND OF MENTAL NAVIGATION TECHNOLOGY

The modern urban planning policy, focused on active mobility, "pedestrianization", improving the quality of public spaces, makes demands on the architectural and functional diversity, on the content of the urban environment. Significant number of methods that evaluate the diversity of the urban environment using Google Maps, GIS geolocations, real estate registers from the standpoint of modeling pedestrian and transport accessibility, which ultimately leads to an increase in the consumer qualities of the urban environment and to an increase in the capitalization of the real estate itself. In this regard, the possibility of increasing the socio-cultural and artistic diversity of the city through the development of the project method is important, which can also lead to an increase in the economic value of urban space, and further understanding of the "meaning and image of the place". The first step in this direction is the problem of understanding the principles of orientation and navigation of a person in urban planning space, so important basic urban planning scenario projected at the stage of the general plan and then understood by the developer and residents without significant distortion.

The theoretical and methodological prerequisites for the development of the "ART-space" mental navigation technology were, first of all, research in the field: cognitive linguistics (Talmy,1983), semiotics (Toporov,1983), sociology of perception (Lynch,1960), composition in art (Rauschendach,1986), mathematical topology (Willard, 2004). In addition, the author's own research on modeling spatial structures taking into account perception in the direction of understanding syntax language of urban space (Kolontay, 1987).

Today, three-dimensional virtual architectural animations have made it easier to understand the appearance of the projected urban development for the future resident. The illusion of full reality in animation creates the feeling that a stable connection is between the urbanist's project, the future resident and the pedestrian. However, when perceiving urban planning animation, viewers do not use the categories of the "image of the city", justly defined by the American architect Kevin Lynch (1960) - landmarks, boundaries, paths, nodes, districts, since they do not orientate themselves in the proposed space, do not analyze the likely paths and appearance of the development, do not falling into the frame. It is essential to separate the objectives of this study from the multitude of sociological studies to establish the "sense of place ". Where it is more about the phenomenology of urban space, which is the cultural and aesthetic preferences of society and is no longer associated with the ease of movement of a person in the space of the city and the syntax of spatial relations, but with the degree of satisfaction with the content of urban space, its semantics.

Modern cognitive linguistics contributes to building bridges between the mental image of the city's space and the graphic language of the architect. Thus, the French linguist Gilles Fauconnier (1985) declares the existence of mental spaces that precede the understanding of a verbal utterance and exist as ordered sets with elements and relationships between them, as models of imaginary and real situations in the form they are constructed by man. American linguist Leonard Talmy (1983) drew attention to how the prepositions of language – "along", "above", "through" and others - form the geometry of mental space. He emphasized that the content properties of the text are associated with the identification of grammatical, "orienting" spatial

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categories in the language, such as figure-background, dimension, pattern of distribution, etc., and considers the most important reference objects, both the spatial orientation of the human body and the spatial orientation to the four cardinal points. These direction specialists interpreted as topological semantics. Thus, cognitive linguistics leads to the fact that in language there are categories associated with human corporeality and physical space at the unconscious level that provide a correct understanding of information about the structure of the spatial environment. Regardless of nationality and level of intellectual development, each person will understand the meaning of spatial prepositions of localization "between", “inside”, “around” or prepositions of the direction of movement "through", “from-to”, “along”, “around”. As we have shown in our PhD dissertation research, simultaneously designate three inseparable elements of the mental space structure: center, border and connecting axis-path, the main compositional elements of the spatial image structure in urban planning. The quality of navigation in a city depends on a person's ability to correlate certain buildings, streets, intersections, areas with the structure of mental space - centers of orientation and represent other territories and objects in the language description as zones of influence of the center, i.e. center boundaries, or what is called “neighborhoods” in the mathematical topology of space. The more different buildings and territories correlate with the zone of influence of the chosen center, the greater the variety and content of public spaces perceived from the paths of movement. However, the main element of the set of buildings oriented towards the center will be an object on the border of its zone of influence, that is, located “between” two centers. In this case, such a border building becomes a new center of orientation, and two previous centers that lie on a common axis-path become the boundaries. At the same time, the principle of continuity of navigation and the principle of continuity of topological space are implemented, which in this case leads to a doubling of the level of diversity of urban space distinguishable by a person. The methodological principle of design and navigation "ART-space" follows: increasing the diversity, density of landmarks, readability and content of the urban environment by endowing each spatial landmark on the street grid with unique topological properties - to be a center, boundary, and axis of orientation at the same time, as three topological measurements of any point in the mental urban space. Evaluation of the design solution and mental navigation in this case will mean the identification of the structure of interconnected places with the above qualities.

3 METHODOLOGY OF MENTAL NAVIGATION

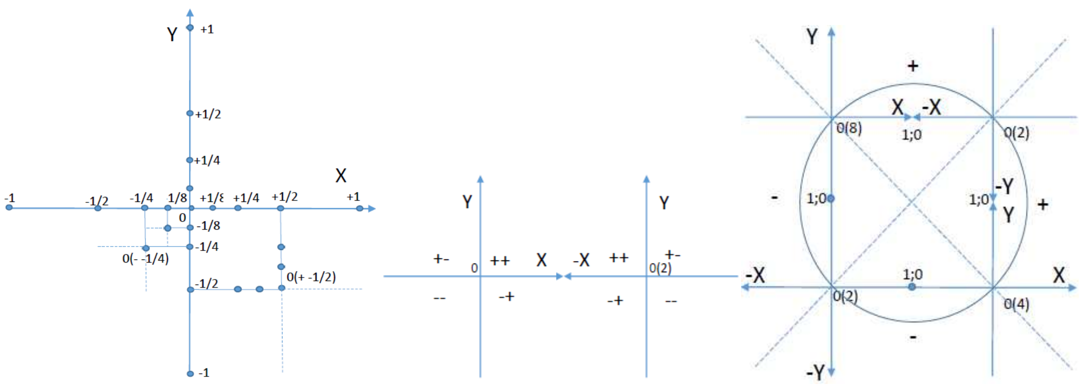
3.1 The elements of the navigation system

The main requirement for this navigation system is to ensure maximum accuracy of the verbal description of the position of a place in an imaginary urban space and on a flat project plan. Landmarks marking a location should be socially and morphologically significant and in intended visual contact with the location. The place "halfway from the park to the school" or "in the middle between tram B stops" is accurate, as opposed to the place "inside area B". Accordingly, places marked with buildings or streets are unambiguously recognized as navigation centers if they are located "in the middle", "between", equidistant from similar objects or places as their boundaries of influence. Any center of orientation is the place of the target of movement or control of the distance to the target or making a decision to change the route. The streets become coordinate axes, and for an unambiguous recognition of the coordinate center, buildings before and after the intersection must expressively change their properties from a conditional plus to a minus with a straight-line movement, and when turning from the conditional street-axis X to street Y, the properties of space should be different, but not contrasting. Traditionally, the center of orientation becomes the socially most significant verbalized objects, indicated on the navigation plan by a point with a distance value of «0». All places in the boundary function are indicated on the plan by numerical values of the distance from the center and are recognized as located “near”, “in front of”, “halfway” (1/2), “a quarter of the way” (1/4) from the center reference, and the farthest border with a value of 1 will be located between the two centers. Orientation axes are a way of establishing mental connections between landmarks in the function of centers and boundaries and function as a route guidance tool for navigation, so the axes can only be straight-line, although real or imagined paths can be of any curvature. Orientation axes can coincide with orienting paths of movement (streets, roads, pedestrian links), and then they are shown on navigation charts with a solid colored line of different thickness, depending on the significance. Orientation axes that do not coincide with the paths of movement, but indicate the location of the final or intermediate target, are shown on the plan by the dashed line of the color of the linked landmarks (in the real space of the district, such axes can form visual diagonal or other connections between landmark objects). Orienting axes-paths of movement in mental navigation systems can intersect only at right angles, and to ensure directionality are indicated on the diagrams by different letter symbols, for example, X for east-west orientation, and Y for north-south direction and are always directed to the most significant border or center. Curvilinear paths of movement are disorienting, therefore, they are divided into segments by orienting axes of movement, and the image "movement in a circle or a curve" will mean movement along an imaginary polygon or broken line.

When forming a navigation system, actions to transform the city as a physical reality into mental spatial geometry, convenient for design modeling, are important. These actions represent a cyclical process: Transformation of physical elements of the city into point, linear and spatial (planar) elements of physical space. Transformation of physical elements into an orienting topological structure by establishing distance relations between designated centers and boundaries along the axes of motion. Ensuring the distinguishability of centers, boundaries and axes by assigning or identifying marking properties, i.e. verbalized functional, morphological, semiotic characteristics of the real urban environment. All three actions can be simultaneously. Based on the foregoing, we assumed that the elements of the "image of the city" by K. Lynch went through the first and third transformations, but the syntax between the elements turned out to be problematic.

3.2 Typology of basic mental navigation systems

The number of possible types of basic mental navigation systems and ways of orienting a person in space is limited to three types. This is due to only three mentally distinguishable ways of movement of a person in space: "from borders to the center", "between opposite borders through the center", "from one side to the opposite side along the border and around the center". The resulting images of spaces correspond to topological figures - a circle, a belt and a ring, where the belt is isomorphic a circle or a broken ring. Taking into account the structure of the mental space, each type of navigation uses and models either the center, or the axis, or the boundaries of the space. The image of the city will be different if spatial navigation is forming from the Kremlin in Moscow, from the Champs Elysees in Paris or the Ringstrasse in Vienna. The mental and topological size of the same physical space of historical Vienna when navigating from St. Stephen's Cathedral will be perceived to be much smaller than when navigating from the Opera building on the Ringstrasse, where the number of related landmarks and their metric distance from the Opera will be much greater than in the first case. Mental navigation is carried out by assessing the distance of all landmarks between themselves and the center of orientation, measured by the number of meters in physical space and the set of related elements-landmarks in the topological mental space. Considering that the described navigation process means a constant mutual transformation of the metric space and topological, we will obtain the simplest navigation system by converting a flat rectangular Cartesian coordinate system into a topological coordinate system in accordance with the above described and logically established requirements for the unambiguous readability of navigation elements.



Figures 1-3.

3.2.1 Monocentric navigation system

The main difference between a topological space as a set and an empty Cartesian space is the boundedness of the first. Therefore, the extreme boundaries of the coordinate navigation system on opposite axes X and Y will be the index "1" as the maximum distance. The center of navigation by index "0", and internal

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landmarks in the function of internal boundaries and centers of lower order will be limited to three values, intervals movements: "half way" -1/2, "quarter way" - 1/4 and "half a quarter way" -1/8 (Fig. 1). The 1/16 interval is mentally difficult to imagine and is excluded from the coordinate navigation system. The four values of the distance of the boundaries from the center are characterized by a change in the physical properties of the landmark boundaries (size, color, functional structure, etc.), as well as the topological properties as a function of an independent center of orientation, since each boundary is equidistant from the main center and is nearest other boundary. We interpret the plus and minus numerical values of the boundaries as distinguishing properties of landmarks-places on the principle of a pair of contrastingly different properties and a pair of similar properties. Graphically, this means that within a single coordinate navigation system, only four distinguishable colors can be used at the same time to distinguish the properties of axes, centers and boundaries. At the same time, each of the 17 places on the axes is characterized by a unique topology, where the mental presentation of any place presupposes ideas about all the other 16 places. In symbolic terms, each border must contain a particle of its center, and the center, in turn, must absorb all the properties of its borders. This may be a special architectural and artistic task of an urban planning work. Further division of space presupposes the formation of new axes and paths of movement that intersect the main coordinate axes only at reference points with established numerical values. In this case, the point boundaries of the center are transformed into linear ones, and when the axes are closed, the spatial boundary-area and the center of the new coordinate system are constructed. The proposed monocentric navigation system controls the perception of space and is a “syntactic pattern” for further understanding the language of the urban area space and its “sense of place”.

3.2.2 Two-centric navigation system

The two-centric navigation system is formed by adding two monocentric systems. 1) Addition of two equal systems with the same direction of the axes and the formation of a common boundary with index 1. 2) When the direction of the X axis is changed and two variants of the direction for the Y axis, one of the centers 0(2) becomes the far boundary of the second center 0. In this case, one common main axis of navigation appears, forming a linear mental image of space. The creation of landmarks according to the rule of two variants of addition of focused monocentric structures provides the maximum variety and accuracy of orientation in a two-centric linear navigation system (Fig. 2).

3.2.3 Ring polycentric navigation system

The ring navigation system, as the most complex, is formed by the addition of four monocentric rectangular navigation coordinate systems, or four linear two-centric structures, or four sectors of a circle (Fig. 3). Accordingly, in a ring polycentric navigation system, the rules for constructing a monocentric, linear and proper ring system are simultaneously applied. This means that the same landmarks include three different characteristics at the same time, and the imaginary space in the process of navigation shrinks towards the centers, stretches along the axes between opposite centers and bends about the diagonal axes between paired opposite centers. The opposite directions of the axes and their plus and minus values on the half rings provide the orientation of this navigation system, creating an image of compression on one side and stretching on the other side of the ring of imaginary space. Each of the four centers of the ring navigation system is assigned its own unique value characterizing its distance and level of complexity in relation to the main center of navigation on the ring. The center with a value of 0(4) indicates that this landmark is located on a semicircle, is the center of one space and the most distant border of the influence of the main center of another space with a value of zero. The mentally distinguishable maximum variety of landmarks with different distances from the center in one direction for the ring system it is indicated on the plan as 0(1/8;1/4;1/2;1;2;4;8). For the monocentric navigation system it is indicated as 0(1/8;1/4;1/2;1). For two-centric-linear - 0(1/8;1/4;1/2;1;2).

3.3 Extension navigation systems

3.3.1 “Projection” of boundaries to the center

Real building and real urban environment are not limited to a set of navigation system landmarks. The navigation system is only an important syntactic part of the urban space, protecting it from monotony, ensuring the "socialization" of the physical space by embedding in it the human ability to orientate and recognize the topology of the environment. At the same time, theoretically, an urban environment can be designed, consisting all of unique semantic spatial landmarks. However, firstly, there will always be restrictions on the number of bases of distinguishable properties of landmarks and limitations in the size of the city block and building plan to designate a limited number of unique places. Secondly, taking into account the technology of systematic "collective" urban planning, in reality there will always be an environmental background building and a unique one that orientates in space. With this in mind, the extension of the navigation system applies only to a part of buildings, streets, intersections and quarters of any considered or projected city-area. Extension of monocentric, two-centric and polycentric navigation systems is achieved by transforming landmarks-boundaries into centers of new spaces with new orientation axes and paths of movement. On navigation models, this looks like a mutual projection of the farthest boundaries onto the coordinate centers, which makes it possible to determine the position of the pedestrian observer within the area in relation to the main center, without being on the main coordinate axes. Such a projection is shown as a broken line and is similar in appearance to a perspective view in graphic art. Each type of navigation system has its own peculiarities of extension and "projection" of boundaries to the centers of orientation, which will be shown further on the example of the analysis of the space of the Aspern settlement.

3.3.2 Superimposing of three navigation systems

Mutual conditioning from each other of the center, boundaries and axis as three mental dimensions of topological flat space suggests the possibility of superimposing three types of navigation systems within the boundaries of one physical space (Fig.9). In terms of urban planning, this means that the same area can be entirely organized in three different ways with the achievement of maximum readable diversity. When orienting in it, an artistic effect of variable dimensions of the mental space will arise - a compact circle when orienting along a monocentric system, an extensive ring along polycentric, elongated two-centric belt. The condition for obtaining maximum diversity when three navigation systems are superimposed is the location of the three main centers in such a way that one of them is located in the middle between the other two on an imaginary axis. The second condition is the exclusion of overlapping of some point landmarks or linear paths with others from different systems when scaling. This is achieved by different spacing of landmarks-boundaries for different orientation systems, if all of them are based on a rectangular metric grid. In a monocentric system, this interval must be a multiple of two, and in a linear and ring system, a multiple of 3. Under these conditions, the mutual superimposing of landmarks with the values 1/2;1/4;1/8 in each system is excluded and the space diversity does not decrease.

4 SIMULATION OF SPATIAL NAVIGATION ON THE PROJECT OF THE CITY DISTRICT ASPERN

Navigation modeling according to the described theory and methodology “ART-space” should be effective on the scale of urban densely built up compact spaces. It can be a projected area of the city on a flat landscape (which complicates orientation in its space), which can be crossed on foot in 20-30 minutes. For modeling and analysis, we have chosen an outstanding project Seestadt Aspern for 20 thousand inhabitants in the 22nd municipal district of Vienna (designer Tovatt Architects & Planners AB), which is underway and has a complex expressive plan of the territory of 240 hectares. To model navigation, we used the design materials of the master plan in terms of the general urban planning concept of the Aspern area (Fig. 4a), functional (b), zoning of buildings in height (c), 3D model of building, parameters of the street network, etc. The authors of the project made minor changes to the final implemented version of the project, but the basic concept remained unchanged, which we further analyze. The author’s most significant components of the urban planning concept of the district were the following. The northern business quarter at the metro and railway stations; a centrally located lake with landscaped areas in the western and eastern directions; the main shopping street oriented towards the spatial center of the district; the main circular street of the entire district as the Ringstrasse refrain of Vienna.

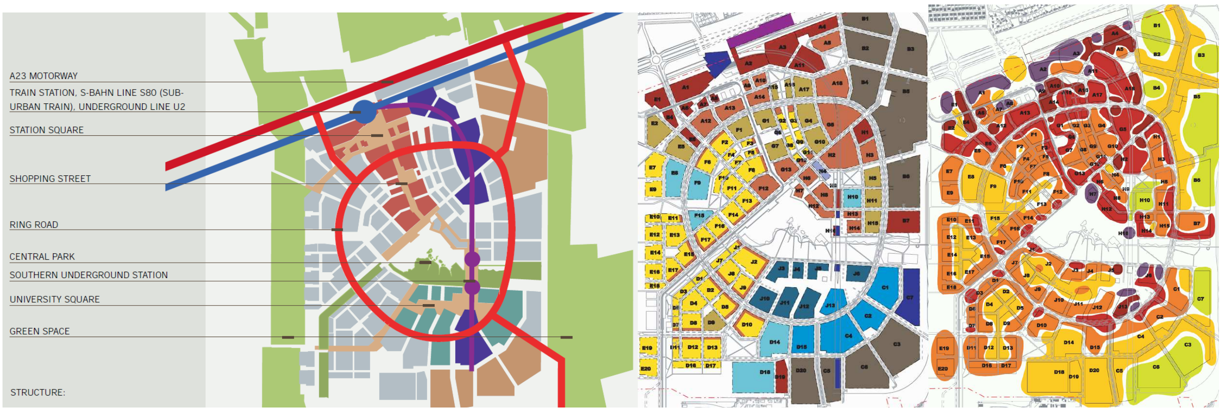
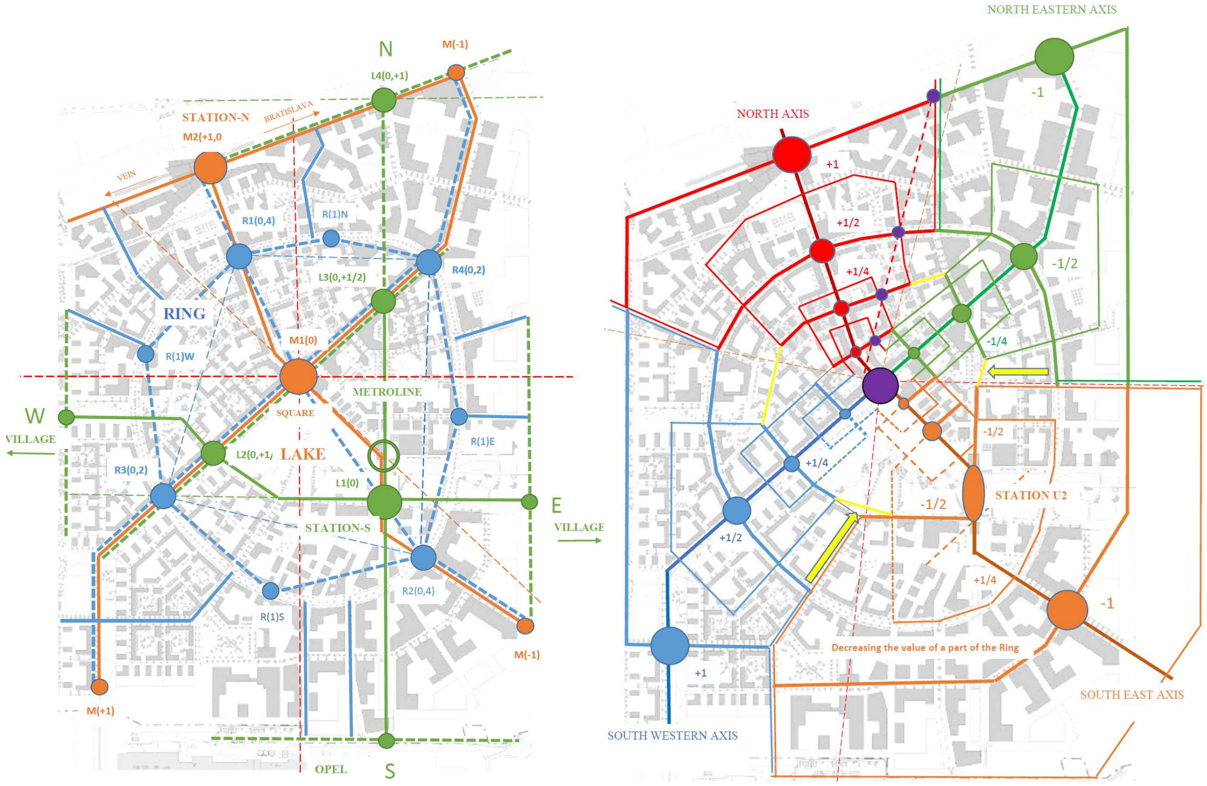


Figure 4.



Figures 5-6.

4.1 Modeling basic navigation systems Aspern

Considering that a monocentric navigation system is the basis for the construction of two other systems, it is necessary to identify all variants of monocentric structures, and then determine their mutual combinations to form more complex and diverse linear and ring, providing navigation that is more accurate. Modeling begins with determining the outer orienting boundaries of the area's development, the intersection of the main transport links with the outer borders of the district (distance index 1), mutual intersection of all main transport links as close as possible to the spatial center of the area (distance index 0) to build the main monocentric coordinate system. The next action reveals other places of mutual intersection of the main external connections like a monocentric, two-centric-linear or ring system. Using the spatially, functionally and symbolically the most significant landmarks in the structure of the Aspern area, three navigation systems are formed that allow free movement within the area, constantly realizing the position of a potential observer (Fig. 5). This will be facilitated by a monocentric system (orange) with a potential central reference point M1 (0) - "Square by the Lake" and reference point M2 (+1.0) - "Area near the metro and railway station" as the main outer border and center at the same time. This pair of landmarks defines the location of the Y-axis and all the main street-axes of the district, despite the need for a "diagonal" orientation of the X-axis and the difficulty of tracing the lower part of the Y-axis with a minus index of the outer boundary - M (-1). The linear navigation system of the Aspern area (green) forms its geographic reference to the cardinal points "north-south" and is mentally recognized due to the physical structures of the U2 metro route as the Y axis and the metro station with two exits by the Lake as the main center - L1. The outer border-center in the north (L2) may be the area of the business zone on the links of the Aspern and the prospective development of the area in the north behind the railway. From a functional point of view, a significant street does not support this axis in the project, but in the image of the district, it is very important. The main X-axis in the linear system is formed by the park boulevard on the north side of the Lake and the development of "green links" in the west and east. Significant landmarks in this system should also be the intersections of the X and Y axes with the "diagonal" street. Four center nodes (R1-R4) of the ring navigation system (blue) are simultaneously the border-landmarks of the monocentric structure, which reduces the potential diversity of the spatial image of the area and the need to use four other strategically located landmarks on the ring with the index R (1) that do not have such significant axes as the first four. Real circle movement should be combined with imaginary or visual routing along the direct links between the four centers shown by the dashed line. Further modeling of each navigation system will show the degree of their influence on the integral perception of the space of the Aspern area.

4.2 Internal extension Monocentric navigation system

The distinguishability of the position of the observer on the main paths of movement should be ensured by the contrastingly different properties of the building along the X and Y axes, including the difference in the properties of the space before and after the main reference point - the "Square near the Lake with a high-rise building" (Fig. 6). This is clearly present in the project. Extension of navigation elements occurs step by step by defining centrally located landmarks with distance from the center of 1/2;1/4;1/8 and laying new orientation path axes with new centers and boundaries. Observing each landmark is the center of one space, an axis similar in size to space and the border of a larger space. Graphically, this looks like a projection of the outer boundaries (for example, purple dots) and axes onto the navigation center. Verbal identification of the unique functional and spatial properties of each uniquely located landmark is a confirmation that the semantics of the detailed monocentric system in the project is provided, which is possible only when the project is implemented or when it in design process by the authors themselves. The confirmation of the syntax of the structure is the absence of gaps between the axes-paths when moving along the main radial axes and along imaginary rings between landmarks with similar values and properties, or in any other direction. In the Aspern project, due to the creation of a Lake and a correspondingly complex structure of the southeastern axis (orange color), the rank of the internal northern connection at the Lake increased from 1/4 to 1/2 and the rank of the Ring avenue in the same Aspern sector decreased (shown by arrows). This means that when navigating the monocentric coordinate system, Aspern will be perceived as two relatively independent parts - one is the southeastern sector, the other is all other sectors, and for orientation in the eastern and southeastern parts, it will be more convenient to use a linear system based on the metro line. A socially and functionally significant landmark "University Square", located in the zone of influence of the U2 metro station in the north, but isolated from the Lake and from the Ring avenue, the more significant axes of the first order, will play a local sectoral role of the second order in monocentric navigation. The orientation of the entire space of the Aspern district is emphasized by the gradual decrease in the size of the quarters from the eastern and southern periphery to the center, which is typical for traditional historical cities, but the appearance of an artificial lake in the center speaks of a new ideology of urbanization.

4.3 Internal extension Two-centric linear navigation system

The technology for modeling two-centric navigation is based on splitting a homogeneous rectangular grid into a system of pairs of heterogeneous monocentric systems (Fig. 7). In this case, the pedestrian observer is guided by two main centers or two pairs of centers, as it could be in Aspern, at the same time. For greater clarity of the proposed method, when scaling the axes and boundaries, we did not lay them strictly along the project streets, in contrast to the main centers and axes, which correspond to the project structure. The basis of this linear system is the obligatory difference between the properties of all main axes-paths in the function of centers from the axes in the function of boundaries. As well as the difference in the properties of all axes in the function Y from the axes in the function X, i.e. having different directions, which is marked on the diagram in four colors. Due to the fact, that external and internal boundaries with different properties on each side of the center are projected onto the main centers when extension the structure, the two-centric system makes it possible to achieve a large variety of a coherent, easily readable system of landmarks. Linear

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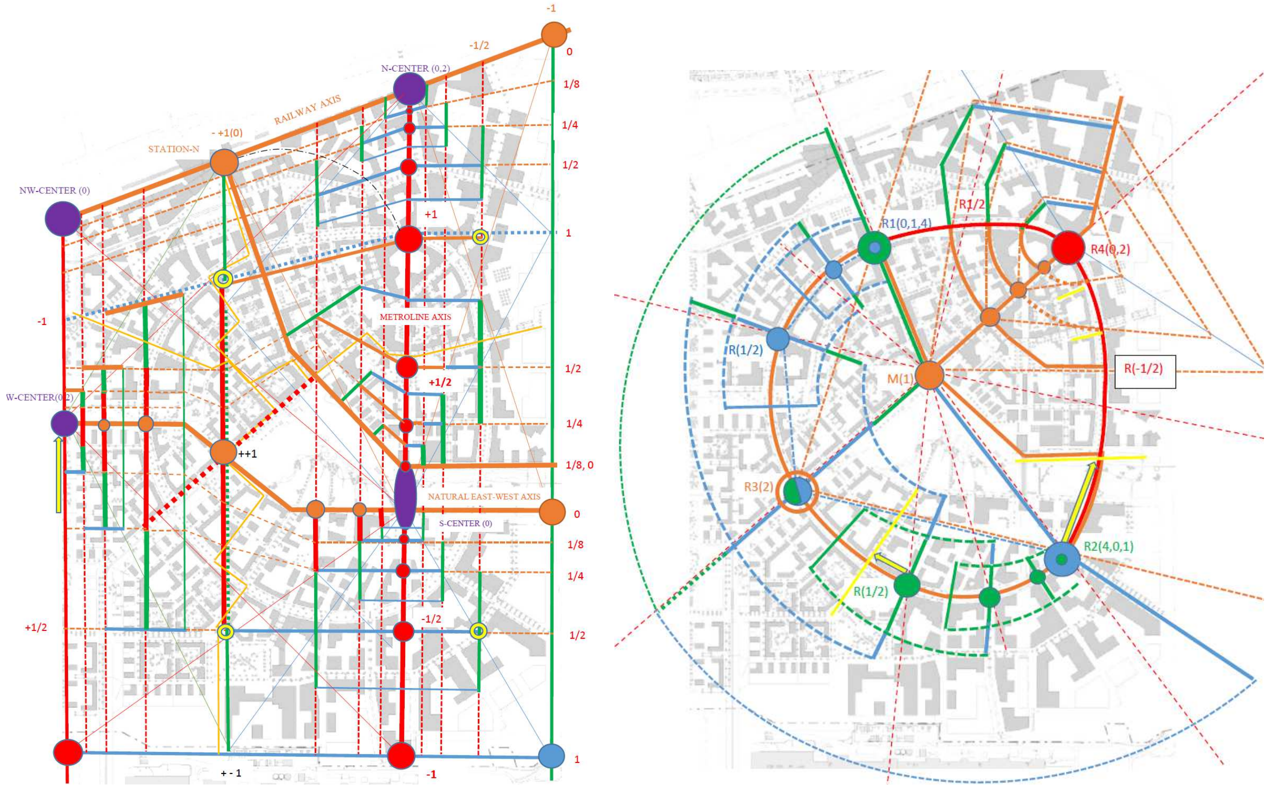
navigation of Aspern is formed by two X-axes (orange) as if moved apart by the space of the Lake and caused deformations of all axes-paths of the northeastern part of Aspern. Obviously, for the authors of the project of the Aspern district, the rectangular grid of streets was not a priority, in contrast to the adopted radial-ring scheme. Therefore, complex zigzag connections (yellow color) arose between opposite sides of the district along the axis with a index of 1/2 between the planned educational complexes on east and west of Aspern, as well as along the axis with a index of 1 between the northern square near the Station and the southern educational complex.



Figures 7-8.

4.4 Internal extension Polycentric ring navigation system

Ring navigation is possible if the system of landmarks on the ring is connected with real or imaginary straight sections of the path, while the technology of forming a route on a rectangular grid differs from navigation in a circle.

Ring-shaped navigation is the most difficult, but it is able to combine the largest number of landmarks according to two basic scenarios. 1) When moving along the ring between landmarks opposite on the ring without crossing the center (R1-R3-R2 and back). 2) When moving through the center of the circle along axes R3-M-R4 (Fig. 8). Readable circle navigation between opposing centers using four sets of landmarks is possible in only two ways. 1) When all four centers are equal and the subject moves in a circle in one direction, sequentially focusing on each of the four centers. 2) When one pair of opposite centers is more significant and the movement between them occurs towards each other, as in the Aspern project.

4.5 Navigating three systems simultaneously

The first sign of the readability of the integrated navigation system Aspern is the location of the main centers of the three coordinate systems on a common (diagonal) axis with a relatively equal distance of the center M1 from R1 and L1 (Fig. 9). However, the duplication of axes and landmarks by different systems (color overlay) indicates the underutilization of the distinguishable diversity. It should be recognized that an objective obstacle to the complete separation (without combining) of the three detailed navigation systems is the impossibility of reducing the size of building blocks and, accordingly, increasing the density of the street network. In the considered version of modeling, the navigation axes and landmarks are laid with maximum consideration for the design grid of streets in the Aspern district. It is for this reason that the integration of the two-centric-linear system is only partially possible, given the non-straightness of the internal latitudinal and meridional connections of the Aspern area. In the project, the dominance of the monocentric system is obvious, where its axes-radii coincide with the axes of the ring coordinate system. This means that radial streets towards the Lake will primarily define the location of the observer, and already secondarily by the opposite centers on the Ring (R1-R2; R3-R4). The very potential presence of a linear navigation system is important due to the U2 metro line along the Y axis and the natural X axis from the center L1 (metro station), as well as two centers L2 in the north and L3 in the west. Obviously, the ease of orientation within the area was not the main task of the authors of the project, therefore there are many deformations, gaps, shifts of axes and paths of movement, creating a feeling of a natural historical development of the building, but at the same time, and we see a clear structure of the composition of the space.

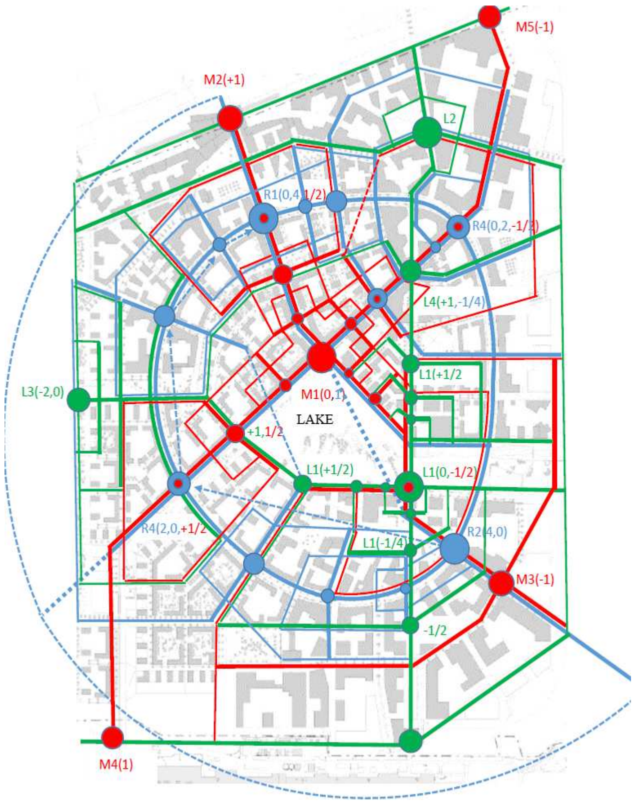


Figure 9.

5 CONCLUSION

The considered method of spatial navigation is the reverse side of the compositional method "ART-space", which can be used both for the development and for the analysis of the design solution in terms of the readability of orienting places and the level of diversity of the spatial structure. The theory and method are based on: 1) the linguistic distinction of the three-element structure of the basic mental space. 2) The rules for the construction, internal development and superimposing of three types of coordinate navigation systems as three dimensions of the urban planning topological space. 3) The rule “to be between” landmark elements in navigation systems and the systems themselves. 4) The semantic rule distinguishing between two similar and two opposite properties of landmarks as a single set. A quantitative assessment of the diversity of space for each individual type of navigation scheme includes the distinction of four properties for point, linear, spatial landmarks at three scale levels of parts (1/2; 1/4; 1/8), which is more than 100 unique orienting elements-places. However, just as any language is not limited to the syntax and the number of words in the dictionary, any city project cannot be reduced to the rules of spatial navigation. At the same time, these rules form a dialogue between an architect and a resident; transmit the important essence of a person into the urban environment - his mental ability to orientate and the ability to perceive the space of an urban area as a work of art. An architect can use these rules to achieve a certain image. The method of analyzing an urban planning project using the example of the Aspern district project confirmed both the applicability of the proposed theory and method of mental navigation, as well as the potential level of high structural diversity and artistic qualities of the district space in the Aspern project itself.

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Innovative Initiatives Usage to Improve Efficiency in the City of Johannesburg Public Transportation

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1 ABSTRACT

Past spatial planning practices have left developing cities such as the City of Johannesburg with sprawling low-density areas of settlement, lacking viable public transport systems. The majority of marginalized citizens in South Africa are still living on the fringes of the cities, commuting daily, often at considerable cost, long distances to access work and economic opportunities. As such, it is very critical in developing cities to trace the existing spatial patterns, economic distribution, and the envisaged mobility innovations. Thus, the aim of the paper is to explore innovative initiatives to meet the envisioned mobility network through the Spatial Development Framework, 2040 and proposed corridors of Freedoms as mobility spines from a high-level perspective within the City of Johannesburg. A mixed-method approach was used which consisted of an exploratory research design that involves an empirical enquiry using spatial and qualitative methods of data. The results reveal that the City of Johannesburg has identified key public transport corridors, consolidating growth and development opportunities around existing and future public transport nodes. The location and concentration of jobs opportunities does not match that of where people live. This job-housing mismatch significantly contributes to inequality in the city as for many residents' access to economic opportunities is stifled by costly and distant commuting. There are also two major spatial discontinuities in the city structure that are barriers to opportunity. In interpreting the current city structure morphology, the city displays a unique structure of inverted polycentricity, inherited largely form its complex history. In conclusion, the envisioned mobility networks of the city have the potential to link citizens to mixed-use development nodes with high density accommodation supported by office buildings, retail development and opportunities for education and recreation. This will give rise to a people-centred city, where communities' needs, their safety, comfort, and economic well-being are placed at the core of planning and delivery processes.

Keywords: Mobility, corridors, public transport; spatial patterns; economy.

2 INTRODUCTION

Urban public transport as a catalyst for urban development in the era of smart mobility is well recognised (Reardon, 2020; Peprah et al.,2019). Typically, smart mobility describes movement patterns or city transport networks which are utilising active travel modes; information and technology; energy efficient renewable forms of energy; or shared vehicles wherever possible, resulting in low carbon output per passenger journey (Dia, 2016; Namiot and Pokusaev, 2019; Liu et al., 2020). Integrated multimodal-networked public systems have emerged as a smart mobility paradigm (Risimati and Gumbo, 2018). They use transfer potential to provide a maximal service for a reasonable and efficient operating budget and a genuinely feasible alternative to automobile travel within urban areas (Jones et al., 2012). As mobility is the essence of modern life in urban areas, it creates serious social, economic, and environmental problems. In a situation of growing car ownership, public transport services are facing tough competition from private automobiles (Alpkokin and Murat, 2012). The continuous increase in the number of vehicles on the road network poses further threats to traffic movements. This is evidenced by traffic congestion, slower flow, more accidents, and waste of time, money and efforts (Agyapong and Thomas, 2018). A shift from mobility-centred to accessibility-centred transport and land use planning has been advocated over decades (Hrelja, 2015; Cervero, 2013; Banister, 2012). This shift starts from the idea that the demand for transportation is largely derived from people's demand to reach their destination, rather than for the sake of movement. it suggests that enhancing accessibility to desired destinations is what really counts for the users of that transport system (Wang and Chen, 2015).

One of the most popular accessibility-centred planning approaches is Transit Oriented Development (TOD) (Ndebele and Ogra, 2014; Makhubu, 2016; Nasri and Zhang, 2014). TOD can enhance accessibility through strengthening the integration between transport and land land-use systems by means of relatively high density, mixed-use, cycling and pedestrian-friendly development around transit stations and networks (Renne, 2016). TOD characteristics are positively related to accessibility at the catchment level. Likewise, at the catchment level, the transport feature of the TOD system is highly related to accessibility, while for transit-oriented land-use patterns the associations are much smaller. This suggests that in order to improve accessibility of an area, transport-enhancing policy should be considered as the first option. If the transport system is kept unchanged, land-use policy relating improving urban density, diversity and pedestrian-friendly development is recognised as an effective tool to enhance accessibility of the area. Consequently, in developing countries past spatial planning practices have left cities such as the City of Johannesburg with sprawling low-density areas of settlement, lacking viable public transport systems (Luke and Heyns, 2017; Chakwizira, 2011). The majority of working class and poor citizens are still living on the fringes of the city, commuting daily, often at considerable cost, long distances to access work and economic opportunities (Risimati and Gumbo, 2018; Seftel and Peterson, 2014). As such, it was very critical to trace the existing spatial patterns, economic distribution and the envisaged mobility innovations for City of Johannesburg, South Africa.

3 METHODOLOGY

This section presents the research approach for data and analysis. An exploratory research design was adopted to assess spatial distribution patterns. The key informant interviews were used to collect information for this study. The interviews were semi-structured, using open-ended questions to guide the conversations on transport infrastructural developments in the city. The interviews were held with officials from the City of Johannesburg Metropolitan Municipality, Johannesburg Roads Agency (JRA), Johannesburg Development Agency (JDA), Gauteng Department of Roads and Transport (Gautrans) and Gautrain Management Agency (GMA).

Content analysis informed by Systematic Review methodology was used to analysis qualitative data in the form of literature on the spatial distribution of urban transportation systems. Using key themes as shown in Figure such as the 'Compact city' and 'Transport Oriented development' case studies on the state of the art in urban mobility planning were identified and evaluated. Using content analysis infrastructure projects by the city of Johannesburg were evaluated such as the Empire Perth Development; Turffontein Development Corridor and Louis Botha Avenue Development Corridor. Likewise inferences to future motorised and non-motorised development were evaluated.

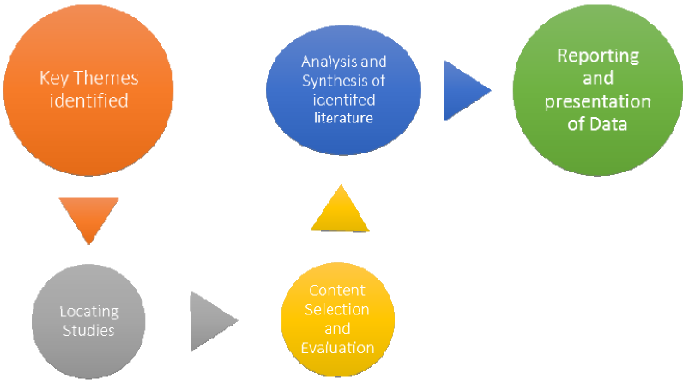

Figure 1: Roadmap of Content Analysis

Spatial data of urban public transport infrastructures (Gautrain, Rea Vaya, Metrorail and Metrobus) were collected in shapefile format from their service providers (Gautrain Management Agency; JRA; JDA; PRASA; and City of Johannesburg). Although, the data is currently not open source, it is available on request from the public transportation providers. The spatial data gathered were used to visualise the spatial trends maps using Geographic Information Application (ArcGIS 10.3 software) to inform analysis and discussion on the envisioned spatial patterns and infrastructure of urban public transport systems in City of Johannesburg.

4 RESULTS

The City of Johannesburg is embarking on new spatial plans in line with the Johannesburg Spatial Development Framework 2040 and the 2040 Growth Development Strategy based on transport-oriented development. The shape of the future city will consist of well-planned transport arteries, the Corridor of Freedom linked to interchanges, where the focus will be on mixed-use development. Joburgers will then not have to use private motorised transport but can opt for the alternative means, which including cycling, bus lanes and pedestrian walkways. The Corridors of Freedom aim to transform entrenched settlement patterns, which have shunted most residents to the city's outskirts, away from economic opportunities and access to jobs and growth. Gone will be the days of being forced to rise at dawn to catch a train, bus, or taxi to a place of work. PRASA has completed a New National Plan which will guide infrastructure investment into specific identified corridors. The City of Johannesburg Strategic Integrated Transport Plan Framework identifies a high-level public transport network for 2040, based on population growth, areas of employment growth and projected densities. It has identified several key public transport corridors, consolidating growth and development opportunities around existing and future public transport nodes, starting from the Corridors of Freedom linking Soweto, through the Inner City, to Sandton (along Empire-Perth and Louis Botha Avenues) and linking Turffontein into the Inner City (see figure 2). This will also include a focus on transit-oriented development nodes, including Gautrain, Rea Vaya (BRT) and Metrorail stations. Some of the public transport corridors will function as transit corridors, transporting large numbers of people from one part of the city to another. Other public transport corridors have the potential to grow into development corridors, with the opportunity to not only link mixed-use development nodes but to articulate public transit with housing, new employment activities and social amenities, while optimising investment capacities (Mbatha and Gumbo, 2019).

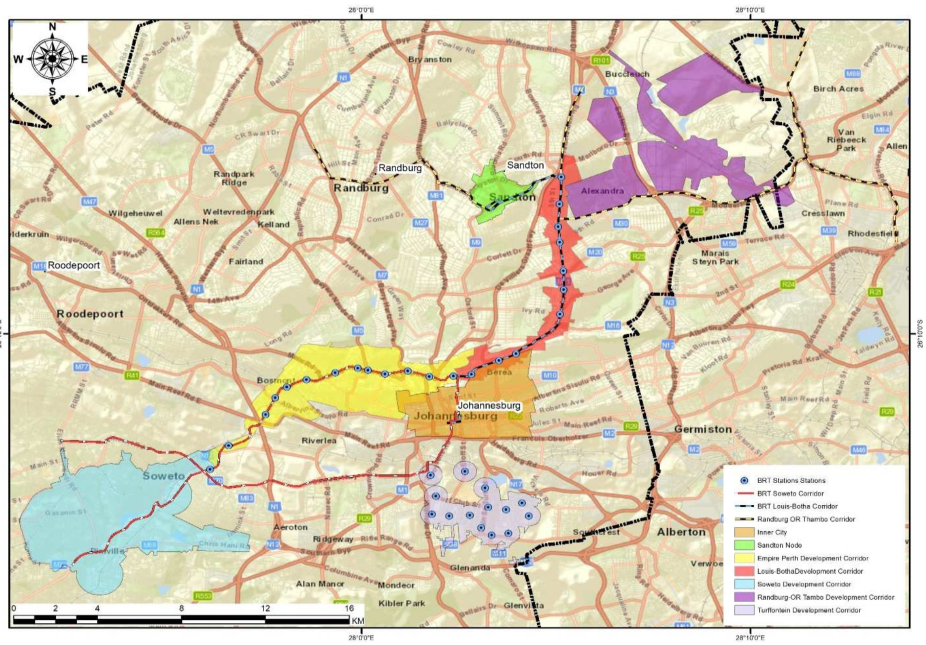

Figure 2: City of Johannesburg Corridors of Freedoms and Development Corridors Map

As depicted in figure 2 above, the proposed Corridors of Freedoms and development corridors are significant as mobility spines from a high-level perspective within the Gauteng City Region. They are also public transport and pedestrian spines, supported by existing active street edges and land-uses. They have the potential to transform entrenched settlement patterns that have kept many communities at the outskirts of the city, away from access to jobs and growth. They can also guide future city growth towards areas best serviced by transit infrastructure and the full range of vibrant urban amenities and services. The intention of the current initiative is to optimise development in and around high intensity movement corridors to create more accessible opportunities for the residents of Johannesburg and economies of scale that are attractive to investors. As such, future growth around these corridors is envisaged as medium to high-rise residential developments growing around the transit nodes, gradually decreasing in height and density as development moves further away from the core. Social infrastructure, schools, clinics, police stations and government offices will be strategically located to support the growing population. The future vision is premised largely

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on theories and best practises around the notion of TOD. This seeks to create urban spaces with a vibrant mix of high-density residential developments, office, retail and recreational spaces within walkable precincts anchored by high quality social amenities.

4.1 The Louis Botha Avenue Development Corridor

The Louis Botha Avenue Development Corridor represents one of three strategic frameworks that deal with the medium-term scope of the Corridors of Freedom, the other two being the Empire Perth Corridor, and the Turffontein Corridor. The Louis Botha Avenue Development Corridor is located to the north-east of the Inner City, between the CBD and northern parts of the City around Alexandra. The southern parts of the corridor study area are predominately residential in nature, encompassing some of the oldest residential suburbs in the City. Further northwards, the corridor passes through several key commercial and industrial areas, such as Bramley, Kew and Wynberg. The corridor is well connected to existing key nodes and elements in the City, including Midrand to the north, a key growth and employment node; the Modderfontein/ Greenstone area, a significant future growth opportunity for the City, and Sandton, one of the key economic nodes to the north of the City. The corridor further links to adjoining metropolitan Municipalities and is one of the main connectors bringing together people and jobs from neighbouring municipalities. Planned inter-modal facilities, such as the envisaged terminal at Watt Street will strengthen this function. Figure 3 below depicts the Rea Vaya Louis-Botha corridor and Louis-Botha development corridor.

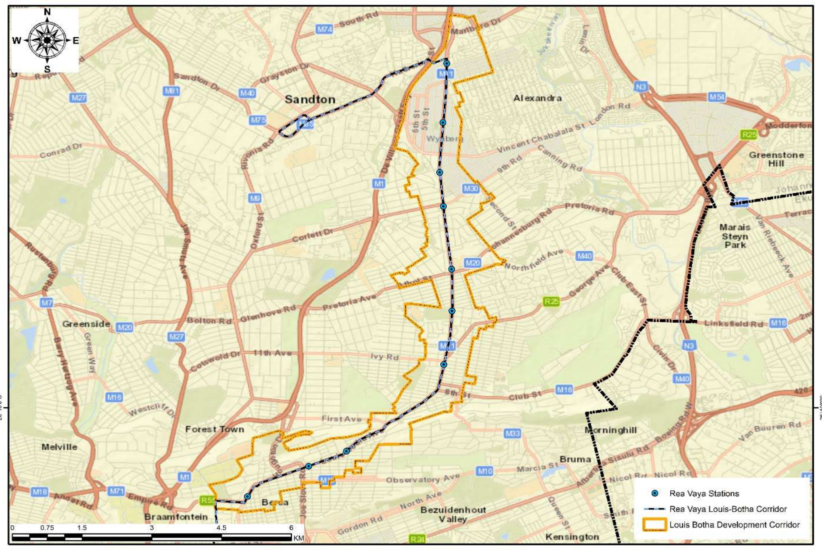

Figure 3: Louis-Botha corridor of freedom

The Louis Botha corridor forms part of Phase 1C of the Rea Vaya BRT. Louis Botha Avenue will function as the trunk route along which services will operate between the CBD and the Alexandra and the Alexandra and Sandton Nodes, connecting with existing Phase 1A and 1B service. Along this trunk route, buses will operate within the medium of the roadway with a segregated right of way. Trunk route stations (in the median) facilitate the physical integration between trunk routes, complementary/feeder services and other public transport systems, and provide strategic locations for future development. Minibus taxis and rail transport constitute the largest proportion of the existing public transport mode share. The Phase 1C of the Rea Vaya system also aims to strengthen public transport services between the CBD and Alexandra/Sandton. Most parts of the Louis Botha Avenue Development Corridor are serviced by the Gautrain Feeder and Distribution service. It is therefore imperative to promote integration between the Rea Vaya and Gautrain services, as Gautrain commuters from Marlboro Station could access the numerous economic, institutional and education opportunities in the corridor by means of public transport. The stations forming part of the Rea Vaya system are critical interventions for realising the benefits of Transit Oriented Development. Sidewalk facilities have been provided on most Class 2 and Class 3 roads but are inadequate, as the network is discontinuous and poorly maintained. In many cases, street furniture has reduced the effective width of sidewalks. No dedicated cycle facilities currently exist, although the City of Johannesburg is currently busy implementing cycle lanes in selected areas.

The Louis Botha Avenue Development Corridor is broadly serviced by the city's existing Metro Bus service, with most suburbs having some degree of walkable access to this service. With the introduction of the Rea Vaya network, however, a process of alignment is soon likely, which should see the optimisation of the Metro Bus system with reference to integrating public transport with systems such as the Rea Vaya. The north-east of the Inner City, which comprises parts of Hillbrow and Parktown is characterised by intense levels of development. Hillbrow remains one of the key inner-city residential areas, and there are isolated opportunities for densification through infill development and redevelopment of certain structures that remain. However, much of the opportunity associated with the current initiative relates to ensuring good connectivity to the planned Rea Vaya stations and consolidating and enhancing the supporting social and community infrastructure that exists in the area. Clarendon Station is the first of the Rea Vaya Stations proposed between Hillbrow and Parktown. The location of the station enjoys good accessibility to the Hillbrow side of Louis Botha Avenue, but relatively poor connectivity to the western side of the road, into the Parktown areas, due to the lack of local connections into this area. It is proposed that a pedestrian/NMT link be pushed through the block west of the Clarendon Station, to tie into Park Street.

Wynberg and Alexandra is anchored by the proposed Watt Street BRT Station and interchange. In terms of prevailing land use and character, the Wynberg area is predominantly industrial with some commercial activity around the Watt Street area. The areas east of Louis Botha Avenue, towards Alexandra, have undergone extensive growth over recent years, with the development of the Pan Africa Mall. These reinforce the strong east-west movement flow, much of which is pedestrian in nature, moving across Louis Botha Avenue towards Sandton. Peak hour pedestrian flows along this route often exceed 1000 people per hour. Movement and connectivity in the Alexandra and Wynberg areas is strongly influenced by the current treatment of Louis Botha Avenue, with the road being more divisive than integrative where it runs through the area. This is due in part to a median barrier which runs along the middle of the route, as well as service lanes which tend to limit integration between the road and the adjoining properties. The Marlboro portion is comprised of portions of the suburbs of Wynberg, Alexandra, Marlboro, Marlboro Gardens and Marlboro South. The area has the potential TOD opportunity for the current stage of the Rea Vaya system, with the route shifting westwards along Lees Avenue and across the M1 Motorway towards the Sandton CBD area. The final station offers good levels of accessibility into the adjoining areas.

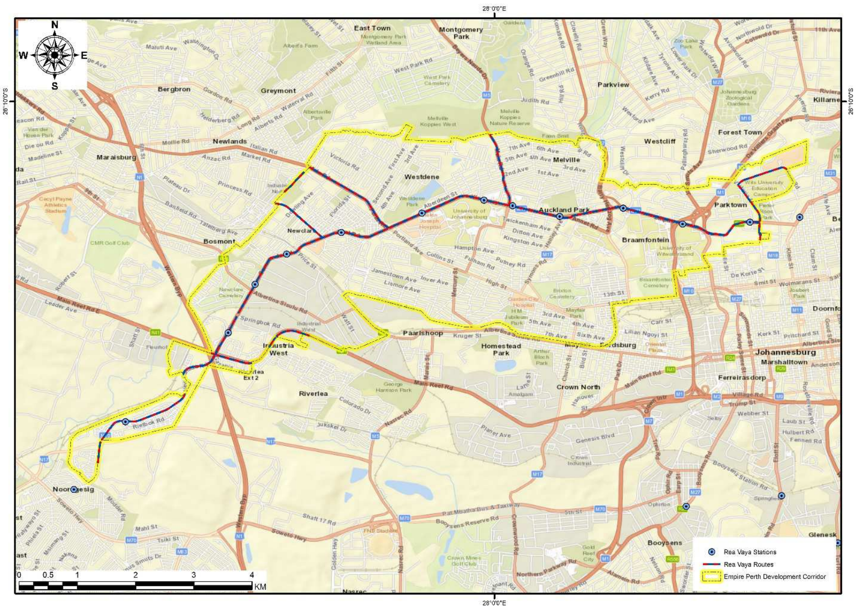

Figure 4: Empire Perth Corridor of Freedoms

4.2 Empire Perth Development Corridor

The Empire-Perth Development Corridor is in Region B of the City of Johannesburg, immediately to the west of the central Business District of Johannesburg. It serves as a regional, national, and continental node and is a thriving centre of trade and increasingly, a living environment to many diverse user groups. It forms part of a large movement corridor and has traditionally been the link between the densely populated residential settlements of Alexandra in the North and Soweto on the southwestern periphery of

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Johannesburg. In the current context, the corridor thus connects two of the most significant settlements affected by apartheid in Johannesburg, linking vast population groups with employment, education and recreational facilities situated along the corridor and in the CBD. Due to its strategic location, the corridor is also an important metropolitan link between the western regions of Johannesburg and the CBD. Several important metropolitan links exist between the wider western regions of Johannesburg and the CBD. Further important metropolitan routes and rail links cross the corridor and the Rea Vaya Trunk route along Empire Road. Figure 4 below depicts the Rea Vaya Empire Perth corridor and Empire Perth development corridor.

The Empire-Perth corridor forms part of Phase 1B of the Rea Vaya and will function as the trunk route along which services will operate between Soweto and the CBD connecting with the existing Phase 1A service. Along this trunk route, buses will operate within the median of the roadway within segregated rights of way at a peak hour frequency of 1 bus per minute. The Phase 1B of the Rea Vaya System aims to strengthen public transport services between the CBD and Soweto. This Public Transport Spine should be supported by complimentary modes of public transport, including conventional Bus networks as well as the Commuter rail network that traverses the corridor area. The trunk route will be supported by complementary routes (extended, circular routes that connect to the main route), as well as feeder routes (routes from outer suburbs that join the trunk route at key stations) that will extend to places like Yeoville, Cresta, Florida, Parktown and the Charlotte Maxeke Hospital. Trunk route stations (in the median) facilitate the physical integration between trunk routes, complementary/ feeder services and other public transport systems and provide strategic locations for future development. The corridor is a connecting point for various districts and areas in Johannesburg and functionally can be viewed as a destination corridor. The corridor is regionally very accessible via private and public transport, with Rea Vaya, Gautrain Feeder services and future high-speed Metrorail services all servicing the corridor area. On a metropolitan scale, the corridor is a gateway between the traditional marginalised areas and the economic, education and recreational opportunities situated not only along the corridor, but in Central Johannesburg. Its current and future function in terms of connecting a vast number of Johannesburg residents with a wide range of opportunities makes the Empire-Perth Corridor a 'Corridor of Freedom'. The area earmarked for the Empire-Perth development corridor comprises of a buffer-zone situated around the existing Trunk Route 1B of the Rea Vaya Network and extends from Empire Road in Parktown in the East westwards to the intersection of Commando and Main Reef Toad in Riverlea. Trunk Route 1B provides a link between the northern and southern parts of the city through the centrally located institutional corridor along Empire and Perth Roads. The location of the area within the city context elevates the potential to restructure the city and bridge the development gap between the south and the north while creating opportunities for accommodation related to tertiary education and other economic and social institutions in the area.

The Parktown and Braampark areas, situated on the eastern boundary of the corridor are served by the Parktown J1 Gautrain Feeder Bus service. This service links the important office and business node of Parktown, as the Charlotte Maxeke Hospital with park Station. The service runs adjacent to the proposed Rea Vaya Trunk route on Empire Road (between Victoria and Queens Road) and could potentially form an integral part of the local network in terms of providing a regional entry point to the corridor on the eastern boundary. It is imperative to promote integration between the Rea Vaya and Gautrain Services as many Gautrain commuters from Park Station could potentially access numerous economic opportunities and institutional and educational facilities in the corridor by means of public transport. The stations forming part of the BRT system are critical interventions in terms of realising the benefits of Transit Oriented Development. The corridor is also served by strategic rail services including the main line linking Johannesburg CBD with Soweto (Naledi-Park). Rail station within the corridor are Croeses, Industria, Langlaagte, Newclare and Westbury. Langlaagte Station handles the largest number of commuters, especially during the morning and afternoon peaks. Langlaagte Station is also considered as both an origin and destination station given the large number of commuters boarding and alighting during the morning and afternoon peaks. Croesus Station is second in terms of the number of commuters going through the station. However, given the largest number of commuters alighting during the morning peak and the large number of commuters boarding during the afternoon peak, Croesus Station is considered a destination station. Longdale Station is close third in terms of commuter number and is also considered a destination station based on its commuters' number. New Canada Station in the southern part of the Corridor area, has short term potential to develop as a significant TOD precinct, with PRASA currently planning substantial housing and mixed-use development within walking distance of this station. Integrating public transport services and improving linkages between rail and Rea Vaya stations is thus crucial to promote a modal shift away from private transport to public transport.

Different areas within the corridor are currently characterised by different types of streetscape and layouts which inevitably influences the movement of people between areas, including to and from transport facilities. Sidewalk facilities have been provided on most Class 2 and Class 3 roads but are inadequate as the network is discontinuous and poorly maintained. In many cases, street furniture has reduced the effective width of sidewalks. No dedicated cycle facilities currently exist through City of Johannesburg is currently implementing cycle lanes in selected areas. Walking distance from several Rea Vaya Stations indicate the impact of large barrier such as the University campuses and the natural ridge within the corridor. Though situated no more than 400m from the station, certain locations in Brixton are more than 2km in terms of walking distance from the nearest station.

4.3 Turffontein Development Corridor

Turffontein is situated in Region F of the City of Johannesburg, immediately to the south of the CBD. The northern portion of the site consists of a swathe of industrial land, warehousing and storage spaces, the remnants of the city's historic manufacturing hub. While industrial activity may have changed substantially in the city, the built form of these industrial areas continues to attract light industrial and warehousing functions. This industrial space is contiguous with a band of partially active mining land, some of which may be reclaimed in the near future. This east-west mining and industrial belt separates the inner city from the lower density residential areas such as Turffontein, Kenilworth and Rosettenville in the south (See Figure 5).

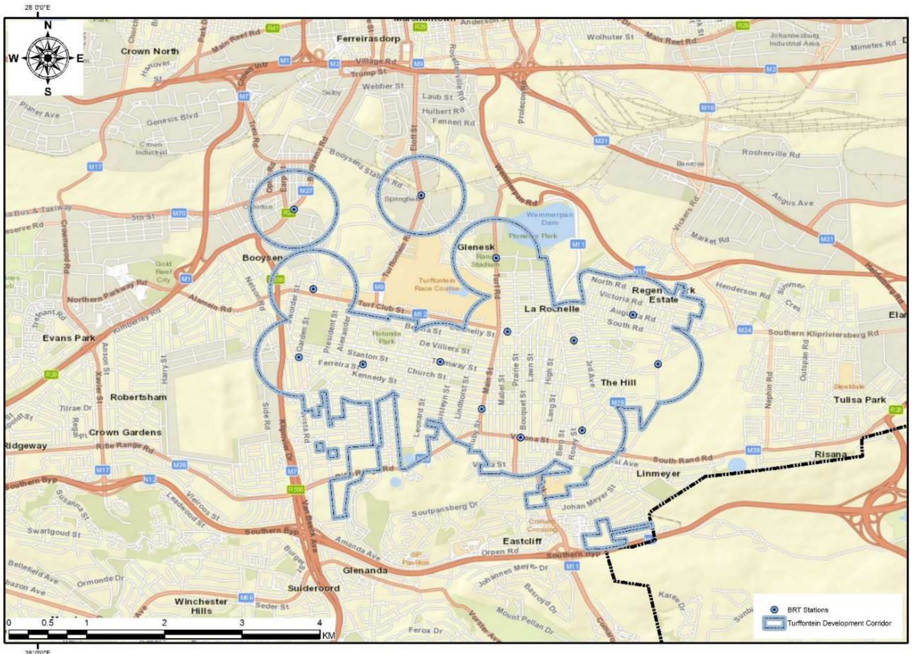

Figure 5: Turffontein Development Corridor

As depicted in figure 5 above, situated to the south of the Corridor area are the very low-density residential areas of Glenvista, and further south Alberton. These areas are interspersed with agriculture activity and some significant natural resources such as the Klipriviersberg Nature Reserve and the scenic East West Ridges/Koppies. Due to its strategic location, the area is well integrated with the surrounding urban areas. All major arterial roads originate from the CBD and radiate out into parts of the city. This includes the national routes N1, N3, N12 and N17 and makes the Turffontein area highly accessible from a local and regional point view. The CBD also houses several key transportation nodes (such as railway station, bus terminuses and large taxi ranks) that are important to national and sub-Saharan movements of goods and people. The existing public transport infrastructure and services in Turffontein are inadequate, given the city's intent to radically transform and re-stitch the city. The identification of a high-quality public transport route linking Turffontein with the wider Rea Vaya Network is central to the Corridor of Freedom initiative for Turffontein. The new public transport route is pivotal in terms of determining future densification and land use strategies in Turffontein and is thus one of the catalytic projects aimed at unlocking the full development potential of the wider area. The proposed route links several destinations including the Johannesburg CBD, industrial and mining belt, Faraday, Village Main and Booysens Rail Station and recreation facilities in and around Pioneer Park, Turffontein Racecourse, and the residential suburbs in the Corridor area. More importantly, the feeder links Turffontein with the Johannesburg CBD, thereby connecting the area with the wider Rea Vaya network, consequently increasing the viability of public transport as a feasible mode from and to the area.

The City of Johannesburg Integrated Transport Plan Framework includes a public transport mode decision matrix which provides guidelines in assessing the role of each mode of transport in possible future transport systems. Given the need for a high-quality public transport service in the area, especially in terms of frequency and level of service, it is proposed that the route be classified as a Rea Vaya feeder. The demand for commuter transport is the determining factor in terms of the mode of public transport. Increased future demand because of the strategic densification in the Turffontein corridor could potentially necessitate a higher order public transport service. Thus, the implementation of a feeder or complimentary route serving the Turffontein area is the main objective of the first phase of the project. Whilst there will be further work that needs to be done on the configuration and viability of the route and service, it is envisaged that the future population of the area will generate sufficient peak hour trips to warrant the possibility of Phase 2 (possible trunk route/ dedicated busways) of the project.

The Turffontein area is served by variety of public transport services linking the area with the CBD and surrounding areas. Metrorail, Metrobus and Minibus taxis operate in the area, with taxis having the largest modal share. Booysens Station is the only significant Metrorail station in the area, functioning as the main link for workers wanting to access the employment opportunities in the industrial belt. Currently no Rea Vaya plans are in place for the Turffontein region, however, based on the current movement patterns and densification strategies proposed as part of the Corridors of Freedom initiative, the future developments in the area could possibly be better served by a public transport feeder route providing a high-quality link between the area and the wider Johannesburg. The three metrorail stations within the corridor area generally appear to be in a state of degradation and are poorly integrated with the surrounding urban environment. Booysens Station is particularly cut off from the industrial area due to the lack of a northern entrance to the station. Booysens could potentially play a more significant role in providing access to the industrial belt and Turffontein area. It is imperative for this station to be connected with the industrial belt, as the current layout is preventing it from functioning optimally. Only 25% (2172) of commuters' board trains at these three stations during the morning peak indicating the limited extent to which these stations are used by residents (Moyo et al., 2021). This movement pattern is reversed during the afternoon peak, as these workers return homewards to areas outside the corridor area.

The area is served by several Metrobus routes, and given the radial pattern of the Metropolitan network, generally provides north south linkages between Southern Johannesburg and the CBD (mainly Ghandi Square and Braamfontein). Although the municipal bus network adequately serves the area in terms of coverage, the irregular operating times of these services limits the ability of residents to solely depend on public transport as a means of accessing adjacent areas. In terms of the Metrobus service, however, the municipal bus fleet contains only six (1% of total fleet) special needs buses, with none of these operating on any of the routes serving this area (Mbatha and Gumbo, 2019). Bus stops and facilities are in a state of disrepair. The majority of these are in a bad condition and currently contribute to the general negative perception towards public transport in the area. Furthermore, buses run at capacity within the morning peak due to the low frequency service. Analysis of Movement and Connectivity. The major north-south movements within the Turffontein area are along Kliprivier and Prairie Roads, which are representative of the proximity and the strength of the job base of the city north of Turffontein. However, most of this north-south movement is external through traffic travelling directly to and from the city. Through movement plays a major contribution in terms of traffic volumes on roads. It is not practicable to disregard or prevent this movement occurring as it is currently perceived to provide support to local economies. Regional east-west movement occurs via the M1 and N12 motorways, with lesser movement along Turf Club and Rifle Range Roads. Moving forward, these roads must be managed effectively such that mobility needs do not compromise the accessibility requirements of internal movement. However, on a larger scale, it must be recognized that continuously providing for private vehicle travel based on current trends is not sustainable and viable. As such, stronger emphasis should be given on providing infrastructure and directing land uses which support shorter trips via public transport, walking and cycling. Local motorised and non-motorised trips are generally characterised by shorter trips. These are generally local trips such as recreation or shopping jaunts. There are a variety of local employment, educational, social, and retail opportunities within Turffontein.

4.4 Spatial Analysis of existing transport infrastructure and Corridors of Freedom

The existing public transport infrastrcture and services in Johannesburg are spatially disintegrated and inadequate, given the city's intent to radically transform and re-stich the city. Spatial connectivity through multimodal public transport networks is still not effective pursued. This has led to creation of modes of public transport which are operationally disintegrated. Even different types of innovative urban public transport systems (Gautrain and Rea Vaya) operate independently of other existing forms or modes. Thus, duplication exists of multiple modes of public transport in the same geographical area without making any difference is inevitable. The proposed Corridor of Freedom routes, as illustrated in figure 6 are central to linking industrial areas, business nodes, mixed use nodes and residential areas.

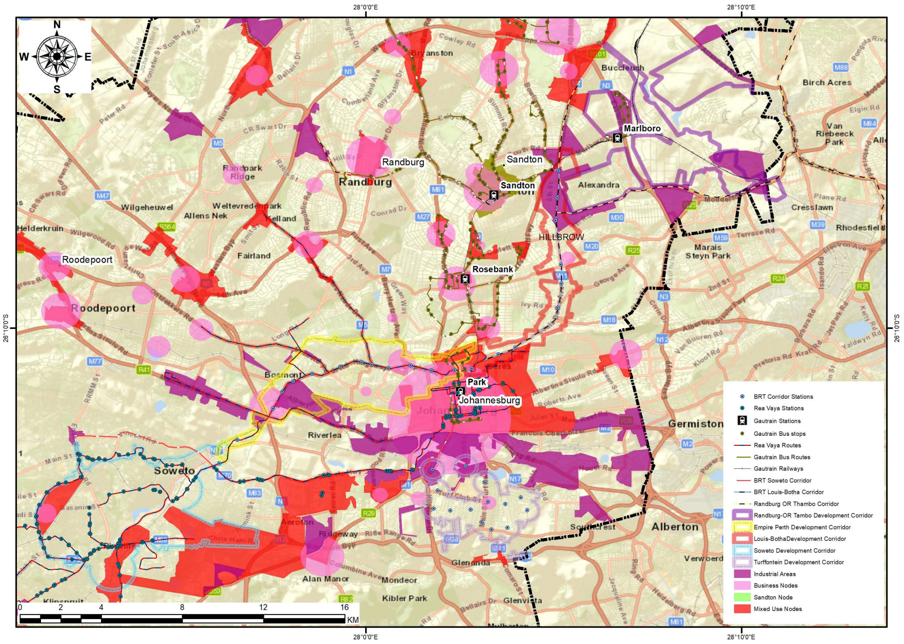

Figure 6: corridors of freedoms, public transport infrastructure, and nodes map

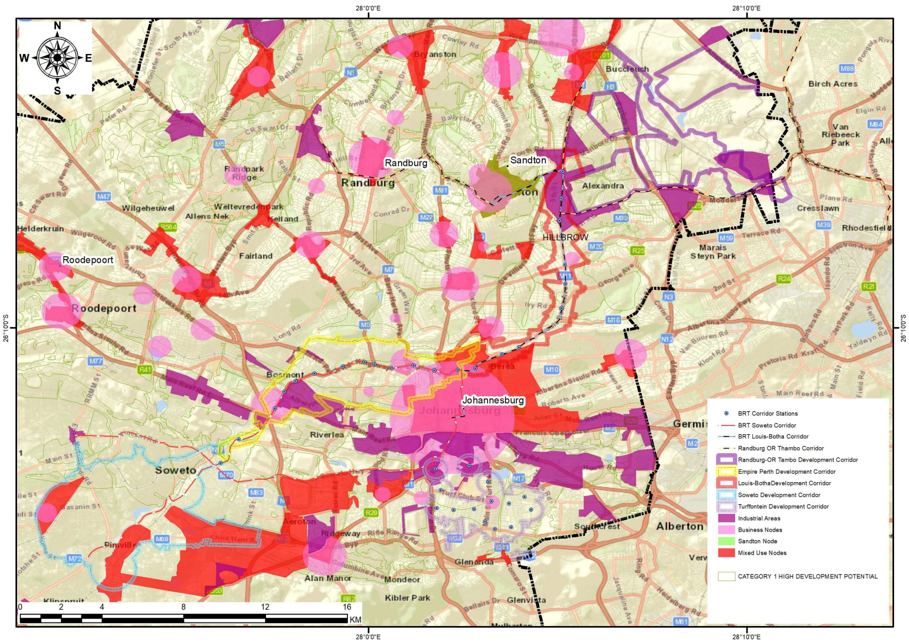

Figure 7: Corridors of freedoms, development potential areas, and nodes map

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As depicted in figure 6 above, the shape of the future city consists of well-planned transport arteries linked to intechanges with focus on mixed used development, high density accodmodation, suppoted by retail development, office buildings and opportunities for leisure and recreation. Joburgers in this future will live closer to their workplace and be able to work, stay and play without having to use transport motorised transport. Affordable, safe, and convenient buses, cycling and pedestrian activity will replac the carbon-burining private car. Ndwandwe (2017) stated that the average travel time between home and work for commuters making use of public transport is 59 minutes. More than 1.3 million South Africans spend more than two hours a day travelling to and from their places of residence. This can be added at leat 30 minutes per trip spent onwalking towards a station and stop and wating for the bus or train to arrive. The Corridor of Freedom will transform entrenched settlement patterns which have shunted the majority of resedents to the outskirts of the city away from economic opportnuities and access to jobs and growth. Figure 7 below depicts Corridors of freedoms, development potential areas as well as business nodes, industrial nodes, and mixed-use nodes.

5 DISCUSSION

Spatial inequality remains a defining characteristic of the settlement pattern of Johannesburg. The location and concentration of jobs does not match where people live. This job-housing mismatch significantly contributes to inequality in the city, as for many residents' access to economic opportunities is stifled by costly and distant commuting. Some of the highest densities of housing, the 'townships' inherited from apartheid spatial policies, are also some of the most deprived areas in the city, located far from areas of economic opportunities. Post-apartheid housing delivery has exacerbated apartheid spatial development patterns by building housing in areas far from economic activities, with the availability of land being the primary logic behind their location. The private sector, through car-oriented developments (for example malls and gated residential estates and office parks) has further aggravated spatial segregation. Newer townhouse and cluster developments have relatively higher average residential density. These new developments are focused on private use and are frequently located in single use clusters, with limited access to public transit infrastructure. As such, they generally do not foster walkable neighbourhoods and often have not been met with requisite public infrastructure. Some of the highest residential densities in the city are some distance from the core, and from economic activity. Soweto, Orange Farm, Diepsloot and Ivory Park for example reflect relatively high residential densities but are all limited in their land use diversity. These are characterized by controlled street patterns that have moved from the historically open grid to the clustered cul-de-sac, loop and 'lollipop' configuration contributing to fragmentation and low levels of walkability. Johannesburg is characterised, inter-alia, by peripheral or satellite nodes that are disproportionately large compared to and are disconnected from the main urban centre (inner city). It is also characterised by illogical density gradient residential areas. This means that many high-density residential areas are located on the outskirts of the city, and far from job and economic opportunities. This spatial contradiction translates into a significant impact in terms of social exclusion, energy, and carbon intensity (by increasing travel time and travel distances from jobs to housing). It also impacts economic productivity (by jeopardising agglomeration economies), with most commuter's flows being directed to the city centre.

The City of Johannesburg presently display the inverse of this polycentric urban model with separated land uses and people living far from work opportunities. The metropolitan core does not perform as the strong, structuring centred it should be. High density residential areas (the 'townships') are separated from urban economic centres and movement structures of the city. This pattern of development results in high social, economic and environmental costs. Thus, the Johannesburg SDF 2040 proposes a shift to a more efficient and inclusive urban logic of compact polycentricity with a focus on the Inner City as the core nodes of Johannesburg, surrounded by mixed nodes of various intensities connected by effective public transport and a more logical and efficient density gradient radiating outward from cores. The future polycentric Johannesburg will bring jobs to residential areas and housing opportunities to job centres (rather than merely transporting people between the two. It will bridge spatial and social barriers and build a framework for a spatially just city. With reference to the emerging spatial framework of the city, the following key spatial opportunities exist as a basis for moving towards a more compact urban form. Integrated development of business and residential densification should occur around key public transport facilities (existing and future); as a mixed-use response within the CBD, increasing intensity and capacity in the Inner City; Around current and future mixed use and economic nodes; within transformation areas identified in this SDF, specifically where nodes exist in these areas (for example the nodes and ToD nodes in Soweto); and around existing social service facilities, including schools, healthcare and public open space. Regionally, Johannesburg is the centre of the Gauteng province, which is home to 12 million residents, 25% of the South African population. Connectivity with the other countries, provinces, municipalities, towns, and cities will foster economic development through specialisation of activities and economies of agglomeration (Risimati and Gumbo, 2019).

5.1 Policy Frameworks Deriving Mobility Innovations and Lessons learnt

It is evident that the South African government has made a priority of improving transport systems through mega investment and strategic policy instruments. Moyo et al, 2021 observes that the South African urban public transport system has reached a crucial stage, with major cities (supported by national and provincial governments) already geared up to the implementation of innovative public transport infrastructure. City of Johannesburg seems to be the one at the centre of innovative transport systems initiatives, while other cities and towns have lagged. This is understandable, given the population concentration and major economic activities in metropolitan cities. Johannesburg is embarking on new spatial plans in line with the 2040 Johannesburg Growth Development Strategy and Spatial Development framework, 2040 based on transport-oriented expansion with a high-level public transport network. Built on population growth, areas of employment growth, and projected densities; the city has identified a number of key public transport corridors These consolidate growth and development opportunities around existing and future public transport nodes, starting from the Corridors of Freedom linking Soweto, through the Inner City, to Sandton and linking Turffontein into the Inner City. This will also include a focus on transit-oriented development nodes, including Gautrain, Rea Vaya (BRT) and Metrorail stations. The public transport corridors will function mainly as transit corridors, transporting large numbers of people from one part of the city to another. Other public transport corridors have the potential to grow into development corridors, with the opportunity to not only link mixed-use development nodes but to articulate public transit with housing, new employment activities and social amenities, while optimising investment capacities. Since the shape of the city will consist of well-planned transport arteries; the Corridors of Freedom will be linked to interchanges, where the focus will be on mixed-use development. The result is that the public will not have to use private transport but can opt for alternative means including cycling, transit lanes and pedestrian walkways.

6 CONCLUSIONS

This paper traced the spatial vision and mobility innovations envisioned for the City of Johannesburg. It was crucial to recognise the City of Johannesburg population dynamics, labour market activities and business operations to enable the study to contribute meaningful knowledge of city conditions. The existing spatial structure of the city and its short comings in terms of costly and distant commuting to access economic opportunities is also discussed with a closer look at how location and concentration of jobs mismatch where people live. The paper further discussed the City of Johannesburg new spatial plans in line the Johannesburg Growth Development Strategy and Spatial Development framework, 2040 based on transport-oriented development. Since the shape of the city will consist of well-planned transport arteries; the Corridors of Freedom will be linked to interchanges, where the focus will be on mixed-use development. Corridors of Freedoms and development corridors are significant both as mobility spines from a high-level perspective within the Gauteng City Region, as well as a public transport and pedestrian spines, supported by existing active street edges and land-uses. They have the potential to transform entrenched settlement patterns that have kept many marginalised communities at the outskirts of the city, away from economic opportunities and access to jobs and growth; and guide future city growth towards areas best serviced by transit infrastructure and the full range of vibrant urban amenities and services. Therefore, the Johannesburg public will not have to use private transport but can opt for alternative means including cycling, transit lanes and pedestrian walkways. The Corridors of Freedom will transform entrenched settlement patterns which have shunted most residents away from economic opportunities and access to jobs and growth.

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Spatial Trends of Adaptive Reuse Projects: Challenges and Opportunities for Developing Cities

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1 ABSTRACT

Contemporarily; there has been increasing complexity and interplay among issues associated with developing spatial forms and structures of urban areas to foster inclusivity and sustainability. Likewise, the emergence of the smart cities discourses has led to planning that is informed and supported by information and communications technology (ICT). Globally adaptive reuse project have been driven by a need to address the sprawl of vacant buildings in the city. These buildings have been neglected over time due to economic structural changes, technological changes and migration of people. This paper explores the spatial trends of adaptive reuse projects in the City of Johannesburg. The study employs a case study approach to assess the adoption and implementtion of adaptive reuse projects in Johannesburg, South Africa from 2002 to 2020. Using geolocation data from municipal records, the spatial location of adaptive reuse projects were visualised and assessed using an ArcGIS prediction analysis. A questionnaire was used to assess the sustainability parameters associated with these adaptive reuse projects. The results reveal accessibility, functional adaptability, and market demand as the key factors influencing the conversion of properties in the past 20 years. The spatial trends revealed locations with a high concentration (hot spots) of adaptive reuse projects being suburbs in the northern portions of Johannesburg, such as Bryanston and Randburg that have had a considerable influx of corporations expanding their operations. Moreover technologies to assess the locations of adaptive reuse projects have the potential to inform the policy and legislative instruments and frameworks on spatial planning to guide better developmental practises in the city.

Key words: adaptive reuse projects; sustainable; Johannesburg; information and communications technology; geolocation

2 INTRODUCTION

Contemporary developing cities are suffering from an acute lack of affordable housing and urban sprawl (Bakker et al., 2015; Hall and Posel, 2019). In South Africa, since the dawn of independence major cities have experienced rapid migration, with people seeking a better quality of life in cities where employment growth is high and social amenities more readily available (Harrison and Todes, 2015). Many people have settled on the outskirts of these cities leading to peripheral growth and less densification, and ultimately unrestricted urban sprawl (Harrison, and Todes, 2015). The migration coupled with high poverty levels and the legacy of apartheid spatial planning causes more people to look for more affordable housing and rely on the government to intervene (Bakker et al., 2015).

The end of apartheid brought accelerated economic growth, urbanisation and racial desegregation, which led South Africa's spatial planning into a self-correcting process to redress the spatial segregation and injustices of the past apartheid system (Bakker et al., 2015). This phenomenon is evident from the growth analysis of metropolitan cities such as Johannesburg, Tshwane and Ekurhuleni. These metropolitan cities, which are situated approximately 50 kilometres apart, are growing towards each other (Bakker et al., 2015), with Johannesburg in the south growing to the north and Pretoria in the north, expanding southwards and Ekurhuleni to the east of Johannesburg and south of Pretoria growing to the west towards Johannesburg and north towards Pretoria. These cities' spatial development growth has caused many companies to relocate to new economic nodes (SAPOA, 2017). The relocation was further made possible by public infrastructure investments such as the Gautrain, which unlocked property development opportunities along the transport corridors (Lombard et al., 2017).

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The growth in the number of companies relocating from what was previously the Central Business District to newly established economic nodes has led to an increase in the number of abandoned, dilapidated and vacant buildings (Vejby, 2015; Drewes et al., 2018) and, consequently in inner-city degradation (Drewes et al., 2018). In more recent times, the slowdown in the economy, coupled with reductions in space per worker requirements, has created new vacancies in the newer office nodes (Vejby, 2015). This has created a challenge for policymakers and developers to consider the adaptive reuse of office buildings to solve the housing backlog in South Africa's major cities and reduce vacancies in the office market.

3 RELATED WORK

Adaptive reuse refers to a process of assigning new use to a building without changing the original structure and material of the building by further extracting raw materials after demolition and deconstruction (Tan et al., 2018). While Vardopoulos (2019) defines it as a conversion process aimed at retaining as much of the original construction of a building while enhancing the functional performance or meet new function of any building. Adaptive reuse can take two forms, either 'within use' or 'across use' (Olivades et al., 2017; Aigwi at el., 2018). 'Within use' refers to adaptive reuse a building without changing the original function, or 'across use' refers to when the adaptive reuse of building assumes a new position from the original, such office to residential conversion (Olivades et al., 2017). Hybrid adaptive reuse refers to the type of adaptive reuse project where new components are added to the existing building to enhance the functional performance of a building to meet new spatial requirements (Adeyeye et al., 2010). Adeyeye et al., (2010) states that this approach combines existing buildings with new buildings to enhance the performance of the old. This study, however, focuses on 'across use' type adaptive reuse.

Adaptive reuse is driven by factors such as climate change, increase in migration and mass tourism (Luciani & Del Curto, 2018), technical innovation, investment momentum, financial distress, decreased Organisational footprint, networking concepts and sustainability requirements (Rovers et al., 2017). Other drivers of adaptive reuse include sustainability objectives, vacant and dilapidated buildings and housing needs (Remøy & Voordt, 2014). Local authority enacting policies that encourage conservation and regeneration in designated conservation areas and buffer zones (Remøy & Wilkinson, 2012). Land use planning is one of the main measures contributing to urban resilience and efficiency and a well-integrated and functioning urban system (Drewes et al., 2018).

Technological innovation is considered as the primary driver of corporate real estate decisions that allow companies to improve their operational efficiency. Thereby meeting new customer requirements, retain market share and seize competitive advantage through enhanced efficiency, staff reductions and reduced operating expenses to achieve the development of efficient running real estate portfolios (Rovers et al., 2017). The downsizing and operational efficiency results are the increase in industrial property vacancy due to less demand for building stock and drive the need for adaptive reuse of the commercial buildings evident in the current global trend showing a reduction in companies' real estate holding (Rovers et al., 2017). Rovers et al., (2017) states further that disposal is driven investment momentum, financial distress, decreased Organisational footprint, networking concepts and sustainable requirements. Corporate real estate disposal framework aims at ensuring financial optimisation by ensuring that all variables are weighted and selected independently. A team with diverse skills sets is assigned to the project, to aligne to real estate market cycle and buyers preferences. Lastly consideration of the future use after disposal is key as it guarantees the management of risk of business disruption and reputational repercussions.

The main aim of adaptive reuse is to preserve the historical and architectural integrity of the buildings, restore the obsolete and dilapidated urban areas, reduce the adverse impact on the environment while increasing efficient usage of material and energy resources (Petković-Grozdanovića et al, 2016). The other benefits of adaptive reuse are value creation for the area and the affected asset by converting them into tourism attractions that can contribute towards urban regeneration and sustainable development and generating economic, social and cultural benefits to the community (Vardopoulos, 2019). Adaptive reuse is cheap and faster and economically, socio-culturally, environmentally and sustainably beneficial to the communities (Aigwi, Egbelakin & Ingham, 2018). Adaptive reuse is an effective approach to regenerating inner city properties and embracing sustainability, and preserving heritage buildings (Aigwi, Egbelakin & Ingham, 2018). Conversion costs of adaptive reuse are lower than demolition and new-build and reduce high level of vacancy and dilapidation (Remøy & van der Voordt, 2014). The conversion of vacant offices was considered sustainable compared to demolition and new-build (Remøy & van der Voordt, 2014). Adaptive reuse is saves building materials and transportation and producing less waste than demolition and new construction (Remøy & van der Voordt, 2014). Property prices experience a positive increase after the completion of adaptive reuse or revitalisation project (Kee, 2019). In addition to the factors driving adaptive reuse benefits include an increase in the life of the building, less consumption of materials, reduce negative impact of old and dilapidated buildings and financial incentives (Dyson et al., 2015).

Critical Success Factors are described as a set of conditions, events and circumstances contributing to project success (Ika et al., 2012). Furthermore, Ika et al., (2012) consider a project as successful when it is relevant, efficient, effective, impactful and sustainable. According to the World Bank, in Africa, ten project development success criteria can be categorised into three as those related to the project management success, those related to project impact, those related to the project profile (Ika et al., 2012). Vardopoulos (2019) identify two types of factors affecting adaptive reuse, namely cause and effect factors. Cause factors refers to positive factors whose influential impact is greater than influenced impact and they are regarded as critical factors to the sustainable development, whereas the effect factors are negative and their influential impact is lower than controlled impact and are not regarded as stable and initiative factors affecting the system (Vardopoulos, 2019). Effect factors are regarded as a result of cause factors hence they are not regarded as critical success factors (Vardopoulos, 2019). Essential factors of success for developments projects can also be grouped into political, legal, cultural, technical, managerial, economic, environmental, social and physical factors (Lavagnon et al., 2011).

Factors bringing success to adaptive reuse development should include a set of revitalisation measures by the government to encourage the wholesale conversion or redevelopment and provide a useful reference to have a clear understanding of adaptive reuse. This will inform the provision of an incentive (Tan et al., 2018), technological innovation (Vardopoulos, 2019), development of regulations and expansion of stakeholder knowledge on sustainable development (Tan et al., 2018). Government policy on the provision of government subsidies stimulates owners or developers to carry out repairs and maintenance on old buildings. Assigning qualified professionals consequently plays a positive role in the success of rehabilitation projects (Sing, Love & Liu, 2019).

Overall the architectural criteria relevant for the success of the adaptive reuse of industrial facilities into residential buildings includes building spatial capacity, natural lightning, the possibility for the addition of open spaces to the housing unit, functional quality of the newly planned housing space and the case of introduction of vertical and horizontal communication (Petković-Grozdanovića, Stoiljković et al., 2016). These innovative municipal building codes refer to adaptive reuse of existing buildings (Olivadese et al., 2017). Linkages to public transport and integration with public and green spaces (Drewes et al., 2018) also increase the probability of project success. A critical step in the success or failure of the adaptive reuse process and consequently the project is the Identification of a new functional purpose (Langston et al., 2008).

In addition, the flexibility of the project, implementation approach, awareness and sense of urgency, professional capacity of the project team, networking and team composition and expertise, project management structure, selecting the right team for the project are also critical to the success of the project (Lavagnon et al., 2011). Other factors such as choosing the appropriate option like incremental implementation versus big bang, strong project management composition, extensive training, use of appropriate individuals, control environment and project implementation are also considered critical (Lavagnon et al, 2011, Vackland & Nieuwenhuijs, 2005), consistency of leadership, policy direction, availability of resources, number of people involved, the attitude of the project team, alignments to clients and stakeholders and potential customers, experience of the project team and local environment and market conditions (Lavagnon et al, 2011, Struyk, 2007), clear understanding of the scope, competencies of the project team, effectiveness of the project team, adequacy of the resources, continuing support and commitment to objectives, clear policy, adequacy of local capacities, strong ownership of the project (Lavagnon et al, 2011, Khan & Moe, 2008) and trust and effective communication (Diallo & Thuillier, 2005).

4 MATERIALS AND METHODS

The study employs a case study approach to assess the adoption and implementation of adaptive reuse projects in Johannesburg, South Africa from 2002 to 2020. Using an ArcGIS prediction analysis, geo-

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location data from municipal records showed that the spatial location of adaptive reuse projects was visualised and assessed. The City of Johannesburg has received approximately over 9185 applications for adaptive reuse of properties since 2002. To examine the applications' spatial locations, the study used word count as a parameterisation to measure the frequency of location names on the applications received by the municipality. Tagul was used to visualise the most frequent location names on the applications.

A questionnaire was used to assess the sustainability parameters associated with these adaptive reuse projects. The study relied on a questionnaire-based survey that was administered to 20 town/urban/spatial planners in the city of Johanneburg. The questionnaire was administered online through Google forms so as to obtain a good response rate. The questionnaire had closed and open-ended questions centred on two themes (see Table 1).

Theme	Description
The success of adaptive reuse projects	Factors influencing the success of adaptive reuse projects Critical challenges affecting the implementation of adaptive reuse
Spatial distribution of adaptive reuse projects	Locational trends Perceptions of professionals in the built environment

Table 1: Questionnaire themes

5 RESULTS AND DISCUSSION

The results reveal applications concerning properties from Bryanston had the highest number being 886 (see Figure 1). Bryanston is an affluent suburb in Sandton with many large companies such as Tiger Brands, Microsoft Corporation, and Google South Africa. This has over time grown the economic potential of Bryanston. Other locations with a high number of applications were Lenasia (305) and Ferndale (314). These suburbs are similar to Bryanston. Over the years, there has been a considerable influx of corporations expanding operations, which has had a positive impact on the suburbs' economy and has led to employment creation.

Figure 1: Word cloud of applications

Through interviews with municipal officials, these locations are cuurently referred to as nodes of economic importance. These nodes are relatively easy to access, with spacious landscapes and ample parking. Another reason for an influx of application at these locations is that the municipality has developed various initiatives to encourage economic growth in these areas, as seen through the Spatial Development Framework (SDF).

Another driving force why people decide to rezone properties has been that specific locations offer cost advantages, such as cheaper to buy an old building and rezone the property to a new use than to demolish and rebuild. However, from interviews with municipal officers, rezoning applications are not always approved as objections can be received against changing the rights of properties.

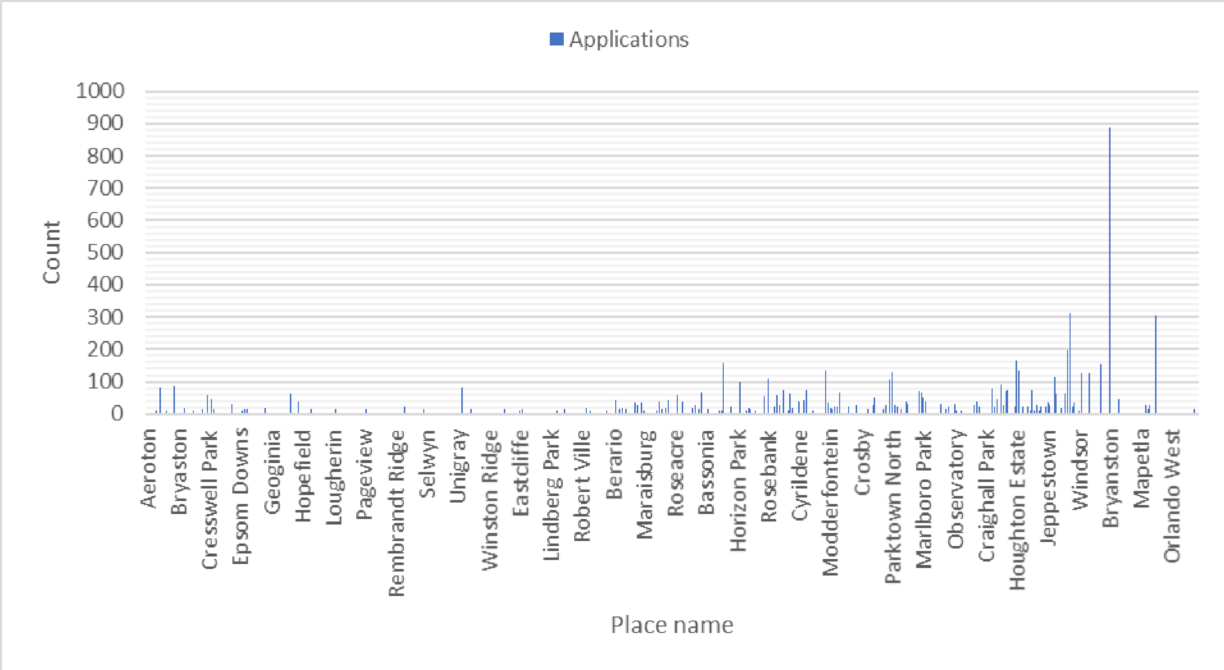

Figure 2: Location of properties vs number of applications

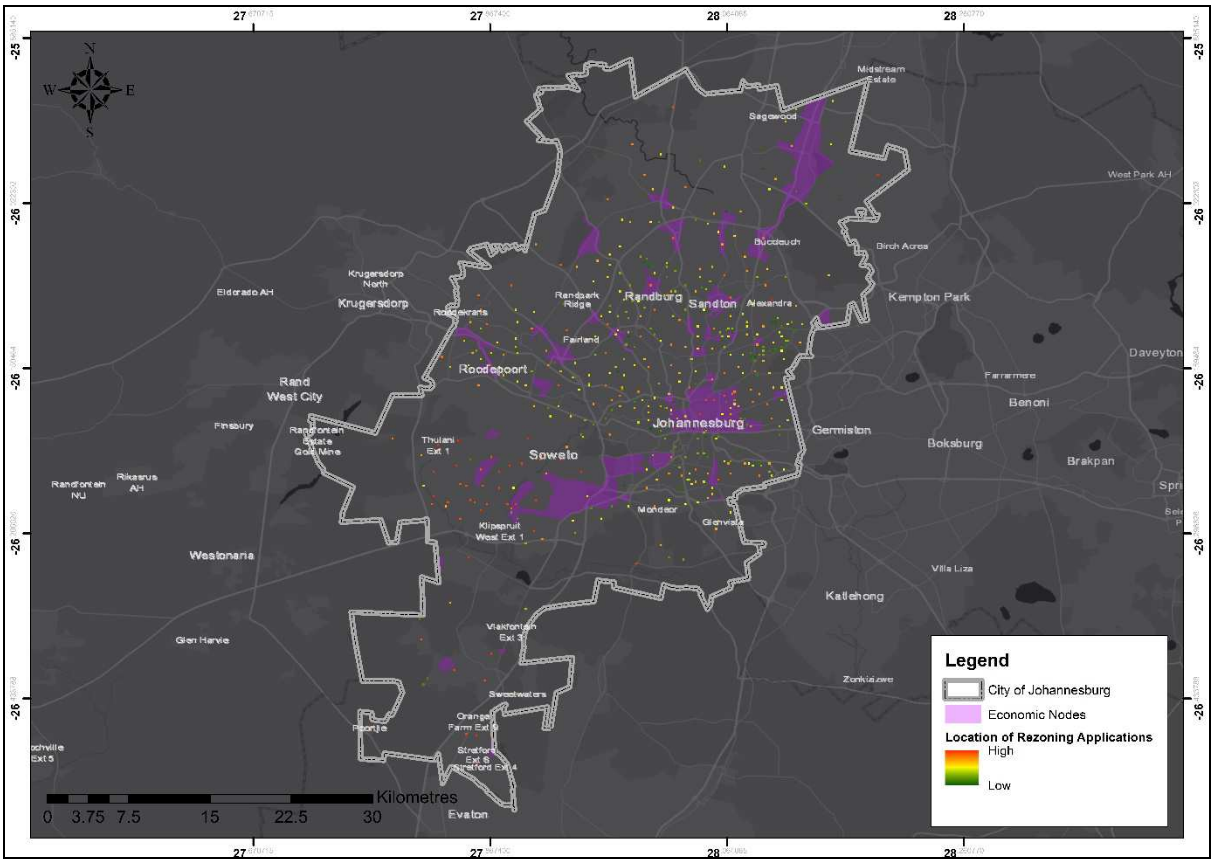

Figure 3: Spatial location of adaptive reuse projects

Figure 2, similar to the word cloud reveals the number of rezoning applications in comparison to the location of the property to be rezoned. Figure 2 shows the locations with the highest number of applications being properties in Bryanston with 886, Ferndale with 314, and Lenasia with 305. Location with applications

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between 100 to 200 was Dunkeld West with 158, Melrose with 134, Morningside with 196, Houghton Estate with 166, Melrose with 134, Rosebank with 111 and Parktown North with 131. This reveals a hot spot as locations in Johannesburg's northern parts have a high number of applications. Whilst locations to the south of the city have less than 100 applications submitted to the municipality.

The spatial distribution of rezoning applications was then visualised using Arc Gis Pro. Arc Gis Pro is a spatial analyst software used for analysing spatial data trends and creating maps. Figure 3 visualises the geographic location of the properties and presents the trends identified in Figure 2. Presenting spatial data in platforms such as Arc Gis Pro has the merit of visualisation of trends. From Figure 3, it is apparent there are a large number of applications for properties that are located at the Central Business Districts of the city.

Through interviewing members of the public and private sector, it was revealed, that although there a fewer rezoning applications from the south of the city, this is not an indication that properties are not converted from their original land-use rights. “There are limited applications from the Southern portion of the municipality due to limited law enforcement on properties to the south, as individuals illegally conduct business on their property without receiving approval from the council” an urban planner revealed. Hence, there is a need for more regulatory measures to ensure all land-use rights change is done through the rezoning process.

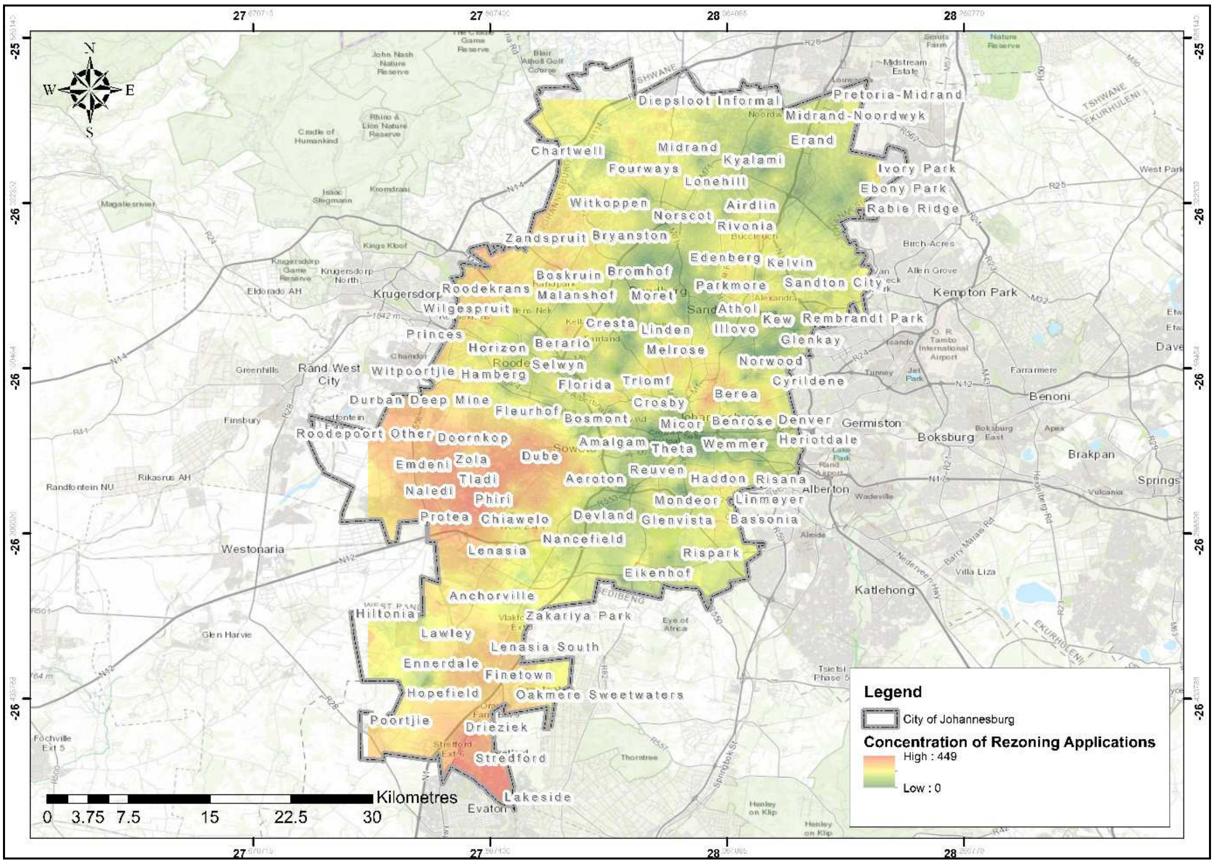

Figure 4: Prediction map of adaptive reuse projects trends

After assessing the spatial distribution of the properties, a need to visualise these trends arises to predict the growth in the number of rezoning applications based on the current distribution of rezoning applications. The research utilises the kriging interpolation tool in Arc Gis to predict the spatial growth of adaptive reuse applications. The results reveal hot and cold spots in the city. Figure 3 revealed a correlation between the economic nodes and locations with high number of applications. Figure 4 reveals a similar trend, whilst also revealing locations of potential economic growth as a hot spot belt is evident towards the South-West of Johannesburg.

An error analysis was then used to determine the margin of error from the prediction analysis from the input data being the blue line (see figure 5 and 6). The standard error revealed in the semi-variogram plot (see figure 6) reflects flaws in the prediction assessment and also reveals limitations on the procedure. A clear trend in the prediction is visible in the Normal QQ plot (see figure 5). The prediction model revealed a heavy-tailed normal QQ plot, which relates to data trends revealed in Figure 2, as shown by the degree of skewing of dots. In addition to spatial analysis, there is a need to reveal the key factors why certain locations attract a high number of requests than others, which was determined by assessing the questionnaire responses.

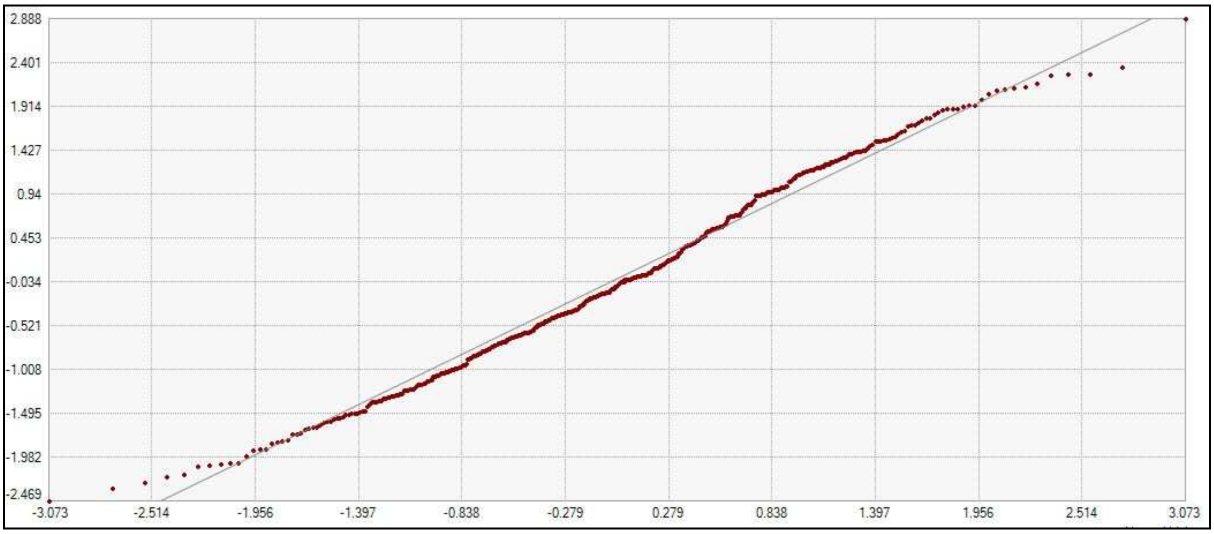

Figure 5: Normal QQ plot

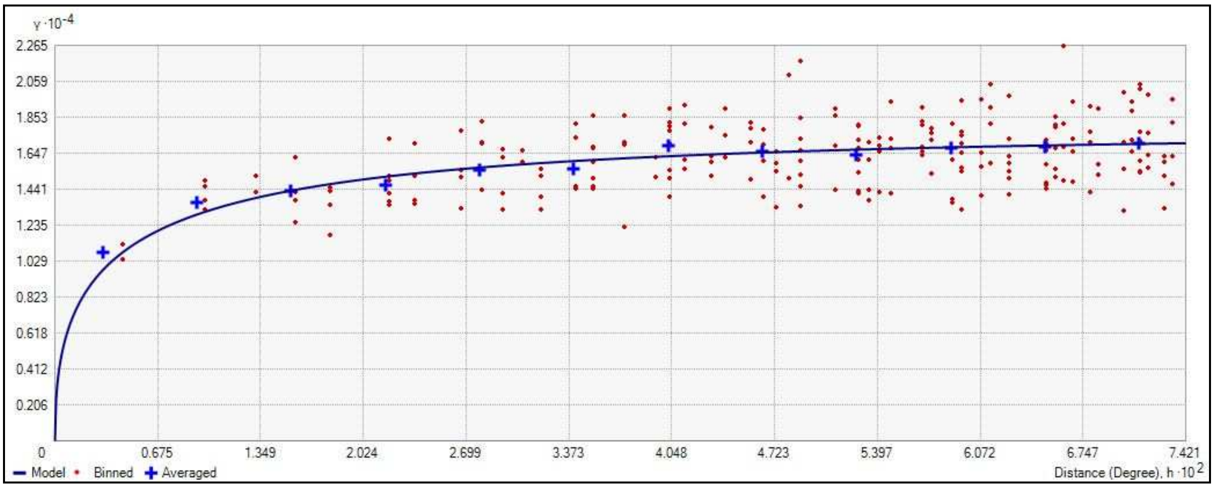

Figure 6: Semi-variogram

5.1 Factors Influencing conversion of properties

In both the private and public sectors, there is an overall agreement that adaptive reuse projects are essential when realising the economic potential of properties. From the private sector perception, this process has a great bearing, particularly in determining project success factors. These factors have over the years been used a ranking to determine which properties should be converted either from office builds to housing units or verse versa. Several challenges hinger whether a property shall be rezoned (see figure 7), among which technological difficulties (98) and conditions of service and systems (91). Functional changeability (82) was also noted as a key challenge, as properties whose key function is not easily changeable generally do not have many rezoning applications, as these general receive comments against the rezoning application from the council. Another notable impediments of rezoning are the space layout of the building (76). The space layout would be an impediment for a developer who wishes to only change the land-use rights of a building or property without changing the building's layout design.

Financial incentives (82) and market demand (74) are also key factors in determining the rezoning of a property (see Figure 8). When there is a high demand for business offices, council has noted there will be a high number of applications to rezone properties so that they have the rights to have business functions. While if there is a demand for housing facilities, there will be many applications to convert the building to accommodate the high demand for housing facilities. For example, a common scapegoat is that increased

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demand for low-cost housing councils will support rezoning applications that are in line with this demand. Another example application for properties located along the corridors of freedom is supported by council to boost economic activities along these corridors.

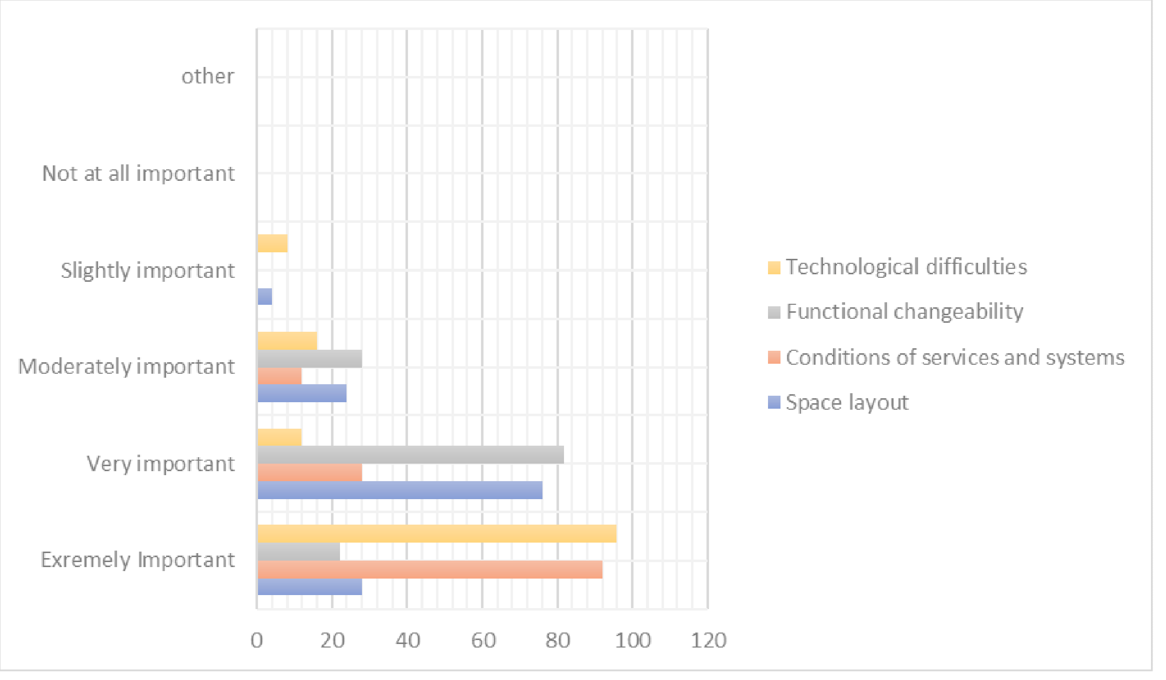

Figure 7: Perceptions of factors influencing adaptive reuse

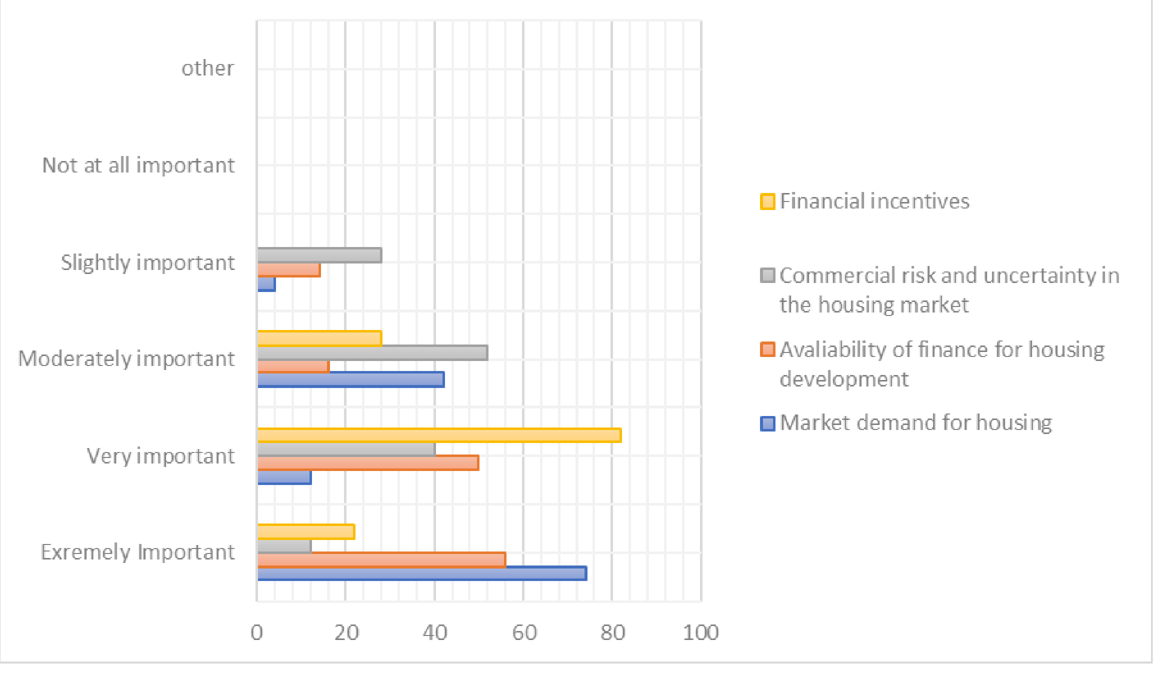

Figure 8: Critical challenges affecting implementation of adaptive reuse

Figure 9 reveals that the project timeline (97) and compatibility with existing surroundings (99) are essential factors in determining the nature of the rezoning application. Council has noted some applications are withdrawn by the applicate such as those that take long to be approved or those that may require the developer to attend a Tribunary to support an application after council has received comments against the approval of the rezoning application. Preservation of history and culture (52) is a moderate impediment, as builds of historical importance can only be rezoned according to guidelines of the National Heritage Resources Act (1999).

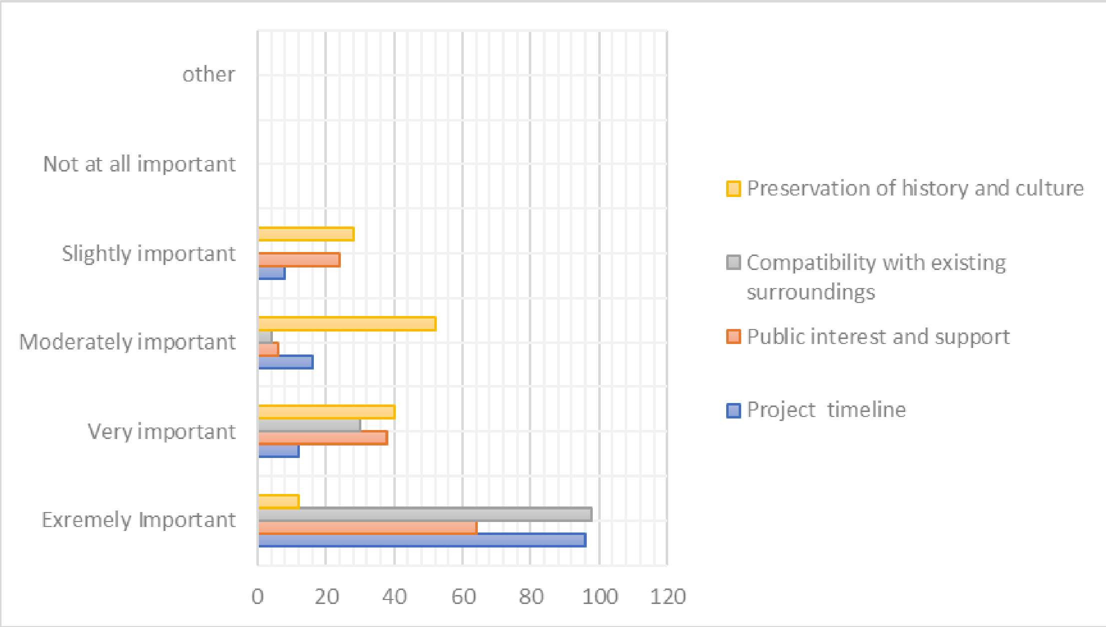

Figure 9: Challenges affecting implementation of adaptive reuse

Implications from the results reveal a need to view and acknowledge the development as a driver for change and infrastructure upgrades. There is a paucity of economic growth in the northern suburbs of Johannesburg. This has led to led to the further decline of Johannesburg's city centre. There is a need for strategic urban management that address the spatial-social divide of the city. However, there is still a key obstacle to inclusive development due to a lack of strong institutions to lead, coordinate and champion this approach. These issues are consistent with other cities across the country. The major challenge in Johannesburg's inner city and marginalised areas is to provide the conditions and the infrastructures that will enable individuals and businesses to develop.

6 CONCLUSION

The results reveal accessibility, functional adaptability, and market demand as the key factors influencing the conversion of properties in the past 20 years. The spatial trends revealed locations with a high concentration (hot spots) of adaptive reuse projects being suburbs in the northern portions of Johannesburg, such as Bryanston and Randburg that have had a considerable influx of corporations expanding their operations. Through assessing the spatial distribution of adaptive reuse, it has been observed that developing cities such as Johannesburg need planning that both promote innovation whilst also looking beyond mere economic needs. The golden era of smart cities referees to it, as a balance in infrastructure investments and a positive contribution to socio-economic transformation and sustainable development. This assessment reveals both the macro-level and micro-level implications of rezoning a property. Building conversions that do not address the community's needs generally receive comments against them during the public participation stage. Hence the developers should clearly outline how they would address the adverse implications of the building conversion as part of the supporting documents for a rezoning application. Moreover, technologies to assess the locations of adaptive reuse projects can inform the policy and legislative instruments and frameworks on spatial planning to guide better developmental practises in the city.

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Städtebau und elektrische Speicher – ein Zusammenspiel im Energiequartier

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1 ABSTRACT

Nachhaltige Energien werden primär außerhalb der Städte produziert. Dabei sind es die Städte und ihre Quartiere, welche einen beachtlichen Teil dieser Energie benötigen und verbrauchen. So entstehen Transportwege, die mit Übertragungsverlusten einhergehen. Außerdem stellt das Zusammenbringen von Energieerzeugung aus regenerativen Quellen- und dessen Verbrauch eine erhebliche Herausforderung dar. Auch aus diesen Gründen muss sich die Stadtplanung in den letzten Jahren vermehrt mit Lösungen für nachhaltige Energien in der Stadt beschäftigen. Sogenannte Energiequartiere bieten das Potential Erzeugung, Speicherung und Verbrauch lokal zusammenzubringen und so höhere Wirkungsgrade zu erzielen. Dabei stellt die Integration von elektrischen Speichern in den Quartieren den Städtebau vor neue Herausforderungen. Knappe Flächenangebote in der Stadt und Nutzungskonflikte der noch zur Verfügung stehenden Flächen sowie der Anspruch an eine qualitätsvolle Gestaltung machen neue Konzepte notwendig. Aus diesem Grund beschäftigt sich das Paper mit der Frage: „Wie kann ein Zusammenspiel im Energiequartier von Städtebau und elektrischen Speichern aussehen?“.

Das Paper definiert zunächst Energiequartiere und die damit einhergehenden Chancen und Herausforderungen für nachhaltige Energien im Quartier. Anschließend werden anhand von drei Konzepten in der Stadt Aachen Möglichkeiten der städtebaulichen Integration aufgezeigt. Zur Erstellung der Konzepte sind Analysen von mehreren Quartieren vorgenommen und anhand eines Kriterienkataloges miteinander verglichen und bewertet worden. Die Konzepte zeigen das Zusammenspiel von Städtebau und der Integration von elektrischen Speichern für unterschiedliche städtebauliche Strukturen und Typologien auf. Im Ergebnis wird graphisch gezeigt wie, und dass trotz unterschiedlicher Flächenverfügbarkeiten, eine qualitätsvolle Integration elektrischer Speicher in Energiequartieren möglich ist.

Keywords: Nachhaltigkeit, elektrische Speicher, erneuerbare Energien, Energiequartier, Stadtplanung

2 ENERGIEQUARTIERE IM STÄDTEBAU

Städte und Quartiere sind weltweit die größten Verbraucher von Energien, weshalb es sich nicht nur die Bundesregierung in Deutschland zur Aufgabe gemacht hat mit der Energiewende wesentliche Veränderungen und Anforderungen an die Energieinfrastrukturen zu stellen. Konventionelle Energiesysteme werden knapp und teurer, sie belasten die Umwelt und haben ungewollte Auswirkungen auf die Nutzer (Hegger et al. 2007). Zurzeit sind die Energieerzeugungsinfrastrukturen in der Regel auf zentrale Technologien mit fossilen Energieträgern ausgerichtet und befinden sich außerhalb der Städte. Ziel der angestrebten Energiewende ist eine Umrüstung auf dezentrale Strukturen mit Fokus auf regenerativen Energien, welche dort produziert und gespeichert werden, wo sie auch verbraucht werden. Damit schafft die Energiewende nicht nur eine Veränderung der Energieinfrastrukturen, sondern auch eine Neukonfiguration der Stadt (Blesl et al. 2020).

Die Themen rund um nachhaltige Energien werden vermehrt in einzelnen Gebäuden betrachtet. Auch die vom BMWi aufgestellten quantitativen Ziele der Energiewende zielen auf das einzelne Gebäude ab (BMWi 2015). Jedoch werden dabei die Potenziale außer Acht gelassen, welche den Einbezug von städtebaulichen Strukturen, einem Quartier bieten können. Unsere Städte und Quartiere sind komplex und müssen, auch wenn es um die Energiewende geht, in ihrer Gesamtheit betrachtet und in den Prozess integriert werden. Hier wird deutlich, wie wichtig es ist, die „Gebäude [...] immer im Zusammenhang mit ihrem Umfeld [zu betrachten]“ (Hegger et al. 2007: 62). Das Energieangebot wird letztendlich nicht nur durch die Gebäude, sondern auch durch externe Faktoren wie Klima, Landschaft, Topographie und auch dem Verkehr bestimmt. Dieser städtische Kontext verlangt nach Lösungen, welche auf lokal basierenden Begebenheiten beruht. (Hegger et al. 2007)

Ebenfalls werden neue Technologien vermehrt im Neubau angewendet, da dort eine Integration einfacher umzusetzen ist. Das Potenzial, welches Bestandsquartiere haben, wird damit außen vorgelassen. Dabei sind bereits 90 Prozent unserer Städte und damit auch Quartiere gebaut und das Ziel der Innenentwicklung vor Außenentwicklung mit dem Anspruch weniger Fläche zu verbrauchen zur Schaffung einer nachhaltigen Stadtentwicklung nimmt zu (Bundesregierung 2021). Daraus entsteht das Ziel der nachhaltigen Stadtentwicklung weniger Fläche im Außenbereich zu beanspruchen und die erhöhten Flächenbedarfe des Energiesystems durch dezentrale Lösungen zu begegnen (Blesl et al. 2020). Um diese Ziele zu erreichen gibt es bereits kleinräumige, oft nur auf das einzelne Gebäude bezogene, Untersuchungen und Umsetzungsbeispiele. Jedoch mangelt es an Untersuchungen auf städtebaulicher Ebene, wie die Stadtplanung die Möglichkeiten zur Speicherung von erneuerbaren Energien umsetzen kann.

3 ENERGIEQUARTIERE ALS POTENZIAL UND HERAUSFORDERUNG IM STÄDTEBAU

Den Potenzialen von nachhaltigen Energien im Quartier, und nicht nur in einzelnen Gebäuden, werden nun vermehrt Beachtung geschenkt. Auf städtebaulicher Ebene hat sich der Begriff der Energiequartiere etabliert. Unter Energiequartieren werden Quartiere verstanden, welche (überwiegend) durch nachhaltige, regenerative Energien versorgt werden. Die Quartiere produzieren dabei ihre benötigten Energien selbst, können diese Speichern und an ihr nahes Umfeld abgeben. Somit entsteht ein Kreislauf der nachhaltigen Energien im Quartier (siehe Abbildung 1). Energiequartiere bündeln damit einige Vorteile: es entstehen weniger Übertragungsverluste, neue Technologien im kleinen Maßstab können erprobt werden, höhere Wirkungsgrade können durch die lokale Erzeugung, Speicherung und Verbrauch erzielt werden und es besteht eine Unabhängigkeit vom zentralen System (Hegger et al. 2007).

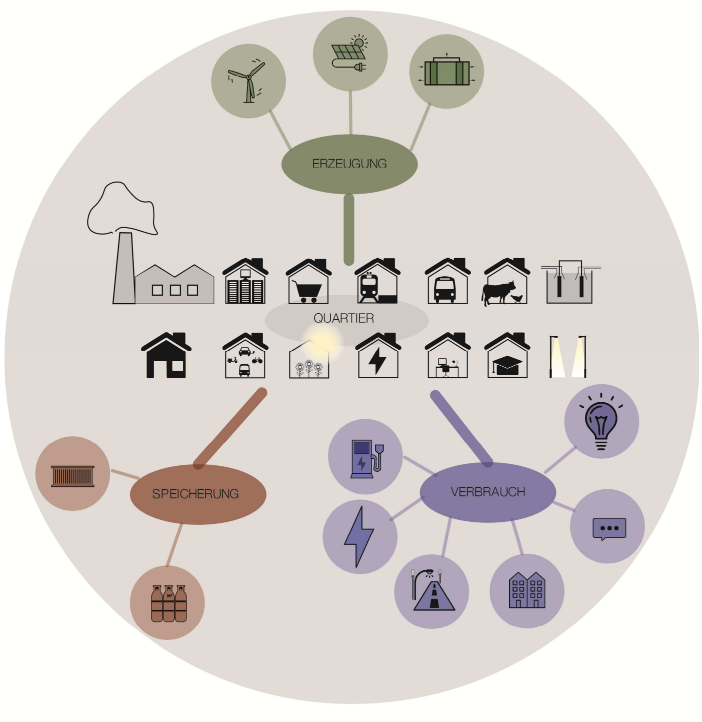

Abb. 1: Potenzielle Bestandteile von (Gleichstrom-) Energiequartieren

Quartiere und Energie zu verbinden bringt neben den Potenzialen einige Herausforderungen für die Stadtplanung mit sich. Eine städtebauliche Integration von Energiesystemen im Quartier erhöht einerseits die Lebensqualität, verbessert das Stadtimage und kleinere Analgen lassen sich leichter integrieren, jedoch erfordert es auch einen langfristigen Umbau der Energieinfrastrukturen im laufenden Betrieb, teils gibt es keine politischen Rahmenbedingungen, die Entscheidungen der Energieversorger sind nicht zwingend auf die der kommunalen Ziele abgestimmt und es können ungewollte Auswirkungen auf die Stadt-Umland Beziehung auftreten (Blesl et al. 2020). Eine weitere Herausforderung für die Stadtentwicklung stellt eine qualitätsvolle Gestaltung der Integration relevanter und raumwirksamer Energieinfrastrukturen dar. Auch das zur Verfügung stehende Flächenangebot zur Erzeugung und Speicherung der Energien ist in bestehenden Quartieren oft eingeschränkt und steht in Konflikt mit anderweitigen Nutzungen. Hier müssen sensible

Lösungen gefunden und Konzepte aufgestellt werden, wie die zu speichernden Energien städtebaulich in das Quartier integriert werden können.

Nichtsdestotrotz kann eine effiziente Transformation der Energiesysteme hohe Potenziale auf lokaler Ebene, dem Quartier, haben. Zum einen schafft die Integration von Energien in das Quartier ein Bewusstsein der Verbraucher, zum anderen kann eine lückenlose Versorgung gewährleistet werden. Das Quartier bietet einen geeigneten Untersuchungs- und Umsetzungsmaßstab zur Erzeugung städtischen Stroms, weswegen sich die sogenannten Energiequartiere gebildet haben.

4 EXKURS GLEICHSTROM & QUARTIERSSPEICHER FÜR ENERGIEQUARTIERE

Aktuell sind Stromnetze in aller Regel durch Wechselstrom geprägt (Hofman 2019). Große, zumeist im ländlichen Raum verortete Kraftwerke erzeugen in beachtlichen Generatoren zuverlässig und planbar große Mengen an Wechselstrom. Dieser Wechselstrom kann auf unterschiedliche Spannungsebenen transformiert und so über große Strecken transportiert werden (Dalheimer 2011). Im Gegensatz zu Wechselstrom, welcher durch seine Entstehung mittels rotieren Elektromagneten eine periodische Änderung der Fließrichtung der Elektronen aufweist, ist Gleichstrom durch eine gleichbleibende Bewegungsrichtung über die Zeit charakterisiert (Clausert et al. 2011). Gleichströme werden beispielsweise von galvanischen Elementen, z.B. Batterien, abgegeben, in denen eine nahezu konstante Ladungsverteilung aufrechterhalten wird (Scholz 2018).

4.1 Gleichstromnetze als Grundlage für Energiequartiere?

Die herausragende Bedeutung von Wechselstrom in unserem Stromnetz wird jedoch (zumindest auf theoretischer Ebene) in Frage gestellt. Auf der einen Seite verändert sich durch die Energiewende die Art der Energiebereitstellung. Immer mehr dezentrale Erzeugungsanlagen werden in die Stromnetze integriert. Viele der urbanen dezentralen Energieerzeuger sind Photovoltaikanlagen, die bereits Wechselstrom erzeugen. Um die Schwankungen der Energieerzeugung und des Verbrauchs auszugleichen, gewinnen u.a. elektrische Speichersysteme an Relevanz, welche wiederum auf der Gleichstromtechnologie beruhen (z.B. IRENA 2016). Auf der anderen Seite hat sich in den letzten Jahrzehnten die Art und Menge des verbrauchten Stroms verändert. So werden z.B. LED-Beleuchtungen, Computer und viele weitere Elektrogeräte im Haushalt oder im gewerblichen Kontext mittels Gleichstrom betrieben (Chochole et al. 2015).

Gleichstromnetze auf Gebäude- oder Quartiersebene bieten daher ein Potenzial die Grundlage für zukünftige Energiequartiere zu werden. Gleichstromnetze können z.B. durch den Wegfall von Umwandlungsschritten effizienter sein. Je mehr Gleichstromkomponenten in ein Quartier installiert werden, desto höher ist die zu erreichende Effizienzsteigerung. In Gebäuden mit Gleichstromnetz, Photovoltaikanlage und Batteriespeichern ist bereits mit einem Energieeinsparpotenzial von mehr als 15% zu rechnen (Haag & Gürses 2017).

4.2 Städtebauliche Relevanz elektrischer Quartiersspeicher

(Gleich-)Stromnetze der Mittel- und Niederspannungsebene haben auf das Orts- und Landschaftsbild in der Regel keine direkte visuelle Auswirkung, da diese hauptsächlich erdverkabelt ausgeführt werden (Casper & Sieber 2017). Die städtebauliche Betrachtung von (Gleichstrom-)Energiequartieren sollte sich daher auf die raumwirksamen Komponenten der Integration von Stromerzeugung, Speicherung und Verbrauch konzentrieren.

Eine wichtige Rolle könnten zukünftig die Quartiersspeicher einnehmen, welche, z.B. mittels Lithium-Ionen-Technologie, große Mengen an elektrischer Energie für eine Vielzahl an Quartiersakteuren lokal speichern und bei Bedarf wieder abgeben und so Schwankungen der Energieerzeugung und Verbrauch ausgleichen. Angenommene sinkende Preise für elektrische Speichersystem und stetig steigende Speicherkapazitäten dürften zu einer deutlicheren Zunahme an Speichern, auch im urbanen Kontext, führen, um die Potenziale von Energiequartieren effizienter realisieren zu können (IRENA 2017). Gegenüber einer Vielzahl an individuellen Heimspeichern, die in den jeweiligen Gebäuden verortet sind, lassen sich durch größere gemeinschaftlich genutzte Speichersysteme weitere Mehrwerte genieren. Neben z.B. dem reduzierten Platzbedarf in den eigenen Immobilien und der verminderten Brandlast, lassen sich Erzeugungs- und Verbrauchsspitzen noch besser ausgleichen (Knoefel & Schnabel 2021, Knoefel & Herrmann 2020). Batteriespeicher auf Haushalts- und Quartiersebene werden aktuell in Deutschland vor allem zur Erhöhung des Verbrauchs von selbsterzeugtem Strom verwendet (Hoffmann & Mohaupt 2020). Daneben identifizieren Knoefel und Schnabel 2021 zahlreiche ergänzende Anwendungsfälle für Quartiersspeicher, wie z.B. dem Stromhandel, die im urbanen Kontext Mehrwerte für die Quartiersakteure realisieren könnten.

Aus städtebaulicher Sicht sind vor allem die qualitätsvolle Integration der Speicher in das Quartier und die Flächenkonkurrenz um die knappe Ressource Stadtraum interessant. Aktuelle Pilotquartiersspeicher, wie z.B. in der Solarsiedlung in Groß-Umstadt, ähneln in ihren Abmaßen und der äußerlichen Gestaltung oft handelsüblichen See- oder ISO-Containern. Mit einer Kapazität von 274 Kilowattstunden ist der Groß-Umstädter Speicher für knapp 80 Haushalte ausgelegt (EnergieAgentur.NRW 2020). Aufgrund geringerer Kosten und dem Zunehmenden Bedarf an Energiequartieren dürften elektrische Speicher also zukünftig häufiger im Stadtbild werden. Umso wichtiger dürfte eine stadtverträgliche Integration dieser raumrelevanten Anlagen sein.

5 INTEGRTATION VON ELEKTRISCHEN SPEICHERN IM ENERGIEQUARTIER

Durch die unterschiedlichen Verfügbarkeiten von Flächen in Städten und Kommunen zur Integration von elektrischen Speichern ist es notwendig, individuelle Lösungen für die entstehenden Energiequartiere zu finden. Aus diesem Grund sind in der Untersuchung unterschiedliche städtebauliche Quartiere -von ländlich bis urban, von dichter bis lockerer Bebauung- im Zuge eines Studierendenprojektes analysiert worden. Ihre Flächenverfügbarkeiten variierten stark. So gab es Quartiere, welche brachliegende Flächen zur Verfügung hatten, als auch Quartiere, in denen Lösungen in bestehenden Gebäuden gefunden werden mussten. Insgesamt wurden 15 Quartiere in der Stadt Aachen erhoben und für fünf Quartiere Konzepte zur Integration von elektrischen Speichern aufgestellt. Im Fokus lag hier vor allem der gestalterische Aspekt, eine qualitätsvolle Integration der technischen Anlagen in das Gesamtbild des Quartiers. Ziel ist es aufzuzeigen, wie elektrische Speicher in einem Quartier städtebaulich integriert werden können.

Im Folgenden werden drei Konzepte zur Integration von elektrischen Speichern im Energiequartier vorgestellt. Die Konzepte unterscheiden sich in erster Linie durch die ihnen zur Verfügung stehenden Flächenangebote. Ebenfalls stand bei den Konzepten im Fokus, dass die elektrischen Speicher sich in das Gefüge des Quartiers integrieren, die spezifischen Charakteristika aufnehmen und trotzdem ein Transferpotenzial für andere Quartiere aufweisen.

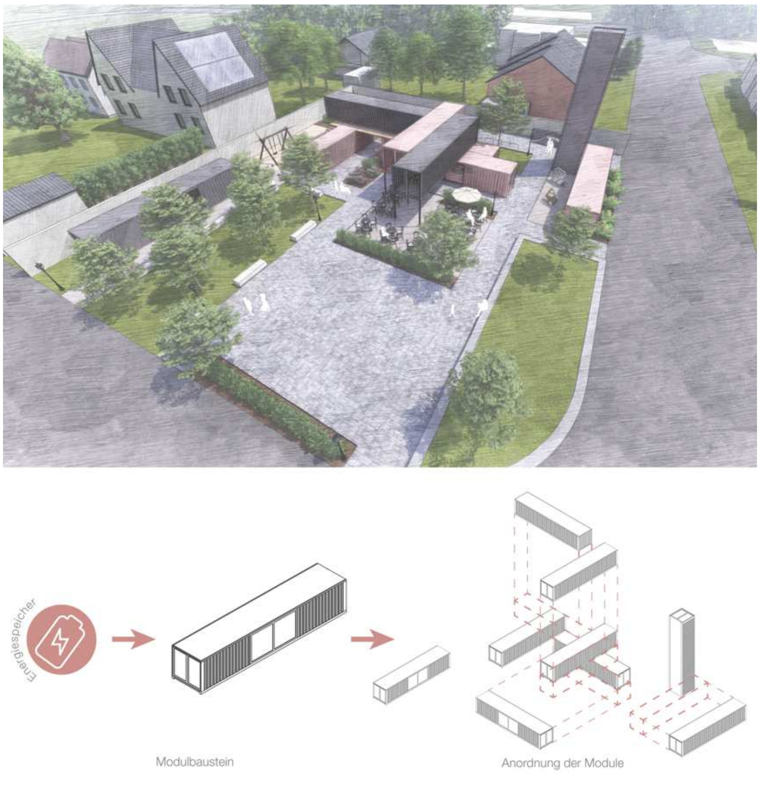

Abb. 2: Modulbaustein Speicher (Quelle: Yann Bettendorff /Selina Stollenwerk 2021)

5.1 Modulares Speichersystem als Quartiersmitte

Das folgende Energiekonzept ist für ein suburban liegendes Quartier im Südwesten Aachens aufgestellt worden. Das Quartier verfügt aktuell weder über eine Quartiersmitte noch einen Aufenthaltsplatz, weist jedoch eine geeignete brachliegende Fläche auf.

Für das Gesamtenergiekonzept werden diverse Energieerzeugungsarten (wie beispielsweise PV-Anlagen) genutzt. Ein essenzieller Bestandteil des Konzeptes ist ein zentraler Speicher, der überschüssige Stromerzeugnisse aufnimmt und bei Bedarf wieder abgibt. Die Bedeutung des Speichers als zentraler Bestanteil des Energieflusses im Quartier wird durch die zentrale Lage in dem Quartier auf einem dafür geschaffenen Platz unterstrichen.

Der Energiespeicher ist dabei in einem Modulbaustein integriert, wovon mehrerer in unterschiedlichen Anordnungen zusammengesetzt werden können. Ein solcher Modulbaustein kann auch Raum für andere Nutzungen wie beispielsweise Ausstellungsflächen, Gastronomieangebote, Fläche für einen kleinen Laden, Foodsharing Angebote oder auch eine kleine Bibliothek bieten. Die modulare Bauweise bietet die Möglichkeit bei Bedarf die Speicherkapazität anzupassen und durch ein weiteres Modul zu ergänzen.

Die Modulbausteine weisen eine schlichte Gestaltung auf, welche die Farben der umliegenden Gebäude aufgreifen und sich so in die Umgebung einfügen. In dem Entwurf wird der Modulbaustein außerdem genutzt, um in vertikaler Aufstellung an die ehemalige Kirche bzw. den Kirchturm zu erinnern. So entsteht eine Art Skulptur, die sich aus der Anordnung der Modulbausteine ergibt und einen Bezug zu der ehemaligen Nutzung durch die Kirche bewahrt und Identität des Raumes schafft. In diesem Konzept ist der Speicher in einem der Modulbausteine als ein Teil der eben beschriebenen Modulanordnung vorgesehen.

Der Energiespeicher ist zum einen als Modulbaustein auf dem Platz durch die präsente Lage in dem Ortsbild sichtbar, zum anderen wird der Speicher als Modulbaustein in die Modulanordnung integriert und ist dadurch nicht als solcher auf den ersten Blick erkennbar. Durch die Speicherung als auch durch die angrenzenden Nutzungen in den weiteren Modulbausteinen kann eine Aufenthaltsqualität und ein Mehrwert für das Quartier geschaffen werden.

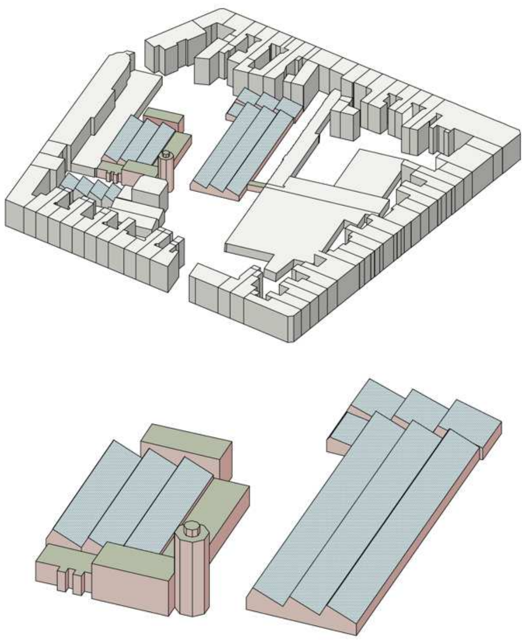

Abb. 3: Integration Speicher in ehem. Tuchfabrik (Quelle: Roland Reinartz 2021)

5.2 Elektrische Speicher im Bestand

Das nachfolgende Konzept ist für ein urbanes Quartier in Aachen aufgestellt worden. Das Quartier ist durch dichte Bebauung mit Gebäuden, die unter Denkmalschutz stehen, geprägt und weist ehemalige industriell genutzte Gebäude, wie eine ehemalige Tuchfabrik auf, welche im Innenbereich einer Blockrandbebauung liegt.

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Zur dezentralen Energieerzeugung im Quartier wird Solarenergie in Kombination mit einem elektrischen Energiespeicher für die Zwischenspeicherung von Energieüberschüssen genutzt. Um weitere Oberflächenversiegelungen zu vermeiden und Leerstand zu nutzen, erfolgt die Integration des Speichers in die ehemalige Tuchfabrik. Teile der Gebäude werden derzeit als Büros genutzt.

Die Tuchfabrik, als ehemaliges wichtiges Fabrikgelände in dem Quartier, wird als Standort der neue Quartiersenergiezentrale zu dem zentralen Punkt des Energiekonzeptes. Dadurch erhalten die Gebäude erneut eine wichtige Bedeutung in dem Quartier.

Der Speicher ist durch die Integration in ein bestehendes Gebäude erst einmal nicht sichtbar, durch eine mögliche Lichtinstallation am Turm, welche den Ladestand des Speichers anzeigt, kann dieser in dem Quartier sichtbar und identitätsstiftend werden. Die Fabrik bietet hohe Potenziale zur Integration in ein Energiequartier, da die Flächen nicht hinreichend genutzt werden und durch die zentrale Lage die Energien optimal an das Umfeld abgeben werden können.

5.3 Adaptive Speichermodule zur Belebung urbaner Räume

In dem folgenden Energiekonzept wird in dem Quartier lokal Energie durch Photovoltaikanlagen und Windkraftanlagen erzeugt und in kleinen Speichern im Quartier gespeichert. Die Speicher sollen ähnlich wie in dem ersten Konzept in Containermodule integriert werden. Je nach Bedarf können die Module weitere Nutzungen beinhalten bspw. Arbeitsräume, Ausstellfläche, Aufenthaltsbereiche in Form eines kleinen Kiosks oder einer Café-Ecke, Paketstationen oder E-Bike-Sharing Angebote. Kombinationen von Nutzungen sind ebenfalls möglich beispielsweise Speicher und Paketstation.

Abb. 4: Containermodul (Quelle: Till Merbecks/Conrad Moschner 2021)

Die Container weisen eine schlichte Gestaltung auf, sind flexibel einsetzbar und können gestalterisch an die Bedürfnisse der Nutzung angepasst werden. Ein wesentlicher Unterschied der Containermodule zu dem Modulbaustein des ersten Konzeptes ist die Größen der Einheiten. Es stehen verschiedene Containergrößen zur Integration zur Verfügung, sodass diese in unterschiedliche Freiräume integriert werden können. Durch die unterschiedlichen Größen, der Möglichkeit Nutzungen in dem Containermodul zu vereinen und die Container einzeln an einem Standort ein zusetzt, ist eine Einsatzort abseits von belebten oder zu belebenden Quartiersplätzen denkbar. Eine Stapelung der Module ist erst einmal nicht vorgesehen, sodass diese eine Grundfläche von bis zu 30 m2 pro Modul benötigen. Für die Integration sollte daher im Quartier eine gewisse Flächenverfügbarkeit vorhanden sein.

Die Containermodule sind im Ortsbild sichtbar und können über die Gestaltung an die Gegebenheiten im Quartier angepasst werden. Zudem bieten die Module durch eine Kombination von Nutzungen, bspw. Speicher, Kiosk oder Paketstation, Mehrwerte sowohl energetisch als auch in Bezug auf die Aufenthaltsqualität.

6 DAS ZUSAMMENSPIEL VON STÄDTEBAU UND ELEKTRISCHEN SPEICHERN IM ENERGIEQUARTIER

Energiequartiere gewinnen immer mehr an Bedeutung und das Zusammenspiel von Produzieren, Verbrauchen und Speichern von Energien vor Ort muss in den Städtebau integriert werden. Gerade die Herausforderungen machen deutlich, dass es einer ganzheitlichen Betrachtung bedarf, immer mit Blick auf die individuellen Gegebenheiten vor Ort im Quartier. Flächenknappheit, Innen vor Außenentwicklung, Leerstand und Nutzungskonflikte heben jedoch nicht die Potenziale der Integration von elektrischen Speichern im Quartier auf. Der Städtebau mit seinem Anspruch an eine qualitätsvolle Gestaltung ohne Funktionsverluste steht in den nächsten Jahren damit vor besonderen Aufgaben. Die vorgestellten Konzepte zeigen, dass eine Integration von elektrischen Speichern in bestehende Quartiere gelingen kann. Dabei erfüllen die Speicher nicht nur ihre technische Funktion, sondern können auch genutzt werden, um brachliegende Flächen aufzuwerten, neue Orte im Quartier und ein Bewusstsein für neue Technologien zu schaffen. Die Neukonfiguration des Raums durch die elektrischen Speicher zeigt, dass damit einhergehend keine Funktionsverluste im Quartier, wie das Wohnen, Arbeiten und Erholen, einhergehen. Nichtsdestotrotz bleibt kritisch zu hinterfragen, wie relevante Akteure für solche ambitionierten und kostenintensiven Vorhaben aktiviert und zusammengebracht werden können. Aktuell sind Quartiersspeicher unter heutigen Markt- und Rahmenbedingungen zur alleinigen Eigenverbrauchserhöhung nicht wirtschaftlich (Knoefel & Herrmann 2021). Die städtebauliche Integration dürfte die Kosten für Planung und Gestaltung noch einmal erhöhen und somit die Chancen einer Realisierung aus ökonomischer Perspektive verringern. Interessant könnten hier die vorgeschlagenen neuen Mehrwerte, wie die Verbindung mit beispielsweise gastronomischen Angeboten sein, welche die wirtschaftlichen Rahmenbedingungen positive beeinflussen könnten. Die technische Realisierbarkeit sowie gesetzliche Regelungen, insbesondere bezüglich geltender Sicherheitsvorschriften, müssten in einem nächsten Schritt geprüft werden, um ein realistisches Bild einer möglichen Umsetzung zu erhalten. Aus der räumlich-baulichen Perspektive dürfte die städtebauliche Integration elektrischer Speichersysteme ein spannendes Potenzial zur Aufwertung für den öffentlichen Raum darstellen.

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🏆 *reviewed paper*

Städtische Angsträume – Analyse zur Steigerung der gendergerechten Stadtplanung für mehr Sicherheit bei Nacht

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1 ABSTRACT

"In general, cities work better for heterosexual, able-bodied, cisgender men than they do for women, girls, sexual and gender minorities, and people with disabilities."[1]

Bei Nacht und Dunkelheit werden städtische Räume teilweise zu Angsträume, insbesondere für Frauen. Dies betrifft vor allem Orte mit wenig Beleuchtung und geringer Frequentierung, somit werden unbelebte, unbefahrene und unübersichtliche Plätze bei Dunkelheit zu Angsträume. Ebenso hat die sozialräumliche Qualität eines Ortes einen Einfluss auf das Wohlbefinden in der Nacht, häufig bedingt durch die Gegebenheiten, wer sich an diesen Plätzen aufhält und wie diese gestaltet sind (BRANDENBURG, WELZEL; 2020). Wie sind solche städtischen Angsträume entstanden? Einer These der hier gefolgt wird ist, Städte wurden von und für erwerbstätige Erwachsene, welche sich tagsüber dort aufhalten, gebaut, historisch bedingt waren das vorwiegend Männer, das bedeutet viele Faktoren, die bei Dunkelheit zu Angst und Gefahr führen kann, wurde nicht mitbedacht und somit nicht mitgeplant. Um jedoch u. a. die nachhaltigen Entwicklungsziele der Vereinten Nationen, zu denen sich auch Deutschland als UN-Mitglied verpflichtet hat, erreichen zu können, ist es unabdingbar, dass Städte und somit die politischen Entscheidungsträgerinnen und Entscheidungsträger einer Stadt zur Gleichberechtigung jedes Geschlechts beitragen. Belästigungen, Gewalt (gegen Frauen) und Diskriminierung im nächtlichen Stadtraum sind Hindernisse, um sich im urbanen Raum sicher und frei zu fühlen und damit ein Hindernis, um das Entwicklungsziel, vor allem das der Gleichberechtigung zu erreichen. Ein Ziel muss es sein, allen Gesellschaftsgruppen „die Teilhabe und Mitbestimmung in allen Bereichen des politischen, wirtschaftlichen und öffentlichen Lebens" (BRANDO, RÜTTEN; 2020) gleich gut zu ermöglichen. Zum Entgegenwirken oder zur Prävention von Angsträumen in der Stadt, gibt es verschiedene Ansätze wie verschiedene Nutzerinnen- und Nutzergruppen und Beteiligungsformate sowie Gender Planning innerhalb der Stadtplanung einzubeziehen und damit eine frauenfreundliche Stadt zu gestalten. Darunter fällt u. a. eine ausreichende Beleuchtung, übersichtliche Straßen und Gehwege, die Planung der Wohngebäude so zu gestalten, dass Aufenthaltsräume zur Straße orientiert sind, um weniger einsame Straßen entstehen zu lassen, zudem sind niedrige Hecken und breite Gehwege ebenso hilfreiche Maßnahmen (BRANDENBURG, WELZEL; 2020). Jedoch lassen sich Angsträume und die Sicherheit, vor allem für Frauen, nicht nur durch eine frauenfreundliche Stadtplanung steigern, ebenso können eine 24-h-Governance und digitale Tools wie beispielsweise City Information Modelling (CIM) erfolgreiche Hilfsmittel sein, um zur nächtlichen Sicherheit und dem Sicherheitsempfinden beizutragen.

Daher wird in diesem Zusammenhang u. a. die Frage bearbeitet: Wie kann nächtliche Sicherheit erhöht werden, ohne einer permanenten Videoüberwachung und -auswertung des öffentlichen Raums ausgesetzt zu sein? Um dieser Frage nachzugehen sollen sozial-gesellschaftliche sowie städteplanerische Aspekte analysiert und verknüpft werden. Der Zusammenhang von baulichen Strukturen und gesellschaftspolitischen Faktoren soll herausgearbeitet werden und mithilfe von qualitativen Erhebungen wie Literaturrecherche, Best Practice Analyse und einer Umfrage beantwortet werden. Ein Lösungsweg wird in diesem Fall sein, eine Infrastruktur für eine erfolgreiche 24-h-Governance zu errichten und bauliche Strukturen mithilfe von Analysen durch CIM dahingehend zu verändern und zu verbessern, dass Angsträume aufgelöst oder präventiv nicht errichtet werden (SCHAUFLER, SCHWIMMER; 2020). Beide Ansätze sollen erfolgreich miteinander verknüpft werden.

Keywords: Nacht, Sicherheit, Stadtplanung, Gender, City Information Modelling (CIM)

[1] World Bank Group (2020): Handbook for Gender-Inclusive Urban Planning and Design. Washington: World Bank Publications. Executive Summary.

2 EINFÜHRUNG, STAND DER FORSCHUNG

Unsicherheitsgefühle im städtischen Raum zählen schon lange zu den Wahrnehmungsempfindungen einiger gesellschaftlicher Gruppen innerhalb des Stadtraums. Eine bundesweite Befragung zum subjektiven Sicherheitsempfinden innerhalb des vom BMBF geförderten Projekts KoSiPol[2] identifizierte im Jahr 2014 drei Personengruppen mit geringerem subjektiven Sicherheitsempfinden, die vom Durchschnitt der Bevölkerung eher in eine ängstliche Richtung abweichen. Das sind zum einen Frauen – fühlen sich im Vergleich zu Männer eher bei Dunkelheit unsicher – zum anderen ältere Bürgerinnen und Bürger – fühlen sich im Vergleich zur Gesamtstichprobe sowohl tagsüber als auch nachts unsicher – und Personen, welche über direkte und indirekte Opfererfahrungen verfügen (BORNEWASSER / KÖHN; 2014 S:10ff). Eine Umfrage von Infratest dimap zeigt einen direkten Vergleich zwischen dem Sicherheitsempfinden von Männern und Frauen aus dem Jahr 2017. Hierbei fühlen sich nur halb so viele Frauen wie Männer im öffentlichen Raum sehr sicher (w: 10%, m: 21%), eher sicher fühlen sich 47% Frauen und 48% Männer und eher unsicher fühlen sich wiederrum mehr Frauen (w: 33%; m: 22%). Sehr unsicher fühlen sich im öffentlichen Raum beide Geschlechter fast gleichauf (w: 9%; m: 7%) (STATISTA; 2018). Diese Diskussion ist nach der Silvesternacht von 2015/2016 und spätestens mit den jüngsten Ereignissen in London (März 2021), bei denen eine 33-jährige Frau auf dem Nachhauseweg nachts entführt und ermordet wurde, wieder prominent auf der Agenda der städtischen Akteure gelistet.

In der konservativen Stadtkritik galt die Großstadt „schon immer […] als bedrohlich, der öffentliche Raum galt und gilt als Raum der Unsicherheit“ (WEHRHEIM; 2002:23 & RUHNE; 2020:429). Das Freiheitsgefühl, welches eine Großstadt durch die Anonymität und kulturelle Vielfalt mit sich bringt, löst somit gleichzeitig ein Gefühl der Unsicherheit und Gefahr aus (RUHNE 2020:437). Vor allem für Frauen scheint diese Aussage vornehmend in der Dunkelheit zuzutreffen. Zu unsicheren Plätzen zählen laut Umfragen u. a. schlecht beleuchtete Umgebungen, Parks und Grünanlagen bei Nacht sowie Bahnhöfe und Haltestellen und das vorwiegend für Frauen (u. a. Stadt Augsburg 2017:8). Seit Jahren werden demnach immer wieder Maßnahmen gefordert, um die Unsicherheiten im städtischen Raum zu minimieren und „den Bedürfnissen von Frauen nach Sicherheit im öffentlichen Raum […] gerecht“ zu werden (RIDDER-MELCHERS 1991:7). Solche Maßnahmen, die im Verhältnis tendenziell gut zu beheben sind, werden seit den 80er Jahren durch Städte und Kommunen beispielsweise „durch Frauen-Nachttaxen, bauliche Veränderungen oder soziale Kontrollmaßnahmen“ auch umgesetzt, jedoch ist das Problem der Unsicherheit trotz der Maßnahmen bisher kaum gelöst (RUHNE 2020:429).

Doch was ist die Ursache dafür, dass bestimmte gesellschaftliche Gruppen sich in bestimmten Umgebungen in der Nacht unsicher fühlen? Sind es vorherrschende Delikte in bestimmten Stadträumen, die Atmosphäre, das eigene Selbstbewusstsein oder selbst erlebte (schlechte) Erfahrungen in verschiedenen Regionen? Um verschiedene Lösungswege aufzuzeigen und Handlungsempfehlungen generieren zu können, muss der erste logische Schritt dahingehend sein, dem Problem der Unischerheit nachzugehen. Zum einen wird der Stadtraum und die umstrittenen Zonen in der Nacht beleuchtet, die Atmosphäre und das Sicherheitsempfinden der betroffenen Personengruppen mit Hilfe bestehender Literatur angerissen und zum anderen werden die durchgeführten 20 Kurzinterviews ausgewertet und skizziert. Es wurde bestehende Literatur zur Bearbeitung der vorliegenden Arbeit herangezogen, welche sich u. a. mit dem historischen Kontext der geschlechterspezifischen Unsicherheiten, der Atmosphäre innerhalb dem Stadtraum und der Nacht beschäftigt, ebenso wird Literatur herangezogen, die die städtische Nacht im Kontext der Sicherheit beleuchtet und solche, welche das Gender Mainstreaming[3] in die Stadtplanung miteinbeziehen. Daneben wurden Veröffentlichungen im Kontext baulicher Auswirkungen auf das Sicherheitsempfinden bei Nacht analysiert.

Bei der Recherche in diesem Kontext fällt schnell auf, dass viele Fragestellungen innerhalb diesem Forschungskontext unbeforscht sind und Lücken aufzeigen. Beispielsweise lässt sich kaum Literatur zum Thema finden, ob und inwiefern sich die Situationen für die betroffenen Personengruppen in der Nacht

[2] „Im Rahmen des vom Bundesministerium für Bildung und Forschung (BMBF) geförderten Projekts „Kooperative Sicherheitspolitik in der Stadt“ (KoSiPol). Hierbei wurden Bürger und Bürgerinnen aus zwölf Städten und vier Landkreisen zu ihrem subjektiven Sicherheitsempfinden sowie zu weiteren Faktoren, die die Konzepte der verschiedenen Erklärungsansätze operationalisieren (Opferwerdung, soziale Eingebundenheit, Verletzbarkeit, Medienverhalten) befragt.“

[3] als durchgängige Gleichstellungsorientierung zu verstehen

verändert haben, nachdem bestimmte Maßnahmen innerhalb der Stadt umgesetzt und in der Stadtplanung mitbedacht wurden. Ebenso lassen sich wenig evaluierte Handlungs- und Maßnahmenempfehlungen für Stadt und Gesellschaft finden, die einen entsprechenden Umgang damit als Leitfaden skizzieren. Auch fällt bei der Recherche auf, dass zum Thema 24-h-Governance – was bedeutet die „nächtlichen“ Belange und Problematiken stärker in die Verwaltung zu integrieren, die Darstellung und Bearbeitung dieser Themen aus der „Außenseiterrolle“ zu ziehen und eine eigene „Verwaltung“ für die Belange des Nachtlebens und der Sicherheit und dem Sicherheitsempfinden bei Nacht aufzubauen – kaum etwas existiert. Ebenso fällt bei der Analyse vorliegender Literatur in Bezug auf baulicher Strukturen in der Stadtplanung auf, dass sich die Gestaltung öffentlicher Räume immer mehr mit erhöhter Aufenthaltsqualität beschäftigt, hierbei aber fast ausschließlich die Stunden mit Tageslicht berücksichtigt werden.

3 ZWEI ANSÄTZE

Um der Frage nachzukommen, wie nächtliche Sicherheit hergestellt werden kann, ohne einer permanenten Videoüberwachung und -auswertung des öffentlichen Raums ausgesetzt zu sein, wird im folgenden Kapitel das Thema aus zwei verschiedenen Blickwinkeln bearbeitet. Zum einen von Seiten der Sozialwissenschaft – hierbei wird der Angstraum innerhalb der Stadt in Abhängigkeit des Geschlechts gesetzt und definiert, die Atmosphäre und der Sicherheitsaspekt beleuchtet sowie eine Stadt als Best-Practice Beispiel kurz skizziert und die Governance-Strukturen in Kontext des Themenbereichs gesetzt. Zum anderen werden die bauliche Strukturen des öffentlichen Raums und ihre Auswirkungen auf das Sicherheitsempfinden betrachtet. Hierzu wird insbesondere die Bebauungshöhe und -dichte sowie die Beleuchtungssituation herangezogen.

3.1 Angst und (öffentliche) Räume

“urban night is a key space for social interaction, as well as for trust and identity building.”[4]

3.1.1 Angsträume

Angsträume sind in diesem Kontext öffentliche Räume an denen sich Teile der Gesellschaft unsicher, unwohl und ängstlich fühlen. Es sind Orte an denen Menschen Angst haben, „Opfer von Kriminalität zu werden“ (HILLER 2010:2). Zumeist treten sie im städtischen Raum bei Dunkelheit in Erscheinung. Dabei werden meist Gassen, schlecht beleuchtete und unübersichtliche Straßen, Parks und Unterführungen genannt. Betroffenen Personengruppen sind dabei vorwiegend Frauen, Personen mit Opfererfahrungen und ältere und somit schwächere Menschen. Innerhalb städtebaulichen Angsträumen fehlen demnach u. a. (formelle und informelle) soziale Kontrollen, technische Sicherheitsanlagen, wie beispielsweise Notrufsäulen und sie sind unüberschaubar, vandalisiert sowie verwahrlost (KUBE 2003:67 und PAHLE-FRANZEN 2011:69). Ebenso werden Orte zu Angsträume an denen sich Bedrohung und Gewalt abzeichnet und „potenzielle Opfer“ sich als Folge dessen fürchten müssen. Das Resultat ist meist, dass diese Orte gemieden oder mit Furcht betreten werden (PAHLE-FRANZEN 2011:70). Folgernd bedeutet das, dass Angst zugleich situationsabhängig ist. Angsträume beeinträchtigen die persönliche Bewegungsfreiheit gewisser Teile der Gesellschaft, beispielsweise von Frauen bei Nacht. Sie nehmen oftmals einen Umweg in Kauf, um eventuell den helleren und damit den gefühlten „sicheren“ Weg zu gehen. Sie geben im Verhältnis mehr Geld für nächtliche Taxifahrten aus als Männer. Oder stehen während des Nachhausewegs durch ein Telefonat oder einem digitalen Schriftverkehr in Kontakt zu einer vertrauten Person. Diese Bewegungseinschränkungen und das Gefühl der Unsicherheit sind in einer demokratischen Gesellschaft keineswegs hinnehmbar.

Angsträume entstehen und verfestigen sich u. a. dadurch, dass betroffene Personen in bedrohten Situationen keine Unterstützung oder Hilfe von Dritten zu erwarten haben oder dadurch, dass sie das Verhalten Dritter als Ablehung deuten (PAHLE-FRANZEN 2011:70). Demnach sind das Alltagsbewusstsein der Mehrheitsbevölkerung, das gesellschaftliche Klima des Sozialraums und die Reaktion öffentlicher Institutionen wichtige Aspekte dafür, wie lange und intensiv ein Angstraum besteht (REDAKTION BELLTOWER NEWS, 2008).

Orte an denen meist in Büchern, Serien und Filmen Verbrechen und Delikte wie beispielsweise Raub, Gewalt und Überfälle passieren, jagen den Menschen, insbesondere Frauen, Angst ein. Nach Ruhne (2020) werden (bauliche) Maßnahmen jedoch nicht zur Verbesserung des Empfindens beitragen. Statistiken

[4] Seijas, Andreina/Gelders, Mirik (2019): Governing the nighttime city: The rise of night mayors as a new form of urban governance after dark. Urban Studies.

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belegen, dass mehr Verbrechen im privaten Umfeld und in privaten Räumlichkeiten stattfinden, als im öffentlichen Raum und damit in dunklen, schlecht beleuchteten und unbelebten Gassen (RUHNE 2020:431). Ängste im allgemeinen entstehen schließlich primär durch persönliche, soziale Wahrnehmungen, wie ebenso aufgrund einem Mix aus Meinungen, Glauben, Beurteilung, Wissen, Überzeugungen und Erkenntnisse. Angst entsteht dabei, „wenn wir Ereignisse erwarten, die vermutlich unerwünschte Folgen für uns haben. Bei der Entstehung von Angsträumen spielt nicht nur das eigene Erleben, die Furcht oder die eigene Wahrnehmung eine Rolle, sondern auch das Erleben, die Ängste und die Wahrnehmung anderer Personen, die ihre Erfahrungen und Ängste weitergeben“ (PAHLE-FRANZEN; 2011:4,71).

3.1.2 Atmosphäre und Sicherheitsempfinden

Schon 1943 hatte Abraham H. Maslow das Sicherheitsbedürfnis als Grundbedürfnis definiert. Egal ob in Form eines festen Arbeitsplatzes, einer Wohnung oder in Form von Gesetzen und Ordnungen (BERKEL 1983:151). Sicherheit umfasst nicht nur die Schutzvorkehrungen der Menschen, sondern ebenso ihre individuelle und gesellschaftliche Vorstellungen von Sicherheit und ihre Denk- und Gefühlswelt, welche sich im Laufe der Zeit verändert haben und damit einhergehend auch die Anforderungen an sie (HAVERKAMP, HUMMELSHEIM, ARMBORST 2012). Vielen Menschen und primär die der deutschen Bevölkerung ist Sicherheit und das Sicherheitsempfinden enorm wichtig, gar wichtiger als beispielsweise durch Kontrollen Beschränkungen der persönlichen Freiheit in Kauf zu nehmen (PAHLE-FRANZEN; 2011:71). Die deutsche Bevölkerung gehört zu der Bevölkerungsgruppe, „bei welcher das Sicherheitsempfinden schon immer eine größere Rolle gespielt hat, als das der Gleichheit“ (MÜLLER 2002:66 und PAHLE-FRANZEN; 2011:71).

Das Sicherheitsempfinden ist trotz der Bevölkerungszugehörigkeit von Mensch zu Mensch unterschiedlich und wird durch Eindrücke, Wahrnehmungen und dem „Vorgelebten“ beeinflusst. Bildung, Handlungsmotivation und Sozialisation strukturieren die Wahrnehmung und demnach das Handeln (SCHÄFERS 2003a:30, SIMMEL 2006:9 und PAHLE-FRANZEN; 2011:71). Bezugspersonen sind wichtige Faktoren für Kinder. Sie übernehmen Verhaltensweisen, Muster und Einschätzungen von ihnen und somit auch zum Teil ihre Ängste. Die Wahrnehmung ist für jede Person ein unterschiedlicher Prozess – er ist hoch selektiv und konstruktiv und wird von einem „Wahrnehmungsschema“ geprägt, welches durch die weitergegebene Wahrnehmung außenstehender Personen beeinflusst wird (PAHLE-FRANZEN; 2011:71). Die alltägliche Konstitution von Raum ist folglich an Wahrnehmungsprozesse gebunden, die durch Kommunikation und Interaktion geprägt werden (ebd., LÖW 2007:195, HEIBACH 2014:266).

Besteht eine zwischenmenschliche Beziehung, ist im sozialen Kontext von Atmosphäre die Rede. Aber auch Stadt und Atmösphäre sind eng verflochten. So werden mit bestimmten Städten Vorstellungen, Gedanken, Gefühle und kulturell geprägte Bewertungen assoziiert. Atmosphären werden aber nicht nur in einer „vorreflexiven Weise vom Subjekt gespürt“, sondern sind ebenso etwas „das Gegenständen, Umgebungen und Örtlichkeiten eigenschaftsähnliches anhaftet“ (HEIBACH 2014:261).

Auch wenn Männer öfters als Frauen laut Statistik Opfer von Gewaltverbrechen im öffentlichen Raum werden, so sind Frauen öfters alltäglichen angstauslösenden Situationen ausgesetzt (URBAN DEVELOPMENT VIENNA 2013:27). Eine Frau kann sich an bestimmten Orten aufgrund der dortigen Atmosphäre unwohl, unsicher und ängstlich fühlen. Denn Angst bzw. das Gefühl, sich im öffentlichen Raum sicher oder unsicher zu fühlen, wird durch physische (z.B. Sichtbarkeit, Übersichtlichkeit), soziale (z.B. vorhandensein weiterer oder verschiedener Nutzerinnen- und Nutzergruppen) und persönliche Faktoren (beispielsweise persönliche Erfahrungen) bestimmt (MIKO 2012:6 und ebd.). Eine Unsicherheit oder Angst kann jedoch ebenso aufgrund von „vorgelebten“ Ängsten und Unsicherheiten entstehen, die als weitergegeben Wahrnehmungen gelten und damit die Wahrnehmungen der Betroffenen beeinflussen.

3.1.3 Gender Mainstreaming und Stadtplanung

Auch wenn nach Ruhne (2020) städtebauliche Maßnahmen keine Verbesserungen für das Sicherheitsempfinden von Frauen im öffentlichen Raum bringen, so kann zufolge der Auswertung unsere Kurz-Interviews (siehe Kapitel 4) eine gendersensible Stadtplanung doch bereits ein hilfreicher Ansatz sein, um Angstgefühle zu unterbinden und ein gewisses Sicherheitsempfinden zu generieren. Um eine sichere Aussage dahingehend machen zu können, sollten jedoch weitere Erhebungen vorgenommen werden, insbesondere die Wirkung umgesetzter Maßnahmen evaluieren.

Aber warum sollte Stadt- und Raumplanung überhaupt durch die Genderbrille gesehen werden? Diverse soziodemographische Merkmale veranlassen differenzierte Ansprüche an die Gestaltung öffentlicher Räume. Neben der Planung nach bestimmten Lebensphasen[5] sind gesellschaftliche Rollen maßgeblich für die Ansprüche: Für junge weiblich gelesene Personen ist der Treffpunkt und die Selbstdarstellung eher in Grünräumen, wobei es bei jungen männlich gelesenen Personen eher ein „In-Besitznahme" von Flächen ist und sie eher auf Sportplätzen, innerhalb eines Wettbewerbs anzutreffen sind (AMT DER VORARLBERGER LANDESREGIERUNG 2008:7). Ein Best-Practice Beispielmodell wie eine Stadt geschlechtergerecht geplant und gestaltet werden kann liefert u. a. die Stadt Wien. Innerhalb des Werkstattberichts der Stadt Wien unterteilt die Stadtgestaltung ihre Planungsziele zunächst in zwei Themenkomplexe. Zum einen in Stadtstruktur, Raumbildung und Wohnqualität und zum anderen in den Komplex öffentlicher Raum und Mobilität. Der erste Themenkomplex behandelt fünf Sektoren (1) die Stadtstruktur im allgemeinen, (2) die Entwicklung von Ortszentren und der Versorgung durch Geschäfte und Dienstleistern, (3) die soziale Infrastruktur, (4) Wohnungsbau und den Frei- bzw. Grünflächen für einzelne Grundstücke sowie (5) die Verbesserung des subjektiven und objektiven Sicherheits- und Geborgenheitsempfindens. Der zweite Komplex mit öffentlichen Räumen, der Aufteilung der Straße im allgemeinen zwischen den Nutzerinnen- und Nutzergruppen, Fußgänger- und Radverkehr sowie dem öffentlichen Verkehr (URBAN DEVELOPMENT VIENNA 2013:31). Teil dieser Vision ist beispielsweise, dass die Sicherheit des öffentlichen Raums eine zentrale Rolle spielt. Dabei ist das subjektive Sicherheitsempfinden von zentraler Bedeutung. Hier folgt Wien dem Prinzip „Sehen und Gesehen werden", welches auf „die Förderung einer (wünschenswerten) sozialen Kontrolle, auf eine wirksame Orientierung im Quartier und auf eine Sichtbarkeit ohne tote Winkel und mit einer effizienten Ausleuchtung von Straßen und Gehwegen" zielt. Eine Gestaltung dieser Art kann dem Gefühl der Angst entgegenwirken oder gar unterbinden und Risiken eindämmen. Weitere Beispiele der Stadtvision von Wien werden ausführlicher in Kapitel 3.2. aufgegriffen.

3.1.4 Governance und Nacht

Um die physischen und sozialen Dimensionen der Stadt(planung) in vollem Umfang zu fassen, sollte sie auch nach Einbruch der Dunkelheit beleuchtet werden. Urbane Studien, die die Nachtzeit bzw. die Nachtplanung aufgreifen, werden erst seit Anfang der 1990er-Jahre verfasst (BONFIGLIOLI 1997:22). So wird beispielsweise die Nachtzeit zu einer wertschöpfenden und sinnvollen (Arbeits-) Zeit für einige Dienstleistungen wie u. a. für Transport- und Lieferdienste oder Lebensmitteldienstleistungen. Eine erfolgreiche und gewinnbringende Nachtwirtschaft benötigt jedoch eine ganzheitliche Strategie, die auf Grundlage des sozialen, kulturellen und wirtschaftlichen Kontexts einer Stadt entwickelt wird und von einem Bottom-up-Ansatz lebt, der den Austausch mit allen beteiligten und betroffenen Akteurinnen und Akteuren fördert (ZHURAVLOVA, MACIULYTE, KRAUSS, SUSKA 2020:8 und KRAUSS 2021). Dies gilt auch für die Sicherheit und das Sicherheitsempfinden bei Nacht, insbesondere für Frauen. Das Potenzial und die Qualität der urbanen Nächte können sich nur dann in vollen Zügen entfalten, wenn alle Menschen der Stadtgesellschaft Gleichberechtigung in ihrer Entfaltung und der damit einhergehende Sicherheit erfahren. In der Verantwortung stehen hierfür die Stadtpolitik und -verwaltung. Die Teilhabe am städtischen Leben zu jeder Tages- und Nachtzeit ist ein Grundrecht, das jedem Geschlecht zusteht. Räume werden gemieden und Mobilität unterbunden, wenn sich betroffene Personen – in diesem Fall Frauen – nicht sicher fühlen. Eine Stadtverwaltung sollte nicht nur die Tageszeiten gestalten; auch bei Nacht findet Leben statt, das sicher gestaltet werden und die Teilhabe gewährleistet sein muss, ohne sich einer permanenten Kontrolle auszusetzen, die eine Videoüberwachung impliziert. Denn die Wahrnehmung von einer permanenten und verstärkten Kontrolle sowie Überwachungsmechanismen lassen a priori auf Gefahr und Unsicherheit schließen. Damit wird gewiss versucht, mehr Sicherheit(sgefühle) herzustellen, dies produziert jedoch im Gegenzug wiederum mehr Unsicherheit(sgefühle) (RUHNE 2020:433).

Für die nächtliche Governance nutzt jede Stadt ein individuelles urbanes System, das auf unterschiedlichen Ebenen operiert. In den meisten Städten sind sie sich jedoch ähnlich: Gesetze und Polizei als staatlicher Akteur und informelle Vereinbarungen und Nachbarschaftswachen beispielsweise als nicht-staatliche

[5] Der Umkreis von Menschen differiert in unterschiedlichen Lebensphasen. Junge Menschen sind noch eher in der örtlichen Nachbarschaft unterwegs, wobei Erwachsene ihren Radius bspw. auch aufgrund der Arbeit erweitern müssen (Urban Development Vienna, S. 19).

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Akteure (SEIJAS, GELDERS 2019:4). Traditionell wird die Nacht als Vorwand für die Aufrechterhaltung von Strukturen der sozialen Ausgrenzung und einer strengeren (polizeilichen) Kontrolle genutzt, die nach Bianchini (1995) als „regulators of behaviour" bezeichnet werden (ebd. und STRAW 2018). Nach weiteren Studien, die sich mit den Untersuchungen der ausgrenzenden Ergebnisse beschäftigen, die aus diesen Strukturen resultieren, basieren diese u. a. auf Rasse und Ethnizität, sozialer Klasse, Geschlecht, Alter und sexuellen Präferenzen (SEIJAS, GELDERS 2019:3). Dadurch wurde in manchen Stadtverwaltungen (vor allem Städte in GB) eine proaktive Diskussion über die Integration von Daten und Planungsmechanismen angeregt, um Probleme innerhalb dem nächtlichen Stadtleben anzugehen und entgegenzuwirken. Dabei wurde ein stärkerer Dialog und eine engere Zusammenarbeit zwischen den betroffenen Personen, der „Nachtlebensbranche" und der Stadtverwaltung gefördert. Solche Art von Kooperationen und Zusammenarbeit fördern einen Konsens über die Vorstellung des nächtlichen Lebens und der nächtlichen Governance, anstatt sich auf restriktive Mechanismen zu konzentrieren. Für diesen Ansatz wurde in den letzten Jahren eine neue Schlüsselrolle geschaffen, die der Nachtbürgermeisterin, des Nachtbürgermeisters. Damit soll den Städten der Weg geebnet werden, um ein breiteres Spektrum an sozialen, wirtschaftlichen und ökologischen Faktoren des Lebens nach Einbruch der Dunkelheit anzugehen (SEIJAS,GELDERS 2019:4). Vor allem für die soziale Interaktion ist die urbane Nacht ein wichtiger Ort und stark umkämpft, hier entwickelt sich Vertauen und Identität. Dieser Raum wurde in der Vergangenheit vermehrt von bestimmten Gruppen wie beispielsweise der LGBTQ*[6] genutzt, um ihr Recht auf das Leben und die freie Entfaltung in der Stadt einzufordern (SEIJAS, GELDERS 2019:12). Innerhalb dieser Schlüsselrolle müssen diverse Sprachrohre verankert sein, so eben auch eines für soziale Faktoren, im konkreten Fall für Menschen, insbesondere Frauen, die sich im urbanen Raum bei Dunkelheit (an gewissen Orten) unsicher fühlen. Damit Maßnahmen gezielt an diesen Orten umgesetzt werden, die die sogenannten „Brennpunkte" darstellen.

Innerhalb der Idee einer 24-h-Governance werden solche Belange „Gehör" finden, hierfür wird eine „eigene Verwaltung" für die Belange des Lebens nach Einbruch der Dunkelheit (zwischen 18 und 6 Uhr) geschaffen, sodass sich mit den Themen, die für ein sicheres und ein für sicher empfundenes Nachtleben sorgen, intensiver und geschlossen auseinandergesetzt werden kann. Nicht nur die Sicherheit oder das Sicherheitsempfinden im öffentlichen Raum sind damit gemeint, auch wird man sich Themen wie häusliche Gewalt, Alkoholmissbrauch, Obdachlosigkeit, sexuelle Belästigung und vielen weiteren, wichtigen sozio-kulturellen Themen annehmen können, die darunter leiden, weil sie außerhalb der „normalen" Arbeitszeiten einer Verwaltung stattfinden. Aber nicht nur innerhalb der Nighttime-Governance, auch tagsüber und vor allem auf der Ebene der Bürgermeisterinnen und Bürgermeister muss diese Thematik verstanden und verankert sein, weil auch sie bei Entscheidungen eine aktive und tragende Rolle spielen. Denn für eine gendersensible Governance ist ein wichtiges Kriterium, alltags- und frauengerecht zu planen und zu bauen.

3.2 Bauliche Aspekte in der Stadtplanung

„only architecture that considers human scale and interaction is successful architecture"[7]

Neben den Aspekten der sozialen Stadtplanung spielen auch die baulichen Strukturen zur Steigerung des Sicherheitsempfinden, insbesondere bei Nacht, eine entscheidende Rolle. Bauliche Strukturen sind Teil des öffentlichen Raums und beschreiben diese durch die Ausgestaltung von Plätzen, Wegen, Straßen, Gebäudekubaturen und vielem mehr. Bauliche Strukturen sind sowohl langfristig geplante und gebaute Bauwerke und Infrastrukturen wie Gebäude und Plätze, aber auch mittelfristig flexiblere Elemente, beispielsweise Beleuchtungsanlagen. Zur Entwicklung nachhaltiger Städte sollten einige Kriterien berücksichtigt werden: Darunter fällt eine sichere und saubere gebaute Umgebung, Parks und Freiflächen, Stätten der Unterhaltung mit Aufenthaltsqualität sowie Aspekte zur Steigerung der geistigen und körperlichen Gesundheit der Bewohnerinnen und Bewohner (SHAMSUDDIN, HUSSIN 2011:8).

3.2.1 Beitrag der Stadtplanung und bauliche Strukturen in der Entwicklung und Vermeidung von Angsträumen

In der Vergangenheit wurde bei der Stadtplanung insbesondere die Gestaltung für den Tag berücksichtigt. Bis zu den 1970er-Jahren wurden Großstädte primär für den Aufenthalt des erwerbstätigen Mannes geplant

[6] Abk. Lesbian, Gay, Bi, Trans, Queer und Intersex. LGBTQ*-Gemeinschaften leisten historisch ihren Beitrag zur Lebendigkeit und zu einzigartigen Charakteren von Städten und Vierteln.

[7] Gehl, Jan (2015) Städte für Menschen

(MITSCHERLICH 1999). In den letzten 20 Jahren hat sich eine Bewegung hin zu lebenswerten Städten etabliert. Dabei spielen Themen wie Aufenthaltsqualität unabhängig von Geschlecht, Alter und Hintergrund eine wichtige Rolle, aber auch die Walkability von Städten. Unter Walkability wird nicht nur die Stadt der kurzen Wege verstanden, sondern auch die Bebauungsdichte, also die Breite der Fußgängerwege und Fahrradwege in Relation zur Straßenbreite und Gebäudehöhen. Hierbei ist der Mensch immer der entscheidende Maßstab für eine Gesamtdichte (SIM 2019:221).

In „Urban Development Vienna (2013)“ werden Modelle und Ziele für eine gendersensible Stadtgestaltung aufgezeigt. Dazu gehört die Stärkung der polyzentrischen Stadtstruktur, welche eng mit der Struktur der „Stadt der kurzen Wege“ und des Walkability-Ansatzes verbunden ist. Die Vision „Stadt der kurzen Wege“ reduziert das Verkehrsaufkommen und ermöglicht die effiziente Kombination von Erwerbsarbeit, Familienarbeit, Pflege, Einkauf und Dienstleistungsnutzung. Innerhalb der polyzentrischen Stadtstruktur liegt das Ziel in der Erhaltung und Entwicklung einer dezentralen Verteilung von Einrichtungen. Das bedeutet es sollen u. a. Dienstleistungs- und Infrastruktureinrichtungen in der Nähe von hoch frequentierten Haltestellen des öffentlichen Verkehrs gefördert werden, sodass junge oder ältere Menschen sowie Personen mit besonderen Bedürfnissen keine Probleme haben, am (kulturellen) Leben teilzunehmen (URBAN DEVELOPMENT VIENNA 2013:25). Ein weiteres Ziel der Stadt Wien ist die Schaffung hochwertiger öffentlicher Räume. Hierbei „soll die Planung, Gestaltung und die Ausstattung an die unterschiedlichen sozialen Bedürfnisse der Menschen angepasst werden“ (ebd. 2013:26). So sollen öffentliche Räume als Ausgleichsfunktion für einkommensschwächere Bevölkerungsgruppen als sozialen Ausgleich dienen und attraktiv gestaltet sein, sodass sie gerne genutzt werden und den Alltag in unterschiedlichen Formen unterstützen. Fehlende (private) öffentliche Räume sowie eine zunehmende Siedlungsdichte verschärfen den Druck auf den öffentlichen Raum zusätzlich (ebd. 2013:26). Ein weiteres Modell in Wien ist die Förderung von umweltfreundlichen Verkehrsmitteln und die Verbesserung der Mobilitätsangebote für nicht motorisierte Verkehrsteilnehmerinnen und Verkehrsteilnehmer, denn Straßen haben nicht nur eine Verkehrsfunktion, sondern sind auch Aufenthaltsorte. Straßen sollten nach Wiener Vision u. a. „atmosphärisch und sicher sein und eine angstfreie und barrierefreie Nutzung ermöglichen“ (ebd. 2013).

Damit öffentliche Räume weiterhin genutzt werden und aufgrund vom Ängsten nicht auf Mobilität verzichtet wird, muss das subjektive Gefühl eine Sicherheit im öffentlichen Raum hervorrufen. Die Stadt Wien folgt dabei Jacobs (1961) Qualitäten einer sicheren Straße – (1) Klare Abgrenzung zwischen privatem und öffentlichen Raum, (2) belebte und bewohnte Straßen, auch Räumlichkeiten im Erdgeschoß und (3) Fenster sollten sich zur Straße hin ausrichten („social eyes“) (URBAN DEVELOPMENT VIENNA 2013:27). Die letzte Vision, der Wien folgt, ist die barrierefreie Stadt, um allen Nutzerinnen und Nutzern die Teilhabe an der Stadt zu ermöglichen. Nicht nur Menschen mit eingeschränkter Mobilität sollten berücksichtigt werden, auch Menschen mit vorrübergehend eingeschränkter Mobilität sowie die Erleichterung des Lebens von Personen mit Pflege- und Familienaufgaben fallen unter barrierefreies Planen. Alltägliche Wege sollen für alle einfacher und sicherer sein (ebd.).

3.2.2 Bestehende Analysen zu baulich hervorgerufenen Angsträumen

Die Analyse der Literatur weist deutliche Forschungslücken bei der Berücksichtigung nächtlicher Angsträume in der Stadtplanung auf. Es erfolgt lediglich auf Basis von Studien und Umfragen eine gewisse Handlungsanweisung und Empfehlungen für die Ausgestaltung baulicher Strukturen für sichere Nächte. Beispielsweise ergab eine Studie zur Konstruktion von Angsträumen und Studierenden in Wien, dass einige Gestaltungsaspekte ungenügend in der Stadtplanung berücksichtigt werden. Hierzu zählen die Themen rund um Übersichtlichkeit, Einsehbarkeit, Zugänglichkeit und Orientierung im öffentlichen Raum, aber auch Beleuchtung. Dazu kommen weitere soziale Aspekte wie Belebung, Verantwortlichkeit und Konfliktvermeidung (HACKENBERG 2015:38). Erwähnungswert bei der Beschreibung baulicher beängstigender Räume ist, dass bei einer Untersuchung des Landeskriminalamts Niedersachsen mit über 2.000 Befragten herauskam, dass subjektiv empfundene Angsträume nicht mit den Orten der tatsächlichen Kriminalität übereinstimmen (VERBUNDPROJEKT TRANSIT 2015:18). In diesem Abschnitt werden einige bauliche Aspekte, die subjektiv unsichere Räume erzeugen, exemplarisch näher untersucht. Insbesondere das Thema Beleuchtung wird immer wieder erwähnt. Die meisten Befragten fühlen sich demnach unsicher, wenn ihr Weg unzureichend beleuchtet ist. Hierunter wird sowohl fehlende Beleuchtung als auch sehr schwache Beleuchtung bzw. Beleuchtung in zu großen Abständen verstanden. Bereits in einer

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früheren Eigenerhebung ergab sich, dass sich Personen generell auch unsicher fühlen, wenn sie sich selbst zwar in einer beleuchteten Umgebung aufhalten, aber ihr weiterer Weg so wie ihr zurückgelegter Weg deutlich geringer bis gar nicht beleuchtet sind, beispielsweise durch bewegungsabhängige Beleuchtung (SCHWIMMER 2017:66). Neben der Helligkeit der Räume spielt auch die Sauberkeit und Belebtheit der Räume eine wichtige Rolle. So ergeben die Studien, dass sich die Befragten in dreckigen Gegenden mit ungepflegtem oder zerfallenem Baubestand und wenig bis keiner Grünfläche zunehmend unsicher fühlen. Hinzu kommt auch die Einsehbarkeit eines vorausgehenden Weges. Je mehr Möglichkeiten es gibt, dass sich jemand verstecken oder unerwartet hinter einer Ecke hervorkommen könnte, desto beängstigender werden diese Räume empfunden (VERBUNDPROJEKT TRANSIT 2015:14). Insbesondere Unterführungen sowie dunkle Parkanlagen sind nach wie vor die subjektiv unsichersten wahrgenommenen Räume (ZANDONELLA, ZAGLOVITS 2008:38). Die Bewegungsgeschwindigkeit durch den Raum hat Auswirkung auf Wahrnehmbarkeit des Raums. Einige Befragte waren der Meinung, je schneller sie unterwegs sind, beispielsweise mit dem Fahrrad, desto weniger können sie wahrnehmen und Gefahren vorhersehen.

3.2.3 Einsatz digitaler Stadtplanungsinstrumente zur Identifikation und Vermeidung von Angsträumen

In immer mehr Stadtentwicklungs- sowie Neubauprojekten werden digitale Werkzeuge zur Planungsunterstützung eingesetzt. Vereinzelt etabliert sich auch ein digitaler Stadtzwilling bzw. ein City Information Modelling (CIM), welches die komplette Stadt mit Daten der verschiedenen urbanen Handlungsfelder, z.B. Klimadaten, Mobilitätsdaten, Abwasserdaten, verknüpft. Auch Bewegungsdaten in Form von EmoMapping, welche Emotionen, beispielsweise Stress, von Probanden in bestimmten baulichen Umgebungen abbildet, wie es bereits 2017 in Dortmund erforscht wurde (SCHLOSSER, ZEILE 2018:79), können in ein CIM integriert werden. Dies wurde 2019 in einem Forschungsprojekt in Herrenberg getestet, neben dem Aufbau des digitalen Stadtzwillings wurden Simulationen zu Wind und Mobilität eingebettet, sowie georeferenzierte Fußgängerdaten, welche aufzeigen, welche Stellen im öffentlichen Raum gemieden werden (DEMBSKI, WÖSSNER, LETZGUS, RUDDAT, YAMU 2020:6). Durch eine digitale Planung im Gesamtkontext Stadt wird zudem ermöglicht Umgebungsdaten der Bebauung besser mitzuberücksichtigen. Die Einführung von bestimmten Parametern in der digitalen Planung könnte die Stadtplanung unterstützen bestehende Angsträume zu identifizieren und zukünftige zu vermeiden. Solche Parameter könnten beispielsweise das Verhältnis von Bebauungshöhe zu Wegbreite bemessen, aber auch die Einhaltung von Sichtachsen und Sichtbezügen können das Sicherheitsempfinden steigern und sind digital abbildbar, genauso wie schlecht beleuchtete Wege, sei es durch unzureichende Beleuchtung bei Nacht als auch durch große Verschattung bei Tag. Durch die Integration solcher Parameter in digitale Planungsprozesse und ein City Information Modelling werden Kommunen befähigt werden, aktiv Angsträume zu vermeiden und Schwachstellen im Gesamtsystem Stadt werden sichtbar (ARP, LEHMANN, SCHWIMMER; SCHAUFLER 2019).

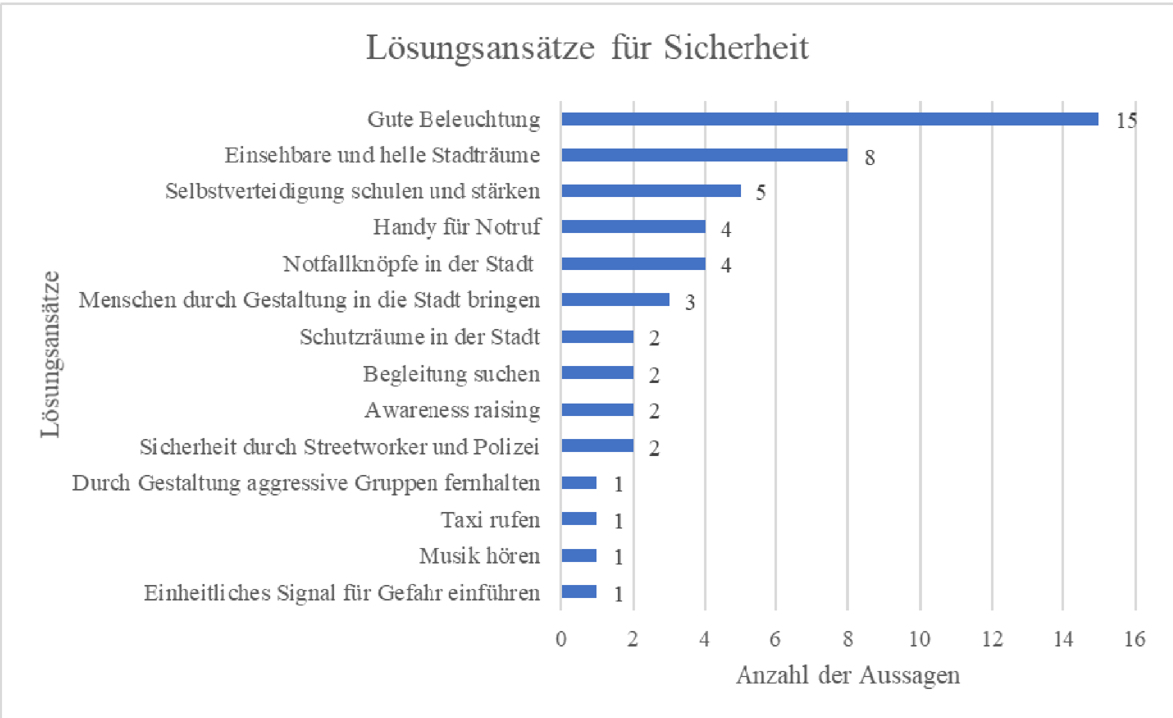
4 KURZINTERVIEWS

Ergänzend zur Literaturrecherche wurden 20 Kurzinterviews geführt, um ein aktuelles Stimmungsbild zu städtischen Angsträumen bei Nacht abzufragen. Die Befragten waren zu gleichen Teilen Frauen und Männer im Alter von 18 bis 45 Jahre. Neben einleitenden Fragen zum allgemeinen Sicherheitsempfinden im öffentlichen Raum, wurde jeweils eine Auswahl von sieben aus vierzehn randomisierten Bildern zur Einschätzung des persönlichen Sicherheitsempfindens gezeigt. Die Bilder stellen verschiedene Situationen des öffentlichen Raums bei Nacht dar, von dunklen Unterführungen, Parkszenen bis hin zu belebten Innenstädten mit niedrigen Bebauungsstruktur. Abschließend wurde nach Gründen für die Unsicherheit bei Nacht sowie möglichen Hilfestellungen zur Erhöhung des Sicherheitsempfinden bei Nacht gefragt.

Die Interviews ergaben, dass sich 94 % der Männer und 84 % der Frauen allgemein im öffentlichen Raum sicher fühlen. Nachts alleine sinkt das Sicherheitsempfinden bei beiden Geschlechtern, bei Männern, aber nur etwas über 10 %, bei Frauen hingegen sind es fast 30 %, was einen Unterschied im Sicherheitsempfinden von rund 26 % ergibt. Die Ergebnisse der Interviews spiegeln die oben aufgeführten Literaturansätze hinsichtlich des Sicherheitsempfinden im öffentlichen Raum wider. Nachfolgende Aussagen fassen die Ergebnisse der Umfrage zum nächtlichen Sicherheitsempfinden zusammen. Das Sicherheitsgefühl ist abhängig von der Baustruktur, der Beleuchtung und der Menschenanzahl im umgebenden Raum. Am sichersten fühlen sich die Befragten bei offenen Baustrukturen oder offenen Plätzen mit niedriger bis mittlerer Bebauungshöhe und Menschen in der Umgebung, hingegen nimmt das Sicherheitsgefühl ab, wenn die Menschenanzahl bei gleicher Umgebung zunimmt. Auch ohne Menschen ist das Sicherheitsempfinden bei offenen niedrigen Strukturen hoch, wohingegen es mit zunehmender Bebauungshöhe trotz sichtbaren Umfelds, breiten Wegs und keiner sichtbaren Menschen um rund 15 % abnimmt. Das Sicherheitsgefühl ist sowohl bei Männern als auch bei Frauen bei dunkler, beengter Bebauung mit Unterführung ohne Menschen am geringsten und verbessert sich bei Frauen nur marginal mit Beleuchtung und vereinzelten Menschen, bei Männern hingegen um knapp 20 %. Das Sicherheitsgefühl bei Frauen, die alleine unterwegs sind, sinkt, je breiter und vielbefahrener eine Straße mit Beleuchtung ist.

Die zwei häufigsten Gründe für Unsicherheiten bei Nacht sind (1) alleine unterwegs sein sowie (2) Dunkelheit in Folge schlechter oder keiner Beleuchtung. Dies gaben jeweils zwölf der zwanzig Befragten an, wobei neun von zehn Frauen insbesondere bei unzureichender Beleuchtung unsicher sind. Der dritthäufigste Grund für Unsicherheiten ist auf bauliche Strukturen und schlechte Einsehbarkeit des Raums zurückzuführen. Häufig entstehen Unsicherheiten aber auch in Zusammenhang mit anderen Menschen, entweder durch Ansammlungen, alkoholosierter Menschen oder auch durch die Ansprache fremder Menschen. Weitere Gründe für Unsicherheit bei Nacht sind folgende: Angst vor Überfälle oder Vergewaltigung, die Möglichkeit, dass etwas unvorgesehenes passieren könnte, eine dreckige Umgebung, obdachlose Menschen oder auch der eigene Zustand.

Für die Befragten ist eine gute Beleuchtung der beste Lösungsansatz, um Unsicherheiten entgegenzuwirken sowie die Gestaltung von offenen und hellen Stadträumen. Um das Sicherheitsempfinden (bei Nacht) bezogen auf Unsicherheiten durch andere Menschen zu steigern, wurden als Alternativen Selbstverteidigung schulen, Absetzen eines Notrufs durch das eigene Handy oder die Einführung von Notfallknöpfen in den Innenstädten genannt. Weitere sicherheitssteigernede Lösungsansätze können der nachfolgenden Abbildung entnommen werden.



5 HANDLUNGSEMFPEHLUNGEN

Um den öffentlichen Raum für alle Personen der Gesellschaft gerecht zugänglich zu machen sowie die Sicherheit bei Nacht zu steigern und damit angstfrei zu gestalten, gilt es von mehreren Seiten und in mehrere Richtungen aktiv zu werden.

Zum einen sind das wie oben beschrieben die baulichen Aspekte, diese lassen sich in kurzfristig bis mittelfristig sowie langfristige Maßnahmen unterteilen. Zum anderen sind zielgerichtete Maßnahmen und ein sichtbares Engagament aus den Reihen der (lokalen) Zivilgesellschaft als auch der Bundes-, Landes- und Kommunalpolitik notwendig.

Beleuchtung: Als kurzfristig umzusetzende Maßnahme müssen neuen Beleuchtungskonzepte für Kommunen realisiert werden. Hierbei müssen nicht nur Orte mit hoher Kriminalitätsrate berücksichtigt werden, sondern auch Räume, die ein subjektives Unsicherheitsempfinden – insbesondere bei Frauen – hervorrufen. Für eine erfolgreiche Umetzung ist es wichtig, auch andere Beteiligte im Stadtgeschehen mit einzubinden, diese könnten beispielsweise Vertreterinnen und Vertreter von öffentlichem Nahverkehr, Einkaufszentren aber auch Bauunternehmen sein.

Notfallkontaktaufnahme: In einer Situation der Unsicherheit muss es Möglichkeiten geben, Kontakt zu Personen aufzunehmen, die einen durch die Situation führen. Dies kann durch entsprechende Notfallsäulen und -knöpfe, beispielsweise gekoppelt an Lichtmasten, sein. Auch können hier „Notfallhubs“ eine Lösungsmöglichkeit für ein gesteigertes Sicherheitsempfinden sein. Diese könnten beispielsweise durch die Reaktivierung alter Telefonzellen und an Bushaltestellen kleine abschließbare Räume sein, die aber ebenfalls über eine eingebaute Kontaktaufnahme verfügen.

Aufwertung des öffentlichen Raums: Durch Begrünungen, Sitzgelegenheiten und temporäre Nutzungen des öffentlichen Raums kann dieser kurz- und mittelfristig aufgewertet werden. Hierzu gehören auch eine Verkürzung des Putz- und Pflegeabstands öffentlicher Anlagen sowie, wo möglich, eine Aufhellung von Fassaden und Verbreiterung der Wege bzw. Rückschneiden von Hecken sein.

Digitale Stadtentwicklung: Langfristig ist es notwendig, bei der Planung von neuen Quartieren oder baulichen Anlagen vorab mit Hilfe von Simulationen und anhand bestimmter Kriterien die Entstehung von Angsträumen zu vermeiden. Da Städte aber bereits größtenteils gebaut sind, kann hier die Etablierung eines City Information Modelings, ein digitales (Echtzeit-) Abbild der Stadt, dabei unterstützen, entsprechende Räume zu identifizieren und geeignete Maßnahmen einzuleiten.

Projektförderungen mit Beteiligungsformaten: Durch Fördergelder und -projekte kann ein gender mainstreaming in der Stadtplanung verankert, Maßnahmen angestoßen und deren Wirkung evaluiert werden. Dabei müssen diverse Nutzerinnen- und Nutzergruppen aus der Zivilgesellschaft, Wissenschaft und Wirtschaft, als auch ressortübergreifende Mitarbeiterinnen und Mitarbeiter (beispielsweise Gleichstellungsbeauftragter oder Gleichstellungsbeauftragte, Baureferat, Nachtmanagerin oder Nachtmanager, Ordnungsamt etc.) in den Planungsprozess miteinbezogen werden. Das kann innerhalb von Beteiligungsformaten unter Einbindung dieser Interessensgruppen geschaffen werden. Dabei sollten sich alle Akteure gegenseitig austauschen, ihre Expertise einbringen, ihr Wissen teilen und Gehör finden. Ebenso sind Ortsbegehungen mit den betroffenen Personengruppen, vor allem Frauen und den verantwortlichen Stadtgestalterinnen und Stadtgestaltern ein sinnvoller Ansatz.

Führungspersonen: Sensibilisierte, überzeugte und zielgerichtete Fürhungspersonen innerhalb der Stadtämtern, aber auch in Form der Bürgermeisterin oder des Bürgermeisters, die diesem Thema Gewicht und Gesicht verleihen sowie (Planungs-)Ziele festlegen, sind unabdingbar für eine gendergerechte Stadtgestaltung.

24-h-Governance: Eine 24-h-Governance in den Städten wird soziokulturelle Themen bei Nacht stärker in den Fokus nehmen und präventiv behandeln, wie beispielsweise gezielte Aufklärungsarbeit bei Jungen und Männern oder einzelnen „auffälligen“ Gruppen leisten. Dabei könnte u. a. ein Leitfaden behilflich sein, der einerseits gewissen Personengruppen aufzeigt wie sie auf andere Menschen innerhalb dem nächtlichen Stadtraum wirken und andererseits die Gesellschaft sensibilisiert, dass oftmals „bedrohend“ Wirkendes wie beispielsweise Situationen mit obdachlosen Menschen harmlos sind. Auch wird die Stadt bei Nacht innerhalb diesem Modell von verschiedenen Seiten beleuchtet und kann demnach Maßnahmen intersektoral, integrierend und bei Bedarf überörtlich ausarbeiten und gestalten. Es muss die Wahrnehmung geschaffen werden, wie viele Themen mithilfe einer 24-h-Governance behandelt werden können, welche die Städte und Kommunen sicherer und offener gestalten. Ein öffentlicher Raum kann nur durch Inklusion für alle funktionieren. Eine eigene Verwaltungsstruktur für die Themen nach Einbruch der Dunkelheit und mithilfe von Gremien, Räten, verschiedenen Ämtern und betroffenen Akteuren werden die Belange, welche die nächtliche Stadt und den nächtlichen öffentlichen Raum betreffen, wie beispielsweise Angsträume, sexuelle Belästigung, Alkoholmissbrauch, Obdachlosigkeit oder Ruhestörungen intensiver erörtern, bearbeiten und lösen können, als es die bis dahin existierende Verwaltungsstruktur behandelt.

Soziale Kontrolle und Solidarität: Auch eine Art Aufklärungsarbeit ist notwendig, um die Menschen dazu zu bewegen solidarisch zu handeln. Ganz nach dem Motto „Sehen und Gesehen werden". Hilfsbedürftige Menschen unterstützen, sich erkenntlich zeigen, Hilfe rufen und gemeinsam Widerstand leisten.

6 AUSBLICK

Um dieser Thematik erfolgreich begegnen zu können, ist es unabdingbar betroffene Personengruppen weiterhin kontinuierlich miteinzubeziehen, vor allem aber auch die Evalution umgesetzter Maßnahmen. Es muss festgehalten werden, was sich für sie in ihrem städtischen Umfeld verändert hat, inwiefern sich ihr Sicherheitsempfinden verändert und an welchen Veränderungen das konkret liegt. Dieses Vorgehen kann zukünftig durch ein City Information Modeling unterstützt werden (SCHAUFLER, SCHWIMMER; 2020). Hierbei haben die betroffenen Personengruppen jederzeit die Möglichkeiten Angsträume zu melden und eingeleitete Maßnahmen zu bewerten. Zudem können Kommunen durch Einführung bestimmter Parameter in digitalen Planungsmodellen mögliche Angsträume bereits in der Planungsphase identifizieren und dadurch vermeiden. Eine geschlechtergerechte Stadtplanung kann, wie viele Bereiche des gesellschaftlichen Lebens, nur dann erfolgreich sein und zum Ziel führen, wenn die betroffenen Gruppen in den Prozess mitinvolviert sind. Auch nachdem die ersten Schritte abgeschloßen und Erfolge erzielt wurden. Dafür muss an bereits umgesetzten Projekte und Maßnahmen angesetzt werden. Auch ist die Sensibiliserung der ganzen (Stadt-)Gesellschaft von enormer Wichtigkeit bei dieser Thematik. Denn nicht nur Frauen und die Stadtgestaltung können dem subjektiven Sicherheitsempfinden gut beisteuern, auch das Verhalten der Stadtgesellschaft bzw. das Verhalten bestimmter Personengruppen kann dazu beitragen, dass sich alle sicher und wohl fühlen. Wichtig ist, nicht nur Leitfäden für die Stadtplanung zu generieren, auch sollten Leitfäden entstehen, die zur Aufklärungsarbeit beitragen und beispielsweise an Schulen oder durch Streetworkerinnen und Streetworker gestreut werden. Weitere Forschungsarbeit mit den betroffenen Personengruppen, Städten, Stadtplanerinnen, Stadtplanern und innovativen Unternehmen ist wichtig, um das Thema Angsträume und Unsicherheit im öffentlichen Raum insbesondere bei Nacht weiter zu beforschen, tiefergründig verstehen zu können und neue hilfreiche Ansätze zu entwickeln und damit der Unsicherheit und Angst im öffentlichen Raum bei Nacht entgegenzuwirken.

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Streetscape Design Elements Approach as a Tool for Urban Soundscape Enhancement A Perspective from Ahmed Oraby Square, Alexandria, Egypt

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1 ABSTRACT

Streetscape design is one of the disciplines that have an effective role in the quality of urban soundscape however, there is a noticeable absence of links between urban soundscape and streetscape design. This research aims to link urban soundscape with streetscape design by creating guideline for the process of enhancing and designing soundscape by employing streetscape design (elements). Therefore, enhancing designers' skills and focusing on enhancement process of open spaces within urban design. This study examines a preference level of urban soundscapes which has been designed based on (potentials of) streetscape design elements. First, a permutation process was applied to six streetscape design elements. Each streetscape element was connected to one acoustic component of the soundscape and with road traffic noise RTN as a major source of the noise, in order to formulate soundscape design proposals. Fourteen proposed situations of soundscape design have been chosen as sample for conducting the experiment. Each situation has been used to create two audios with two sound pressure levels SPL of RTN (73 and 66 dBA) to produce 28 audios representing proposed soundscapes. A total of twenty subjects took part in a laboratory experiment to evaluate preference levels of produced audios using a scale divided into ten levels (zero for the worst and ten for the best) and 3D created shoots were displayed simultaneously with every audio. Unlike previous studies, the results showed that the soundscape preference level of multi-sounds situations (situations have three acoustic components) gained a higher percentage than singular situations when road traffic noise level at 73 dBA. In contrast, in the case of low road traffic noise level (66 dBA) the preference level is higher in singular situations than in multi-sounds situations. Finally, a four stage guideline of urban soundscape design and enhancement, based on streetscape design elements is produced which enables examination of soundscape quality before design interventions and decisions.

Keywords: Sonic environment, Preference level, Design Guideline, Urban Soundscape, Streetscape Design

2 INTRODUCTION

The sound of the environment in urban spaces is one of the important aspects that affects quality of life and health. For example, noise has been associated with health diseases such as stress, cardiovascular disease, and sleeping disorders (Basner et al., 2014; WHO (2011). In addition, Cohen and Spacapan (1984) showed that noise influences social behaviour. Although sound has a negative effect on health, it also has a positive effect, for instance, nature sounds have been used by Alvarsson et al. (2010) and Annerstedt et al. (2013) as assisting approach in stress healing as well as in the rehabilitation process of patients Cerwén et al. (2016). Considering that the sound aspect has many possibilities in the design process, the sound approach is always neglected despite that. The focus is always directed to the visual aspects and when sound aspects have been considered the subject is always about the negative (passive) approach, most often about noise abetment. Urban designers and related disciplines have not fully recognised the importance of linking the two aspects. Thus, it is always about solving the noise problem and just excluding or masking the noise source while there is no attention given to enhancing the complete soundscape of a site. Streetscape plans design is one of the disciplines that have far/near-reaching effects, positive and negative, on the soundscape patterns. In present time, there is a noticed absence of linking the urban soundscape to the streetscape design. Considering that sound affects health, life pleasure, and has an environmental influence this is a problem. This research aims to create a guideline for the process of designing and enhancing urban soundscape with the use of streetscape design. The objectives are first, to enhance designers' skills and awareness in order to link soundscape to streetscape and secondly, to focus on the enhancement process of open spaces in urban design. In this research two types of methods have been used, analytical deduction and induction research process with an explanatory case study. This experimental method is the manner that has been used to apply a case study which was performed by a number of subjects to rate their preference level of soundscape proposals after enhancement of the site's soundscapes. According to this method, the following steps were taken: reviewing streetscape and soundscape design elements, features, and possible approaches to soundscape; analysing each of them; explaining suggested software for measurements and the modelling process. This was applied to a case study with previously analysed data regarding design enhancement of soundscape based on streetscape design elements. The results were analysed and followed by a discussion of derived design enhancement guideline/tool and the research concluded with a mention of further studies. The paper consists of two main parts: a literature review and a practical part aimed to derive a soundscape enhancement tool. The first part of the study includes literature on soundscape, streetscape, and previous studies; the second part consists of the practical case study of the selected area, results, discussion and conclusion.

3 SOUNDSCAPE OF URBAN ENVIRONMENT

In ISO (2014) standardisation of definitions, the acoustic environment is defined is the combination of all the acoustic resources, natural and artificial, within a given area as modified by the environment. Schafer (1977) defined soundscape as the environment of sounds, music, and noise that surrounds us. He noted that the soundscape is the sonic environment. According to Schafer (1977), the term “soundscape”, derived from “landscape”, designates those elements that shape a landscape from an acoustic perspective. Therefore, he recognised the main features of soundscape as keynote sounds, signals, and sound marks. According to him, keynote sounds are "those sounds which are heard frequently enough to form a background against which other sounds are perceived". Whereas, signals are any sound that can be listened to consciously as a conscious signal, such as bells, whistles, horns, and sirens. Finally, a sound mark is derived from a landmark and refers to a community sound that is unique or possesses qualities that make it regarded or noticed specially by the people in that community. The sound mark is what makes the soundscape of a place different from any other place in the world (Guzy, 2017). The design elements of the soundscape are relating the acoustical and visual elements. For example, water sounds are related to water features such as fountains, which are considered as a streetscape element as well. In a previous study by Jeon et al. (2011), six design elements of soundscape have been derived. These elements include water features, green spaces, people's activities, traffic, performances, and construction fields.

4 APPROACHES OF SOUNDSCAPE DESIGN IN URBAN ENVIRONMENT

In the past, when the topic of studies related to acoustics in urban design, it is always about noise abatement issues with the meaning of sound reduction (Ponten, E. 2009) which are considered as a passive approach of dealing with the soundscape. Even the early soundscape concept has been suggested as an approach to rethinking when evaluating the noise and its effects (Brooks et al., 2014). Starting from this point, many attempts were made to introduce pleasant sounds to acoustic environments polluted by urban noise in order to enhance the quality of the acoustic environment which is considered as an active approach to acoustic design. As a comprehensive approach to soundscape enhancement in the current study, both approaches, active and passive, are applied for the purpose of achieving the best preference level of proposed soundscapes. Some of the soundscape design elements have a double effect of noise reduction and the introduction of pleasant sounds, as Cerwéna et al. (2017) mentioned. For example, vegetation (trees e.g.) weaken sound waves by acting as noise screens, while also introducing pleasant sounds such as from birds.

5 PASSIVE APPROACH (QUANTITATIVE MANNER)

Referring to Praticò et al. (2013), two different aspects of decreasing noise pollution problems are mentioned. The first is the integrated planning aspect to transportation and land use and the second is a corrective approach through sound reduction techniques (e.g. vegetation, low-noise paving material, etc.) which is appropriate for the current study. Two techniques were used here for noise reduction: vegetation and low-noise ground material. The concept is that vegetation influences sound waves and weakens them by propagating them, thus well-planned use of vegetation can achieve useful road traffic noise reduction up to 6 to 7 dBA when inserted into a balanced design (HOSANNA, 2013). This can take multiple images and forms as vegetation can be implanted in different manners by means of trees, shrubs, and bushes, as well as green facades and such vegetation forms can be considered as noise barriers. The effect of vegetation screens to reduce noise varies depending on the type of their properties, while height is the most important determinant (HOSANNA, 2013). Noise screen materials vary. They can be wood or concrete, but vegetation is the most common use for low noise screening, which is up to around one meter high (Defrance et al., 2015)/ It is appropriate in urban environments where visibility above the screen is important (Cerwéna et al., 2017), inter alia for reasons of security and public space. Thus, in the present study vegetated facades, vegetated low-rise barriers (noise screens), trees in addition to cherubs have been used, depending on the design of each proposal. In terms of ground material, Praticò et al. (2013) showed that quiet asphalt pavement like rubberised asphalt, stone-matrix asphalt, and fine-graded surfaces can help reduce highway noise by 7 decibels (dB). Rubberised asphalt contains crumbs of recycled tires that provide some flexing in the road surface as tires pass over it, allowing the air a bit more time to be forced out at lower pressure (Careless, 2015). Therefore, rubberised asphalt was used in the case study as it was particularly appropriate and affordable.

6 ACTIVE APPROACH (QUALITATIVE MANNER)

Although, Rådsten Ekman (2015) said that the introduction of new sounds does not necessarily improve soundscape quality, Yang and Kang (2005) reported that the introduction of a pleasant sound such as water or music could considerably improve perceived acoustic comfort in urban spaces, even when the sound level was rather high. Progressively, water features in urban spaces became considered an essential element in the context of the soundscape. In a questionnaire survey conducted by Guastavino (2006), water sounds deserved the second-largest rank of favourable responses among natural sounds. A case study in the Peace Garden in Sheffield, UK has been conducted to investigate perceptions of urban soundscapes and sound preferences proved that soundscape quality in urban squares improved greatly by the introduction of water elements (Yang and Kang, 2005). It was found that the sound of water was evaluated as the favourite sound of approximately 80 % of interviewees. Another importance of water sound is the potential of masking noise such as construction, trains, or traffic (Brown and Rutherford, 1994). The degree to which water sounds successfully mask urban noises refers to the overall level of water sound which depends on the design and type of water features in urban spaces. Therefore, in a variety of road traffic noise levels it is requisite to identify the appropriate pressure levels of water sounds (You et al., 2010). Water features are classified into three groups: water structures, moving water structures, and fountains (Dewar, 1990).

In terms of vegetation, the sound of vegetation can enhance the soundscape quality of urban situations which can be described as the rustling of leaves in the wind, the sound of rain on tree leaves, or the singing of the birds they attract (Cerwéna et al., 2017). Axelsson et al. (2010). The sounds of nature like birdsong are generally perceived as pleasant. Birds sound rated as the most favourable in an international sound preference survey conducted and published by Schafer (1977). Cerwéna et al. (2017) mentioned that conditions to attract songbirds can be achieved by considering aspects such as dense and varied vegetation with many layers. Specific species of dense trees like oak, mulberry, and eastern white pine are known to attract songbirds (Exploring Birds). Among the ten most attractive trees for songbirds the oak tree is a very popular tree for use in Egyptian streets (Zayed, 2020). There are ten types of birds in the world known for their pleasant signing (Bravo Animals, 2021) and the two types known in Egypt are the song thrush and the house sparrow (Bird list Worldwide, 2001). Furthermore, the sound of wind garnered the largest proportion of favourable responses among the natural sounds in surveys carried out by Guastavino (2006). Poplars, bamboo, and beech are species of trees that are known to produce stronger sounds in the wind than others (Cerwéna et al., 2016; DeGroot, 2015; Yang et al., 2016). The poplar tree is one of the common trees used in Egypt's streets (Zayed, 2020) and has been used as a producer of leaves sounds. Human activities are considered an effective component of urban soundscape because they communicate through sound. “Activities striking is the construction of zones that attract certain human activities that influence the soundscape“ according to Cerwéna et al., (2017) who concludes with different examples of activities that encourage everyday social activities, such as a kiosk, a cafe, or a seat. In general, previous research identified that technological sounds are perceived as annoying, whereas natural sounds are perceived as pleasant (Axelsson et al., 2010). The sounds of human beings’ were somewhere in between (Cerwéna, 2017). In the International Sound Preference Survey conducted by Schafer (1994) for testing how people are liking or disliking sounds by sound category, natural sounds of birds, wind, and water won as the most pleasant sound; music, and human sound came after them. although it was also found that the attitudes and perceptions of human sounds varied depending on loudness, social context, and phase of treatment (Cerwéna et al., 2016).

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Auditory masking is defined as an effect that occurs when one sound (masker) is introduced with the intention to reduce the impact or shift the focus from another sound (target). There are two kinds of auditory masking, energetic and informational masking (Cerwéna et al., 2017). For the current study, energetic masking will be used which happens when the masker sound is literally covering the target sound energetically with the introduction of a masker sound. Most commonly, there is an 8–10 dBA difference in sound pressure levels between the masker and the target (Brown and Rutherford, 1994).

7 METHOD

This research is a qualitative research with a quantitative dimension. Two types of methods have been used, analytical deduction and induction research process with an explanatory case study.

7.1 Site Selection

The area that has been chosen is Ahmed Orabi square in the Al-manshya district in Alexandria city. It is located between two main horizontal streets, Omar lofty street forms the north and Salah Salem street forms the south boundary, and two parallel streets run from east and west as shown in figure 1. The area is considered a mixed used, where commercial use dominates on the ground floor whereas residential use is occupying the other floors of the buildings.

In general, Ahmed Orabi square is rich with acoustic sources caused by the mixed uses. Vendors' cheers, drivers' cheers, walking and talking of people and the tram, railway, road traffic are the main sources of noise. The selected part of the square has significant problems and potential. On one hand, street vendors occupy the sidewalk and more than two car lanes along the street. On the other hand, a wide area of sidewalk in the square's streets enables variety of uses in addition to gathering of people because of the existing of the ATM, CIB bank branch the and settled vendors. The site has been selected for significant reasons, firstly to enable dealing with problems and potentials of the crowded soundscape and secondly to create a significant transformation of the urban soundscape throw streetscape elements to enhance the site's soundscape. Finally, the purpose of paying attention to and raising awareness of streetscape design is an effective approach to enhance and design the site's soundscape. Ahmed Orabi square is a symmetric square, thus it could be divided into four similar parts. The experiment implemented on the north-eastern part, is a sample of the other four parts.

Fig. 1: To the right, selected Site of Ahmed Orabi square in the middle of Al-manshya Al-Kobra quarter, Al-Gomrok district, Alexandria city, and to the left, the two horizontal streets (Omar Lotfy and Salah Salem Street) and the two parallel vertical streets on both sides of Ahmed Orabi square. Source: Researchers, 2020.

7.2 Variables

The wide sidewalk which is four meters wide enables a variety of uses and activities, so that different types of vegetation, water features and spaces for activities have been inserted as design proposals. Based on the potential problems were analysed. Three categories of six streetscape design elements related to three categories of acoustic sources that have a significant effect in soundscape preference and quality have been inserted into the design proposals as variables. Two categories represent the natural sound sources and the third category represents human sounds as shown in table 1. Firstly, the water category includes two types of water features which are street fountains connected to drop water sound in addition to the natural waterfall sound connected to falling water. Secondly, the vegetation category includes two types of trees, the poplar tree which is connected to songbirds (thrush and sparrow especially). Whereas, the second component is the oak tree connected to sounds of moving leaves. Finally, the category of people's activities includes sounds of vendors' cheers which maintain the area sound mark but inside small kiosks. The second component is street seats connected to people's talks. Streetscape elements named with reference to sources name are drop water (D), falling water (F), songbirds (B), sound of leaves (L), people's talking voices (T) and vendors' cheers (C).

Acoustic categories	**Water sound**	**Vegetation**	**Peoples' Activity**
Streetscape Design Elements	**Streets' small fountain** (Drop water sound)	**Poplars trees** (Birds singing)	**Kiosks** (vendors' cheer voices)
	Natural Waterfall (water fall sound)	**Oak trees** (leaves sounds)	**Seats** (talks voices)

Table1: Variables of soundscape represented in three acoustic categories, each category corresponding to two streetscape design elements which connected to two types of acoustic categories. Source: Researchers, 2020.

7.3 Procedure

7.3.1 Acoustical Modelling

After applying permutations of six previous streetscape elements, fourteen situations have been chosen as samples of soundscape proposals (situations). Two types of proposed acoustic scenes have been created, multiple and singular sounds situations to end up with eight multiple-sound situations and six singular situations. Firstly, each one of the eight multiple-sound situations consists of three acoustic components (represented in streetscape elements as acoustic sources) mentioned above. whereas singular situations consist of one from each category. The multiple situations are named as D + C+ B, D + T+ L, D + C + L, D + T + B, F+ C + B, F+ T + L, F + C+ L and F + T+B. Singular situations consist of only one acoustic component and they arenamed as D, F, B, L, T and C. All Fourteen situations are created with two sound pressure levels (SPL) of RTN which are considered as the main source of noise: firstly, in the existing condition which is 73 dBA and secondly after applying rubberised asphalt (which reduces the SPL to 66 dBA) to test the reduction effect on the preference level. This results in twenty-eight proposed situations to test.

Introducing positive sounds and reducing levels of unwanted sounds have to be conducted as comprehensive approaches to soundscape design. Therefore, in the present study vegetated façades, vegetated low barriers, and trees in addition to cherubs were used as noise reduction techniques. Each of these techniques can reduce the overall traffic noise up to 4 dB on average and up to 6 to 7 in balanced combination of these solutions. In conclusion, SPL of RTN became 68 dBA and 61 dBA in the silent asphalt case. In general, signal-to-noise ratio (SNR) between the road traffic noise and natural sounds (water, birds and leaves) is -3 dBA or the same of RTN. In the current study the energetic masking technique was used. Water sounds and vegetation sounds were considered as a masker for reducing RTN effect (target). Therefore, sounds of birds and leaves and water sounds were set with extra 10 dBA in both levels of RTN. So that birds singing, rustling sounds, falling water and dropping water would be 78 dBA and 71dBA in the silent asphalt case. Finally, peoples' activity category which includes street vendors' cheers and people talking were set as the real site values, which are 77 dBA and 60 dBA respectively.

For data collecting, five minutes' record of RTN, vendors' cheer and people's talks have been recorded from the site and with 1 meter distance from the sound source as a sample. The two water features and birds singing (thrush and sparrow) in addition to leaves sounds were downloaded from the Sound Snap (2008) online library as one-minute audio for each. Fifteen seconds have been extracted from records and audios in order to produce audios which represent the proposed soundscape for each situation. The time of fifteen seconds was chosen to prevent boredom and loss of focus in the parallel aspect of commercial advertisements.

7.3.2 Visual Modelling

For visualisation of acoustic scenes proposals, a whole 3D model was created for the selected part as shown in figure 2. A reference street view point was fixed in all shoots in order to avoid influence of different view angles. In total, fourteen 3D shoots were created. Each shoot was displayed simultaneously for the two RTN levels. An oval fountain rectangular shape of downpour simulated the natural waterfall. Both were distributed in a balanced way five times along the street and with dimensions of 1.5-meter length. For the vegetation elements, 3D blocks of poplars, intensive oak trees, vegetated barriers and cherubs were downloaded from Turbo Squid website (2021).Vegetated barriers, were one-meter high. A kiosk model was created with 1*1.8*2 dimensions. Finally, two models were created for two types of seats; the first was two single seats against each other and second type was one long seat.

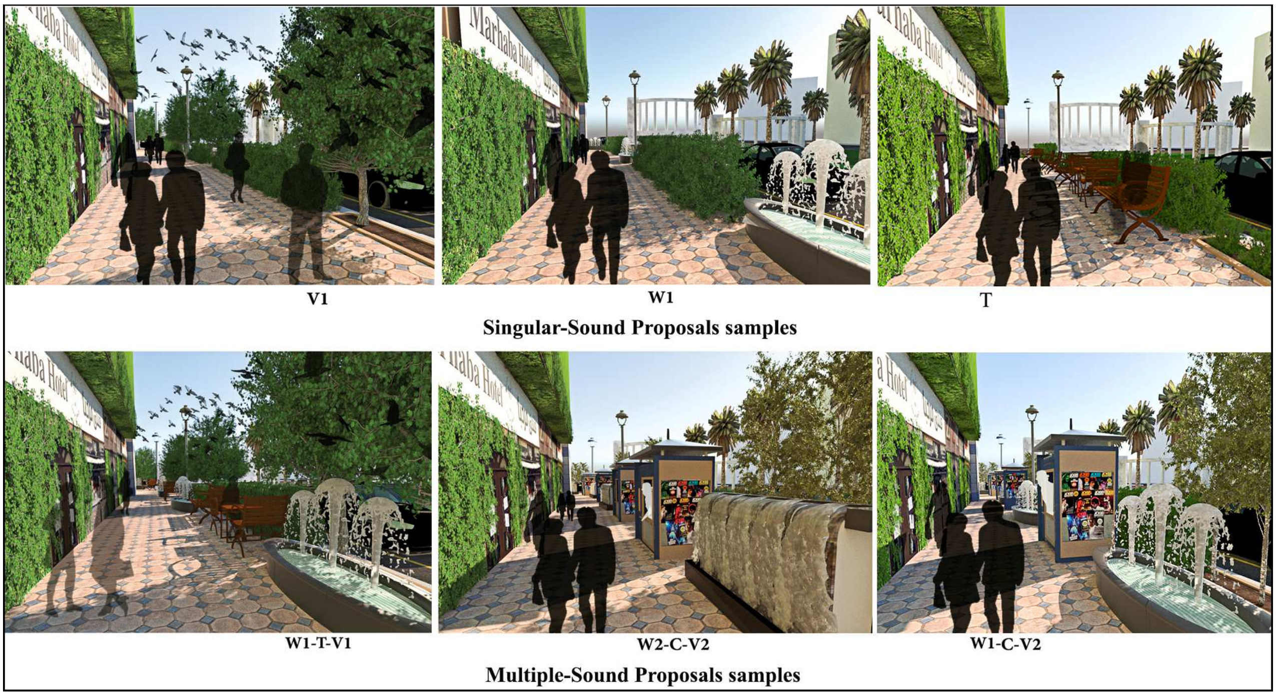

Fig. 2: Samples of visual modelling of acoustic proposals, first type above is the singular-sound proposals samples (V1: Poplars trees with Birds singing, W1: streets' small fountain with drop water sound and T: seats with peoples' talking voices whereas, second type down is the multiple-sound proposals samples (W1-T-V1: streets' small fountain, seats, and Poplars trees, W2-C-V2: natural Waterfall item, kiosks, and Oak trees W1-C-V2: streets' small fountain, kiosks, and Oak trees) Source: Researchers, 2020.

7.3.3 Used Software

Four different programs have been used in the complete process. The first is the Voice Recorder Pro application for recording the existing sounds. The second is the NIOSH application as a professional sound levels meter. The third is the Adobe Audition program for sounds extracting, editing and mixing to produce the proposed audios. Finally, 3D max for 3D modelling and rendering were used in addition to Adobe Photoshop CS6 for postproduction of displayed shoots.

7.3.4 Laboratory Experiment

The main purpose of a laboratory experiment is to validate the proposed stages by experts (subject from the urban design field) for linking soundscape preference with streetscape design in order to extract an independent soundscape design and enhancement tool. Therefore, the guideline could be used for soundscape enhancement based on people (non-experts) preferences. In this experiment the preference level of urban soundscape where it was designed based on design elements of streetscape was examined. A ten-minutes video has been created as a presentation manner of the twenty-eight proposed audios and 3D shoots have also been created. Fifteen seconds of each scene and five seconds as transition time between them were used to answer the evaluation of each.

As shown in figure 3, the laboratory experiment was conducted in a computer lab of the engineering faculty at Alexandria university. PC computers with HP Compaq Elite 8000 small form factor desktop and Dell 17" inch DVI-D VGA flat panel monitor were used in addition to beats headphones model STN13 for displaying the created video for each participant. Subjects were required to assess each audio throw a preference scale with numbers from zero to ten (with zero to the worst and ten to the best) in an evaluation handout. Before the video was started, a two-minutes quick brief about the experiment was presented explaining the assessment manner for participants. A total of twenty-five subjects (17 females and 8 males) were chosen with categories of participants of fresh-graduates, under graduated (students), designers in the academic field and in practice.

Fig. 3: Samples of participants while they were conducted the Laboratory Experiment in computer labs of Alexandria Faculty of Engineering by using PC computers and headset to the left Menna (students of Pharose University) and Mo'men (freshly graduated students of PUA) also to the middle Mohamed and Osama with the same rank , to the left , Isra'a and Riham (demonstrators in Architecture department of PUA). Source: Researchers, 2020.

8 RESULTS

Fig. 4: Laboratory experiment's results of soundscapes proposals which implemented in two sound pressure levels of road traffic noise RTN (77 dBA and 66 dBA), orange chart represent the experiment with the high level of RTN (77 dBA) whereas blue chart represent the experiment of the low level of RTN (66 dBA), concluding singular and multiple situations of proposals and starting with the multiple situations in both RTN levels. Source: Researchers, 2020

As shown in figure 4, the two charts explain the preference levels of 28 audios which represent soundscape proposals that have been evaluated by participants twice, first with 73 dBA and second with 66 dBA. In

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general, the score of preference level in the first case was around 8 whereas the second case was around 9, the rest of the scores ranged between 8.7 as maximum value and 3.3 as minimum value in both cases.

For the first chart (where RTN was set at 73 dB), the best preference of an acoustical scene of the 14 soundscape proposals is when only the birds singing was used (singular case of birds singing); a close value was for the combination of drop water, people's talks and birds singing scenes, whereas the lowest score was for falling water, people's talks and leaves sounds as a combined situation.

For the scenes which include the people's talks who sat on the pavement's side in combination with drop water sound and bird singing produced the best preference at all, followed by the combination of drop water and leaves sounds. A close score followed closely for the singular case of people's talks. The lowest score was for the mixing between falling water and leaves sounds. Conversely, for the scenes which include the vendors' cheer of the kiosks, the best evaluation has been rated in the condition of drop water and leaves rustling, followed by the fall water and birds' songs condition, as opposed to people's talks scenes. In contrast, the least rating was for the combination of fall water and rustling sound, with the same value for the single sound of vendors' cheer. As for the single sounds for each drop water, fall water, vendors' cheer, people talks, birds' songs and leaves rustling, the bird's songs have been rated as the best and the fall water as the lowest, with close score for vendors' cheer.

In the second chart (where T.N. was set 63 dBA), the best preference rated of the 14 audios was acquired by the singular case of the drop water sound and, with a similar level also by the singular case of bird singing. The composition between fall water and leaves rustling in the presence of people's talks rated the lowest. In cases of people's talks sound, the case which include people's talks alone is rated the highest, followed by the composition of drop water and rustling sound, in contrast to the case of fall water and the rustling which rated lowest. Alternatively, in the first chart, in the presence of vendors' cheers the combination of drop water and birds' songs was represented as the best proposal for that type of activities sound, whereas in the separate case of cheers, it ranks before the last which is obtained for the omposition of falling water and leaves sound. For the singular cases, the best preference has been evaluated for the drop water case, followed by the birds singing with almost one score lower, whereas the vendors' cheer ranked the lowest as a separated case.

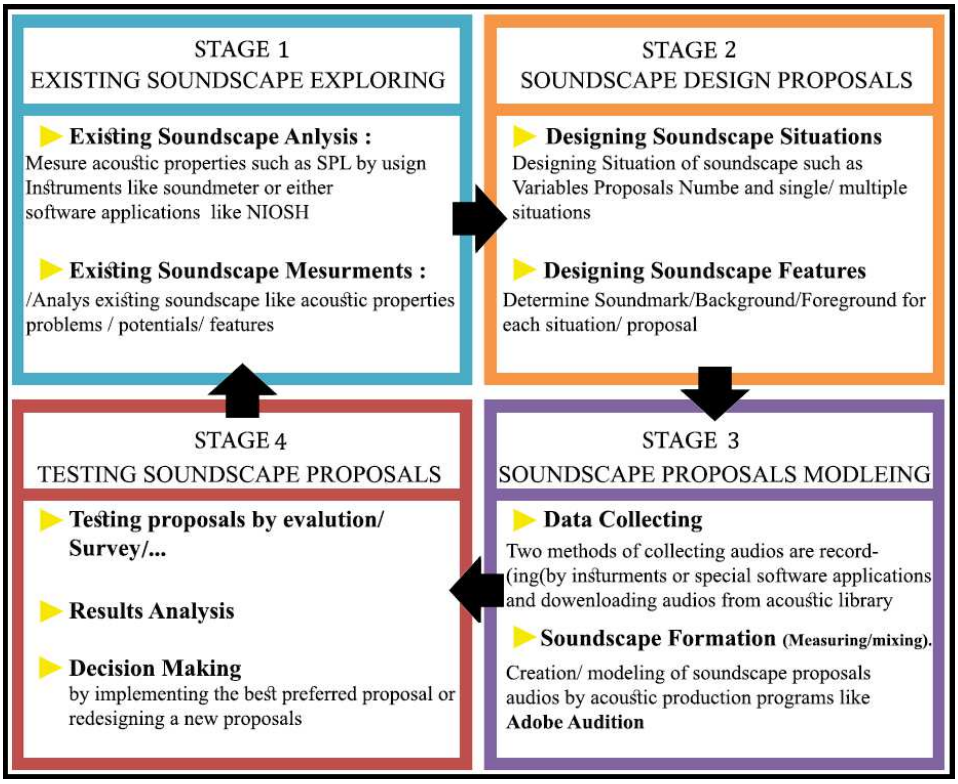

Fig. 5: Four Stages Soundscape design tool based on streetscape design elements with each step under every stage and as a looping process in order to enable the variety of proposals and solutions. Source: Researchers, 2020.

The laboratory experiment validated stages have been proposed for the current case study, so that we could extract a general guideline with four stages (as shown in figure 5): existing soundscape analysis, soundscape design proposals, testing soundscape proposals and soundscape design proposals modelling. The guide line stages represent a loop process, so that we can repeat the process until reaching the required evaluation/ assessment for a specific area with a specific soundscape.

9 DISCUSSION

The main purpose of this study is to extract an independent guideline for soundscape design and enhancement based on streetscape design in order to link soundscape and streetscape design, (through a laboratory experiment conducted to validate the steps/stages of the guideline that would be extracted). The laboratory experiment validates the stages of the guideline extracted from the experiment, so that it could be used in similar environments with the same variables, adjusting the variables or even adding new variables related to the contexts/conditions and create unlimited numbers of proposals with the purpose of finding the most appropriate soundscape design. Unexpectedly, the results show that where traffic noise is 73 dBA, high levels of a preference have been achieved with multiple mixture of sounds situations/ scenes (the case of 3 sounds together: people talk, drop water and bird singing) unlike the singular sounds which rate with less preference, as opposed to previous researches. The situations where the traffic noise is 66 dBA, the higher percentage of preference evaluations were in favour of singular situations (such as the drop water alone).

10 CONCLUSION

This paper was based on an experiment of an existing case study for the enhancement of soundscape quality in the urban environment. A new guideline was proposed as a tool for soundscape design and enhancement for urban designers. In the experiment analysis, four comprehensive stages of soundscape design were extracted. As a tool, the soundscape guideline is based on an organised analysis and previous studies of acoustic design and enhancement. Stages were generated in collaboration with the practical case study. This was considered as an asset to ensure its validity and usability in urban design. The tool enables designers to adjust, enhance or even design the soundscape scenes and test them before implementing any interventions in order to select the best design and solution. The present study did not aim to extract constant parameters of soundscape design to deal with acoustic environment, but instead it was to highlight that it is possible to take a number of procedures (or stages) related to acoustic aspects. These procedures prove that they contribute to form the individuality and identity of the environment like any other design interventions.

The urban environment is never growing and developing all its components, such as mobility patterns (transportation methods), types of activities or lifestyle and improvement projects at the same pace. Therefore, the need for studies, researches and knowledge about soundscape, alternative approaches and requirements for their implementation is likely to increase. Thus, the need to improve understanding of the acoustic discipline of the urban environment will persist. The requirements for dealing with the acoustic environment will differ from one urban context to another. For instance, the commercial context (like the current case study) varies from residential or historical contexts. Hence, these other contexts are also in need to study and research their acoustic requirements in addition to applying this knowledge during actual progress.

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reviewed paper

Subjektiven Verkehrsstress objektiv messen – ein EmoCycling-Mixed-Methods-Ansatz

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1 ABSTRACT

Als ein Baustein für eine postfossile Mobilität gewinnt das Fahrrad zunehmend an Bedeutung. Um den Anteil der Radfahrenden in der Stadt und auf dem Land weiter zu fördern, steht neben der Verbesserung der objektiven Verkehrssicherheit auch die Steigerung des subjektiven Sicherheitsgefühls der Radfahrenden im Mittelpunkt. Oftmals bildet das subjektive Gefühl von Unsicherheit für Personen, die bisher wenig bis überhaupt nicht Fahrrad fahren, und damit für die Steigerung des Radverkehrsanteils in Stadt und Land von hoher Bedeutung sind, eine Barriere für eine häufigere Nutzung des Fahrrades. Bisher ist die Analyse des subjektiven Sicherheitsgefühls jedoch nur eingeschränkt möglich. Für eine objektive, quantitative Messung der subjektiven Sicherheit fehlten bislang geeignete Methoden. In verschiedenen Studien wurden Radfahrende zu ihrem subjektiven Sicherheitsgefühl befragt. Durch solche Befragungen können jedoch nur eingeschränkt konkrete Standorte und Situationen identifiziert werden, an denen sich Radfahrende besonders unsicher fühlen. Die vorliegende Arbeit adressiert diese Forschungslücke und wendet einen Mixed Methods Ansatz zur quantitativen Messung des subjektiv beim Radfahren empfundenen Stresses an. Zum Einsatz kommt die Methodik des EmoCyclings, welche aus biostatistischen Daten physiologische Stressreaktionen des Körpers identifiziert und diese lokal verortet. Die Stressmomente beim Radfahren werden nach den Testfahrten mittels einer Interview-Analyse verifiziert. Mit dieser Methode werden subjektiv „unsichere" Standorte und Situationen für Radfahrende identifiziert.

Um das subjektive Verkehrssicherheitsgefühl von Radfahrenden zu erhöhen, ist stressarme, objektiv sichere und qualitätvolle Radverkehrsinfrastruktur erforderlich. Von Interesse ist, ob Personen, die bisher wenig bis überhaupt nicht Fahrrad fahren, verschiedene Führungsformen des Radverkehrs unterschiedlich stressarm empfinden. Erkenntnisse über stressarme Infrastruktur könnte helfen, das subjektive Gefühl von Unsicherheit als eine Barriere für die häufigere Nutzung des Fahrrades zu überwinden. In der vorliegenden Studie wird untersucht, wie sich das subjektive Sicherheitsempfinden und der gemessene Stress bei Radverkehrsinfrastruktur im Seitenraum (eigenständiger Radweg, getrennter Geh- und Radweg etc.) oder Infrastruktur auf der Fahrbahn (Radfahrstreifen, Schutzstreifen, Fahrradstraße, Mischverkehr etc.) für verschiedene Nutzergruppen wie interessierte Radfahrende, Alltagsradfahrende und furchtlose Radfahrende unterscheidet.

Bei Personen, die das Fahrrad bisher kaum nutzen (interessierte Radfahrende) und Alltagsradfahrenden konnten mehr Stressmomente bei der Nutzung der Radverkehrsinfrastruktur auf der Fahrbahn im Vergleich zum Seitenraum nachgewiesen werden. Die Nutzergruppe der furchtlosen Radfahrenden empfindet hingegen bei der Infrastruktur auf der Fahrbahn weniger Stress. Die Erkenntnisse können genutzt werden, die objektive Verkehrssicherheit für den Radverkehr zu erhöhen und das subjektive Sicherheitsgefühl der Radfahrenden zu fördern.

Keywords: Urban Emotions, Führungsformen, Subjektive Sicherheit, Fahrradverkehr, Mixed-Method-Ansatz

2 HERAUSFORDERUNGEN FÜR DIE FÖRDERUNG DES RADVERKEHRS

Laut der Studie „Mobilität in Deutschland 2017" sind über 72 Millionen Fahrräder in 76 % der deutschen Haushalten zu finden (Nobis and Kuhnimhof, 2019). Folglich steht dreiviertel der Bürgerinnen und Bürger ein Fahrrad zur alltäglichen Nutzung zur Verfügung. Wird jedoch die tatsächliche Fahrradnutzung betrachtet, so lassen sich die befragten Personen nach Ihrer Fahrradnutzung in drei etwa gleichgroße Teile einteilen. Ein Drittel nutzt das Fahrrad regelmäßig, das zweite Drittel repräsentiert die Gelegenheitsnutzer (ein bis drei Tage Fahrradnutzung pro Monat oder seltener) und das letzte Drittel der Bevölkerung fährt äußerst selten bis nie Fahrrad (Nobis and Kuhnimhof, 2019). Daher werden im gesamtdeutschen Modal-Split nur rund 11 % aller Wege mit dem Fahrrad zurückgelegt (Nobis and Kuhnimhof, 2019). Um den Radverkehr zu fördern ist das Verständnis der Nutzergruppen der Radfahrenden von hohem Interesse, denn Radfahren im Alltag kann nur gefördert und neue Nutzerinnen und Nutzer angesprochen werden, wenn die Bedürfnisse der unterschiedlichen Nutzergruppen klar definiert sowie Handlungsvorschläge daraus entwickelt werden können.

Zahlreiche Veröffentlichungen wie (PGV-Alrutz, 2016; SINUS Markt- und Sozialforschung, 2019), Birk und Geller (2006), Nello-Deakin (2020) sowie Pucher und Bühler (2017) zeigen auf, dass der lokale Ausbau der Radinfrastruktur die Zahl der Radfahrenden erhöht und damit einer der wichtigen Ansatzpunkte für die Radverkehrsförderung ist. Daher nennt der „Nationale Radverkehrsplan 2020“ „[…] eine sichere, bedarfsgerechte und komfortable Radverkehrsinfrastruktur […]“ als die zentrale Grundlage zur Förderung des Radverkehrs (BMVBS, 2012).

Für die bauliche Radverkehrsinfrastruktur hat sich in den letzten Jahrzehnten ein bewährter Kanon an Führungsformen entwickelt (FGSV, 2010). Innerhalb der durch Geschwindigkeit und Verkehrsmenge des MIV sowie dem vorhandenen Platz vorgegebenen Einsatzbereiche kommt es für die Sicherheit der Radverkehrsinfrastruktur meist weniger auf die Art der Führungsform, sondern vielmehr auf deren Ausgestaltung im Detail an (FGSV, 2010). Aktuell wird der Einsatzbereich verschiedener Führungsformen des Radverkehrs insbesondere im Hinblick auf deren subjektive Sicherheit wieder kritisch diskutiert (ADFC, 2018; Becker et al., 2018; Graf, 2016). Die vorliegende Studie will zur Klärung der Frage beitragen, ob Radfahrer bei Führungsformen auf der Fahrbahn mehr Stressmomente erleben, als auf Radverkehrsanlagen im Seitenraum.

Die überwiegende Mehrheit der bisherigen Studien untersucht die subjektive Verkehrssicherheit anhand von Interviews oder Online-Befragungen. Im Gegensatz dazu ermöglicht die in dieser Studie eingesetzte EmoCycling-Methode eine objektive Erhebung von Stressmomenten anhand von psychophysiologischen Reaktionen der Radfahrenden während Testfahrten. In der Studie werden verschiedene Radfahrtyp-Gruppen unterschieden. Das Ergebnis der Stressmessung erlaubt dabei einen Einblick in das individuelle Stressaufkommen der einzelnen Nutzergruppen. Ergänzt wird die Studie durch Interviews nach der Testfahrt und einer Emotionsanalyse der Antworten. Die Antworten aus den Interviews zeigen, ob die durch die Nutzenden wahrgenommene Stressbelastung mit den, durch die objektive Stressmessung erhobenen Ergebnisse vergleichbar ist. Die vorgestellte Methode ermöglicht mit dem Mixed Methods Ansatzes, das subjektiv von Radfahrenden empfundene Verkehrssicherheitsgefühl objektiv messbar zu machen.

3 STAND DER FORSCHUNG ZUM SICHERHEITSEMPFINDEN VERSCHIEDENER RADFAHRERTYPEN

3.1 Objektive und subjektive Sicherheit

Die Sicherheit des Radverkehrs, wie generell im Verkehr, setzt sich aus einer objektiven und einer subjektiven Dimension sowie deren Wechselwirkungen zusammen (Johannsen, 2013; Klebelsberg, 1982). Die objektive Sicherheit fokussiert mit einer quantitativen Betrachtung die eingetretenen Unfälle und basiert meist auf einer Analyse der polizeilichen Unfallstatistik. Die subjektive Sicherheit hingegen betrachtet die emotionale Bewertung der Bedrohlichkeit einer Verkehrssituation durch Verkehrsteilnehmer (Fuller, 2005). Die subjektive Sicherheit wird geprägt durch Verkehrssituationen in denen sich die Radfahrenden gefährdet oder überfordert fühlen (Hagemeister, 2013; Schwedes, Wachholz, and Friel, 2021). So wird das subjektive Sicherheitsempfinden der Radfahrenden durch Konflikte, Beinahunfälle, kritischen Situationen oder Behinderungen im Verkehr geprägt.

Das Thema des subjektiven Sicherheitsempfindens der Radfahrenden wird bereits durch umfangreiche internationale (Aldred und Crosweller, 2015; Chataway et al., 2014; Cho, Rodríguez, und Khattak, 2009; Fernández-Heredia, Monzón, und Jara-Díaz, 2014; Horton, 2007) sowie nationale (Alrutz 1998, FixMyCity 2020, Fuller 2005, GDV 2013, GDV 2010, Hagemeister 2013, Richter et al. 2019, Schwedes 2021) Forschung betrachtet. Zudem wird die subjektive Sicherheit bereits im technischen Regelwerk, wie den Empfehlungen für Radverkehrsanlagen (kurz ERA, (FGSV, 2010)) sowie dem Nationalen Radverkehrsplan thematisiert. In der ERA (FGSV, 2010) wird Verkehrsplanerinnen und Verkehrsplanern für die grundlegende Entwurfsanforderung der subjektiven Verkehrssicherheit die „Vermeidung von Situationen, in denen sich die Nutzer gefährdet oder überfordert fühlen“ (FGSV, 2010) und die „Wahl von Führungsformen mit geringer Abhängigkeit vom Verhalten anderer“ (FGSV, 2010) empfohlen. Was den Nutzenden Angst macht, sie gefährdet oder zu einem Gefühl der Überforderung führt, wird jedoch nicht genauer spezifiziert. Der

„Nationale Radverkehrsplan 2020“ (BMVBS, 2012) weist ebenfalls auf die Bedeutung des subjektiven Sicherheitsgefühls der Nutzenden hin.

Nach (Geller, 2009; Horton, 2007; Hull und O’Holleran, 2014; Schwedes et al., 2021; Wang et al., 2014) bildet das subjektive Sicherheitsempfinden ein wichtiger Faktor für die Förderung des Radverkehrs. So ist das subjektive Unsicherheitsgefühl für viele potenzielle Radfahrende ein Hemmnis für eine häufige Nutzung des Fahrrades. Insbesondere Personen die bisher wenig bis überhaupt kein Fahrrad fahren, und damit für die Steigerung des Radverkehrsanteils in Stadt und Land von hoher Bedeutung sind, bildet das subjektive Gefühl von Unsicherheit eine Barriere für die häufigere Nutzung des Fahrrades (Aldred und Woodcock, 2015; Bill, Rowe, und Ferguson, 2015). Der Umstieg auf das Fahrrad funktioniert nur mit erlebter Sicherheit (DStGB, 2016). Auch der „Nationale Radverkehrsplan 2020“ führt an, dass Radfahrende, die sich besonders unsicher fühlen, weniger Fahrrad fahren (BMVBS, 2012).

Aus dem Verhältnis zwischen objektiver und subjektiver Sicherheit lassen sich unterschiedliche Handlungserfordernisse ableiten. Maßnahmen zur Förderung der Verkehrssicherheit sind eindeutig, wenn eine Verkehrssituation sowohl objektiv als auch subjektiv unsicher ist. Situationen, die objektiv sicher sind, sich jedoch subjektiv unsicher anfühlen bilden ein subjektives Hindernis Rad zu fahren (Hagemeister, 2013). So kann sich eine Führung des Radverkehrs auf einem Schutzstreifen im Sichtfeld des Kfz-Verkehrs aus Nutzersicht zunächst unsicher „anfühlen“, bietet jedoch vielfach eine hohe objektive Verkehrssicherheit (Schnüll, Alrutz, und Lange, 1992). Eine Erhöhung der subjektiven Sicherheit bietet sich aus Sicht der Radverkehrsförderung an, darf aber nicht auf Kosten der objektiven Sicherheit gehen. Als problematisch wird angesehen, wenn das subjektive Sicherheitsgefühl der Radfahrenden höher ist, als die objektive Sicherheit, da in diesen Situationen die Radfahrenden eine mögliche Unfallgefahr nicht erkennen (Hagemeister, 2013; Klebelsberg, 1982). Klebelsberg (1982) empfiehlt, dass die objektive Sicherheit mindestens gleich groß oder größer als die subjektive Sicherheit sein sollte, und sieht als Lösungswege die Erhöhung der objektiven Sicherheit oder eine Senkung der subjektiven Sicherheit. Eine Senkung der subjektiven Sicherheit würde sich jedoch kontraproduktiv auf die Förderung des Radverkehrs auswirken. Ziel bei der Gestaltung von Radverkehrsinfrastruktur ist daher, die objektive Verkehrssicherheit zu erhöhen und gleichzeitig das subjektive Sicherheitsgefühl der Radfahrenden zu fördern (FixMyCity, 2020; Schwedes et al., 2021).

Trotz der Einigkeit über die Förderung der objektiven und subjektiven Verkehrssicherheit, werden unterschiedliche Empfehlungen für den Entwurf von Radverkehrsanlagen abgleitet. Der ADFC sowie FixmyCity (2019; 2020), geben grundsätzliche Empfehlungen, einzelne Führungsformen des Radverkehrs wie z. B. Schutzstreifen aus Sicht der subjektiven Sicherheit zu meiden und andere Führungsformen wie beispielsweise Protected Bike Lanes oder separate Radwege getrennt vom Kfz-Verkehr grundsätzlich zu bevorzugen. Alrutz (2009) sowie Alrutz et al. (2015) betonen hingegen die hohe Bedeutung einer sorgfältigen Gestaltung der Details von Radverkehrsanlagen für die objektive und subjektive Sicherheit. Nach Alrutz (2009) kann basierend auf den bisherigen Erkenntnissen keine generelle Präferenz für oder gegen einen einzelnen Typ von Radverkehrsanlagen getroffen werden, da bei Beachtung sicherheitsrelevanter Entwurfsmerkmale und betrieblicher Anforderungen alle Typen objektiv verkehrssicher gestaltet werden können. Wichtige Entwurfsmerkmale sind selbsterklärende und fehlerverzeihende Verkehrsanlagen, gute Sichtverhältnisse, Einhaltung von erforderlichen Anhalte- und Bremswegen sowie Schutzräume für Radfahrende (Alrutz et al., 2009; Bekiaris und Gaitanidou, 2011; Schnüll et al., 1992).

3.2 Radfahrtypen

Für die Analyse der Bedeutung der subjektiven Sicherheit für die Förderung des Radverkehrs ist eine Unterteilung der Radfahrenden in verschiedenen Radfahrtypen hilfreich. Eine Möglichkeit ist die Einordnung der Radfahrenden anhand ihrer Fähigkeiten auf dem Fahrrad nach Mekuria et al. (2012). Radfahrende werden hierbei in die Gruppen „sehr gute“, „durchschnittliche“ und „geringe Fähigkeiten“ eingeteilt. Auch eine Einteilung nach Alter oder Alltags- bzw. touristischer Radfahrenden (FGSV, 2010) ist möglich. Diese Einteilung hilft jedoch bezüglich des subjektiven Sicherheitsempfindens nicht weiter. Die oftmals verwendete Einteilung nach Sinus-Milieus (SINUS et al., 2017) erfolgt auf Basis von Lebensauffassungen, Wertehaltung und sozialer Lage (SINUS GmbH, 2019) und wird in verschiedensten Bereichen der Wissenschaft als sinnvolle Gruppeneinteilung eingesetzt. Jedoch ist die Nutzung der Sinus-Milieus aufgrund der großen Anzahl verschiedener Gruppen und dem fehlenden Bezug zum

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Verkehrssicherheitsempfinden nicht zielführend. Darüber hinaus wurden von Francke et al. (2018; 2019) vier in Deutschland vorkommende Radfahrtypen Sporadische, Beständige, Sichere und Ambitionierte Radfahrende identifiziert. Diese Radfahrertypen lassen sich im Hinblick auf die subjektive Verkehrssicherheit in zwei Gruppen zusammenfassen: Sporadische und Beständige Radfahrende fühlen sich beim Radfahren subjektiv gefährdet, Sichere und Ambitionierte fühlen sich entsprechend der Gruppencharakteristika subjektiv sicher.

Auch Geller (2009) unterteilt die Bevölkerung in Bezug auf ihr Radfahrverhalten in vier Gruppen: „Die Starken und Furchtlosen“, „die Begeisterten und die Souveränen“, „die Interessierten aber Besorgten“ und „Keine Chance, ganz egal wie“. Die wichtigsten Merkmale der Gruppen sind in Tabelle 1 dargestellt. Die Übergänge zwischen den unterschiedlichen Gruppen sind als fließend zu verstehen. Durch sich verändernde Verkehrsgewohnheiten im Laufe eines Lebens kann sich die Gruppenzugehörigkeit eines Menschen immer wieder ändern. Wenn Interessierte aber besorgte Radfahrende längere Zeit das Fahrrad regelmäßig nutzen, kann es zum Gruppenwechsel hin zu Alltagsradfahrenden (begeistert und souverän) oder gar (starken und) furchtlosen Radfahrenden kommen. Die Gruppenzugehörigkeit wird aus dem aktuellen Mobilitätsverhalten in Bezug auf das Fahrrad und die verschiedenen anderen Merkmale bestimmt. Jedoch muss auch beachtet werden, dass manche Menschen sich nicht eindeutig einem einzelnen Typ zuordnen lassen. Diese Gruppeneinteilung wurde bereits in verschiedenen Studien (Dill und McNeil, 2013, 2016; Portland State University et al., 2014) angewandt und werden der vorliegenden Untersuchung zugrunde gelegt.

Die Gruppen Furchtlose Radfahrende und Alltagsradfahrende nutzen das Fahrrad bereits regelmäßig in der Alltagsmobilität und bilden damit nur Randzielgruppen für die Radverkehrsförderung, mit dem Ziel sie an das Verkehrsmittel Fahrrad weiter zu binden. Die Gruppe „Keine Chance, ganz egal wie“ entfällt in der weiteren Betrachtung, da diese Personen entsprechend ihrer Gruppendefinition nicht oder nur unter erheblichem Einsatz für das Radfahren begeistert werden können. Im Mittelpunkt für die Radverkehrsförderung steht die Gruppe der Interessierten Radfahrenden. Diese Gruppe möchte mehr Radfahren und ist geprägt durch den Wunsch nach einer, vom Kfz-Verkehr getrennten Radverkehrsinfrastruktur (Mekuria et al., 2012; Sanders, 2013; Winters et al., 2011). Dies hängt unter anderem mit dem eher unsicheren Umgang mit dem Fahrrad, als auch der geringen Erfahrung in Bezug auf das Verhalten im fließenden Verkehr als Radfahrende:r zusammen. So muss auch der Umgang mit dem Fahrrad und das Verhalten im Verkehr nach der Ansicht von Forester (1993) erlernt werden.

Radfahrgruppe	Die Starken und Furchtlosen [furchtlose Radfahrende]	Die Begeisterten und Souveränen [Alltagsradfahrende]	Die Interessierten aber Besorgten [Interessierte Radfahrende]	Keine Chance, ganz egal wie!
Eigenschaften	Nutzt Rad immer, sicher und souverän	Fährt täglich Strecken, Souverän aber mittleres Sicherheitsbedürfnis	Keine Alltagsmobilität mit dem Rad; besorgt bezüglich der Sicherheit, aber dem Rad gegenüber aufgeschlossen	In der Regel keine Radnutzung
Fahrkönnen	Ausgezeichnete Beherrschung des Fahrrades	Selbstbewusst, teilweise defensiv wegen Sicherheit	Weniger souverän	Schlechte Kontrolle über das Rad, fehlende Fahrpraxis
Stresstoleranz	Hoch	Mittel	Niedrig	Sehr niedrig
Typische Vertreter	Jung, männlich	Frauen und Männer aller Altersklassen und Lebenssituationen	Überproportional viele Frauen und Senioren, Wiedereinsteiger	Senioren

Tabelle 1: Eigenschaften der Radfahrergruppen nach Geller (Quelle: verändert nach Graf, 2016)

3.3 EmoCycling

Trotz der hohen Bedeutung der subjektiven Verkehrssicherheit für die Förderung des Radverkehrs fehlen immer noch Erfahrungen, wie das subjektive Sicherheitsgefühl der Radfahrenden (objektiv) erfasst und für konkrete Entwurfsprojekte nutzbar gemacht werden kann. Die angewandten Erhebungsmethoden reichen von der Führung von Tagebüchern mit gefährlichen Situationen, über „Stated Preference Befragungen“ von Entwurfssituationen bis hin zur Messung des physiologischen Stresses von Radfahrenden (Bill et al., 2015; Chataway et al., 2014; FixMyCity, 2020). Bisher wird weder im „Nationalen Radverkehrsplan 2020“ (BMVBS, 2012) noch in der „Radstrategie Baden-Württemberg“ (Baden-Württemberg, 2016) oder in den verschiedenen Richtlinien der FGSV (FGSV, 2010) das subjektive Sicherheitsgefühl der Nutzenden für die in der Praxis arbeitenden Verkehrsplanerinnen und Verkehrsplaner handhabbar konkretisiert. So fehlt eine

Spezifizierung, was Ursachen für ein schlechtes subjektives Sicherheitsgefühl sein können, wie das subjektive Sicherheitsgefühl der Nutzenden erhoben wird oder was konkrete Maßnahmen für die Verbesserung der subjektiven Sicherheit sind. Die Operationalisierung der subjektiven Verkehrssicherheit ist für die Förderung des Radverkehrs von hoher Bedeutung.

Die Methode des EmoCycling hat methodisch-technologisch ihren Ursprung im Projekt Biomapping von Christian Nold (2009), der erstmals in Greenwich die georeferenzierte Erfassung von biostatistischen Parametern zur Detektion von „Arousal" – einen Erregungszustand im urbanen Kontext - durchgeführt hat. So dient ganz im Sinne der VGI von Goodchild (2007) der Mensch mit seiner physiopsychologischen Reaktion als Sensor, der einen situativ-räumlichen Kontext erfasst und analysiert (Zeile, Höffken, und Papastefanou, 2009). Erste Versuche zur Stadtkartierung von Fußgängern wurden bereits in den späten 2000er Jahren durchgeführt (Höffken, Papastefanou, und Zeile, 2008; Zeile et al., 2010). Der Begriff EmoCycling wurde 2013 geboren (Höffken et al., 2014, p. 854): „Mittels eines Sensorarmbands (Smartband) zur Erfassung psychophysiologischer Reaktionen des Körpers in Kombination mit Video-Kamera-Daten und GPS-Koordinaten wird der emotionale Zustand der Probanden sekundengenau gemessen. […] Damit bietet sich diese Methode hervorragend an, um im Kontext des Fahrradfahrens angewandt zu werden."

Der Auswertungsprozess basiert auf Arbeiten von Papastefanou (2009), dem Entwickler des verwendeten Smartbands. Aufgenommen in der Urban Emotions Initiative (Zeile et al., 2016) und durch die bessere Usability des Auswertungsprozesses direkt als „R"-Script in der Open Source Software QGIS (Beyel, 2016; Beyel et al., 2016) konnte die Datenverarbeitung in dem vorgeschlagenen Workflow zeitlich um den Faktor 10 beschleunigt werden.

Die Rohdaten des Sensorarmbands und des GPS-Loggers werden auf einen PC übertragen, GPS- und Vitaldaten (Hautleitfähigkeit und Temperatur) werden synchronisiert, geglättet und in R in einer Messfrequenz von 1 Hz zusammengefasst. Über ein Scoring System der Messreihen (Bergner und Zeile, 2012) wird das Muster für eine „Stressreaktion" identifiziert: Steigt die Hautleitfähigkeit an, und fällt 3 Sekunden später die Hauttemperatur ab, so ist dies ein Indikator für einen Auslöser von negativer Erregung. Die genaue Prozedur ist bei Teixeira zu finden (2020, pp. 13–14). Optimiert sind diese Ansätze auf den Einsatz des prototypischen Smartbandes, einen vielversprechenden Ansatz für den Einsatz von Consumerprodukten liefern Kyriaku et al. (2019), die das Empatica E4 verwenden. Eingesetzt wurde das E4 unter anderem bei (Dörrzapf, Zeile, et al., 2019; Dörrzapf, Kovács-Győri, et al., 2019; Werner, Resch, und Loidl, 2019)

4 ANWENDUNG DES MIXED METHODS ANSATZES ZUR MESSUNG DES STRESSES VERSCHIEDENER RADFAHRTYPEN IN KARLSRUHE

4.1 Aufbau und Ablauf der Studie

In einer Studie in Karlsruhe werden die Ansätze des EmoCycling sowie der Radfahrtypen kombiniert (Merk, 2019). Dafür erfolgte die Auswahl der Testpersonen anhand eines Fragebogens, welcher die Befragten einen Radfahrtyp nach Geller (2009) zuweist. In der Studie werden nur drei der vier Radfahrtypen einbezogen, die Nicht-Radfahrenden bleiben unberücksichtigt. Insgesamt wurden 12 Personen, jeweils 4 Personen pro Radfahrtyp, zu Testfahrten eingebunden. Aufgrund des hohen Erhebungsaufwandes der EmoCycling Methode sind nur vergleichsweise geringe Stichprobengrößen möglich.

Die Teststrecke verläuft zu 50 % auf Radinfrastruktur, welche sich auf der Fahrbahn befindet und zu 50 % im Seitenraum. Dabei wurden jeweils verschiedene Infrastrukturlösungen (gemeinsamer-, getrennter Geh- und Radweg, eigenständiger Radweg, Mischverkehr, Radschutzstreifen, Radfahrstreifen und Fahrradstraße) genutzt, um etwaige Unterschiede zwischen einzelnen Anlagetypen zu erfassen.

Zusätzlich wird eine ausreichende Länge der Strecke berücksichtigt. Ist die Strecke zu kurz, so sind die Ergebnisse weniger aussagekräftig, ist sie jedoch zu lange, dann ist insbesondere bei Interessierten Radfahrenden mit Ermüdungserscheinungen zu rechnen. In Abwägung zwischen zu berücksichtigender Radinfrastruktur und Streckenlänge wird eine 8,4 km lange Route gewählt.

Alle 12 Probanden wurden für die Testfahrt mit einem Sensorarmband (Smartband), Video-Kamera und GPS-Logger ausgestattet. Dabei wurden die psychophysiologischen Reaktionen des Körpers erhoben, um die Stressmomente der Probanden zu erfassen. Die Rohdaten werden auf einen PC übertragen und mittels eines automatisierten Auswertungsprozesses über das Scoring System die „Stressreaktion“ identifiziert. Anschließend werden die identifizierten „Stressreaktionen“ mithilfe der Videoaufnahmen vordefinierten Stressauslösern zugeordnet.

Nach Identifizierung der Stressreaktionen und der Selektion mittels des Videomaterials wird mit allen Studienteilnehmern ein leitfragengestütztes Interview durchgeführt, welches der Überprüfung sowie der Einschätzung der Ergebnisse durch die EmoCycling Methode dient. Im Interview wurden stressrelevante Abschnitte sowie vorher definierte Abschnitte der Radinfrastruktur der individuellen Testfahrt mittels Videoaufnahmen gezeigt und besprochen. Anhand der inhaltlichen Antworten und der Identifizierung spezieller Markerworte wird die Präferenz der Studienteilnehmer für einen Infrastrukturtyp herausgearbeitet. Die Fragestellungen im Interview sind offen gehalten, um den Testpersonen die Möglichkeit einer freien Antwort und Meinungsäußerung zu geben und eine Beeinflussung durch die Interviewleitung auszuschließen.

Die Auswertung der Interviews umfasst zwei Analyseschritte. Zum einen wird der Inhalt der Antworten analysiert. Hierzu werden insbesondere die Antworten zu den einzelnen Infrastrukturen untersucht und die Präferenz für das Fahren im Seitenraum oder auf der Fahrbahn erfragt. Zum anderen werden die emotionalen Präferenzen zu den einzelnen Infrastrukturen analysiert. Hierzu werden die Antworten der Testpersonen auf emotionale Äußerungen, sowohl positive als auch negative, untersucht. Zusätzlich wird vermerkt ob die Emotionen in relativierendem, neutralem oder steigerndem Kontext auftreten. Final wird aus diesen Ergebnissen eine emotionale Präferenz für das Fahren im Seitenraum oder auf der Fahrbahn abgeleitet.

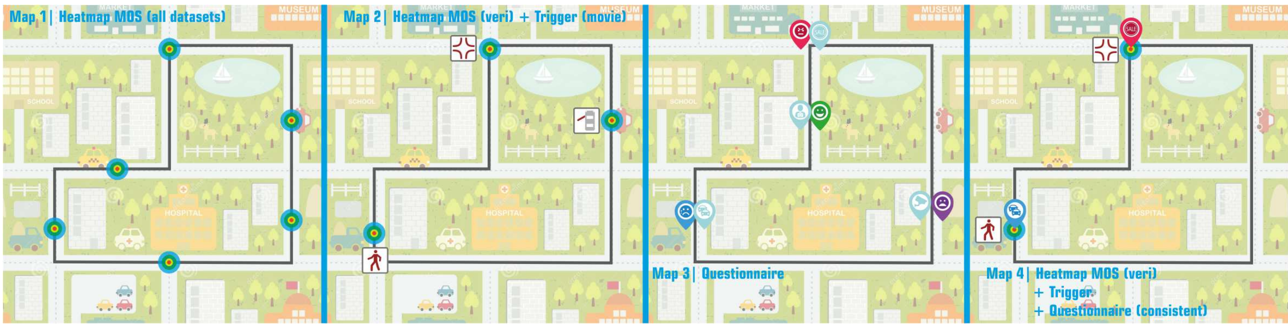

Abbildung 1.: Auswertungsschritte mit dem Mixed Methods Ansatz (Zeile et al., 2016)

Im Verlauf verschiedener Interviews wird ersichtlich, dass einige der durch EmoCycling identifizierten Stresspunkte auf individuellen negativen Erfahrungen für einzelne Standorte beruhen. Hierbei liegt bei den Testfahrten, wie im Video erkennbar, keine Stress auslösende Situation vor, jedoch wurde durch die einzelne Testperson in der Vergangenheit an dieser Stelle eine kritische Situation erlebt. Folglich wird dieser Bereich durch die Testperson mit erhöhter Aufmerksamkeit und Konzentration angefahren und die körperliche Reaktion wird als Stress detektiert.

4.2 Ergebnisse der Studie

Die Verteilung der erlebten Stressmomente je Kilometer auf der Fahrbahn und im Seitenraum wird in Abbildung 2 aufgezeigt. Für die Berechnung der durchschnittlichen Anzahl der Stressmomente je Kilometer werden alle identifizierten Stressmomente für die verschiedenen Infrastrukturtypen zusammengezählt. Dabei zeigt sich eine tendenziell höhere Anzahl von Stressmomenten für Führungsformen auf der Fahrbahn im Vergleich zum Seitenraum. Die meisten Stressmomente wurden auf Schutzstreifen erfasst. Der getrennte Geh- und Radweg erweist sich auf dieser Teststrecke als besonders stressarm. Der recht hohe Anteil der Stressmomente in der Fahrradstraße kann zum Teil auf schlechte Fahrbahnverhältnisse und kreuzende Fußgänger zurückgeführt werden. Die niedrige Anzahl an Stressmomenten im Mischverkehr bei einer Geschwindigkeit von 50 km/h ist aufgrund von sehr kurzen Abschnitten und einer geringen Verkehrsbelastung nur bedingt übertragbar.

Um ein genaueres Bild von den Stressmomenten zu erhalten, werden die Stress auslösenden Ereignisse identifiziert (vgl. Abbildung 3). Hierbei sind sowohl im Seitenraum, als auch auf der Fahrbahn die drei Hauptauslöser „überholendes Fahrzeug“, „Kreuzung“ von Fahrwegen und „Fußgänger“. Sie vereinen jeweils über 50 % der Stressmomente auf sich. Im Unterschied zum Seitenraum, in welchem die drei Stressauslöser eine vergleichbare Häufigkeit von rund 20 % haben, zeigt sich auf der Fahrbahn ein starkes

Ungleichgewicht. Bei Führungsformen auf der Fahrbahn ist das Überholen durch ein Fahrzeug mit 36 % der dominante Stressauslöser. Zu vergleichbaren Ergebnissen kommt die Studie von Richter et al. (2019). Die Ergebnisse zu den Stressauslösern sind für unterschiedlichen Nutzergruppen konsistent. Bei allen drei Gruppen liegt der größte Anteil der Stressmomente beim Stressauslöser „überholendes Fahrzeug".

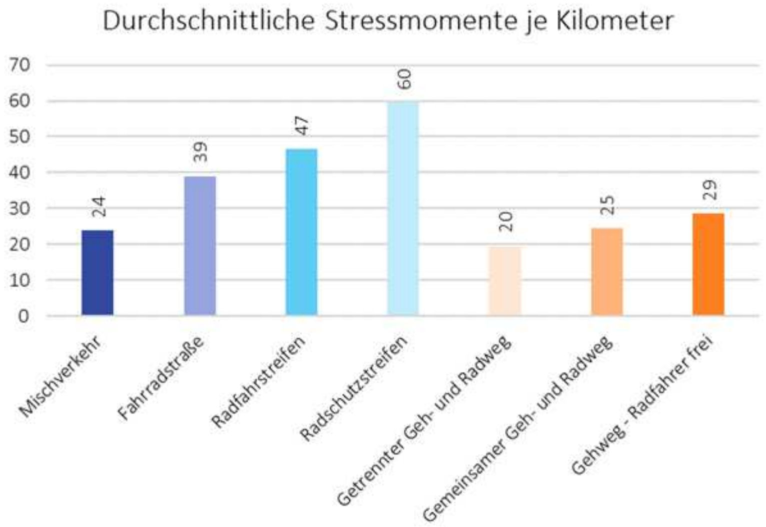

Abbildung 2: Anzahl der durchschnittlichen Stressmomente je Kilometer auf unterschiedlichen Infrastrukturen (eigene Darstellung).

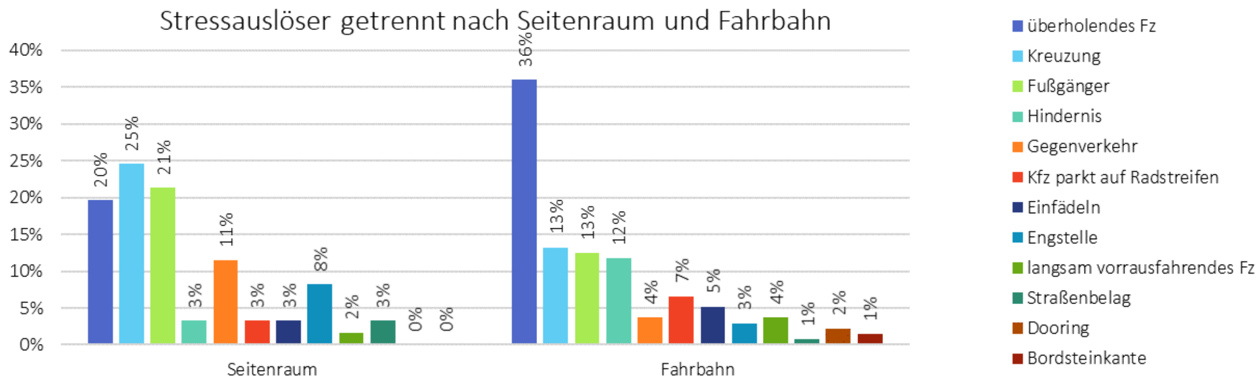

Abbildung 3: Häufigkeit des Auftretens verschiedener Stressauslöser getrennt nach den Bereichen Seitenraum und Fahrbahn (eigene Darstellung)

Das Verhalten der einzelnen Nutzergruppen wird analysiert. Wie erwartet haben Furchtlose Radfahrende eine kürzere durchschnittliche Fahrzeit und damit eine höhere Fahrgeschwindigkeit. Alltagsradfahrende sind etwas langsamer unterwegs und Interessierte Radfahrende benötigen die meiste Zeit für die Teststrecke. Entgegen der Annahme von Geller 2009, dass furchtlose Radfahrende die wenigsten Stressmomente aufweisen, wurde in der vorliegenden Studie bei der Gruppe der Furchtlosen Radfahrenden die meisten Stressmomente gemessen. Auch das durch die Studienteilnehmerinnen und Studienteilnehmer im Fragebogen angegebene Stresslevel ist bei dieser Gruppe im Durchschnitt am höchsten. Alltagsradfahrende bewegen sich sowohl bei der Anzahl gemessener Stressmomente als auch bei dem subjektiven Stresslevel im Mittelfeld, Interessierte Radfahrende weisen die niedrigste Anzahl an gemessenen Stressmomenten auf.

Zudem wird analysiert, ob sich durch die gemessenen Stressmomente eine nutzergruppenspezifische Präferenz für die Führungsformen des Radverkehrs auf der Fahrbahn oder im Seitenraum ergibt. In Abbildung 4 ist das Verhältnis der Stressmomente zwischen der Infrastruktur im Seitenraum und auf der Fahrbahn dargestellt. Insbesondere die Gruppen Interessierte Radfahrende und Alltagsradfahrende empfinden die Führungsformen im Seitenraum als deutlich stressärmer als auf der Fahrbahn. Furchtlose Radfahrenden empfinden hingegen mehr Stressmomente im Seitenraum.

Zudem werden in Interviews die Präferenzen der Testpersonen abgefragt und die emotionale Präferenz mittels Signalwörtern analysiert. Insbesondere die Gruppe der Alltagsradfahrenden hat eine konsistente Präferenz für Führungsformen im Seitenraum. Die Interessierten Radfahrenden zeigten hingegen einen

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Widerspruch zwischen dem geäußerten Wunsch nach Führung auf der Fahrbahn sowie emotionalen Präferenzen für den Seitenraum, der sich nicht eindeutig abschließend lässt. Die Furchtlosen Radfahrenden zeigen in Interview und emotionaler Präferenz eine deutliche und einheitliche Präferenz hin zur Infrastruktur auf der Fahrbahn.

	TestID	Stress im Seitenraum	Stress auf Fahrbahn	Weniger Stress	Wunsch der Nutzer	emotionale Präferenz	Übereinstimmung der Ergebnisse
Interessierte Radfahrer	P12	35%	65%	SR	FB	SR	×
	P11	23%	77%	SR	FB	SR	×
	P1	17%	83%	SR	SR	SR	✓
Alltags-radfahrer	P3	14%	86%	SR	FB + SR	SR	✓
	P9	25%	75%	SR	SR	SR	✓
	P8	6%	94%	SR	SR	SR	✓
Furchtlose Radfahrer	P5	71%	29%	FB	FB	FB	✓
	P13	40%	60%	SR	FB	FB	×
	P2	63%	38%	FB	FB	FB	✓
	P7	50%	50%	FB + SR	FB	FB	✓
	P6	30%	70%	SR	FB	FB	×

Abbildung 4: Zusammenfassung der gemessenen Stressmomente, dem geäußerten Wunsch der Nutzenden sowie der emotionalen Präferenz für verschiedene Nutzergruppen (SR = Seitenraum; FB=Fahrbahn) (eigene Darstellung)

In der Gesamtbetrachtung der gemessenen Stressmomente, der in den Interviews geäußerten Wünsche sowie der emotionalen Präferenzen zeigen sich zwei Gruppen: Die Interessierten Radfahrenden und die Alltagsradfahrenden bevorzugen mit großer Mehrheit Radverkehrsanlagen im Seitenraum. Die Furchtlosen Radfahrenden präferieren hingegen Radverkehrsanlagen auf der Fahrbahn. Dieses Ergebnis zeigt, dass die Einteilung in Radfahrtypen für die Präferenz der Radverkehrsführung zielführend ist. Nichtsdestotrotz kann nicht ausgeschlossen werden, dass auch individuelle Aspekte der einzelnen Radfahrenden zu berücksichtigen sind (Loidl und Zagel 2013).

5 DISKUSSION DER EMOCYCLING-METHODIK

Die vorgestellte EmoCycling-Methode, insbesondere die Messbarkeit der Stressmomente, bringt die Diskussion zur subjektiven Sicherheit im Radverkehr auf eine neue, sachlichere Ebene. Durch die „Quantifizierbarkeit" von Stress durch eine objektive biostatistische Messung eignet sich der Ansatz in – manchmal hoch emotionalen Diskussionsprozessen – in Behörden und Bürgerformaten. Es findet eine Versachlichung statt und ermöglicht dadurch eine neuartige Sichtweise und Diskussion zu beim Radfahren empfundenen subjektiven Ängsten. Bedürfnisse von Radfahrenden sind so besser zu quantifizieren, visualisieren und können auch räumlich zugeordnet werden. Im Gegensatz zu persönlichen Berichten oder bei der Anhörung von Interessensgruppen, die entweder persönlich oder zumindest hinsichtlich der Fachcommunity potenziell eine Art Lobbyismus betreiben, kann die körperliche Reaktion auf Stress im Straßenverkehr nicht beeinflusst werden, sie ist nicht manipulierbar und dementsprechend objektiv – zumindest in der Theorie.

Durch den Einsatz des Smartbandes ist die Methode relativ zeitaufwendig in der Datenbearbeitung und deren anschließende Aufbereitung, trotz des angepassten Auswertungsprozesses. Die Methode der Stressdetektion über elektrodermale Aktivität und Hauttemperatur befindet sich immer noch in der Entwicklung. Ersten kleinere Studien mit einem E4-Armband lassen zumindest auf eine höhere Zuverlässigkeit in der Datenaufnahme und eine größere Robustheit der Sensoren gegenüber Umwelteinflüssen wie Regen, Luftfeuchtigkeit sowie hohen und sehr niedrigen Temperaturen schließen. Die eingesetzte Methode ist noch nicht massentauglich, im Vergleich mit der Historie des „Emotional Sensing" mit seinen ersten Gehversuchen von Nold im Jahr 2009 und der ersten Anwendung im Kontext des Radfahrens 2015 befinden wir uns jedoch so langsam auf der Zielgeraden. Eine vorsichtige Prognose für eine massentaugliche Methode ist das Jahr 2023. Zum aktuellen Zeitpunkt ist die Erhebung mittels EmoCycling Methode jedoch nur mit kleinen Stichproben durchführbar, was die Einsatzmöglichkeiten der Methode einschränkt.

Die Identifizierung von Stress auslösenden Situationen mittels der vorgestellten EmoCycling-Methode ist insbesondere aufgrund der zeitlichen Verzögerung der körperlichen Reaktionen (ca. 3 Sekunden nach Eintritt des Stressauslösers) zum einen räumlich nicht so exakt, wie sich manche das gerne wünschen, und zum anderen durch die zeitliche / räumliche Latenz auch nicht immer eindeutig in der Interpretation. Ein Vergleich mit den Videostreams der Fahrten ist hilfreich, jedoch wird nur ein Ausschnitt der Situation aufgezeichnet, sodass nur die auffälligsten und sichtbaren Trigger erfasst werden. Ursachen könnten allerdings auch Trigger sein, die nicht im Videobild erfasst sind. Auch kann die Kombination von kleineren Ereignissen, die erst mal so nicht sichtbar sind, eine Stressreaktion auslösen. Der hier vorgestellte Mixed-Methods-Ansatz versucht die beschriebenen Ungenauigkeiten zu reduzieren, damit der jeweils passende Stressauslöser auch identifiziert werden kann. Stressmomente, welche keinem Stressauslöser zugeordnet werden können, werden aus der Auswertung entnommen, sodass nur eindeutig identifizierte Auslöser in die Ergebnisse der Studie eingehen.

Eine der großen Stärken der Methode und damit auch der Studie ist die Anwendung im „Real Life“ der Radfahrenden. Im Gegensatz zu Simulatoren, die eine Laborsituation erzeugen könn(t)en, werden wirklich alle sensorischen und umweltbezogenen Einflüsse berücksichtigt. Gleichzeitig bildet dies aber auch ein Problem für die Vergleichbarkeit von Ergebnissen, da „Störgrößen“ zufällig auftauchen. So zeigen sich, dass bei Testfahrten in der realen Welt jede Testfahrt individuell verläuft und damit auch immer wieder unterschiedliche Reize auf die Studienteilnehmer einwirken. Dieses Gemisch an Situationen bildet dabei den realen Alltag von Radfahrenden ab, bei dem keine Situation gleich ist. In der Bilanz tragen die Stärken der EmoCycling Methode dazu bei, praxisgerechte Beiträge zur Förderung des Radverkehrs zu entwickeln.

6 DISKUSSION DER ERKENNTNISSE FÜR EINE STRESSARME RADVERKEHRS-INFRASTRUKTUR

Die Studie veranschaulicht, dass insbesondere das Überholen durch Kfz bei Führungsformen auf der Fahrbahn Stress bei Radfahrenden auslöst. Dieses Ergebnis ist konsistent in allen drei Nutzergruppen festzustellen und deutet auf einen gruppenübergreifenden Stress auslösenden Faktor hin. Die hohe Stressbelastung durch überholende Fahrzeuge lässt sich eventuell dadurch erklären, dass Radfahrende diese zunächst nur durch ihr Gehör wahrnehmen, die potenzielle „Gefahr“ jedoch nicht selbst sehen und einschätzen können. Zudem können die Eigenschaften des Überholvorgangs, wie Überholabstände, Differenzgeschwindigkeit etc. nur sehr eingeschränkt durch die Radfahrenden beeinflusst werden. Die Radfahrenden müssen sich daher auf das rücksichtsvolle Verhalten der überholenden Kfz-Fahrenden verlassen. Zudem ist die Breite der Radverkehrsanlage von hoher Bedeutung, da diese bestimmt, ob ein Überholen mit ausreichend Abstand unabhängig vom Verhalten der Kfz-Fahrenden möglich ist. Darüber hinaus wirken bei einem Überholvorgang durch ein Kfz Zug- und Sogkräfte auf die Radfahrenden, welche ebenfalls Auswirkungen auf das Sicherheitsempfinden haben können (Gromke und Ruck, 2021). Um die Ursachen für die hohe Bedeutung des Stressauslösers „überholendes Kfz“ genauer zu verstehen, sind weitere Erhebungen erforderlich.

Auf Radverkehrsinfrastruktur im Seitenraum, wie getrennten oder gemeinsamen Geh- und Radwegen fühlen sich insbesondere die Nutzergruppen „Alltagsradfahrende“ und „Interessierte Radfahrende“ weniger gestresst und haben ein höheres subjektives Sicherheitsgefühl, als auf Radverkehrsinfrastruktur auf der Fahrbahn. Jedoch kann die objektive Verkehrssicherheit der Radverkehrsinfrastruktur im Seitenraum im Einzelfall z. B. durch eingeschränkte Sichtverhältnisse hinter parkenden Fahrzeugen oder zahlreichen querenden Einfahrten und Einmündungen beeinträchtigt sein. So ist nach Alrutz (2009) die durchschnittliche Unfallrate von Radwegen im Seitenraum leicht höher als die von Schutzstreifen oder Radfahrstreifen auf der Fahrbahn. Aus Sicht der Verkehrssicherheit ist jedoch gefährlich, wenn das subjektive Sicherheitsgefühl der Radfahrenden höher ist, als die objektive Sicherheit. Diese Situation kann zur Unaufmerksamkeit der Radfahrenden und unfallträchtigen Situationen führen (Li et al., 2013). Daher ist bei der Gestaltung von Radverkehrsinfrastruktur im Seitenraum darauf zu achten, dass die Aufmerksamkeit der Radfahrenden bei potenziell gefährlichen Situationen, wie Einmündungen und Knotenpunkten, hoch gehalten wird und gute Sichtverhältnisse zwischen Kfz- und Radfahrenden gewährleistet werden. Zudem sollte regelwidriges Verhalten von Radfahrenden welches objektiv mit einer hohen Unfallgefahr verbunden ist, wie z. B. das Fahren entgegen der Fahrtrichtung auf Radwege im Seitenraum (Alrutz 2009), vermieden werden. Zur Vermeidung von Konflikten im Seitenraum ist zudem eine Trennung bzw. ein verträgliches Miteinander zwischen Radfahrenden und zu Fuß Gehenden anzustreben (Blaszczyk und Zwernemann, 2019).

Die Ergebnisse der Erhebung zeigen, dass eine Radverkehrsführung auf der Fahrbahn (Mischverkehr, Schutzstreifen, Radfahrstreifen etc.) von den Nutzergruppen Alltagsradfahrenden und Interessierten

Radfahrenden als deutlich stressreicher empfunden wird, als die Führung im Seitenraum. Um eine attraktive Radverkehrsinfrastruktur für diese Nutzergruppen zu schaffen wird daher von (Allgemeiner Deutscher Fahrrad-Club, 2019; FixMyCity, 2020; Graf, 2016) gefordert, keine Radverkehrsführung auf der Fahrbahn, wie Schutzstreifen oder Radfahrstreifen vorzusehen. Dies erscheint im Hinblick auf die Planungspraxis der städtischen Verkehrsplanung jedoch wenig praxisgerecht. So wird die Wahl zwischen Führungsformen auf der Fahrbahn oder im Seitenraum häufig stark durch die vorhandenen lokalen Platzverhältnisse im Straßenraum geprägt. In vielen Fällen ist eine freie Wahl zwischen verschiedenen Führungsformen kaum möglich. Zudem besitzen regelwerkskonform gestaltete Radfahrstreifen und Schutzstreifen objektiv eine hohe Verkehrssicherheit (Schnüll, Alrutz, und Lange, 1992; Alrutz 2009). Ein weitgehender Verzicht auf Radfahrstreifen und Schutzstreifen auf der Fahrbahn erscheint daher nicht angemessen. Im Hinblick auf das hohe Stressempfinden der Alltagsradfahrenden und Interessierten Radfahrenden sind jedoch Maßnahmen erforderlich, um die objektiv sicherere Infrastruktur auf der Fahrbahn stressärmer zu gestalten. Für die Steigerung der subjektiven Sicherheit sind qualitativ hochwertige Radverkehrsanlagen erforderlich. Zentral ist die Breite der Radverkehrsanlagen, welche ausreichend Raum sowohl zwischen überholenden Kfz und Radfahrenden als auch ausreichend Sicherheitsabstand zu parkenden Fahrzeugen gewährleisten sollte. Zudem kann eine Reduzierung der Geschwindigkeit des Kfz-Verkehrs und damit die Senkung der Geschwindigkeitsdifferenz zum Fahrrad das subjektive Unsicherheitsgefühl verringern. Auch die Reduzierung des Lkw-Verkehrsaufkommens kann helfen den Stress für Radfahrende zu reduzieren. Darüber hinaus können auch auffällige Farbmarkierungen oder bauliche Trennelemente zwischen Kfz-Verkehr und Radverkehr das subjektive Sicherheitsempfinden unterstützen. Stressarmes Radfahren ist weiterhin von der Routenwahl (Makrorouting) der Radfahrenden abhängig. So sind neben der Radverkehrsinfrastruktur an Hauptverkehrsstraßen auch Routen auf Nebenstraßen vorzusehen, um stressärmere Routen zu ermöglichen. Hauptverkehrsstrecken des Kfz-Verkehrs müssen nicht identisch mit den Hauptverkehrsstrecken des Radverkehrs sein.

Die Studie verdeutlicht, dass das subjektive Verkehrssicherheitsempfinden der potenziellen Radfahrenden nicht ignoriert werden darf. Insbesondere bei den Gruppen der Alltagsradfahrenden sowie Interessierten Radfahrenden kann eine stressarme Radverkehrsinfrastruktur zur Fahrradförderung beitragen. Wichtig ist dabei eine objektiv und subjektiv sichere Radinfrastruktur zu gewährleisten.

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Sustainable Development in The Healthcare Enterprises Management Through BIM And FM Interaction Based on a Holistic Aspect Structure

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1 ABSTRACT

Sustainability stands out as a widespread topic that cannot be neglected in the field of the healthcare management. Building Information Modelling (BIM) can potentially act on every aspect of the enterprise. This can lead to the feasibility of BIM programs to implement the criteria of facility management (FM) in the real estate sector. The progression of sustainable management measures in healthcare industry requires effective, clear and integrated interaction systems in a holistic organizational aspect structure during the entire building life cycle. BIM implementation in the life cycle of a building project incorporates and merges precise and reliable data for building management and offers outstanding business value in the operating period. Hence, digital interaction paradigm for all types of documents and properties through all building phases is a necessity that leads to life cycle BIM based on FM. This concept is called enterprise BIM (EBIM) that is targeted to focus on integration, information exchange and openness across the core business structures. This paper is aimed to discuss the potential of BIM and FM interaction in EBIM systems that can lead to a sustainable approach in the healthcare enterprises management. In this regard, the literature review/case study discussion as a methodology for conducting research is chosen. This can be an overview of the different types of reviews of BIM, FM and EBIM, as well as some guidelines for how to perform and evaluate. Collaboration and interactivity are the most important factors in a sustainable system. EBIM by having the ability and potential to access of all stakeholders, users and operational organizations to the virtual building in all phases of the enterprise activities will have a major impact on the quality, knowledge transfer and user interaction and it allows owners to make unique decisions about the optimal and efficient use of building stock.

Keywords: Building Information Modeling (BIM), Facility management (FM), Enterprise BIM (EBIM), Health care industry, Sustainability

2 INTRODUCTION

Health is an issue of paramount importance and an inescapable part of struggling for one’s livelihood together with the fusion of food and dwellings (Morgon 2015). Healthcare institutions as social and economic organization that preserve value and wealth for people and communities in society need to find a way to create public value by Gaining legitimacy to build and maintain public trust for all stakeholders. Therefore, it is very important for the sustainable healthcare industry to consider the importance of management at all stages and discover development of policies with the aim of effective communication improvement with all users and building trust-based relationships. Hence, the advancement and operation of healthcare institutions systems which are based on strengthening sustainability as a core concept drives the healthcare sector to success in development and helps to survive and create public value and benefits to promote health and wealth for people and communities in society. In this regard, healthcare systems must move forward towards sustainability by utilizing and enhancement of business management, knowledge sharing, collaboration and implementation of sustainable practices and processes in a holistic aspect structure that authorize to ensure quality of healthcare services and enable all stakeholders to interact positively within the technology (Romanelli 2017).

The structure and provision of healthcare services have changed rapidly in the recent years (Patry, Morris, and Leatherman 2010). In fact, the forward-thinking framework and structure of human society has resulted in an organization that contributes to a healthy society through more efficient care coupled with education and other public utilities. In such circumstances, FM in healthcare industry has incrementally shifted from Evidence-based experience to systematic and scientific, and simultaneously the bioscience industry has gradually shifted from the bourgeois and materialistic efforts to developed and logical innovations. Hence, the dynamics and go-getting of sustainable outreach in the healthcare industry needs to cover all principal and significant aspects of the industry, including research and development, processing, production, administration, market access along with trading opportunities, and public management (Morgon 2015).

In fact, innovation is the key factor in healthcare management, and it can lead the sustainability approach to any health-care system. Throughout the years, innovation has been a motive power in ameliorating treatment outcomes, lab results, and functional efficiency in healthcare system services. It is certainly true that pursuing real innovation requires a significant investment of time, energy and money and in this regard, the expense of innovation is the overriding consideration to decision-makers and health system managers. Therefore, one way to ensure and guarantee the sustainability of health care systems is to use the suitable "business model" for these systems. This will drive innovation and optimize the management throughout the industry (Barei 2015).

Over the last few years, breakthrough technological innovation has disrupted traditional research in the field of real estate. Hence, invigorating the technology-based in real estate sector is heavily influenced by computer-assisted facility management (Wills, Ponnewitz, and Smarsly 2018b). In fact, in an overall view, if firms want real estate resources to add value to the company, they should harmonize companies' real estate strategies and intentions with core business strategies (Gibler and Lindholm 2012). In this regard, supporting the incorporation of BIM which is used extensively in the architecture, engineering, and construction (AEC) sectors has the possibility to carry out FM procedures and allocate FM activities to different stakeholders in accordance with BIM standards. BIM is a digital representation of geometric and functional features of a center that can serve as a common source of knowledge for FM. Despite the obvious correlation between FM and BIM, BIM applications are not included in the FM sustainable Guidelines(Wills, Ponnewitz, and Smarsly 2018b). This is practically, the point of absence of a holistic organizational aspect structure that can support important functions in the core business. In this regard, in 2012, St. Olav's University Hospital, together with the Central Norway Regional Health Authority (HMN), started a project called Life Cycle BIM in reliance on FM. In fact, EBIM is founded on the understanding that the world is three-dimensional (3D), comprehensive, object-oriented and process-oriented. This implies that, both the actual and the digital built environments with all objects and interconnected objects and processes are joint in an interrelated complex network which are accomplished as an Authoritative Data Source (ADS) in a model server (Evjen, Hosseini Raviz, and Petersen 2020). This paper examines how EBIM can be an advantageous and sustainable platform for supplementing BIM and FM interactions. Hence, the synergistic highlighting between BIM and FM in EBIM system show how the concept of EBIM, is aimed to extend a process-driven approach with a holistic business perspective. In this regard, the St. Olavs Hospital as a pioneer of using EBIM system is considered as an evaluation to provide a deeper insight into effective network collaboration between various actors involved and their interaction. The goal is to implement a comprehensive approach in the light of a holistic organizational aspect structure by using effective tools in the various processes and management of existing buildings, as well as the implementation of technologies to enhance cooperation between all actors and stakeholders in the healthcare industry.

3 RESEARCH METHODOLOGY

This paper is based on the sustainable development approach in the healthcare industry by focusing on interaction between BIM and FM in a holistic organizational aspect structure throughout the lifecycle of a building. the importance of improving business management, knowledge sharing, digital interaction and connection in the different phases of the building life cycle as key components in defining and understanding could be considered. Therefore, in the first step, it should be understood the definitions and keywords terms in the field of sustainable development in healthcare enterprises through BIM and FM interaction in EBIM system. In the following, the paper considers the relevant literature review/case study and introduces the EBIM concept and the performance of BIM and FM in the EBIM system. The main source of information for the present study is scientific reports at St. Olvas Hospital. During the study, the authors held several meetings in the real estate department at St. Olvas Hospital with leading technicians and specialists. Emphasizing on EBIM capabilities means that upcoming investigation will be able to address more solutions for FM developing and meet sustainability demands from the initial phases to involving end users

4 LITERATURE REVIEW - FM DEFINITION AND EVOLUTION

Sustainability is generally and extensively accepted as a factor with ability of enhancing the quality of human life while we live in the supportive capacity of ecosystems. In FM field, sustainability issues encompass considering the enhancement phase of building planning, design, construction, reconstruction, operation and demolition, and how the building adapts to fit its users' goals, maximizing its resources over its lifetime. Despite the fact that, there is widespread debate among FM professionals about the necessity of sustainable solutions performance, this sector is still undeveloped in terms of execution (Støre-Valen and Buser 2019). FM is a functional organization consisting of diverse and several processes, activities, and maintenance services used to support the core functions of a building or facility. In this regard, due to the capabilities of BIM in visualization and coordination and its background that has been used for many years for design and construction, the interest of experts in using BIM in FM processes has increased (Yalcinkaya and Singh 2014).

FM seems to have expanded into the industry in a short period of time, over the last 40 years. Today, many literatures know FM as a developing discipline that is increasingly recognized in every corner of the globe. The divergence in its definitions has been so fast that it may not have strong roots, or it may have been defined in line with the taste, environment and demographics of the inventor at that time. The description, field of application and scope of FM remains a controversial subject, and definitions rely on local customs, organizational and personal interests. The basic hypothesis of the various literature is that the definition of FM truly is influenced by the purpose and motivation of the observer. However, after examining the various definitions of FM, it is entirely obvious that the definitions of FM, although quite diverse and multifarious, still have a joint perspective and mission. In today's world, it can be found that FM practically revolves around the main axes of financial resource management, physical resources, human resources and information and knowledge resource management. The main role of FM is management of resources, at the grade of strategic and operational support. General types of resource management to the core functions of FM are financial resource management, manpower resources, physical resources, and information and knowledge resource management (Mohamat Nor, Mohammed, and Alias 2014).

From the late 1980s, FM incrementally found its place as a profession in the real estate and construction industry. The foundation of professional FM enterprises throughout the world (e.g. IFMA in the USA, JFMA in Japan, BIFM in the UK, FMA in Australia, etc.) testify to its growing significance. However, several years later, the profession is still suffering from an serious identity crisis. In fact, the role and scope of tasks of one facility manager probably different from another. Such confusion does not seem to exist in other occupations in the real estate and construction industries, such as architecture, project management, and urban planning. Although it may be claimed that FM is a quite new functional organization and therefore still in development, it is essential to assess the core competency of FM as a discipline and occupation at this stage of formation (Tay and Ooi 2001). Developing an accurate comprehension and awareness of the evolution of FM is very significant, so that when the FM theme is varied, the original theme is fixed in order for the next result does not fade with the newer components and elements of FM knowledge, which can obscure the main areas of the issue. In Europe, for example, many stakeholders use FM terms to affect customers, but do not offer professional FM services (Mohamat Nor, Mohammed, and Alias 2014). Hence, it should be noted that despite the fast expansion and growth of FM over the past decade, its definition and domain are still controversial. FM definitions assessment during the past indicates that FM is clearly focused on the workplace and in this regard, location, type, quantity, quality, content and allocation of workspace are the most important factors (Tay and Ooi 2001).

5 THE ROLE OF BIM IN EBIM SYSTEM

BIM is transition of methods and technology from a single traditional consecutive form to a modern multiple parallel form of data combination (Kouch, Illikainena, and Peräläa 2018). It is fundamentally a digital platform for establishment and development of virtual buildings. If BIM is used, a model can provide all the information needed to collaborate, predict, and decide on the design, construction, operation, cost, and maintenance of pre-construction facilities (Tjell 2010). In this regard, it acts as a procedure of information exchange and distribution with the capability to use the data through abundant applications for managing various multidimensional assignments and activities in architecture, engineering, construction, maintenance and different types of operation all along the building life cycle. The era of automation, artificial intelligence, robotics and three-dimensional printing is coming faster on account of the remarkable advancement and new features in the digitalization and according to the lack of productivity and efficiency in the building industry, BIM can play an efficient role to provide and offer the required and detailed information and also precise data to be employed for model simulation in different phases of the building industry (Kouch, Illikainena, and Peräläa 2018). Hence, BIM enables the way to more effective multidisciplinary collaborations with a total lifecycle and supply chain integration perspective which means that it is the process of creation and managing data and information about the built environment during its lifetime. BIM brought the most transformative power into architecture and engineering especially in the field construction and facility management during the last decade with regard to its fundamental lifecycle and digital collaboration (Evjen, Hosseini Raviz, and Petersen 2020).

Therefore, in this regard, proper implementation of digitalization and BIM will contribute to efficiency improvements at all stages, reduced costs and better quality. As a virtual and digital tool, BIM provides the space for analysis, understanding, support for acceptance and decision, as well as necessary support for realization and management. In this regard, BIM acts as project-centric and focus on project data, technical subject solutions and real estate operations from a business perspective where building is one of many business structures. By considering BIM as a digital interaction paradigm for all types of properties through all phases, where everyone can initially share and gain insight through different digital interfaces, the focus is shifted from the project-centric to see BIM in a business perspective. In this regard, St. Olavs Hospital, together with Helse-Midt-Norge (HMN) initiated a project entitled Life-Cycle BIM based on facility management. This concept is called Enterprise BIM (EBIM or Business BIM) that the main emphasis is on integration, information sharing and openness across business structures (Evjen, Hosseini Raviz, and Petersen 2020). EBIM philosophy was adapted where all buildings are an integral part in the entire portfolio of buildings, as well as the aspect structure defined in the hospital business structure (Evjen et al. 2020).

Figure 1 shows digitization of building documentation. Technology and process development is defined as follow:

Level 0: Computer-aided design (CAD) consisted of strength-based visualization with or without visible surfaces, to produce drawings.

Level 1: object-oriented representation in 2D / 3D and assembly of 3D CAD models.

Level 2: virtual building elements representing doors, windows and walls.

Level 3: the introduction of IFC and integrated server-based data models with support for compiling professional models with a view to operation as well.

Level 4: involves a development where one does not see the BIM models detached from the organization, but as an integral part of the company's systems, the model has relationships with and communicates with processes in the company.

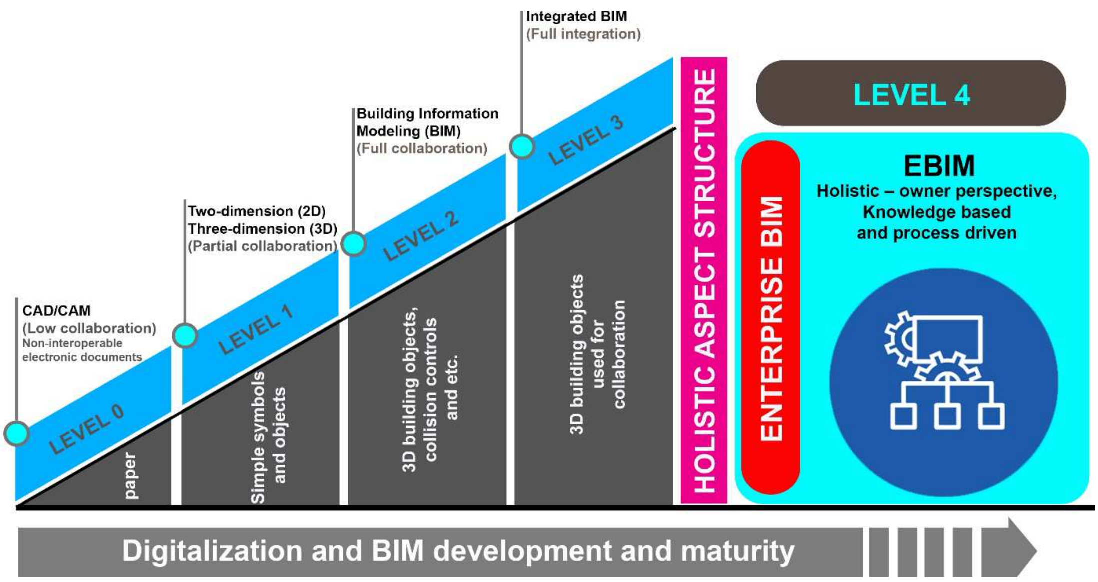

Figure 1: digitalization and BIM development (Bew and Richards 2008)

In this regard, St. Olav Hospital has been at the forefront of using BIM models and data usage in BIM models and scrutinizing the concept of EBIM. St. Olav's delineates EBIM as a discrete database intended to sustain and strengthen many organizational aspects and empower the consolidation of core business and different healthcare activities in a holistic organizational aspect structure (Øgård Aksnes 2016). The information accumulated by way of the EBIM system process and stored in its database leads to a functional efficiency for a variety of FM practices, such as operationalization, quality control and guarantee, cleaning, maintenance and repair, and spatial management.

6 BIM ON THE PATH OF SUSTAINABILITY

BIM is a revolutionary way in designing, development and construction management by creating digital representations of buildings and simplifying the exchange of information digitally. The most important main features of BIM include database, reusability, change management. (Hussain, 2020). Today, the integration of BIM technology and sustainable development is more and more absorbed attention in the AEC industry (L. Zhang et al., 2019). Hence, the necessity to realize and recognize the significance of sustainable development has become a major concern. The emerging and state-of-the-art technologies around the building industry can be a great help in achieving the goal of sustainable development. There are a variety of frameworks for ranking sustainability around the world, each built with the goal of enhancing the performance of the entire building to achieve the establishment objectives of a healthy environment. In this regard, data integration is the key to sustainable development that requires a change from traditional procedures of information interchange between different stakeholders. Accordingly, today, BIM is rising and developing as the predominant and influential technology with the gradual integration of more and more people in the AEC industry (Khattra et al., 2020). The Innovation in BIM technology is a new tool for predicting, managing and monitoring the environmental repercussions of the construction and development stages of a project via a one-stop-shop. BIM plays an important role in supervision and management environmental sustainability throughout the full life cycle of a building. In addition, BIM provides a possibility to expand its scope in sustainability through information embedded in a building project. In fact, it can be claimed that without the development of BIM aptitude, no real advancement and development can be made towards AEC sustainability. BIM is inherently a sustainable system and helps to design and measure the environmental performance of a building (J. Zhang et al., 2016). Sustainability in construction is not only low-consumption mechanical devices installation. In fact, sustainability is a point of view that affects all parts of the related programs and the development process, just as ongoing support and structural activity continue (Khattra et al., 2020). The benefits of BIM at this stage is obvious, but with this concept of sustainability, its capability for realizing buildings and structures with less environmental impact becomes with continual acceleration apparent. In this regard, sustainable development is a measure of the potential of the AEC industry, technical capacity and portability, along with social responsibilities and environmental performance, which is becoming frequently common today (InterFocus, n.d.) (InterFocus, n.d.) and in this regard, BIM can assist in the analysis of various functions in the building sector to ensure a maximized sustainable building design. (Azhar & Brown, 2009)

7 INTERACTION BIM AND FM IN EBIM SYSTEM AS A SUSTAINABLE PERFORMANCE

FM is defined as a vocation that includes several disciplines to guarantee the performance, security, comfort, effectiveness and productivity of the built environment by integrating place, people, processes and technologies (Tezel and Giritli 2019). In other terms, FM acts as a functional organization to ensure the performance of the built environment covered by numerous activities such as property management and maintenance, air condition, cleaning and safety, and the social integration, places and technologies. Sustainability is one of the most significant challenges in the Architecture, Engineering and Construction (AEC) industry and is one of the considerable factors in FM. Sustainability is defined as the potency of management to guarantee that the ongoing functional needs of the facilities take place without compromising the capabilities to meet future operational needs. One of the important factors in the AEC sector is cooperation between project participants (Wills, Ponnewitz, and Smarsly 2018a). In this regard, BIM is recognized as a promising tool for establishing, saving and managing all sorts of information and details throughout the project lifecycle (Tezel and Giritli 2019). The life cycle of a building represents the greatest investment in time and resources in the course of the occupation, various operating processes and maintenance periods (Figure 2). BIM acts as a repository for digital three-dimensional (3D) information and

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data generated by the design and simulation process. All construction information, installation instructions and project management logistics are collected in a one database. There is a data model for the building lifecycle, and it can be applied to conduct and handle stakeholders assets. The use of technologies such as BIM also sets out possibilities for savings during related activities and processes. Obviously, pre-set deliveries can prevent interruptions in the program, therefore, it can be planned for the most convenient time and often reduce on-site storage difficulties (Cotts, Roper, and Payant 2010). (Cotts, Roper, and Payant 2010). If the actors involved work together in a project, mistakes, differences and duplication of work in the AEC industry can be avoided. AEC industry stakeholders use BIM methods to handle pertinent documents in models, design documents, technical drawings, and reports. Accordingly, BIM can be defined in three branches. The first part encompasses the building models, which is a structural data set that characterize the building and fundamentally forms an intelligent digital demonstration of building-related data. The second part is the cooperative operations of connecting various building-related data and building information models creation. The last part is the BIM management system, which includes the coordination of operations and processes (Wills, Ponnewitz, and Smarsly 2018a).

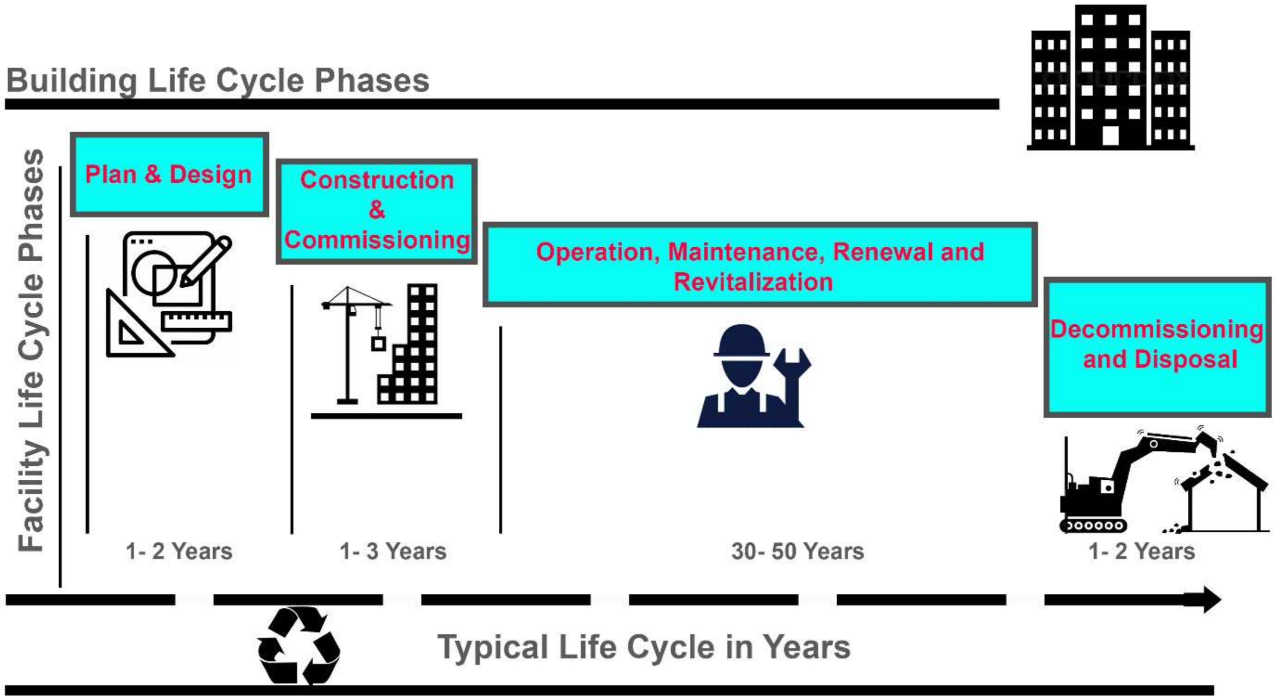

Figure 2: Relative timeline for each stage of a typical building life cycle, and sustainable operations that are considered throughout the operational phase (Cotts, Roper, and Payant 2010).

On the other hand, FM includes and needs multidisciplinary proceedings and therefore it has a wide range of information needs. While some of these requirements are met by numerous available FM information systems, BIM with its features of visualization, analysis, control and given that it is extensively accepted by the building industry, has underdeveloped opportunities to offer and support FM methods (Becerik-Gerber et al. 2012). In fact, FM applies to an overall and integrated approach to the operation, maintenance, improvement and compatibility of an organization's buildings and infrastructure with the aim of establishing an environment that vigorously supports and assists the initial goals of the organizations and covers the longest period in the buildings life cycle (Tezel and Giritli 2019). Buildings are designed to meet the requirements of organizations, but in the course of the operational phases when the building are occupied, they require special FM measures. Since FM processes produce and need a lot of information, the efficient use of BIM in the implementation phase to obtain a greater quality-built environment becomes very important factor for all stakeholders (Tezel and Giritli 2019).

As mentioned previously, EBIM is a method based on the concept of cooperation between all stakeholders and is based on the process-oriented and object-oriented nature of a three-dimensional and comprehensive world. This means that both real and digital settings are built with all interconnected objects and processes in an interconnected intricate network, which is realized as an Authoritative Data Source (ADS) on a model server (Evjen, Hosseini Raviz, and Petersen 2020). The model server has the duty to visualize and management of St. Olavs University Hospitals EBIM. the application is called MSM (Model Server Manager) (Øgård Aksnes 2016). In MSM, all old, new and future buildings are an integral unit in all building portfolios. (Van der zwart and Evjen 2018). Thus, EBIM facilitates and elucidates the inherent complexity by creating an enterprise specific aspect structure that is linked to other organizational and all stakeholders' structures. This indicates that EBIM includes 3D geometric data and other building information, which in turn is related to other aspects such as economics and facility management. one of the most significant aspects of EBIM is the focus on integration, data exchange and transparency in business structures that avoid the vendor lock-in. This happens when a company is restricted due to reliance on the services provided by a vendor or manufacturer. Figure 3 shows the concept and the connection between the actual building, EBIM and the structural processes, which means that all information is shared and EBIM consider the actual building complex as much as possible, irrespective of the phase (Evjen, Hosseini Raviz, and Petersen 2020).

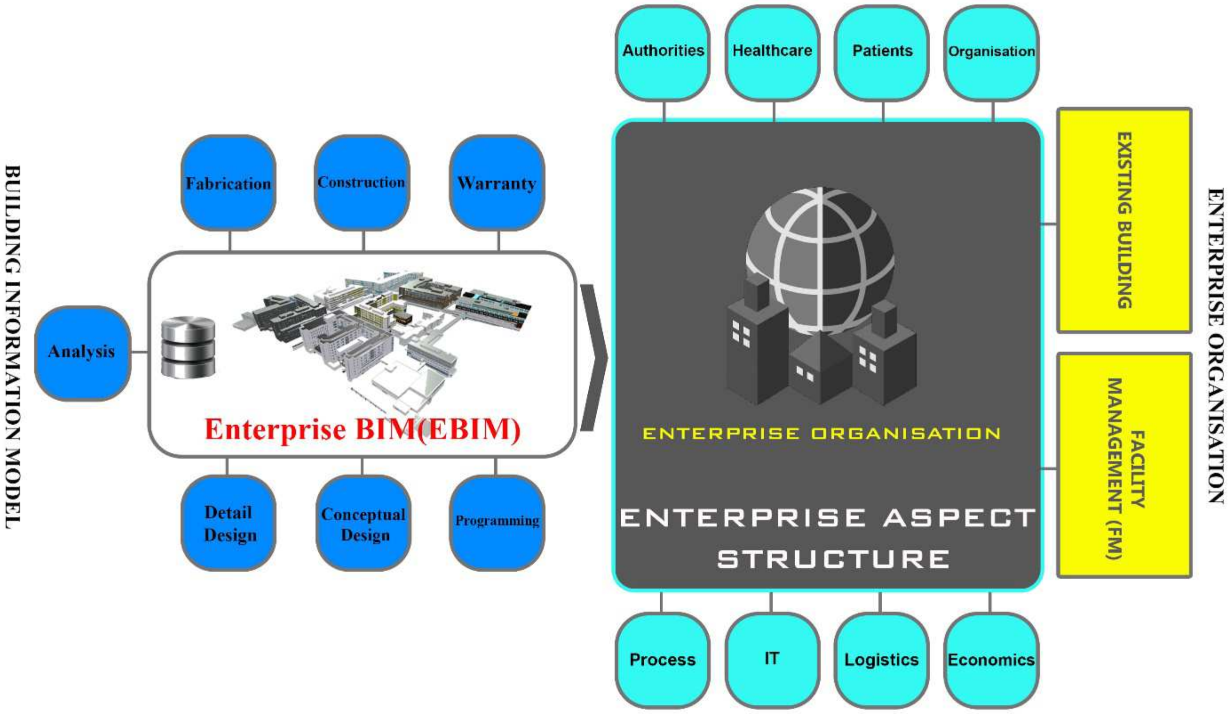

Figure 3: Enterprise BIM as an aspect structure

As it is shown FM is not dedicated or separate system. It uses the same data as rest of the building project. By creating EBIM as an independent structure instead of a part of the FM system, gives the BIM a more prominent position in the company. Adapted from (Evjen et al. 2020).

Hence, St. Olav Hospital is currently using EBIM to achieve better and cheaper construction project goals and to manage real estate operations with the goal of using resources more efficiently. Buildings used during the EBIM process have better performance and maintenance quality and provide higher services to employees and visitors than traditionally designed and constructed buildings. In this regard, other benefits include good performance, easy benchmarking against other projects, faster implementation, fewer construction faults, reduced costs, reduced energy intake and carbon footprint, coordination and simplification of operations (Evjen, Hosseini Raviz, and Petersen 2020). Hence, EBIM can be a new vision and concept in FM that uses digital representation of the building process to facilitate the exchange and collaboration of information in digital template and acts as a shared source of knowledge for decision making process throughout the buildings lifespan and can also be a dependable basis for FM. EBIM creates an environment based on reproducible, verifiable, transparent and sustainable information.

8 DISCUSSION - EBIM AND SUSTAINABLE DEVELOPMENT

The modern age has promised a transformation in the industrial society in which the sustainability of knowledge, especially digital systems, is mainly used as a tool to achieve sustainable development (Stuermer, Abu-Tayeh, and Myrach 2016). In this regard, the principle of digital sustainability has been defined in researches on digital preservation together with openness platform in which the technical durability of digital information from data storage on suitable hardware devices to standardization of file formats and continuous identification schemes for data structures are the main factors (Stuermer 2014). The capability to perform BIM and obtain data well determines which consultants or resources we use and with which building automation system we get ahead (Cotts, Roper, and Payant 2010). Although BIM can serve as a powerful management tool, we also need a holistic organizational structure to interact efficiently with FM and to optimize and improve business management. In this regard, EBIM plays an important role in new marketing, management and operational tools (figure 4) in the core business which are the most important factors in sustainable performance. EBIM forms the basis for the strategic property management of the future through the use of virtual models and open standards. In fact, EBIM is the concept where 3D and other building data are used throughout the building's lifetime and are combined with sensors and the companies' own work processes. Thus, building owners will have a unique decision basis for optimizing the use and operation of the building stock. To make the EBIM system work, St. Olavs University Hospitals uses a model server manager (MSM). Hence, the building owners can gain security and ownership of their own data, which in turn makes it possible the integration of other systems and processes such as FM or finance in business. Today, St. Olavs Hospital manages all its areas in BIM on MSM. Indoor positioning system (IPS) is an example of the use of sensors which are installed on hospital equipment that provide extremely accurate locational tracking (Jotne EPM Technology 2017).

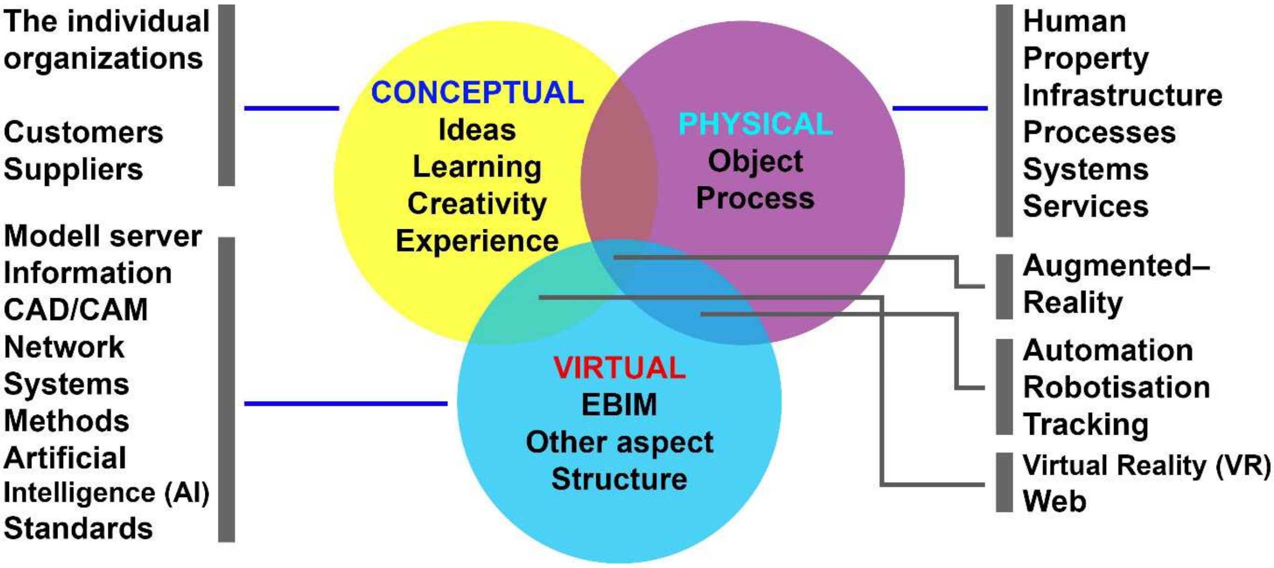

Figure 4: Digital interaction and interfaces with EBIM

One of the most important aspects of sustainability in EBIM system is that it allows all stakeholders to use the same BIM throughout the buildings lifetime based on open data standards. Stakeholders of this solution include the building sector chain (AEC, managers, owners) and other groups such as patients, logistics, authorities, marketers, etc. EBIM implements new sets of rules and models for the building industry. This innovation is a unique approach in the global market and has a great possibility and ability for fast market uptake. (Jotne EPM Technology 2017). EBIM underlines the necessity for integrated and participatory strategies and organizational processes during the whole building's lifecycle that are specifically tailored to the requirements of professionals and stakeholders. Hence, the role of FM in the EBIM system becomes a powerful functional organization for achieving sustainable objectives. In this regard, FM professionals have the greatest opportunity to add value to their establishment and customers through effective governance of sustainability issues and methods (Støre-Valen and Buser 2019)

9 CONCLUSION

Designing sustainable health care systems is emerging as a strategic goal for developing new functionality and applications with the aim of more efficient use of resources over time. This article hopes to provide a platform on which the joint interaction between BIM and FM in the light of EBIM as sustainable system can stand and thrive. BIM undertakes to deliver primary data to FM systems and supports and improve other FM functions by providing forward-thinking visualization and analysis abilities. Cooperative design should support data exchange as knowledge and not just data transfer as information in documents related to business processes. Such cooperation can be seen as a response to industry integration. As a result, this collaboration can lead to the support of good services and increase performance and reach to a stage of significant changes. Hence, EBIM can provide the valuable judgments needed to make a more sustainable infrastructure for the satisfaction of owners and all stakeholders in a holistic aspect structure. EBIM is a system for using digital models to manage data possession throughout the buildings lifecycle and to support the core businesses.

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🏆 *reviewed paper*

Sustainable Smart City – the Path of Vienna

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1 ABSTRACT

Urban development faces numerous challenges in the 21st century and a central task is the sustainable and liveable design of the city. Can the concept of a Smart City be a tool to making cities more liveable and sustainable? To find out, we chose a biographical method to analyse the steps towards a successful Smart City and to better understand the structures behind it. We combine the innovation biography method with a process model from sustainability governance research, namely Steurer's sustainability governance model and apply them to Vienna's Smart City, especially the preparation of the Vienna Smart City framework strategy (Steurer & Trattnigg, 2010). On the one hand, this article shows that a transfer of the innovation biography method to urban research can generate deeper insights on urban development processes in general. On the other hand, the approach chosen can show that Vienna integrates the sustainable urban design into the process of Smart City design. So the smart and sustainable city design, often called for in theoretical contributions, is practised in Vienna. Due to its reconstructive character, the biographical method has revealed that it is possible to govern sustainability by using Smart City as an umbrella strategy, as long as one manages it in an integrated and holistic way, recognises trends and is able to acquire and use research funds effectively and efficiently.

The knowledge gained from the new method for urban and Smart City research is twofold. Firstly, the transfer of the method previously developed in the human sciences and subsequently for organisations, institutions and products and services also works in urban research. Second, the innovation biography provides in-depth insights into the process towards the Smart City and the stakeholders involved. The use of the biographical method highlights the relevance of good governance in terms of interdisciplinary cooperation on the one hand and high political commitment on the other through the micro-level perspective and is also sensitive enough to highlight the importance of an appropriate narrative in and for the process towards the Smart City.

Keywords: Innovation Biography, Smart City Governance, Vienna, Sustainable Smart City, SDG 11

2 INTRODUCTION

In the last 20 years, numerous Smart Cities have emerged all over the world. The Smart City remains a black box in several ways: regarding its external perception, its understanding of internal processes and outcomes produced. It is often unclear how the city became a Smart City, who was involved and why a Smart City is being created at all. In theory, the Smart City is often associated with sustainable urban design. But whether this is a normative idea or really implemented in practice must be considered on a case-by-case basis. Digitisation has the potential to make the city more sustainable, but is does not have to. Just managing all the data that a Smart City must collect takes a lot of energy (Höfner et al., 2019, Jones, 2018). An analysis of inputs and outcomes is needed. The latter must include the environmental effects along the entire value chain if we are serious about sustainable development.

By adopting a micro-perspective, the innovation biography method aims to clarify how the process towards a Smart City is shaped, how knowledge is shared in this innovative process and who cooperates with whom for this purpose (Butzin et al., 2012, pp. 123-124). The fact that knowledge is of great importance for innovations and will continue to gain relevance in a knowledge society is sufficiently proven (Dannenberg & Junges Forum, 2009, p. 191). The analysis of the Smart City by using an (innovation) biographical method offers the possibility of recording the process.

The biography of a Smart City is created by going all the way from the first ideas to the actual implementation of the innovation – in our case the Smart City. As a case study, Vienna is selected as a city that not only ranks high in the target dimension 'smart' in the well-known city rankings, but also in the target dimensions 'sustainable' and 'liveable'. The reason for the complementary selection of the target dimension 'smart' with the target dimensions 'sustainability' and 'liveability' is twofold. On the one hand, it is the normative idea that digitalisation does not serve an end in itself and should be used to make the city sustainable, inclusive and liveable in the sense of SDG 11 (Günthner et al., 2017). Furthermore, this requirement for a modern urban design coincides with the current definitions and descriptions of sustainable Smart Cities in science (Treude, 2021, pp. 2-4). So the sustainable Smart City "[…] meets the needs of it`s present inhabitants without compromising the ability for other people or future generations to meet their needs, and thus, does not exceed local or planetary environmental limitations, and where this is supported by ICT." (Höjer & Wangel, 2015, p.14).

The innovation biography is intended to complement Smart City research with a process-oriented method that allows the relevant determinants behind the process towards a Smart City to be presented. At the same time, this should expand the application areas of innovation biographies with those of urban research and test it on the Smart City in its processes, structures and procedures. Every city has its own economic, political, socio-cultural conditions; accordingly, the drawing of a blueprint by means of the innovation biography of the Smart City is not possible. But the understanding of shared networks, transdisciplinary collaboration, the importance of visions and shared narratives, the relevance and mapping of actors, governance and the role of the community and policy makers can be adapted to other cases. In the definition of a sustainable City, we are guided by the United Nations Goal 11: "Make cities and human settlements inclusive, safe, resilient and sustainable", which includes, among other things, participatory, integrated and sustainable human settlement planning, as well as climate change mitigation and adaptation.

We begin with a brief introduction to innovation research, the description of the method of innovation biographies and their current scope of application, followed by the methodological approach to the case study for transfer: the Smart City Vienna. This is followed by the results of the research and a discussion of the methodological transfer on the one hand and the results that emerged from the biography of Vienna on the other hand. Finally, a conclusion is drawn and the need for further research is identified.

3 FROM INNOVATION TO INNOVATION BIOGRAPHY

An innovation is "[...] basically the purposeful implementation of new technical, economic, organisational and social solutions to problems [...]". (Vahs & Brem, 2015, p.1, own translation). The Smart City is characterised by its innovative power in different areas. Based on Schumpeter's cases of innovation, it is at least a new sales market, and therefore also a structural innovation, since it involves innovations in organisation and governance (entity). If one follows further subdivision into categories or types of innovation, the Smart City represents also a process innovation, since processes and procedures in a Smart City (should) be subject of change (Schumpeter, 1997, p. 101). The fact that the Smart City is an innovation has already been elaborated elsewhere (e.g. Angelidou, 2017, Nam & Pardo, 2011). The relevance of networks as important drivers for innovation are also undisputed (Kleinaltenkamp, 2006, p. 93, Benkler, 2006, pp. 1 f.). The same applies to innovation-networks and the know-how formed within them, which is often newly acquired and coordinated (Benkler, 2006, Cooke, 2007).

Van Der Duin et al. further classify innovation processes into four generations along structures and collaborations of the innovation process: „In the fourth generation, innovation processes have become innovation systems." (Van Der Duin et al., 2007, p. 200). The fourth generation (from the mid-1980s to the early 2000s) is characterised not only by a network of partners, but also by parallel processes within the innovation process (ibid., p. 200). The complexity in these increases accordingly, so that one no longer speaks of individual innovations, but of innovation systems (Cooke, 2007, p. 54). And the emergence of networks in this system is a long process: „[…] relationships within a network or system do not form overnight but need some time to develop. Long-term relationships are the result of a mutual trust that is reinforced by repeated innovation successes." (Van Der Duin et al., 2007, p. 211). The relevance of networks, cooperations and their meaning in the process of becoming a Smart City will be elaborated by the method of innovation biographies. It will be applied here for the first time in urban and Smart City research. Following Van Der Duin et al., the Smart City can be understood as a regional innovation system. To investigate this innovation system of a Smart City, the innovation biography can offer an adequate methodological framework.

Innovation biographical research belongs to the methods of biographical research, which have their origins in human and social sciences, as well as in sociology (Keupp & Weber, 2001, p. 266-275, Bohnsack, 2010, pp. 57 ff., Schulze, 2010, pp. 1-15, Schütze, 1983, pp. 283-293 as well as Butzin et al., 2012). In the interplay of spatial perspective, knowledge creation and diffusion, and the underlying actor network, innovation biographies can outline the paths towards an innovation. The individual steps towards an innovation biography for a Smart City as well as the expected challenges and how to deal with them are listed in table 1 under Results.

4 CASE STUDY SELECTION AND PROCEDURE

The case study for applying the innovation biographical method is the Smart City Vienna. The process started about ten years ago and has been performing well for years in available Smart City Rankings as well as in the Sustainable City and Liveable City Rankings (Treude 2021, p. 11). Vienna is one of nine federal states of the Republic of Austria and its capital. 1.92 Million people lived here in the year 2020 on an area of about 415 km2 (Statistics Vienna, 2020). According to Roland Berger 2020, Vienna has one of the best Smart City strategies, which is the decisive criterion of successful Smart Cities (Roland Berger, 2020, p. 3). These characteristics make Smart City Vienna an interesting case study for the transfer of the innovation biography method: there is a long process to analyse and it is widely considered successful.

For gaining a reconstructive process description of the innovation Smart City, a description of the course of the innovation is needed, the interactions within the organisation, as well as relevant actors and stakeholders, who have been actively involved in the process. For this purpose, the innovation biography combines a number of qualitative methods in a multi-stage and iterative procedure (see working steps in table 1). The innovation biography consists of three main components/elements, namely the biographical approach, the ego-centred network analysis and the space-time path (Butzin et al., 2012, pp. 131-134). In this multi-stage methodology, we first conducted a document analysis of freely accessible websites and documents of the City of Vienna as an introduction to the preliminary investigation. The document analysis "[…] is a hermeneutic procedure that is assigned to qualitative social research. It is about an understanding of the meaningfulness laid down in the respective documents and then, in the next stage, a socio-historically guided, politically and sociologically informed contextualisation of ideas." (Salzborn, 2018, p. 24, own translation). Then an initial narrative interview was conducted with a key person in the Smart City Vienna process, which, in conjunction with the document analysis, formed the basis for the ego-centred network analysis: „Egocentric research is focused on individuals and their immediate social environment" (Perry et al., 2018, p. 25). This social environment in its composition and combination is important for the individual. The individual (in our study the individual is the Smart City itself) is influenced and shaped by this social environment (and the actors involved). So, the ego in the egocentric network analysis is used for the current focus of attention – in our case: The Smart City Vienna.

Based on the ego-centred network analysis, another 15 stakeholders from all three identified areas (politics/administration, science, and business/consultancy) were chosen to be interviewed, drawing from around 140 stakeholders in the process for the Smart City framework strategy Vienna (or 270 stakeholders in the further development in 2019). Six of the respondents belonged to the administration of the city of Vienna or to city enterprises. Another person belonged to the administration of another city. Here, the "outside perspective" very much coincided with the view from "inside". Six of the interviewees were part of the scientific community at the time of the development of the framework strategy, but not all of them at the present time (2021). Some of the actors in Vienna`s Smart City process have changed their professional position over the ten years. Three of the interviewees stem from business and/or consulting.

The egocentric network analysis was considered complete when none of the respondents mentioned any new stakeholders that had not yet been mentioned. To this end, we asked each time at the end of the interviews: "Who else should we talk to about the process from your perspective?" A total of 16 interviews were conducted accordingly. We chose free storytelling in the narrative interviews because it sometimes leads to subconscious structures of meaning, that would be lost in systematic questioning, as is the case with the questionnaire (Mayring, 2008, pp. 72-73). The 15 interviews that followed the first interview were conducted face to face within 2 months (February-April 2021). This is the preferred survey method of ego-centred network analyses (Perry et al., 2018, p. 45). However, due to the ongoing global Corona Pandemic, these were conducted via online conferencing tools and lasted about an hour each (for more information on the advantages and disadvantages of face-to-face interviews see among others, Perry et al., pp. 45-55). Afterwards the interviews were transcribed.

The narrative interviews were conducted in four steps (Mayring, 2008, p. 75):

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(1) Definition of the topic and open narrative invitation: "Could you tell me about the process towards Smart City Vienna?".

(2) Stimulation of the narrative through non-verbal communication patterns and the maintenance of the narrative structure.

(3) Return to the topic (in case of too much deviation).

(4) Questioning phase.

The analysis of the transcribed interviews was carried out as a reconstructive case analysis according to Rosenthal (Kaya, 2009, p. 91, Schulze, 2010, pp. 573-579, Fischer-Rosenthal & Rosenthal, 1997, pp. 152-146) and in accordance with Schütze, (1983) in six successive steps:

(1) Analysis of the biographical data with regard to the process

(a) Listing of what has been described

(b)Comparison with historical processes or background knowledge

(2) Text analysis and thematic field analysis

(a) Which issues were addressed, which were not? This step needs the alignment with step 1b.

(b)Why are some things told in brief, others in great detail?

(c) Which topics are related?

(3) Reconstruction of the case history and development of the chronology of the biography.

(4) Detailed analysis of selected interview passages for in-depth analysis of individual process steps.

(5) Comparison and generalisation

(6) Typification

The last two steps are mentioned here for the sake of completeness, but initially have no significance in the evaluation for the biography of the Smart City Vienna, i.e., an individual case study, because at this point in time neither generalisations are to be made (step 5) nor typologies derived (step 6). However, when comparing several Smart City biographies regarding their processes and networks among each other, these points are relevant. The same applies to step 2. It leads to a more detailed insight into the individual actors and their underlying positions within the whole process. This is interesting but less relevant for this article and in need of interpretation.

To complete this egocentric network analysis, archival methods were combined with the narrative interviews. These archival methods have the advantage of being completely independent of the researcher and can independently validate or supplement the network structures (Perry 2017, p. 58). The documents used were freely accessible documents and websites listing inter alia the actors in their functions of the respective departments and organisational units, and also 117 council resolutions of the City of Vienna from the years 2005-01/2021. These monthly meetings, documented in their wording, were, inter alia, intended to validate the start date or the start phase of Smart City Vienna mentioned in the interviews. In the ego-centred network analysis, the importance of the identified individuals of the network is also very relevant - their networking or non-networking with each other and their view of the cooperation and learning processes within the ten years leading to Smart City Vienna.

5 RESULTS

The results of the transfer are twofold. Firstly, the transfer of the method to urban and smart city research was successfully adapted. Secondly, the transfer provides results regarding the the process towards the Smart City of Vienna, the actors involved, the cooperation between them and the learning processes.

5.1 Transferring the innovation biography to Smart City research

The innovation biography method worked for the reconstruction of the Vienna Smart City process and it presents interesting results regarding the Smart City process, its structures and relevant networks. All steps necessary for the innovation biography method could be transferred to the Smart City (see table 1).

Innovation biography				
Theoretical procedure and working steps	**Conditions for the transfer to Smart City research**	**Potential Challenges**	**Dealing with challenges**	**Application to Smart City research using the example of Smart City Vienna**
1. Case study selection	Identifying a successful Smart City	For the definition "successful", grey litertaur is used: Smart City Rankings	Comparison of ranking systems with regard to indicators, inclusion of desktop resaerch	Vienna, due to numerous top placements in the Smart-, Sustainable- and Liveable City Rankings
2. Document analysis for the case study	Identification and collection of all relevant documentation	Planning documents and municipal decisions may not all be freely accessible	Request the city to be investigated for documents	Good data basis available, including publicly accessible council decisions from the years 2000 -2021 for reconciliation
3. Selection of a key actor	Often long processes towards a smart city, there may be several key players	Conducting several interviews already in the first round	Comparison of the processes described in the interviews	Good communication of the responsible key actors in the process
4. Conducting a narrative interview	No special conditions for the transfer to Smart City Reasearch	To elaborate the process towards the Smart City from the experiences of relevant actors	Strengthen narrative demand phase and evaluation on the basis of narrative-structural methods	No problems at all, even when requested for two-hour narrative interviews
5. Egocentric network analysis	The hub of the network analysis is the Smart City itself	The egocentric network analysis is selective with regard to the actors and	Combination of the ego network with geographical and temporal data	Draft of a first version of the life story possible
6. Further interviews	No special conditions for the transfer to Smart City reasearch	Identify and complete actors from the first interview	Strengthening the narrative demand phase from step 4 and deriving further actors from the following interviews	From the network analysis, the key actors quickly became clear. However, some of them have changed jobs
7. Triangulation of the data	Collect all data relevant to the innovation biography from and with involved actors	The aggregation and analysis of different types and amounts of data	Using triangulation as an approach to link the different research perspectives	Versatile data available. Selection challenge
8. Creation of the innovation biography	No special conditions for the transfer to Smart City Reasearch	Identification of a start and an end point for the innovation	Through the triangulation of the methods	The representation of the process is well possible, the representation of the networks is challenging due to the size and diversity and only possible in tabular form, therefore limited use of a space-time path
9. Analysis of procedural factors	No special conditions for the transfer to Smart City Reasearch	Derivation of procedural factors only determinable for the analysed city	Transfering of the analysed factors and cross-check in other smart cities or continuation of the innovation biographies in comparable Smart Cities	Procedures factors well derivable

Table 1: Theoretical challenges of applying the method of innovation biographies to Smart City reasearch and the transfer of nine individual steps. Source: Revised presentation based on Treude, 2021

To illustrate the innovation biography of the Smart City Vienna (working step 8, table 1), an actor network is presented (figure 1), a space-time path related to the Smart City framework strategy (figure 2) and a biography of important steps over time (figure 3). The individual process steps towards Smart City Vienna are presented based on success factors of a sustainability steering model according to Steurer from 2010 (figure 4). In the process for the framework strategy from 2014, there were almost 140 contributors from various municipal departments, institutions and companies of the city, other institutes and organisations as well as contributors and consultants from research and science. This was increased for the further development of the framework strategy from 2019. Here, almost 270 people were involved in the process. It is also not expedient for Smart City Vienna to present the components and actors in their spatiality, as almost all of the actors involved come from the city of Vienna. Therefore, this has been dispensed with. However, they are displayed visually in a complex network[1] (figure 1).

[1] This network was developed on the basis of the contributors mentioned in the 2014 and 2019 strategies. If other documents were added, e.g. the monitoring report or the current projects on the website https://smartcity.wien.gv.at/projekte/, the mapping would be too complex and confusing. For this reason, it has been dispensed with in this figure.

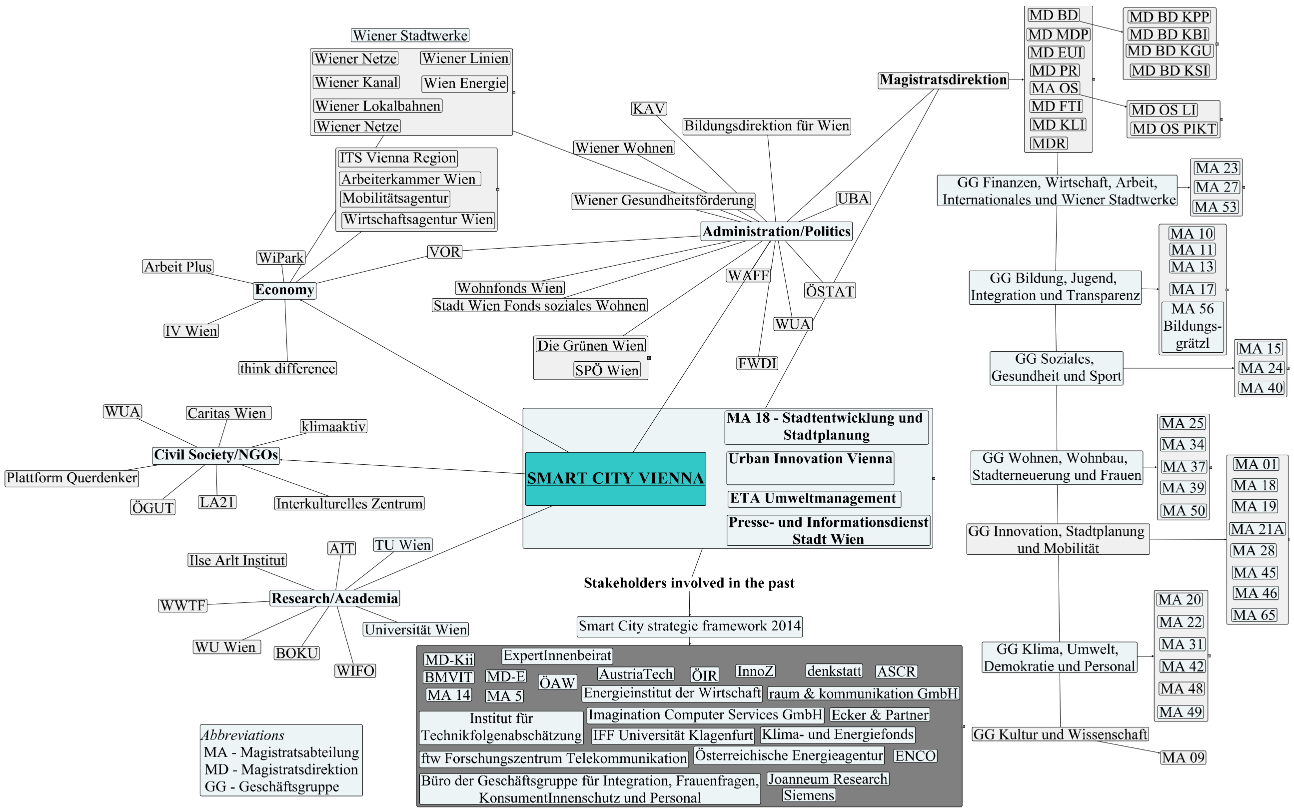

Figure 1: Network Smart City Vienna based on the contributors mentioned in the Smart City Vienna framework strategy (2014 and 2019). Source: Own Illustration, based on Magistrat der Stadt Wien, 2014 and Magistrat der Stadt Wien, 2019

The results from the narrative interviews provided much depth of procedural detail. They are compiled below using a governance model by Steurer 2010, which deals with the governance of sustainability at the strategic and political level. This model will be used to show how the actors have shaped their process towards the Smart City and what their success factors were.

5.2 Results of the innovation biography – The path of Vienna

Some of the interviewees date the beginnings of the Smart City Vienna to the beginninof the turn of the millenium, some even earlier. Thus, Smart City Vienna builds on good groundwork and activities in the field of social sustainability, such as social housing construction in Vienna. However, most of the 16 respondents (Interview Person 1-16: IP1-IP16) mentioned the years 2010 and 2011 as the main starting point. In 2010, the Smart City is mentioned for the first time in the Vienna City Council (Gemeinderat Stadt Wien, 2010) and named as „[…] strategy for the future […]“ at the meeting on March 2011 (Gemeinderat Stadt Wien, 2011a, p. 27, own translation). In the same year, the Vienna City Council discussed the advantages of a broad Smart City initiative and the possibility of becoming an international leader and learning from other leading cities (Gemeinderat Stadt Wien, 2012b, p. 45). In March 2011, this Smart City Initiative is then proclaimed by the Mayor (Gemeinderat Stadt Wien, 2012a, p. 20). Under the leadership of a central steering group, which currently meets about four times a year and has a high-ranking membership, the City of Vienna followed these main steps: (1) an inventory of existing structures, initiatives and Smart City definitions (2010/2011); (2) a broad participation process, in which a vision, a roadmap and an energy plan for the City of Vienna were developed (2011-2013); (3) developing of the Smart City framework strategy (2013-2014) (IP1). From 2013 until the finalisation in 2014, almost 140 people with their respective organisational units, research institutions, departments, etc. were involved in the process (almost 270 in the revision in 2019). The strategy development process for Smart City Vienna can thus be described as an open innovation process (Jaworski & Zurlino, 2009, p.18). The strategy is the central component of Smart City Vienna and is therefore also the focus of the Smart City Vienna innovation biography (figure 2). All respondents agree: Smart City Vienna is based on its framework strategy. All references in the documents also lead back to this strategy. It serves as a basic framework for the governance process guided by an idea of “preventive innovation” (IP3). The respondents see the Smart City as a transformation programme and digitalisation as an innovation in this programme. However, no plans for a large-scale disruptive technologisation of the City of Vienna can be discerned, but rather a gentle digitalisation that reveals a digital humanism .

Already in the run-up to the development of the Smart City framework strategy in 2012/2013, there were numerous participation formats and topical workshops (see figure 3). One interview shows that more than a hundred interviews were conducted with the aim of sensitising the city administrations and magistrate departments to the upcoming processes and winning them over (IP6). The aim was not to adopt all the content without conflict, but to create a basis for acceptance and trust in the process. According to the respondents, this has been successful. Many council decisions, especially from the years 2014-2016, show the need for discussion and also critical queries from the members of the Vienna City Council, but also the legitimacy of the Smart City framework strategy from 2014 as an important milestone in the Smart City process (Gemeinderat Stadt Wien, 2014, p. 65). Almost exactly 5 years later, on 26 June 2019, the revised version would go through Council: "The Smart City Vienna framework strategy and its objectives presented in the updated version, which thus replaces the strategy adopted by the Vienna City Council in 2014, are adopted. [...] As an umbrella strategy, the Smart City Vienna framework strategy is a guideline for the organs of the City of Vienna, for all municipal departments and other institutions of the City of Vienna. Specialised concepts and strategies, as well as implementation activities and decisions that are important for the achievement of the objectives of the Smart City Vienna framework strategy must be oriented towards its objectives.“ (Gemeinderat Stadt Wien, 2019, p. 7, own translation). In 2020, the City of Vienna started a new roadmap within the framework of the EU initiative EIT Climate-KIC, which will define concrete measures and steps for implementation as a link between the Smart City framework strategy and the new requirements for a climate-neutral city (City of Vienna, Rathaus, no year).

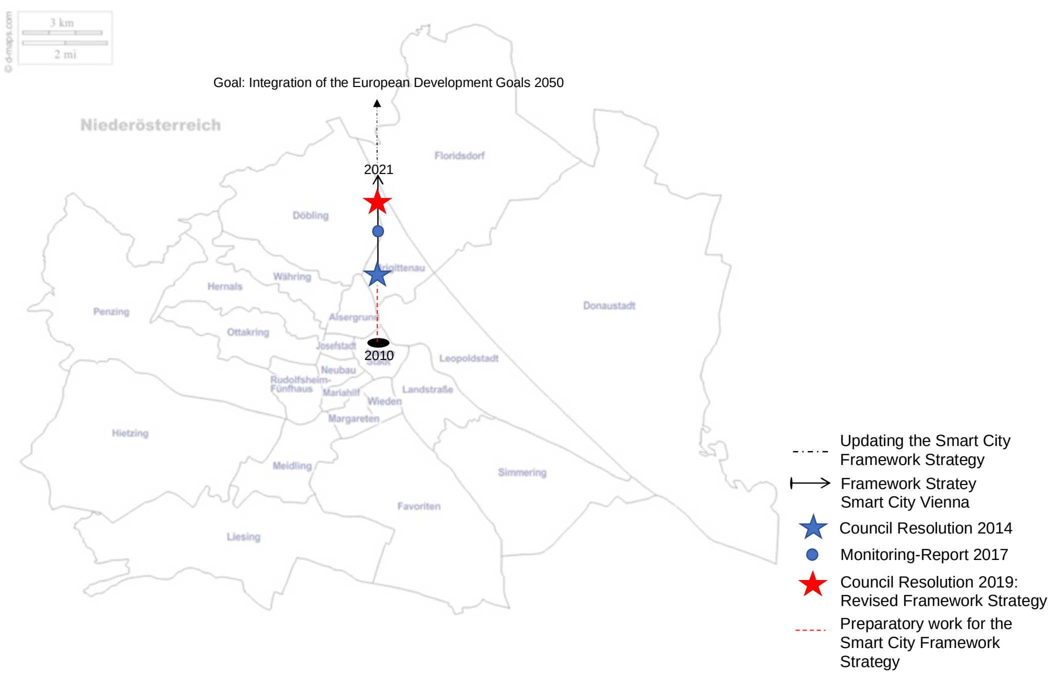

Figure 2: Space-time path of the Smart City Framework Strategy Vienna. Source: Own Illustration

The Smart City actors shaped the process in Vienna like a funnel. Thus, at the beginning, the process was very broad on the administrative side, the topics were very wide-ranging and the criteria and goals were initially formulated qualitatively. The initial aim was to win over the entire administration and as many departments as possible to explore and take up topics that already existed through the numerous sectoral strategies in Vienna. There was a lot of preparatory work, among others in the two accompanying projects TRANSFORM and TRANSFORM+ (see figure 3). The jointly developed vision, the Smart City marketing and the story-telling about the Smart City Vienna and its framework strategy had an activating function, both internally to the administration and externally to the citizens of Vienna (IP1, IP 6). The first framework strategy from 2014 did not yet contain any concrete measures for implementation; these were in the individual sectoral strategies or were to be created (Magistrat der Stadt Wien - MA 18, 2016).

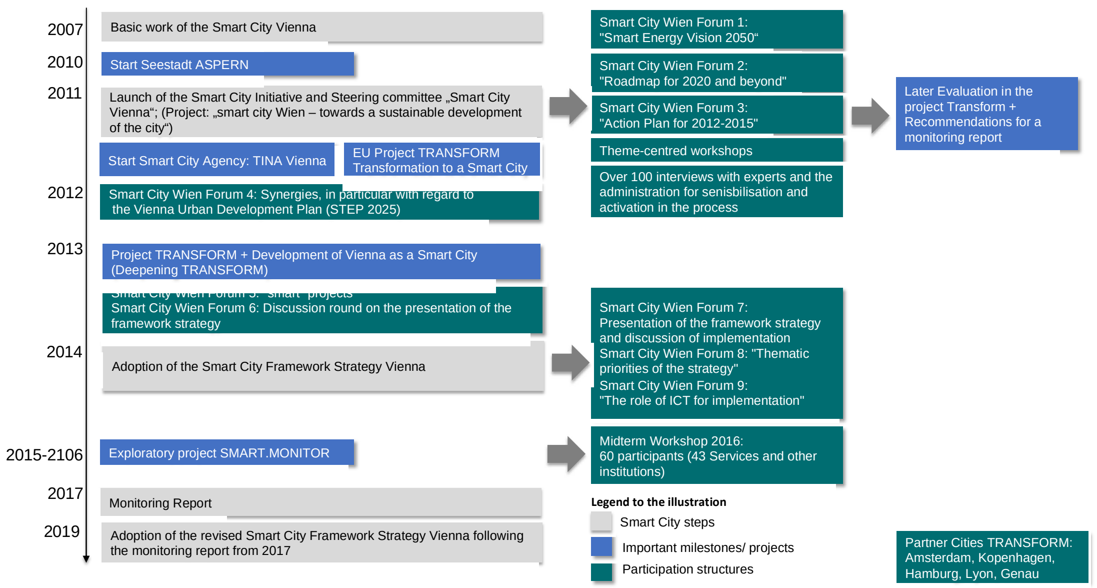

Figure 3: Biographical representation of Smart City Vienna. Source: Own Illustration, Sources: free available internet sources and 16 Interviews (IP1-IP16)

Analogous to the image of a funnel, the objectives of the Smart City Vienna framework strategy get more concrete, more narrowly defined and formulated in more detail in the 2019 revision process (IP12). According to the interviewees, almost the entire Viennese administrative system, across all hierarchical levels and driven from the very top by the municipal directorate, was integrated.

The aim was to bundle competences and to build up and consolidate capacities and cooperation structures. Cross-sectoral working groups emerge, particularly in the context of the revision of the second framework strategy in 2019 and in the 2017 monitoring report that preceded it. According to the interviews, these working groups were not conflict-free and still are not, but they are the only place to ask fundamental questions and form compromises (IP10, IP16). The respondents see the ability to cooperate within the process and the interdisciplinary cooperation as a decisive driver for the Smart City Vienna framework strategy. The initial breadth at the beginning of the process is now shown to be an advantage, because over 10 years, the departments of the administration have firmly committed themselves to the umbrella strategy, according to the respondents. The departments of the administration have learned that they can maintain their autonomy as long as they cooperate towards the common goals (IP1, IP10). Thus, it was possible to become much more concrete in the revision in 2019, also because work towards the first monitoring report in 2017 was again spread across all departments. The meetings of the steering group and other working goups are described by all as very enriching with cooperation constantly increasing. Furthermore, the interviewees describe that the exchange with other Smart Cities is very instructive (IP2, IP5). Here, some report on informative and enriching delegation trips and the resulting networking that often lasts for many years. The interviewees report that at the beginning, the disputes on certain topics were often tedious. Yet they see the interfaces between different areas of action as setting the course for success, even if they are not without conflict. According to the interviewees, the Smart City framework strategy is now, in 2021, a matter of course for all departments.

There is a strong continuity of people involved in the process from 2010 until today. Among the 16 interviewees, 9 persons are still involved in the ongoing process, 4 interviewees come from institutions that are still involved through different members. Only two of the respondents are no longer involved directly in the process themselves or through their organisations (Status April 2021).

Overall, the review of the persons and participating institutions, organisations and research facilities reveals a very heterogeneous and very stable network over the period 2014-2019 (see figure 1). The interviews also show that there is a stable core of participants in the process, both throughout the entire process and currently. The core team consists of the steering group around the Department of Urban Development and Urban Planning of the City of Vienna. They are the central drivers of the Smart City process. The Smart City steering group consists of, among others, senior officials of the City of Vienna, the management and senior staff of the Vienna Business Agency, Municipal utilities of Vienna, “Wiener Wohnen” and “Wien Energy”. It is complemented by the “Wiener Wissenschafts-, Forschungs- und Technologiefonds” with the role of external consultant and Urban Innovation Vienna, the Smart City agency which emerged from the process towards the Smart City. Working groups have been set up for the individual thematic goals and are responsible for their implementation (Magistrat der Stadt Wien, 2019). For this, the interviewees emphasise the relevance of strong networking so that people at the interfaces exchange information (IP14). In addition, parallel processes converge at some crucial points, e.g. in the planning department. From the interviews, it appears that these interfaces are extremely important for the integration of the different processes and strategies, as they expose possible contradictions and create coherence. In the interviews with the stakeholders, the importance of good and functioning cooperation based on mutual respect and working across levels is emphasised again and again (see figure 1) (IP1, IP10, IP14).

It emerges unanimously from the interviews that the framework strategy does not follow any digitalisation ideology. On the contrary, some of the interviewees even distanced themselves from the term. Social inclusion, on the other hand, plays an important role and is emphasised again and again (both in the documents and in the interviews): A good life for all Viennese. Some formulate the basic ideas of Smart City Vienna as: thinking together, networking and integrating (IP1, IP3, IP14). All interview participants show the same understanding of the Smart City, in which sustainable urban design is a central component. One interview states: "Smart City Vienna is the coalition of the city's future-minded and innovative people" (IP2). Furthermore, the stakeholders emphasise the relevance of the different partners and players within the City of Vienna and their influence on the design of the Smart City Vienna. In particular, the interviewees describe the cooperation on joint externally funded projects between administration and science as very fruitful and as an important learning process towards interdisciplinary cooperation (IP15).

The dialogue and process effort behind Smart City Vienna should not be underestimated, as all interviewees agree. It requires incentive systems, win-win situations, motivation and attractiveness. Financing issues are also often an important and contentious factor (IP2, IP3). Moreover, the interviewees describe these cooperation partnerships as learning processes. They report that the beginnings of cooperation were much more difficult (IP15). Many staff members first had to get used to acting and cooperating beyond departmental logic in particular.

5.3 Procedural results – “Governing Smart City” based on “Governing Sustainability” – Vienna as best practise

The process description drawn from the interviews on Vienna’s Smart City largely matches that from the anlysed documents. The interviews offer insights into essential details, which are clustered along the model for steering sustainability below (Steurer & Trattnigg, p. 149) (see figure 4). The identified good governance criteria will be presented biographically in the following whenever possible, including dates where applicable. The Smart City Vienna is centered on its framework strategy. This is in line with Roland Berger's studies from 2020 and 2019 (Roland Berger, 2020).

All respondents agree that Vienna started to develop Vienna`s Smart City on a solid existing basis. This means that the process towards a Smart City did not start in 2010, but with many good steps, some of which had already begun decades earlier (IP2). The triad of resource conservation, innovation and quality of life for all Viennese has remained constant over the years, according to the interviewees. However, in the first years, the city was looking for a new narrative that offered more possibilities for development than the concept of sustainability. According to the interviews, at the time around 2010, the concept of sustainability was too inflationary in use and too vague to be able to adequately meet Vienna's urban challenges, above all the strong growth. According to one of the interviewees, it was no longer sufficient and it can be seen as a paradigm for preserving systems rather than developing them. Attributes such as dynamics, innovation and growth had to be included, and they worked better under the term Smart City (IP10). With the development of the SDGs in 2015, these have been incorporated into the revision of the framework strategy 2019: "With the Smart City Vienna framework strategy, Vienna emphatically commits to the international and national targets and makes its contribution to achieving them. Conversely, in order to realise the Smart City goals, Vienna needs suitable framework conditions, which the federal government and the EU must create." (Magistrat der Stadt Wien, 2019, p. 19, own translation)

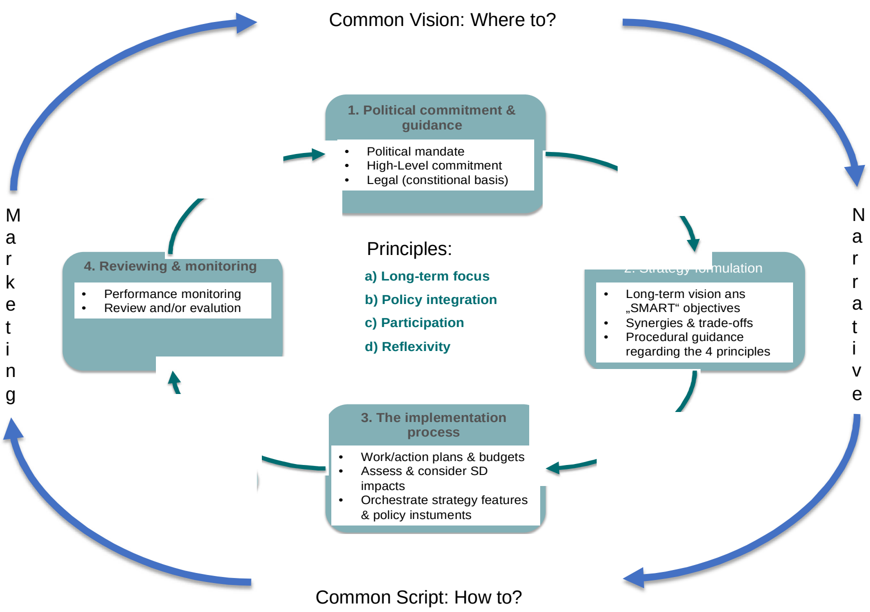

Figure 4: Policy Cycle of Sustainability Strategies. Source: Own extended illustration according to Steurer & Trattnigg, 2010, p. 149

All interviewees agree: The Smart City Vienna is about a sustainable design of the city. All 16 interviewees from administration, municipal departments, research or municipal organisations said this. The same is stated in the 2014 framework report as well as in the further development in 2019, in the workshop report from 2015 and in the monitoring report from 2017. Vienna chose a new narrative under whose flag it could better formulate a future-orientated urban design than under the mere term of sustainability (IP10). According to a long-term companion of the process, this was not accepted uncritically without reservation, especially at the beginning of the process. For many, the term smart contained a strong technological aspect, which the Viennese had to frame differently in their process - towards quality of life, conservation of resources and social as well as technical innovations.

The document analysis and the results of the narrative interviews revealed components and governance principles that can also be found in sustainability research and research on sustainability strategies (see figure 4). They involve the essential actors of a city, have (worked out) a common vision of the future of Vienna, developed a strategy and are currently working on a roadmap for implementation (IP12). For implementation, they have numerous partners and links that mediate between urban demand and businesses.

The initial impetus for the process towards a Smart City in Vienna was the political mandate of the Mayor to develop and formulate a strategy that has such a long timeframe (2050), integrates all policies, has a participatory character and develops iteratively. The implementation of the strategy in Vienna takes place through thematic projects with a holistic reference to the development goals of the framework strategy. From the joint development processes and the projects, knowledge transfer and joint learning take place in Vienna, both in terms of cooperation across departments and in terms of content. In 2016, preliminary work on monitoring was carried out as part of a research project, which then resulted in a report in 2017. This was distributed across the supplying departments and shows internally and externally where there is room for improvement. And the results showed learning experiences that were incorporated into the revision of the strategy. Here, not only internal development processes were taken into account, but also the new requirements of the EU and the UN, e.g. the integration of SGDs in the further development of the Smart City Vienna framework strategy in 2019 (see figure 3).

5.4 Detailed success factors within the governance structures in Vienna

The narrative around the Vienna Smart City has been relevant from the very beginning, and the same applies to its Smart City Vienna framework strategy (IP11). The communication is consistently positive, and there was a strong marketing campaign for the Smart City before it had even been fully defined. The narrative, i.e. how to communicate about the Smart City, and the marketing, i.e. how to promote the Smart City product, are important drivers for progress, connected to but also sometimes independent from the actual content (IP11).

(1) Political commitment (in Vienna from 2011- today)

With the normative governance principles of horizontal and vertical political integration (Steurer & Trattnigg 2010, p. 37)

All interview partners agree that the strong political will on the part of the mayor in 2010/2011 gave the initial impulse for Vienna`s Smart City. Thus it is a top-down initiative (IP3).

The initial phase is formative for such large projects, so it is crucial who you involve from the beginning (IP3). The project management is based in the Municipal Department of Urban Development and Urban Planning. This office is part of the steering committee, as are some top officials of the City of Vienna and various stakeholders (see above). The Smart City Forums are open to interested persons, but are mainly attended by experts from different fields (see figure 3). "Smart City requires especially horizontal integration." (IP3, own translation).

Coherence of policy fields was a frequently raised point in the interviews and the relevance of good cooperation across disciplines. Here, the cooperation of governmental and administrative levels was addressed (vertical integration) as well as the coherence of different policies and the underlying issues (economic issues, environmental issues and social and cultural concerns).

Clear areas of responsibility, regular exchange formats (both same hierarchy levels and across hierarchies, both topical and again across hierarchies) are mentioned as another important point.

Vienna shows a strong orientation towards the climate goals of the EU and the federal government and thus follows the principle of vertical linkage.

(2) Development and formulation of the strategy (in Vienna from 2013-today)

With the normative governance principles of participation and reflexivity

The first step was to take stock of the situation in order to build on existing strengths (and already existing strategies) and to bundle the measures. In addition, this first step served to activate the stakeholders (IP1, IP6, IP15).

At the beginning, a measured amount of digitalisation was included in the framework strategy, as it was not intended to become a digitalisation strategy. In the first version of the strategy in 2004, digitalisation was only mentioned in connection with information and communication technologies, and here specifically the topic of open government, with a commitment to the principles of participation, transparency and data security. In the further development, this topic was readjusted once again and was given its own theme (IP12).

In particular, the linking of innovation with sustainability is a groundbreaking topic for all interview partners.

The multidisciplinary approach is an important factor for the success of the Vienna Smart City strategy for the interviewed persons from all sectors. The integration of many municipal departments and sectoral strategies into the process led to acceptance and openness towards the process.

The research institutions are often named as important partners. In the interviews, they are motioned as important partners by the administration, but they also refer to themselves and other research institutions as such. The long time horizon of the strategy as an umbrella strategy is an important point that provides both, the necessary framework for the sectoral strategies and leaves freedom for their own, shorter objectives.

Many of the interviewees perceive the sharing of knowledge between the departments as a driving force in the process (IP1, IP2, IP 9, IP10, IP15). It is also accompanied by headwinds and contrary opinions and discussions, but the interviewees see this also as constructive for the process and thus desirable.

The Smart City Vienna consists of small iterative steps in different teams and frequent cross-sectoral and cross-departmental meetings at different hierarchical levels, according to the interviewees. They thus follow the governance principles of participation and reflexivity.

(3) Implementation Process (in Vienna from 2014 – today)

Especially in implementation, the actors look to other cities. The learning aspect is emphasised by the interviewees, in terms of learning and practical experiences from the individual departments in which they were confronted with implementation. Here, many report on the good trips to other smart cities and the exchange with other cities.

As early as 2011, the Vienna City Council aimed at peer learning among the cities themselves (Gemeinderat Stadt Wien, 2011b, p. 45).

At the operational level, the framework strategy is supported by many individual projects. These are often accompanied scientifically. This is where Vienna's municipal enterprises see themselves as enablers. They actively drive projects in these areas (especially in the fields of energy and mobility).

The inclusion of research institutions enabled transdisciplinary consortia to acquire funding and test Smart City projects.

Access to digital solutions is always demand-driven. Once the city's needs are defined, innovative solutions are sought (IP2).

(4) Evalaution, Monitoring and Further development (in Vienna from 2016 – today)

According to the interviewees, a monitoring system at the process level is a prerequisite for identifying and resolving conflicting goals. It should also serve the learning of the organisation, according to one of the process staff members.

The impact monitoring process from 2017 was itself internally evaluated. This shows a strong will to improve also at the process level.

The further development in 2019 was expanded with experiences from practice and lessons learnt from the departments. These had time to test themselves on the topics or grow into them over the years following the decision by the Council in 2014.

Further awareness was created through monitoring

The learning and developing aspect is not only emphasised by the interview partners. They can also be found in the documents, for example in the form of learning from cities such as Copenhagen, Berlin, Paris, Amsterdam or Stockholm, as contained in the revised framework report (Magistrat der Stadt Wien, 2019, S. 45).

6 DISCUSSION – TRANSFER AND FURTHER DEVELOPMENT

The innovation biography proved to be a good descriptive method to depict and analyse networks and cooperation relationships and connections, as well as knowledge relationships within the innovation process towards the Smart City.

The biographical retrospective method also shows interesting insights with regard to the derivation of successful governance. Similar to a process analysis, it reveals process components and thus serves to address them. The use of the open interview method also allows for a high level of detail. In this way, we were able to link the Smart City Vienna process with a model for governing sustainability. It is therefore possible to manage sustainability through the Smart City concept. In the initially top-down process of strategy development in Vienna, participation is very much in evidence, but less by a broad public than by selected representatives. Participation processes of rather abstract strategies are more difficult to implement than concrete implementation plans in which local citizens can be involved (Steurer & Trattnigg, 2010, p. 167). In the 2019 revision process, the stakeholders of the Vienna Smart City framework strategy have now set out to establish participation as an important action programme (Magistrat der Stadt Wien, 2019, p. 126). After all, participation processes are an important principle of good governance in Europe (Steurer & Trattnigg, 2010, p. 125).

With the interviews and some of the documents, their intentions must of course be taken into account. As the interviewees have been involved in the Vienna Smart City process for at least ten years, it can be assumed that they are experts in this field. You could tell how experienced they are at telling the story of Vienna`s Smart City. The statements from the 16 interviews did not contradict each other in any point. This is astonishing and speaks for the validity of the statements.

The documents are part of the marketing of Vienna. They do not reveal the underlying difficulties or hurdles in the process, but describe the success story of Smart City Vienna. Cross-checking the transcripts of the interviews reveals important procedural factors and the importance of continuity and coherence. The teams have been working together in almost the same constellation for years, and unanimously enjoy doing so. These factors have played an important role in Vienna's process, but are also strongly anchored in Viennese culture. In addition, there are personality traits of the driving actors that were repeatedly mentioned in the interviews and are not transferable (cf. Schumpeter's pioneer).

However, procedural factors are very much transferable, such as the knowledge that in complex processes the selection of the actors involved is decisive and that people are more inclined to drop out of processes when complexity is too high. Also a high political committment in Vienna has been one of the most decisive criteria in the creation of a Smart City, as well as the integration into the individual departments. The same applies to the creation of a strategy and learning from other good examples. In the interviews, it was repeatedly emphasised that Vienna also looks at good projects and programmes in other cities, not to transfer them one-to-one, but to translate them into their city, to modify them or to generate new ideas with them. The relevance of creating a strategy has also been visible in Vienna and, according to other studies, is a decisive factor for the success or non-success of a Smart City. Thus, short-term ad hoc solutions or quickly manufactured compromises are not in the spirit of a strategic, i.e. long-term plan. Furthermore, the continuity of the actors (not only in the steering group) proved to be very successful. The same applies to the high level of political commitment. The interviewees all agreed that without this it would simply have been impossible to set up such a process in Vienna. The support of the municipal administration as a whole was equally instrumental. The process in Vienna has been a successful top-down model, which might not work for other cities. It may make sense to consider and compare an innovation biography of a bottum-up process alongside it. This "urban development from below", with sustainable design approaches in the context of urban gardening initiatives and repair cafes, i.e. interactionist urban development, also has its place in Vienna. The top-down approach of a framework strategy seems to offer enough space for this. As long as the Smart City is not (only) technology-centred, there is enough room for people to shape the city - by the administration for the big picture and by civil society for active action on the ground. Nevertheless, the question of who took the initiative for the respective Smart City is very relevant, given that companies can also design a Smart City (see Toyota Woven City in Japan).

What can certainly also be considered a success factor is the open learning culture that the process has shown. The interviewees talked about wanting to learn more about how Smart City works but also to share their knowledge. Although this is a normative aspect, it has been mentioned repeatedly: interdisciplinary cooperation. What is taken for granted in the management of successful companies, cities still have to conquer for themselves: "Innovation teams are always interdisciplinary" (Jaworski & Zurlino 2009, p. 61, own translation). Within the interviews it became clear that in Vienna this is still challenging but also crucial in the Smart City process. Especially in the initial phases of an (innovation) process, it is important to have different disciplines involved. According to the interviews, this was also very enriching in the Vienna Smart City process. The diverse disciplines generate different perspectives and ensure that the users and customers can also use the products and services (ibid., pp. 61-64). These products and services have been developed as a part of, or are related to, the Smart City framework strategy of Vienna.

Innovation is one of the foundations of Smart City Vienna, as evidenced by numerous projects, reallabs and the innovation interest of the stakeholders involved. "Innovation culture means "[...] norms, values and attitudes [...] that shape the behaviour of the people involved in innovation" (Jaworski & Zurlino 2009, p. 24, own translation). However, this innovation culture cannot be copied (ibid., p. 7). The same applies to local conditions, which influence the innovation capabilities of cities. The respondents are well aware of this. Vienna, for example, has good geopolitical and economic conditions for interdisciplinary and transdisciplinary cooperation as well as for the social dimensions of urban development.

The Smart City process in Vienna also shows that becoming a Smart City takes time (10 years in Vienna so far) and that the processes for joint cooperation are long and often laborious. In the interviews it became clear that it takes not only competence but also passion on the part of the participating actors to shape a Smart City. The actors of the Smart City Vienna need more interfaces in governance in order to further integrate the silo logic of the individual departments. However, this function requires a high degree of social competence as well as content-related and technical qualifications.

7 CONCLUSION AND NEED FOR FURTHER RESEARCH

Our document analysis was tasked with contextualising what was described in the interviews. It was therefore a matter of comparing the content. What this study could not do, since it is not part of the research design, is to evaluate the texts and documents on a linguistic basis. Also with regard to the narrative interviews, this supplementary method could certainly generate exciting further results, especially with regard to the scripts and narrative being so important for urban planning (van Hulst, 2012). Without going deeper into the research, it is immediately noticeable that Vienna has a good communication strategy - in general and in particular with regard to its Smart City as a way of sustainable urban design. Here we recommend further research at the interface of urban planning, urban research and linguistics. In this way, more profound statements could be made on the question of what role positive narratives have in urban planning and for urban planning (see e.g. van Hulst, 2012). "[…] [P]lanners should tell future-orientated stories, that help people imagine and create sustainable places." (Throgmorton, 2003, p. 125). There are already interesting approaches to this, e.g. "From the garden City to the Smart City" (Gurr, 2021).

This study is a case analysis. It helps to reveal the process towards a Smart City, to get a look behind the scenes and to derive success factors. It shows very clearly the complexity of this single case, the interrelationships and the background. By extending the method to other cities, such an ideal case can be placed in a larger context and compared. Also, the comparison of identified process factors from the Vienna Smart City to a Smart City that has not (so far) delivered the desired success would possibly validate these governance criteria again. Possibly, greater resistance, more conflicts or lack of cooperation within the cities towards a Smart City would also complicate the procedure of the analysis with the method of innovation biography. And of course, the structuring of the Viennese process on the basis of Steurer's governance model is an ideal-typical one and always falls short of a simple transfer. For a city to turn around and become the city it wants to be is a long, iterative and, above all, learning process. Nevertheless, the ideal-typical process from Steurer's model and the biography of the Smart City Vienna give confidence for a possible governance of sustainability via a Smart City. Vienna shows that the Smart City is more than a purely technical innovation. It is a concept, an idea, a political control model and contains more than technical prerequisites. "There is no blueprint for the perfect Smart City, so cities should not be afraid to encourage entrepreneurs to try new solutions. Innovation labs as well as technical and financial support will help." (Roland Berger, 2020, p. 16). We need sustainability strategies for the cities, that show the way to a $CO2$-neutral, resilient and climate-adapted city and see digitalisation as one part of the solution, not as a panacea. Vienna`s Smart City framework strategy shows that such an understanding of sustainable Smart City is possible.

The connection to a sustainability governance model (Steurer in this case) is only a beginning in the governance framework of Smart City. Further research is needed to explore these processes further. Knowing that a strategy is an important success factor for a Smart City is helpful, but knowing how to develop and implement such a strategy needs to be further investigated. The investigation of procedural factors in Vienna has shown that sustainable development can very much be advanced politically and administratively, also through the Smart City. Which form of governance is the right one for this can be another exciting field of investigation. Vienna shows strong tendencies towards mutual learning across disciplines as well as integrated knowledge production and interactive negotiations, i.e. the concept of collaboration, which correspond to the strategies of reflexive governance (Steurer & Trattnigg, 2010, pp. 250-251). "Sustainability is perhaps the quintessential terrain of reflexive governance." (Meadowcroft & Steurer, 2018, p. 7). Here, further research on links to the Smart City as a governance model of sustainable development can certainly be very informative.

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reviewed paper

Synthetic and Tangible Agents for an Activity-based Urban Planning Tool

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1 ABSTRACT

AI is on the rise. Powerful cloud platforms and networked software components can perform increasingly complex data evaluations and simulations. Recent research and development projects[1] show how great the potential of artificial intelligence is for urban planning. However, despite the impressive, technical possibilities, it currently remains unclear how planning stakeholders and the affected population can be meaningfully involved in the intelligent processes of the "black box". The authors are of the opinion that sustainable urban development planning not only requires acceptance of the spatial planning result, as has been the case up to now, but also requires acceptance of the increasingly digitally supported planning process. For this reason, it must also be possible for laypersons to understand the digital analysis and evaluation processes and to comprehend their relevance and spatial interactions. Consequently, simulations must not only run in the computers of the respective planning or engineering offices, but require a simple, haptic analog translation that can also be used in participation processes as already shown in the CityScope projects[2].

For this project, the big revitalization project of Deutzer Hafen in Cologne to a future district with more than 9.500 daily users is used as a case study in building a decision support system for urban planning. It is composed of three parts: an agent-based model, a tangible user interface and a synthetic population. The project enables users to get in touch with an agent-based model (ABM) without any knowledge in coding or even interacting with computers. It connects physical objects to digital information. Based on the theories of Castiglione et.al.[3] , Gehl[4] , Shannon[5] and Jacobs[6] this project shows how to use an artificial and analog simulation model to measure the urban vitality of the public spaces in the district, based on the activity and travelling patterns of the population. This is done by testing different scenarios in which we change interactive parameters of the model: the use of the buildings and the demographics of the population. We can then determine which scenarios benefit the most life in the public spaces of the district, by finding areas of interest or problematic ones.

Keywords: Smart Cities, Agent-based modelling, KI/AI, Participation, Tangible Data

2 INTRODUCTION

The revitalization project of Deutzer Hafen aims to transform the old industrial harbor district of Cologne into a new, vibrant neighborhood. Designed by the danish architecture firm COBE[7], the project was chosen in a competition organized by the city in 2016. The mixed-use buildings are supposed to house 5.000 people and serve as workspace for another 4.500.

We use the future district as case study for a decision support system for urban planning, that is composed of three parts: an agent-based model (a), a synthetic population (b) and a tangible user interface (c).

a.) As the district Deutzer Hafen is not build yet and not even populated by now, this project takes simulation methods to help in order to describe future possible conditions. Therefore agent-based-models give a particularly good setup, because this technology is able to simulate multiple different scenarios of spatio-temporal relations. Agent-based models (ABMs) are used in multiple fields to simulate complex systems through a set of independent agents that follow certain rules and react on an environment. In urban planning,

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[1] PLANERIN 1/2019: Künstliche Intelligenz: Die Transformation gestalten, SRL - Vereinigung für Stadt-, Regional- und Landesplanung e.V.
[2] https://www.media.mit.edu/projects/cityscope/overview/
[3] Gehl, J., Life Between Buildings: Using Public Space, 2012
[4] Castiglione, J. et al.: Activity-BasedTravel Demand Models: A Primer, 2014
[5] Shannon C.E.; A mathematical theory of communication; SIGMOBILE Mob Comput Commun; 2001
[6] JACOBS, J. The life and death of great American cities. New York, 1961.
[7] https://www.cobe.dk/idea/deutzer-hafen

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activity-based travel demand models (ABTDM) are used to estimate the demand for travel in a region and the resulting performance of the transportation system, according to different scenarios and policy, economic, demographic or land use changes, as i.e., defined by Castiglione et. al in “Activity-Based Travel Demand Models: A Primer”. They also define the focus of these models as “whether, when, and where to participate in activities and for how long. Travel is a derived demand resulting from the need for people to engage in activities outside the home”[8]. This need for traveling and engaging in activities has also been connected to quality of urban spaces. In “Life Between Buildings”, Gehl describes that in public spaces of poor quality, people only pass by on the way to necessary activities that they must do, like going to work or shopping. On the other hand, if the public space is of good quality, people start engaging in more optional activities, such as taking a walk or sitting on a bench. People attract more people, and so social activities, that result from the presence of others, such as just watching people passing by, also arise[9]. Jacobs, in “The Death and Life of Great American Cities”, connects urban vitality to diversity in the built environment. Successful street life is described by her as “An intricate sidewalk ballet”[10] where a diversity of people, with different purposes and during different times of the day pass by.

b.) Based on these theories, we aim to use an ABTDM to measure the urban vitality of public spaces in the district, based on the activity and traveling patterns of the future population. To simulate the activity and traveling patterns, the model needs a *synthetic* population, which is a virtual representation of the community of the modeled area. Commonly this population is built by combining census data and travel or time use survey data. But this leads often to problems, because the data may not always be up to date, because of the amount of time and resources taken to make appropriate surveys. To bypass this an experimentation with a new approach is made: building a synthetic population based on metadata of social media. The present constant flow of user generated content is mostly coming from location based social networks (LBSN), where people share where they are when and what they are doing. Mining this data makes it possible to produce a sort of digital census, that is cheaper and fresher than traditional surveys. According to this project social media posts inside the city of Cologne were collected from Twitter and Instagram. The used profiles are kept anonymous and have their activity patterns inferred, resulting in a population that reflects a sample of the city. These profiles are then used to populate the model. The model will enable more innovative and broader user participation in urban planning.

c.) The interaction with the model is done through a tangible user interface (TUI), that connects the digital information of the ABTDM with a physical model of the district. The TUI makes interaction with the complex system more feasible and intuitive. The participation in the design process gets much easier and includes all stakeholders, not only the specialists. In a game-like experience, the user can change the use of buildings in the model by moving tags around or adjust the demographics of the population with a slider. Visual statistics give immediate feedback to the user’s actions, making complex relationships become clearer.

3 RELATED WORK

As shown in the CityScope Projects of the City Science Group (CSG) at the Media Lab/Massachusettes Institute of Technology (MIT), a tangible user interface (TUI) can increase the purpose of a rapid prototyping urban design tool. The CityScope model has been used in several cities and projects to simulate scenarios with the participation of all stakeholders involved. With its open-source approach, the CSG tries to encourage people to use CityScope as a platform and also develop it further, in order to keep this network growing. One particular project worth mentioning is Finding Places[11], developed by the City Science Lab at Hafencity University Hamburg, a sister lab of the MIT CSG. The project aimed to help finding locations for accommodating the enormous number of refugees that were coming to Germany in 2015. The CityScope table with its TUI always serves as a hub for participation. The content that is shown, varies depending on the projects from daylight analysis[12] to complex agent-based models[13].

[8] Castiglione, J. et al.: Activity-BasedTravel Demand Models: A Primer, 2014; page 76
[9] Gehl, J., Life Between Buildings: Using Public Space, 2012; page 11
[10] JACOBS, J. The life and death of great American cities. New York, 1961.
[11] Noyman, A. et al.: Finding Places: HCI Platform for Public Participation in Refugees’ Accommodation Process.
[12] Cody M., R.: Towards interactive sustainable neighborhood design: combining a tangible user interface with real time building simulations.

The tangible user interface used in this project builds up on the technology developed by the MIT for the earlier stages of the CityScope table, which is available as opensource on Github[14]. For the building process of our table, the focus was on easy fabrication with commonly in FabLabs available digital fabrication tools.

Our modified table is connected to an activity-based travel demand model based on a synthetic population. For this model, the Urban Vitality benchmark was introduced, as a way of measuring and predicting street life. This Benchmark goes back to Jacob's theories of Urban Vitality through diversity.

4 METHODOLOGY

4.1 Synthetic

The synthetic population is created following a series of steps described in the upcoming sub-sections. The steps range from data collection and preparation to geolocated points classification over pattern mining and finally user profiling and classification.

4.1.1 Data Collection and Preparation

The data collection and preparation was segmented into three steps, with the goal of finding users that could be profiled for the population.

First collection: between May 27 and August 09, 2020, 31.817 posts were collected from Twitter and Instagram, using the Tweepy[15] and Instaloader[16] Python libraries. Tweets were filtered by a bounding box around the city of Cologne and Instagram posts by hashtags with the city name.

Filtering users: First, all posts without coordinates or with coordinates outside of Cologne are discarded. Posts are then grouped by authors and every user that posted from less than two different locations is deleted. This step already discards a good number of bots or business profiles. Twitter has a self-proclaimed location field for each user's profile, so all users with a location different from Cologne are discarded. Both Twitter and Instagram have a description text field for each profile, which businesses usually use to describe their activities. A list of business key words is used to try and filter these profiles. Instagram also has an extra "is business account" tag, so those with "true" values are also discarded. After this filtering process, 163 unique users remain.

Collecting users' timelines: In the next step, all posts from each of the users' profiles are collected, to determine their individual mobility patterns. Some profiles could not be found, likely because they were deleted by the users in between the data collection period. In total, 115.967 posts from 122 users were collected. After going through the same filtering process of deleting posts without coordinates and outside of Cologne, the total amount of posts goes down to 9.305, as seen in Table 1.

Step	First collection	Posts Geo-tagged	Posts Inside Cologne	Users	Filtered Users	Found users	Timeline Posts	After Filtering
Twitter	21.117	1.010 (4,78%)	817	241	63		103.835	6.637
Instagram	10.700	6.642 (62%)	4.628	2.642	100		12.132	2.668
Total	31.817	7.652	5.445	2.883	163	122	115.967	9.305

Table 1: Overview of collected data from social media.

4.1.2 Geolocated Points Classification and Pattern Mining

For the agent-based model, each agent must have an activity table for the day, so all the geolocated points from each user's posts are categorized in activities, which is done in three steps:

Clustering of spatially redundant points: the points are clustered to filter out points that represent the same place, but with slightly different coordinates values. We use Python and its scikit-learn implementation of the DBSCAN density-based clustering, as done by Boeing[17]. A function from Boeing's paper is used to calculate

[13] Grignard, A. et al.: The Impact of New Mobility Modes on a City: A Generic Approach Using ABM.
[14] https://github.com/CityScope
[15] https://www.tweepy.org/
[16] https://instaloader.github.io/
[17] Boeing G., Clustering to Reduce Spatial Data Set Size.

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the coordinates of the cluster's centroid and find the member of the cluster closest to it, that will be categorized.

Reverse geocoding and tagging: To classify the points into one of the activity categories, an approach similar to the one from Swier et al.[18] is followed. We use the Overpass API[19] to return information from OpenStreetMaps[20]. The around filter finds all elements within a radius around the input coordinates. The elements returned by the API are tagged with numerous keys and values, describing their location or use. To fit each point in one of our categories, a dictionary with tags separated by categories is used. For points that return multiple elements, with multiple tags, the category is defined as the one in where most of the tags fit. This "location-based" method of classification of the posts only through their coordinates was chosen over "content-based" methods, because, as observed by Rout et al.[21], when someone writes about an event, they might just be talking about it and not necessarily be there.

Defining home and work location: Home and work location can be determined by finding the locations from where the user generates more content, like shown by Cui et al.[22]. The home location is defined as the most repeated point in the "WOHNEN" category. As mentioned by Swier et al., "this is a bold assumption" that might not always be right but "seems reasonable" [p. 28]. The work or study location is defined as the user's most repeated point, that is different from the home point and belongs to any category other as "WOHNEN", "FREIZEIT" or "KULTUR".

Pattern mining: Before deriving each user's mobility pattern, it is necessary to filter those that have enough information to do so, meaning a minimum number and variety of activities. To define these requirements, we look into two main references. Gehl simplifies outdoor activities in public spaces in three categories: necessary, optional and social activities [Ibid., p. 9]. Castiglione et al. present, on the other hand, four general categories in which activities are grouped for models: mandatory, maintenance, discretionary and at-home [Ibid., p. 79]. Similar with Gehl's categories, they are also influenced by their priority in the daily activity pattern schedule. It is defined then that to be considered a valid activity schedule, each user must have at least three necessary activities (one mandatory, one of maintenance and one at-home) and one optional/discretionary activity. From the total of 122 users, 83 ended up being profiled. For each user two tables with 24 slots corresponding to each hour of the day are created, one for weekdays and one for weekends. Every geolocated point is appended to the slot corresponding to the time when the person posted from that location, in the appropriate table depending if the post was created on a weekday or weekend. The plot in Fig. 1 of the most repeated activity for each hour shows potential in using geolocated social media posts to infer activity patterns. We can see that, on weekdays, ARBEIT occurs consistently during working hours. SCHULE has a peak in the morning and another one after lunch, probably reflecting the time when kids go first to school in the morning and then the time they come back from lunch. GASTRO has also peaks during lunch and dinner hours. And ZUHAUSE appears as the major activity during the whole day, which might be reflective of the period when the data was collected, during the COVID-19 pandemic, when a great part of the population was quarantining in compliance to the social distancing rules and because most commercial places were closed.

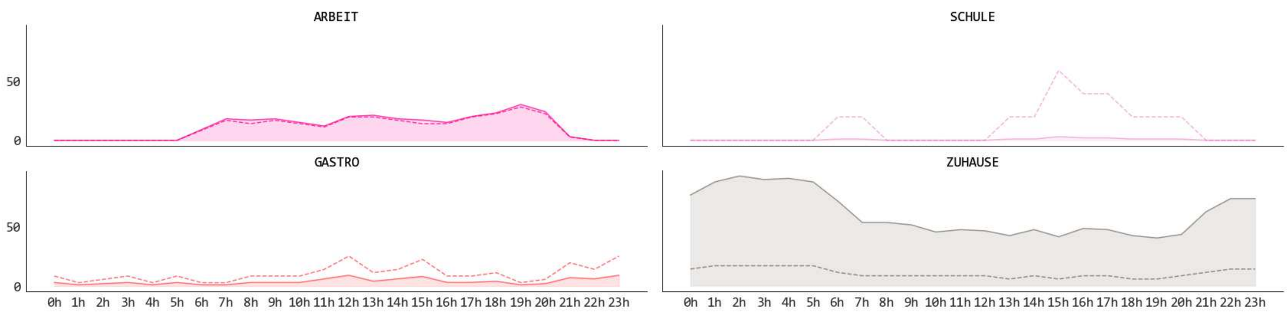

Figure 1: Activity frequency on weekdays. - (% total of all activities) - - (% total of each activity)

[18] Swier N, Komarniczky B, Clapperton B (2015) Using geolocated Twitter traces to infer residence and mobility
[19] http://overpass-api.de/
[20] https://www.openstreetmap.org
[21] Rout, D. et al. Where's @wally? A Classification Approach to Geolocating Users Based on their Social Ties.
[22] Cui, Y. et al. Social Media and Mobility Landscape: Uncovering Spatial Patterns of Urban Human Mobility with Multi Source Data.

These tables represent a fraction of a typical weekday and weekend for each user, but of course, they are not complete since it is impossible for even very active users to collect posts for every hour of the day. Additional to gaps in the timetable with no activities, some anomalies could also be observed, such as particular activities happening in unlikely hours, like GESUNDHEIT at 1:00 am or NACHTL in the middle of the day. These seemingly mistakes are probably related to the reverse geotagging done with OSM, that could sometimes retrieve wrong activity tags for the buildings. The anomalies are deleted, and gaps are filled with activities in the close slots.

4.1.3 User Profiling and Classification

Besides the activity table, the synthetic population needs at least two other characteristics to simulate travel patterns in the model, which are type of person and type of vehicle owned. In our model the population is divided in six different types of people, adapted from CityScope [Ibid.]. These are Student, Young professional, Executives, Mid-career workers and home maker. Types of vehicles are none, bike and car.

Similar to existing approaches[23] a Bayesian Network model is used to predict these missing characteristics. A Bayesian Network is a "Probabilistic Graphical Model (PGM) that represents conditional dependencies between random variables through a Directed Acyclic Graph (DAG)"[24]. These dependencies can be defined initially or can also be learned from data. In our case, we want to find out what is the relationship between activity table, type and vehicle ownership, so we train the model with a time use survey dataset from IPUMS[25] that contains more than 15.428 time use diaries with all three variables present. The model is built in Python with the pomegranate library[26]. To avoid bias in the training dataset, we use an equal number of types of people and an even distribution of vehicle types per type of people in the dataset.

As seen in the structure of the learned graph model in Fig. 2, type is influenced by the amount of time people spend at school and at work, which on the other hand is influenced by the amount of time one spends at home. Vehicle is influenced by school, because the students are the ones that tend to have more bikes. Leisure activities, on the other hand, are independent of the other variables, which could make sense, considering that all types of people have some type of leisure activity.

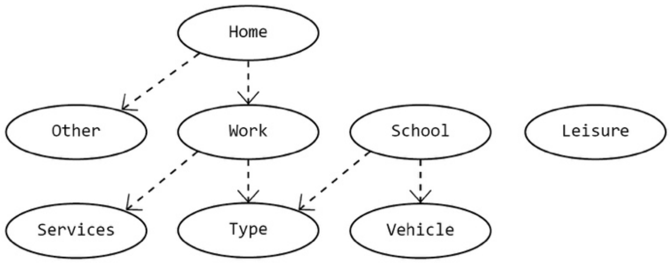

Figure 2: Network structure of trained model.

The model predicts that our users are divided in the following groups: 9 Students, 12 Young professionals, 23 Home makers, 20 Mid-career workers and 19 Executives. But the vehicle ownership prediction did not work as expected, with only students having bikes and all the other types having cars. That might be because the size of the profiles samples is too small to make a realistic prediction for each type of person. For this reason, we decide to attribute vehicles to each person inside the agent-based model, as explained in 4.4.2.

The sample reconstruction, which is the final step of creating the synthetic population, is also done inside the agent-based model. It consists in drawing samples of people profiles until the distribution matches the desired demographics. Since this will be an interactive parameter, that can be adjusted to visualize different scenarios, the sample reconstruction is made alongside with the running of the model, as necessary.

[23]https://medium.com/sidewalk-talk/a-first-step-toward-creating-a-digital-planning-laboratory-is-populating-it-beeb87d485f1
[24] https://towardsdatascience.com/introduction-to-bayesian-belief-networks-c012e3f59f1b
[25] Fisher et al., Multinational Time Use Study Extract System: Version 1.3 [dataset].
[26] https://github.com/jmschrei/pomegranate

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4.2 Tangible

The tangible user interface spans the bridge between digital and analogue world. From a technical point of view, the TUI is based on a pipeline that detects physical change of a model, translates it to a digital equivalent that triggers an action and connects the resulting digital information back to the physical object. The objective is to mirror the physical model into a digital twin, that updates almost in real time.

4.2.1 Hardware

Instead of Lego bricks as done by CityScope, the model was built from plywood and 3d printed, custom made components. These materials were easily approachable, and fabrication was possible in the local FabLab. The hardware consists of three main layers, as visualised also in Fig. 3:

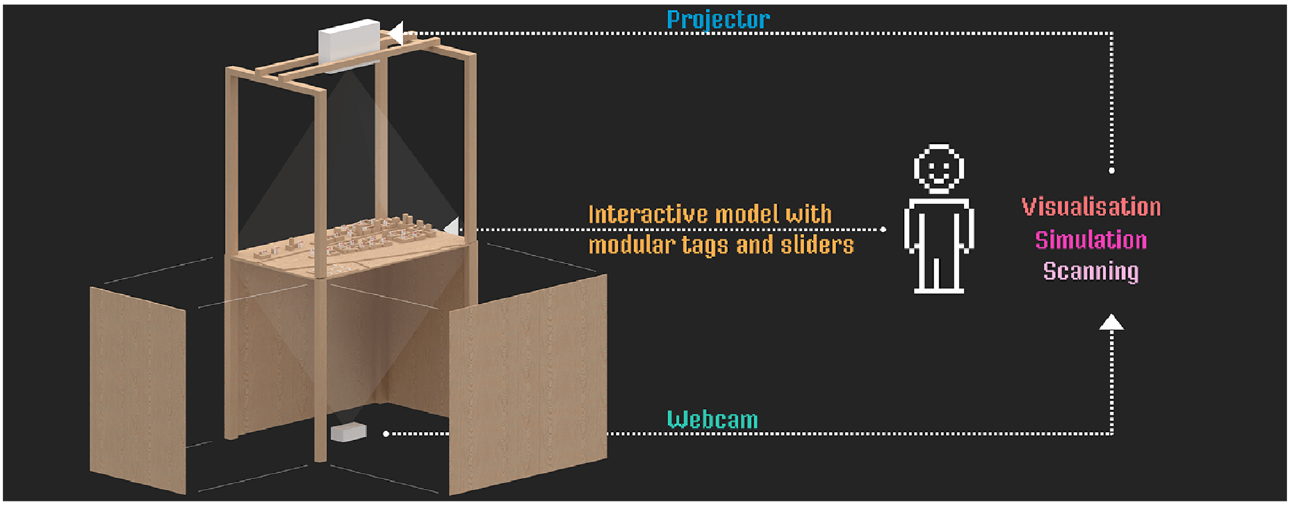

Fig. 3: Interface overview

On top, the projector that visualises the simulation on top of the model and gives near real time feedback to the user's action. Another projector gives more detailed, complex information and statistics of the simulation.

In the middle, the 1:1000 representation with its tags and sliders serves as interface for the user. The way of interaction is explained more in detail in 4.3.3.

On the bottom, two webcams capture a real time picture from the downside of the model and stream the current model configuration to the computer. The final setup is visible also in Fig. 5.

4.2.2 Software

This process can be divided in two parts and was developed in Grasshopper, a visual programming interface for the 3d modelling software Rhinoceros[27]:

The scanning process, a basic computer vision framework. This is an adoption of the script shared by Cityscope on Github. During this process, the incoming picture from the webcams is translated into digital information about the current table configuration. The special challenge here was, that unlike the CityScope model, this model is not based on a regular grid, where one tangible element comes after the other, always with the same distance. And in addition, it was necessary to use very small elements that are able to represent the specific city scale.

The data exchange. After successfully reading the webcam picture, the information has to be sent to GAMA[28], the programming environment used for the simulation. For this, the Google Firebase realtime database was used. After organizing the data in Grasshopper in a JSON format (JavaScript Object Notation) it can be streamed to the database. From GAMA, it is possible to directly access that database and deconstruct the JSON file.

[27] https://www.rhino3d.com/de/
[28] https://gama-platform.github.io/

4.2.3 Interaction

After connecting hard- and software and enabling the bridge to the simulation in GAMA, the final setup, as seen in Fig. 5 is ready and interaction with the model is possible. There are two ways of interacting with the simulation:

Through so called tags (on the left in Fig. 4). Each building of the model has two of these tags, representing lower and upper-level use of the building. Through these tags, the use of the building can be changed.

Through so called sliders (on the right in Fig. 4). The model also has five sliders integrated. Through those, different parameters such as demographics of the district or simulation speed, can be changed.

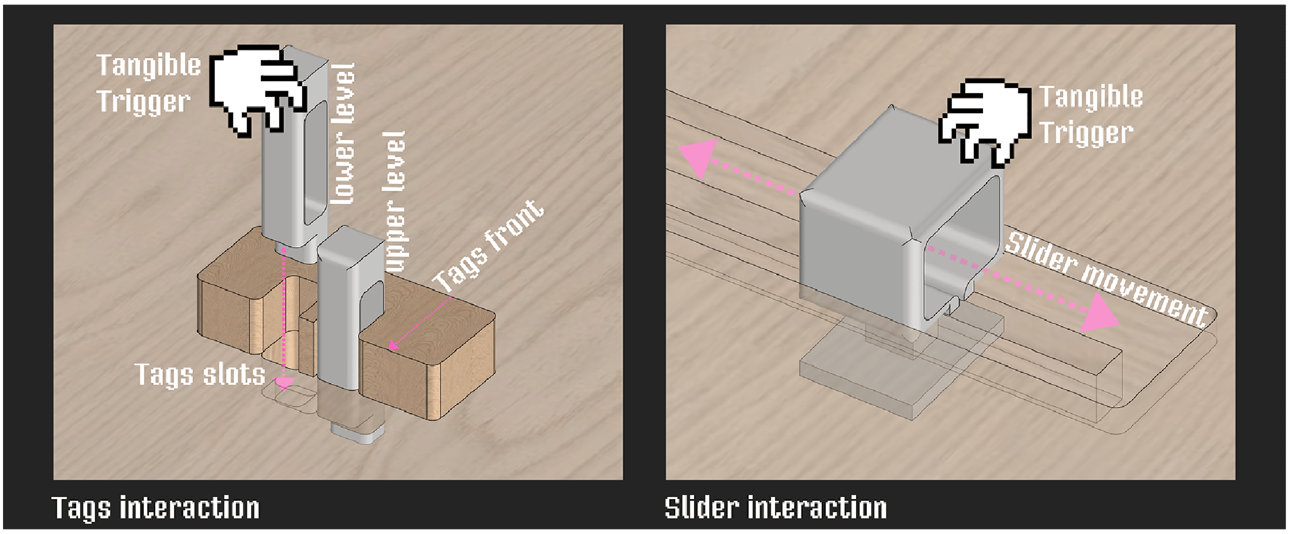

Fig. 4 Ways of interaction with the model

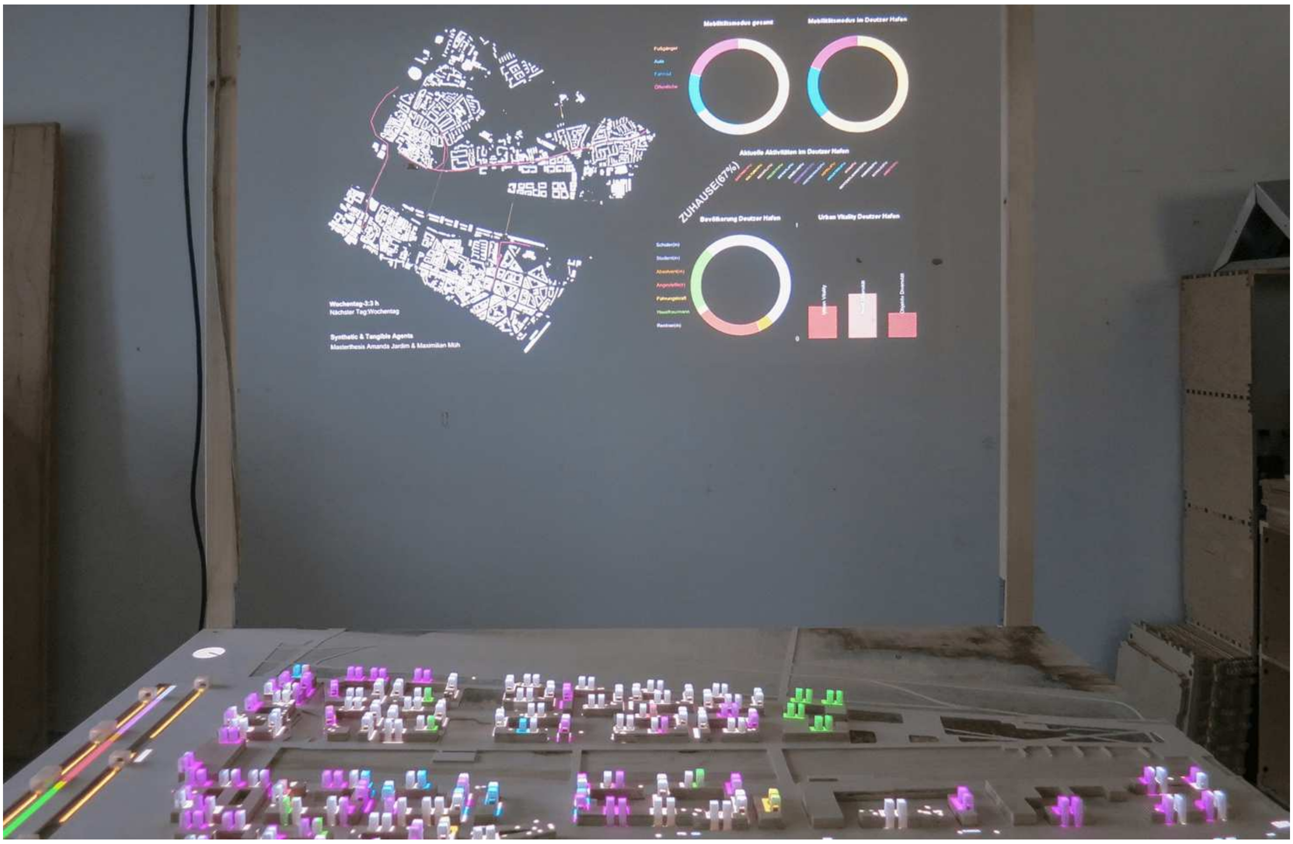

Fig. 5: Final setup with projection on top of the model and second screen projection with extra information in the back

4.3 Agents

GAMA is an open-source project, available and well documented on Github. Along with the available examples from CityScope on Github, this helped in developing the here described model.

4.3.1 Environment

Before building the actual Agent Based Model, the environment and the agents to populate, must be defined, and built. The environment is centred on the Deutzer Hafen district and includes the surrounding city in a radius of 1,3 km around it. The necessary data such as buildings and their use, streets, nature, but also population and households, was collected from OSM (Open Street Maps) and combined with demographics data from Offene Daten Köln[29], an open-source data initiative from the city of cologne.

4.3.2 Agent: People

The agents in the model take on the role of the future residents of Deutzer Hafen and the residents of the surrounding districts. To optimize the simulation speed, a percentage of 8% is used to populate the district and the surrounding area, otherwise it would be impossible to run the model with our resources. Through optimizing the code, this percentage should be increased in the future. As mentioned by Castiglione et al., it may not be necessary to run the full-scale model, in order to get representative results, though.

People attributes such as type and activity table are imported for each agent from the CSV files with the profiles created before in 4.1. Other attributes such as living or working place are defined in the model. The distribution of different profiles relates to the demographics gathered in 4.4.1. While this is fixed for all people agents living in the surrounding city, the demographics in the Deutzer Hafen district are changeable. The people agents get vehicles (car and/or bike) assigned according to statistics from the German Ministry of Transport[30].

During the simulation, the people agents follow their individual activity table. While the positions for living and working are fixed, the headed locations for other activities such as shopping, etc. get defined by special distance and proximity. Depending on the agent's profile, its assigned vehicles and the distance to the next activity, the people agents choose the mode of transportation and plan their next trip, with a maximum of four different modes available (walking, public transport, bike, car).

4.3.3 Agent: Public transport

The public transport network of Cologne was also integrated in the simulation, using the data collected in 4.4.1. A number *n* of vehicles is created at the beginning of the simulation, each one in a different stop, so there is an interval in between them. The vehicles move from stop to stop according to their schedule and embark and disembark people. When a people agent chooses public transport as mode for a trip, they find the next stop and walk until there. They also find the stop closest to their target location and save that information. When the vehicle arrives at the stop where the people agent is waiting, the people agent 'embarks' on the vehicle and is added to the list of people who will disembark at their target stop. As soon as the vehicle arrives at the target stop of that people agent, they 'disembark' and walk the rest of the way until their target building. This agent is of course a simplification of the public transport available in the district and represents only the tram.

4.3.4 Agent: Building

Using the data that was collected in 4.4.1, the buildings are generated in GAMA. These building agents then carry information such as building use, available living space and number of residents. This information is then accessible for the people agents, which interact with the buildings.

4.3.5 Agent: Urban Vitality cell

Jane Jacobs defines urban vitality as an essential factor in terms of street life [Ibid.]. As part of this project, an urban vitality benchmark is implemented as a high resolution, real time heat map. This benchmark should be based on the diversity of people currently moving, their current objective, and the pedestrian flow related to time. Desired is a diverse, continuous pedestrian flow with little peaks or valleys in public places.

As mentioned, Jacobs defines three main drivers for street life: (a) diversity of people (b) different purposes and (c) during different times of the day [Ibid.]. This can be interpreted as diversity of agent profile, agent objective diversity and diversity in time.

[29] https://www.offenedaten-koeln.de/
[30] https://www.bmvi.de/SharedDocs/DE/Artikel/G/mobilitaet-in-deutschland.html

Diversity itself is a measurable value and can be calculated using the Shannon entropy Index H_S (Equation 1). This index was introduced by Shannon as part of his paper "A mathematical theory of communication"[31]. H_S describes the variety of different species in a dataset, considering the number of different species *(i)* and the number of individuals from each species *(n)*. *N* is defined as the total number of individuals in the dataset.

$$H_S = -\sum_{i}^{s} p_i * \log p_i \text{ } where \text{ } p_i = \frac{n_i}{N}$$

Equation 1 Shannon entropy index

Commonly used in ecology to describe the diversity of species, it is also applied to describe diversity in an urban context as done by Cerrone et al.[32] or the diversity of people in cities[33].

The grid cells with a resolution of 50 x 50 m evaluates the urban vitality of this space in real time and gives a visual feedback. Therefore, every round of the simulation, the people agents that overlap the cell, give two information values to the cell: profile and current objective. Along with those two, the current time stamp is saved. H_S is then used to calculate the diversity of each of those three values. Since we always know the number of different species (*i* in Equation *1*) we can calculate the maximum H_S and from that the amount of diversity that is reached depending on that maximum. The result is a value between 0 and 1. Combining diversity of profiles, current objectives and time stamps, the urban vitality of each cell is calculated in real time. The current value is then translated in colours which indicate the quality of the public space as a heat map on the model. Black stands for no vitality, values in the red area indicate a bad vitality with little diversity and blue is rpresenting high urban vitality (see Fig.6).

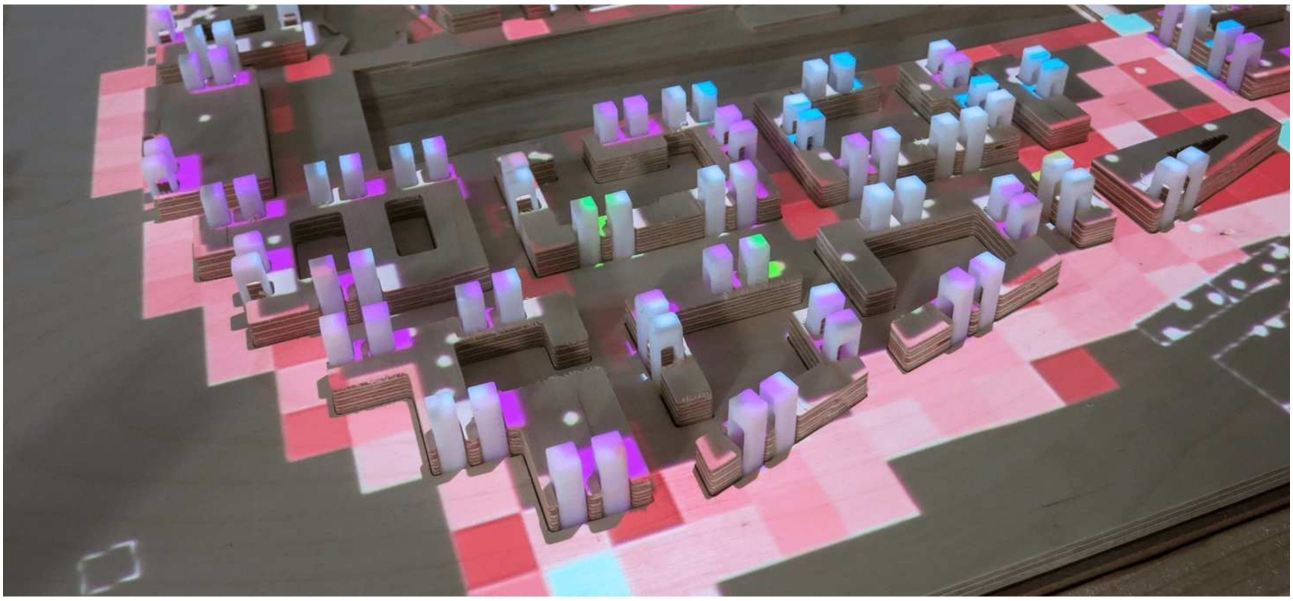

Fig. 6 Urban Vitality Cell projected on the model

5 LIMITATIONS AND FUTURE DEVELOPMENT

Time limitations and limited range of accessed user profiles lead unfortunately to larger gaps in the streamed social media content. In favour of building the profiles for the agent-based model, the social media data had to be enriched to fit the needed purposes for a trouble-free simulation process. Additionally, some technical issues might have affected the accuracy of the obtained profiles. First, gaps and anomalies in the activity table could be solved with a bigger volume of data and using a different service for the reverse geocoding,

[31] SHANNON, C.E.; A mathematical theory of communication; SIGMOBILE Mob Comput Commun; page 36
[32] Cerrone, D. et al.: Integrative Urbanism: Using Social Media to Map Activity Patterns for Decision-Making Assessment.
[33] Kemeny, T.: Immigrant diversity and economic development in cities: a critical review.

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like the Google Places API[34], or even by building context for the activity from the user's posts with text analysis or image classification. More data, maybe from phone location, would also mean more users profiles, that would make a better sample of the city than the limited number of profiles integrated now.

While using the interface, it became clear that the scanning process used now is heavy in computational power and not precise enough. Therefore, future processes should be written in Python, using a computer vision library such as OpenCV[35]. This is also done now by CityScope in recent projects and could be adopted from the Code available on Github. This could speed the process up and make it more precise. Another way of increasing the speed of interaction but also of the agent-based model would be to change from an online database to a local solution. Especially promising here is the use of UDP (User Datagram Protocol)[36].

For the ABM, a big limitation was computational power. The simulation could run only with 8% of the 70.000 people agents, that inhabit the investigated area. Since GAMA is generally able to run simulations with many agents, this could probably be improved by a further optimizing of the source code. While running the ABM, it also became obvious, that the model is a closed system, meaning the influence of the surrounding investigated area is not considered in any decision. This is especially visible when looking at the mode of transportation, where most of the agents chooses "walking". This is mostly because of the lack of long-distance trips since the radius of the investigated area is 1.3 km only. Introducing households and their members travel relationships would also result in a more realistic model.

6 CONCLUSION

The simulation of different scenarios in the district, by changing parameters of population demographics and building use, resulted in a big impact on the calculated urban vitality of the public spaces. This response of the model not only highlights some obvious assumptions but also shows surprising results in different settings – like how easy it is to lose visitors when removing certain commercial buildings. Many uncertainties remain due to simplifications in the agent-based model and limited data and technical resources. Despite still not have been tested in a bigger group due to the current social distancing rules, the tangible user interface performed well between a small group of real estate and urban planning experts. The model performed easily understandable, intuitive and gave almost immediate feedback to the user while interacting with it. A constructive note was the suggestion to calibrate the simulation by testing it with already existing districts, which should be a next step for further development. Built with a much more affordable set-up than similar tools such as touchscreen tables, it still has the potential of being reused for different projects, just by replacing the tabletop and keeping the rest of the hardware. Also approachable was the concept of the agents in the simulation being based on real people from social media, as noted by a guest who interacted with the table. Such feedback hints at the potential of making citizens feeling recognized in urban design decisions, since social media is so familiar to almost everybody nowadays. Even with the possibility of privacy concerns raising, people tend to feel comfortable in having their data used when they know how, why and for what it will be computed. So, the combination of (blackbox-)simulations with an interactive tangible user interface is a powerful tool in clarifying some of these questions and showing to what individual data could be contributing to. The project was presented as part of the Detmold Conference Week 2020[37] and experts from building industry, real estate management and urban planning gave valuable feedback.

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Telecommunication and Travel Behaviour of Households in the Rural Areas of Nigeria: Substitution, Complementarity or Trip Inducement

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1 ABSTRACT

Several studies have been documented on travel behaviour and mobility patterns. Recently telecommunications have been adopted and implemented to influence and transform behaviour and mobility pattern of commuters. There has also been a major debate on the impact of telecommunications and travel, while some subscribe to the complementing effect of technologies on travel, others believe in the substitution or trip generation effect. Consequently, this study explored the effect of telecommunication on trip making in the rural area of Akure North Local Government Area, Nigeria. Systematic sampling technique was used to survey 4 percent representing 495 household heads of a total 12,365 registered buildings by means of questionnaire administration. However, 339 copies of the questionnaire were retrieved and found usable for analysis. This accounts for 72.9% response rate. The study found 1.36 as average number of respondents' trips while 46.4% of the respondents normally travel by non-motorised means of transport. The Global System of Mobile Communication (GSM) serves as frequent means of telecommunication for 64.3% of the respondents. However, most of the respondents being 92.9% do not use social media platforms of telecommunication. The study further revealed that the complementing effect of telecommunication was significant. The correlation coefficient (R) for the relationship between telecommunication usage and complemented trips equals 0.409 significant at p=0.000. The study concluded that the use of telecommunication go beyond call linkages as there are other purposes served by telecommunication and recommends that telecommunication facilities should be provided and encouraged as an alternative to physical movement by the rural dwellers to avoid the inherent transport problems in the cities and urban centres.

Keywords: Telecommunication, Travel, Travel Behaviour, Households, Rural Areas

2 INTRODUCTION

As society grows in terms of population and functions, people's activities (shopping, recreational, health, religion, among others) being performed by people in space vary, thereby resulting in changes in their travel behaviour. Because of this, it has necessitated the need for interaction among various transport components. Despite the crucial role being performed by transportation, its negativities resulting from externalities pose some threat to the people and the society at large, among which are traffic congestion, poor transportation infrastructure due to over-dependence on the available ones, among others (Bannister, 2002). There is, therefore, the need to generate alternative means of reducing or altering physical movement to reduce some of the transport difficulties encountered by people. One way this can be effective is using telecommunications to serve a substitution or complementarity effect on transportation. Telecommunications and the internet offer a wide range of possibilities for people to conduct activities virtually, without traveling to the activity places.

Telecommunications involves the transportation of electrons over cables or radio waves through the air. These information and communication technologies refer to all those means and methods of transmitting information, ideas, images, and non-tangible messages from one place to another (Ogunsanya, 2005). The major mediums through which telecommunications are facilitated are telephone, internet, radio message, and fax. As a result of this, it is easier for family, friends, and colleagues to interact. Household members might call during a journey to ask for a favor that obliges the traveler to make another trip or prevent the caller from embarking on trips. (Olawole 2013).

The relationships that are possible between telecommunication and physical travel as identified by (Mokhtarian, 1990; Mokhtarian & Salomon, 2002; and Nobis & Lenz, 2009) include substitution, complementarity, inducement, and neutrality. It is now generally recognized that Information and Communication Technologies (ICT) in its several forms may impact activity patterns and travel behaviour, along the lines of the four components of accessibility. This paper adds further weight to such discussions of telecommunication and travel behaviour by focusing on the rural environment of Nigeria, where there has been little research on the influence of telecommunication on travel. With this purview, this study examined the influence of telecommunication on travel behaviour of rural households in Akure North Local Government Area, Nigeria.

3 LITERATURE REVIEW

The relationship between transportation and telecommunication is complex as it involves the constant change of individual behaviour and organizations.

3.1 Telecommunication and Travel

One of the purposes of travel is to exchange information (Salomon,1986); thus, mobile phones or any other telecommunication technology directly impact trip rates, travel behaviour, and the transport system. The literature is replete with studies detailing the impact of telephones on travel behaviour (Moktanan 1991; Hanson 2000; Ogunbodede 2002; Gbadamosi 2004). Specifically, this impact exists in the form of an interactive relationship between transportation and telecommunications. The relationship between telecommunications and transportation has been advanced in the literature in two ways: substitution and complementarity (Oyesiku, 1996). Substitution impact of telecommunications on travel assumes that the more advanced and widespread the telecommunications system becomes, the smaller the travel demand. The second type of interaction is that telecommunications and trip generation complement each other. Complementarity comprises two distinct types of interaction. The first is that one system increases the efficiency of the other. For example, unnecessary trips will be eliminated as better coordination is achieved regarding how, where, and when to make trips.

The second type of complementary interaction is that an increased use of one system causes an increase in the complementing system. According to Gbadamosi (2004), empirical studies have shown that telecommunication (GSM) does not totally substitute human movement involving transportation modes, but it enhances movement. This is in line with an earlier view of Oyesiku (1990) on the impact of the telephone on social trips; the study asserted that the social and cultural background of the people in Nigeria society is such that the physical presence of friends, relatives, and business associates in gatherings is often appreciated. Telecommunication does not merely serves as a means of contact for social and business activities but also, to a large extend, induce face-to-face interpersonal connections, which in the most case involved actual travel. However, opinions still differ as to whether telecommunications generate more trips or curtail them. In an extensive body of published work, Salomon (1985) has argued against the wisdom that telecommunications are a substitute for transportation, as there is much more to be learned about how travels and telecommunications interact. Taking these views together, it is therefore not clear whether telecommunication usage induces, substitutes, complement or have no impact on physical travel in Nigeria; especially the rural areas where people may likely have little or no access to telecommunications facilities.

3.2 Concept of Rural area

The term ‘rural’ is indeed ambiguous. Laah, Abba, Ishaya, and Gana (2013) point out that there is no exact definition of the term. Still, those rural areas are ‘recognizable,’ which implies that the physical attribute of an environment could depict if it’s either rural or urban. The rural area constitutes the space where human settlement and infrastructure occupy only small patches of the landscape, dominated mainly by fields and pastures, woods and forest, water, mountain, and desert. (IFAD 2001) adds to this that rural people usually live in farmsteads or settlements of 5-10,000 persons and point that ‘national distinctions between rural and urban are arbitrary and varied.’

The word “rural” connotes different meanings to different people depending on their background. What is regarded in developed countries as rural may be considered as urban in developing countries. Given certain criteria, rural settlements in Nigeria are regarded as settlements with less than 20,000 people and predominantly engage in primary production (Aderamo & Mogaji 2010). Rural settlements were also described by (Weir and McCabe 2012) as areas with relatively low development densities, typically less than one resident per acre.

Olatunbosun (1975) cited in Omale (2005), a rural area is an area with a population lower than 20,000, occupationally specific, locationally removed from an urban area in terms of services, e.g., water, health, electricity, transport, among others. Measured by the index of demography, Nigeria is 80% rural. Therefore, Anele (2012) hypothetically said; that life in the rural areas is challenging, rustic, and sometimes inhuman. Many rural dwellers are traumatized by poverty, starvation, and diseases. It has been succinctly observed that: there is a realization that a dangerous gap exists in the development levels of both urban and rural areas. This seems to be threatening the political and social stability of the nation. Even though an overwhelming proportion of our national population resides in the rural areas, they are characterized by depressingly meager annual per capita income, pervasive and endemic poverty, manifested by widespread hunger, malnutrition, poor health, general lack of access to formal education, livable housing and various forms of social and political isolation compared to their urban counterparts (Muoghalu, 1992). In an explicit description, Roberts (2014) explained that the term rural is highly cryptic. Some metropolitan cities in Nigeria have impoverished areas and what is described as rural in general terms is noticeable. It understood rural areas to make up of space where homes and infrastructure occupy minimal space. Most landmarks are dominated by fields, pastures, forest, water, mountains, and deserts.

In developing countries, rural farmers contribute significantly to the socio-economic development of nations. Today, more than two-thirds of the Nigerian population whose primary occupation is subsistence agriculture reside in rural areas. These rural areas serve as sources of the nation's staple food like maize, cassava, yam, wheat, guinea corn, and plantain for urban dwellers and provide raw materials for industries. With all these efforts, the rural farmers earn meager income and are always neglected. It is easy to observe that the rural sector constitutes the economically backward areas of Nigeria and has been so since the colonial days.

Olatunboson (1975) in Omale (2005) is of the view that the term "rural" is measured by two indices viz:

(1) A spatial index indicating the percentage of the people living in rural areas and,

(2) An occupational index that shows the percentage of the labour force in an agricultural occupation.

(3) Anazodo (1982), cited in Nwachukwu and Adejuwon (2012), identified the characteristics of rural dwellers in Nigeria to include;

(4) Their standard of living is static and declining

(5) They generally engaged in agriculture, working small plots of land with traditional hand tools.

(6) Most are engaged in subsistence farming or generate only small marketable surpluses.

(a) They are primarily located in areas poorly served by almost all public utilities which transport is one

(b) Their family incomes are unlikely to exceed more than a few tens of naira a year.

In this context, the rural area being adopted for this study was chosen based on the criteria cited above, such as population, infrastructural facilities, occupation, among others.

3.3 Telecommunications and Rural Development

According to Ndukwe (2002), it was noted that information and communications have always formed the basis for human existence. This fact has driven man to continuously seek ways to improve the processing of information and communicating; such information to one another irrespective of distance and on a real-time basis. Advancement in information and communication technologies (ICT) has demonstrated opportunities for people to utilize it in their socio-economic and cultural development better and more sophisticatedly. Using it, the government finds the importance and role of delivering services at the locations convenient to the citizens. The rural ICT applications attempt to offer development ideas and solutions to the people deprived of basic human facilities such as safe drinking water, diary, education, immunization, reproductive health, employment generation, and human rights. Thus, telecommunication is a reflection of the economic activity of a society. In order to remedy the rural-urban telecommunications gap, it is necessary to address the economic gap in living standards between regions. In this 21st century, the world has witnessed an upsurge in telecommunications and information technology in nearly all aspects of human endeavour. Access to telecommunications is therefore essential to the development of a nation's social and economic life. In the new world order that is driven by knowledge and exchange of information and ideas, surviving in the information age, therefore, depends on access to national and global information networks hence the need for all members of the society to have access to telecommunications facilities to aid their mobility.

4 STUDY AREA AND METHODOLOGY

4.1 Akure North Local Government Area.

Akure North Local Government Area came into existence on 1st October 1996 when it was carved out of the defunct Akure South Local Government. The administrative headquarter is situated at iju/itaogbolu. The local government is made up of so many small communities, villages, and camps. Among the towns are Oba-ile, Itaogbolu, Iju, Ogbese, Igbatoro, while few among the smaller communities are Eleyowo, Owode, Igoba, Isinigbo, Orojuda, Bolorunduro, Ala, Ilu- Abo, Ago Dada, among others. The administrative headquarter is headed by a recognized traditional ruler or an Oba, while Olus and Baales administer the small communities.

The local government is located at the border area of Ondo and Ekiti States, with ikere Ekiti as its immediate neighbor. It is also bordered in the south by Idanre local government, in the east by Akure South Local Government, while in the west with Owo local government Area. The local government is blessed with fertile land, suitable for agriculture. This has made farming the primary occupation of the people. This typically depicts the area as rural as the majority of the populace engage in agricultural activities.

Due to the agrarian nature of the local government, with fertile lands in all parts of the area, farming becomes the major occupation of the people, with many of the households concentrating on the growth of cash and food crops. It is interesting to know that the local government is one of the major cocoa-producing local governments. The majority of the people practice subsistence farming, operating in small-scale agriculture due to the shortage of funds to embark on mechanized agriculture. Moreso, the majority of the farm produce is sold locally in their neighbouring markets such as itaogbolu, iju, oba ile, ala, and ogbese. This is one of the typical characteristics that characterized the local government as a rural area as most households engage in agricultural activities. Information from the Akure North Local Government Area revealed that there is no presence of any big industry in the local government. This is another feature that typically depicts the local government as a rural area. Nevertheless, the availability of hard rock has led to the establishment of granite depots in some parts of the local government e. g J.C.C, Phoenix, Samtex, among others.

As established by the National Population Commission in the 2006 national housing and building census, the total population of the Local Government revealed that there are 130,765 people in the local government, with males amounting to 66,526 and females 64,329. It is worthy of note that the local government is one of the least populated towns in the state; this is due to some of the rural attributes of the town making it difficult for people to settle. Further information on the study, as asserted by National Population Commission (2006), revealed that 11,932 people in the local government do not have access to telecommunication facilities while 10,900 use the few business centres in the community when there is an urgent need for it.

To get information on the availability of telecommunication for the rural areas, point locations of the availability of telecommunication mast was established using a GPS. This was later to the ARCGIS software where it was digitized. This is a method of spatially referencing the base stations in the selected locations (wards), and it was digitized by the ARCGIS software. Through this, information on the availability of the networks/telecommunications stations in the study area was established. From the study, it was discovered that Oke ofa/Owode has the largest number of telecommunication base stations with eleven (11) telecommunication mast of different network providers; precisely MTN, GLOBACOM and AIRTEL. Agamo/Oke ore and Moferere has nine (9) base stations each. Isimija/Ilado Ward has six (6) base stations while Ayede/Ogbese and Odo Oja has three (3) and, two (2) telecommunication stations, respectively. From the, it can be asserted that the number of base stations in some selected rural settlements such as Ayede/Ogbese and Odo oja are few compared to other settlements in the local government. As such, there will be congestion on the few available ones since it is inadequate. Further to this, the issue of power in major parts of the rural settlements is a problem and this has disrupted accessibility to telecommunication networks. Although, power/electricity is a problem in major parts of Nigeria, because there has been instability in the supply of electricity in both the urban and rural areas. Nevertheless, the rural areas are more affected in this respect thus, discouraging telecommunication subscribers from putting up their base stations in the remote areas.

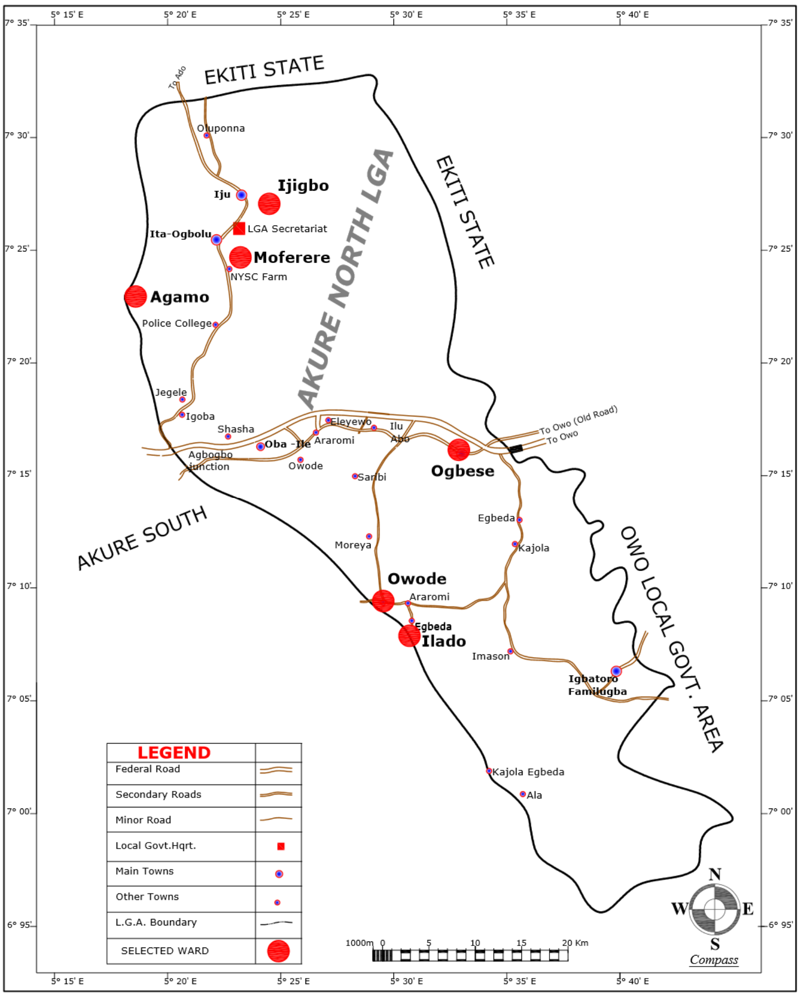

Fig 1: Map of Akure North Local Government showing the study locations (Selected Wards)

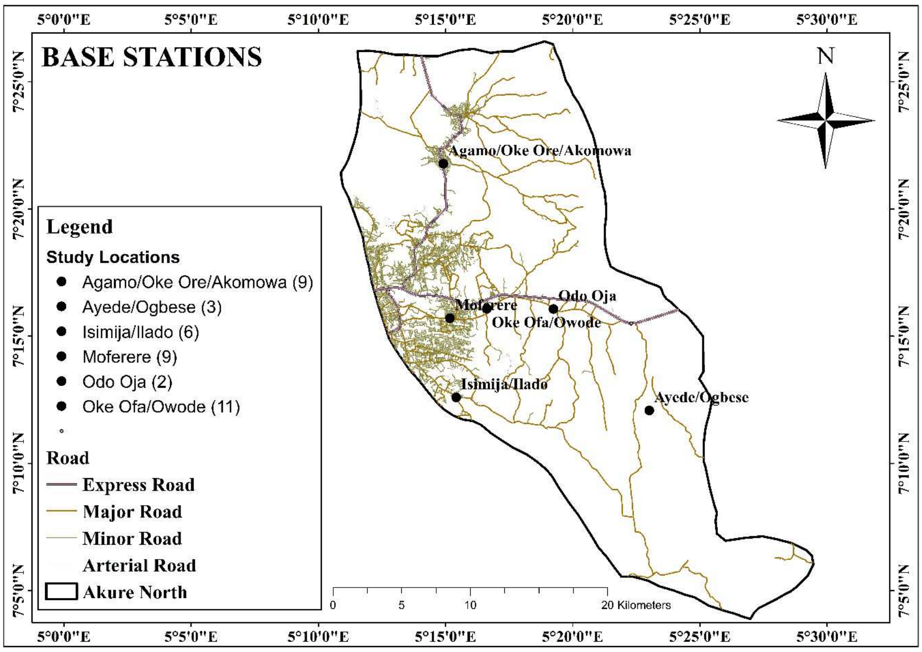

Fig 2: Telecommunication stations in the study area

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4.2 Methodology

Information from the Akure North Local Government Area of Ondo State revealed that there are twelve (12) political wards in the local government. 50% of the wards were randomly selected. Base on this, six wards were chosen for questionnaire administration in the town. The selected wards include ayede/ogbese, agamo/oke ore/akomowa, isimija/ilado, odo Oja/ijigbo, oke afa/owode and moferere. Further information from the National population commission revealed a total of 28,341 buildings in the local government. This includes semidetached houses, hut structures made of traditional materials, among others. However, there are a total of 12,365 buildings in the selected wards. 4% of the building were systematically selected. This implies that 1 out of every 25th building was systematically selected. Base on this, a total of 495 buildings were selected. In each building, the household head was sampled. Questionnaires were administered on the household head, not below the age of 18years, on each floor of the selected buildings sampled. Where the household head was not available, the next building was thus selected for sampling. A total of 339 questionnaires were retrieved during questionnaire administration.

The study tested hypothesis which was stated in the Null and Alternative form:

H0: There is no significant relationship between telecommunications and complemented trips

H1: There is a significant relationship between telecommunication and complemented trips

5 RESULTS AND DISCUSSIONS

5.1 Socio-economic characteristics of Households

The age distribution of respondents in the study area revealed that participants between the ages of 60-69 accounted for the largest (43.7%) proportion of the respondents. This agrees with World Bank's (2008) assertions that the aged, who are from 60 years upwards, dominate the rural areas. Further to this, the Individual highest level of education attained to some degree determines the kind of occupation someone can engage in (Jayamala 2008). This could also be a determinant of individual income. The study showed that those with secondary education accounted for the largest percentage of the respondents with 54.4%, while those with tertiary education were next with 33.9%. 5.9% and 5.2% of the respondents had no formal education and primary education, respectively. This information shows that most of the respondents in the rural areas had no tertiary education, thus corroborating the findings of Olawole (2013) which asserted that households in the rural areas has low level of education compared to those in the urban areas where about 72.1% of households had tertiary education (Gbadamosi & Aderibigbe, 2019).

As established from the study, the occupation of residents revealed that a higher proportion of the household head (40.3%) in the rural areas engage in farming. This could be related to the level of education as contained in the respondents' information, where most of them had secondary education. Nwachukwu (2016) argued that farming is one of the dominant household activities in rural areas, thus corroborating these findings. Income of residents is another important variable in the explanation of travel behaviour of people. To present this, the income group for federal tax rating was adopted to illustrate the income distribution of respondents; it was discovered in the study that 34.8% of the respondents earn below N 20,000, thus constituting the most significant percentage in the income-earning rate of the respondents. Next to this are those who make between N 40,000- N 59,999, with 21.5% of the population. Only 5.9% of the respondents earn above 100000 compared to what was obtainable in the urban areas. It can be inferred from the study that the income-earning rate of respondents in the core areas of the metropolitan area and the rural area is similar as the majority of these categories earn below the minimum income adopted by the federal tax rating. The mean income for the rural populace is N 35215.9, while the minimum and maximum incomes are N 1000 and N 120,000, respectively. It can be opined from the study that the demography attributes of households in the rural area showed a lower income category for the majority of the respondents, and the majority of them had secondary education.

5.2 Travel Behaviour of Households in Akure North Local Government Area.

5.2.1 Trip frequency of respondents

Information on the trip frequency based on all-purpose trips indicates that 71.9% of the respondents make on average one trip in a day that constitutes the largest in that category; this is closely followed by 22.9% of those who make two trips in a day. In summary, a larger percentage (93.9%) of the respondents make between 1-2 trips daily. This corroborates the study of the 2017 National household travel survey (2019), which stated that rural dwellers make fewer trips compared to those in the urban environment. Likewise, the average trips made by respondents weekly by the rural respondents indicate that a larger proportion (71%) makes between 5-9 trips while 20.6% make between 10-19 trips weekly. The mean trip volume daily is 1.36, while that of the week is 8.34.

Number of Trips made in a day	Daily trip frequency		Weekly trip frequency		
	Frequency	Percentage (%)	Number of trips	Frequency	Percentage (%)
1	235	71.9	Less than 5trips	20	6
2	72	22.0	5-9 trips	235	71
3	16	4.9	10-19 trips	68	20.6
4	2	.6	20 trips -above	8	2.4
5	2	.6			100
6 and above	-	-			
Total	327	100.0			
Mean	1.36		8.34		
Std. Dev.	0.663		3.77		

Table 1: Average Daily trips of respondents. Source: Author’s Field Survey 2020.

5.2.2 Trip purpose of respondents

Travel is a derived demand, in that people do not travel for travel’s sake. Transportation occurs to facilitate community services, both socially and economically (Oyedepo & Makinde, 2009). They thus asserted that each trip is made for a particular purpose. The trip purpose of respondents was classified into discretionary (social, shopping, medical) and non-discretionary (work and school). The trip purpose of respondents is examined based on the dominant trip made daily. The result on the trip purpose of households in the study area established that 65.3% make more of work-related trip, which is non-discretionary trips, next to this is 12.2% of them who make school-related trips. The remaining 22.5% of the respondents made discretionary trips such as recreational trips, shopping trips, religious trips and health related trips.

5.2.3 Transport mode of respondents

Examination of transport mode of respondents reveals that non-motorized mode of transport such as (walk) accounted for the largest proportion in this section with 43.2% of the total respondents in the study area. 24.6% and 13.9% make use of public transport and private cars respectively. This is no different from the findings of Starkey, Ellis, Hine, and Ternnel (2002); Clark, Chatterjee, and Melia (2016) and Tao, Fu, and Comber (2018), which attested to the use of non-motorized transport as the dominant mode of transport for most rural dwellers.

Dominant mode of transportation used	Rural	
	Frequency	Percentage (%)
Walking	137	43.2
Bicycle	10	3.2
Private car	44	13.9
Public transport	78	24.6
Others	48	15.1
Total	317	100.0

Table 2: Transport mode of respondents. Source: Author’s Field Survey 2020.

5.3 Telecommunication usage of respondents

5.3.1 Access to telecommunication facilities

Access to telecommunication facilities of respondents indicates that the majority (85.8%) do have access to a form of telecommunication against the 14.2% of their counterparts who do not have access to any form of telecommunication facility. This indicates that the level of awareness on telecommunication is okay in the study area, and it is not surprising, as Nigeria's teledensity level is relatively high, thus corroborating the findings of Wojuade (2014) and Olawole (2013). The findings from this study contradict the previous assertion from the National Population Commission (2006) that 11,932 of the households do not have access to any form of telecommunication facility. This shows an improvement in the households' ownership and access to at least one of the telecommunication media from 2006 to 2019.

5.3.2 Type of telecommunication facilities frequently used

Information and communication technologies go beyond mobile phones, which people commonly use. It ranges from mobile phones, personal computers, and desktops where internet services such as e-shopping, e-banking, e-business, etc., emails, among others, can be performed. In lieu of this, information on the type of telecommunication facilities commonly used and available to people was sought. As established in table 3, the majority (64.3%%) of the respondents indicated the GSM as the most available and frequently used. This includes personal phones and call centres (mobile phone business centres). 14.5% of the respondents indicated they use of the internet such as emails, and 7.1% use other social media platforms for communicating. It can be asserted from this that mobile phone is the most available and frequently used form of telecommunication in the rural area.

Telecommunication Facility Used Frequently	Rural	
	Frequency	Percentage (%)
GSM	218	64.3
Internet (Personal Computer, Desktop)	49	14.5
Social Media (Facebook, Instagram, Whatsapp)	24	7.1
None	48	14.2
Total	339	100.0

Table 3: Frequently used telecommunication facility/services. Source: Author's Field Survey 2020.

5.3.3 Internet facilities use and awareness level of respondents in the rural area

As established by scholars such as Kashorda and Waema's (2014), the use of information and communication technology at enhancing or substituting physical trips is on the increase globally, hence the need for this. Information on internet facilities such as e-banking, e-shopping, emails, and e-business revealed that 85.5% of the respondents do not utilize any of these platforms to conduct business activities and shopping. 4.7% of those sampled used email, while 9.1% and 0.6% use the e-banking and e-business platforms, respectively, for their activities. This indicates that using other forms of telecommunication facilities (personal computers, desktops, and tablets) outside the GSM for making calls is low in the rural area of the study.

5.3.4 Social media platforms as a form of communication in the rural area

From the study, it was discovered that 92.9% of the rural respondents do not use any of the social media platforms (Instagram, Facebook, and Whatsapp) as a means of communication as these platforms may displace the execution of physical trips or complement physical movement thus having an impact on their trip making and travel behaviour. This is particularly relevant to shopping trips as examined by Lens and Nobis (2007), which opined that telecommunication leads to a reorganization of activities in time and space. As established from the study, 4.4% use WhatsApp while 0.9 use Instagram as a form of communication. 0.6% and 1.2% make use of Twitter and Facebook as a means of communication. The result of the findings may be attributed to the assertion of Oyesiku (1990) that the social and cultural background of the people in Nigeria society is such that the presence of friends, relatives, and business associates in gatherings is often appreciated; hence they may not appreciate the use of social media for communicating with friends which is typical in the rural areas.

Amount Spent on Recharge/ mobile subscription

From the study, 69.9% of the respondents spend 100 naira to recharge their phones while the remaining 23% and 7.1% spend 200 naira and 400 naira respectively to subscribe or recharge their phones. The amount spent by respondents in the rural areas to recharge or subscribe to mobile telecommunication is very low, as seen in the study a larger percentage spent less than one USD (1$) on mobile subscription monthly, which is very low when compared to households in the urban areas and developed countries.

5.4 Effect of Telecommunication on Trip Making of Respondents

5.4.1 Average Daily Trips Complemented, Induced, and Substituted by the different Telecommunication Means

This section examined the number of complimentary trips induced and substituted by the different telecommunication media. It aims to examine the most frequently used form of telecommunication by households at either complementing, inducing, or substituting trips. The average number of trips complemented, substituted, and induced by telecommunication revealed that phone calls were more predominant at substituting, complementing, or inducing trips in the rural areas. It was discovered that 1654 trips were influenced by the use of phone calls in the rural area. The study further revealed that 217 trips were being carried out through the use of email. It implies that only a few respondents in the rural areas compose mails, which may indicate their socio-economic status as revealed by Olawole (2013) since the most of them havee a low level of educatio,n, which may have a significant effect on their usage of telecommunication.

The use of e-banking to communicate in the study area revealed that 361 trips were either complemented, substituted, or induced through that platform. The use of the social media platforms such as Facebook, Instagram, and Whatsapp to either complement or substitute physical movement was low in the rural areas; a total of 505 trips were influenced through the platform in the rural areas of the study. The study shows that phone calls were more predominant in the study area as a larger volume of trips were being influenced through that platform. This corroborates Fadare and Olojede (2009) finding, which stipulated that mobile phones are no longer a symbol of economic status as most households now have access to it.

5.4.2 Trip Activities Complemented, Substituted, and Induced by Telecommunication in Akure North Local Government Area.

This section examined the dominant trip purpose, which was influenced by telecommunication. The aim is to examine the trip activities that were more impacted by telecommunication in the study. Findings from the study revealed that the complementarity effect of telecommunication was significant for the different trip purposes in the rural areas. A total of 546 (49%) work/business trips were complemented via the use of telecommunication in the study area. The reason is not farfetched from the fact that households in the rural areas engage in primary activities (farming) where the use of telecommunications might lead to a modification of their trips; this implies that the use of telecommunication provides information to users in the study on where to travel and time to make trips. This does not necessarily mean the trip will not be made but gives information on the time and place to conduct their activities to avoid some of the negative externalities of transportation thus corroborating the study of Oyesiku (1996) which opined that the use of telecommunication enables individuals to be better coordinated regarding when, how and where to travel. In addition to this, 519 (48.3%) of work trips were also substituted through telecommunication. Further to this, a larger proportion of 252(28%) of social/ recreational trips was induced due to telecommunication use in the rural areas. This is an indication that the use of telecommunication has not replaced family and social gatherings in the rural areas and is a testament to the assertion of Oyesiku (1996), which explains that the physical presence of friends and relatives can not be replaced through telecommunication. In summary, telecommunications had more impact on the non-discretionary trips (work) of households in the rural areas of the study.

5.5 Hypothesis Testing:

The hypothesis stated under the research methodology was tested in this section to ascertain the relationship between telecommunication and travel

The result of the hypothesis testing revealed that a relationship exists between the average number of complemented trips and Telecommunication usage (call volume) in the rural areas of the study. This implies that the null (H0) hypothesis is therefore rejected and the alternative (H1) hypothesis accepted. The result shows a weak positive relationship (0.409) between telecommunication and complemented trips in the rural areas of the study. The correlation coefficient for the relationship between telecommunication usage and complemented trips in the rural area is 0.409 and is significant at 0.00. The findings from this study corroborate the findings of Zumkeller (1996), Gbadamosi (2004), and Wojuade (2014), who found a complementarity effect of telecommunication on the trip. The correlation result for the relationship between telecommunication usage and substituted trips were not significant in the rural area, likewise, the correlation result for trips generated and telecommunication use were also not significant in the study.

		Average No of Calls(call frequency)	Telecommunication capacity to complement trips
Call volume/frequency	Pearson Correlation	1	.409**
	Sig. (2-tailed)		.000
	N	339	339
Telecommunication capacity to complement trips in the rural areas(number of complemented trips)	Pearson Correlation	.409**	1
	Sig. (2-tailed)	.000	
	N	339	339
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 4: Correlation Coefficient for Complemented Trip and Call Frequency in the Rural Areas. Source: Author's Field Survey 2020.

6 CONCLUSION AND RECOMMENDATIONS

The study has investigated the telecommunication and travel behaviour of rural dwellers. It was established from the study that non-motorized transport modes were more prevalent among rural households and the majority of households in the rural areas make fewer trips. In addition to this, the majority of respondents in the study area make use of the Global System of Mobile Communication (GSM) than other telecommunication media such as Personal Computer, Desktop among others.

As established from the study, the consequential effect of this revealed that households in rural areas rely more on telecommunication for call-making against the many benefits of telecommunications such as email, e-banking, and e-shopping and shopping, just to mention a few. As such, its impact on the trip-making behaviour of households may not be very effective. The study also established that the complementarity effect of telecommunication on the trip was significant in the study area. In lieu of this, stakeholders in the transport and telecommunication sectors should ensure that good and efficient transport and telecommunications systems are made available, accessible, and affordable to rural communities. The rural dwellers should be enlightened on the other benefits of telecommunication as telecommunication facilities go beyond call linkage as there are other purposes served by telephone that goes more in-depth and advance than call linkages.

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Temporary Urban Pop-Up Environments – Design Requirements and Sustainable Solutions

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1 ABSTRACT

With more than half of the world's population already living in urban areas, cities are increasingly faced with the challenging and conflicting target of providing a high-quality living environment for its inhabitants whilst at the same time ensuring that the rise in population does not come at the expense of increased land use and loss of green space. Looking at the aspect of space, increasing the density in urban agglomerations is one key approach. However, another way forward is also to consider the aspect of time by assessing which needs can also be catered for by temporary means. In addition to the morphology and structural density of a city, consequently the temporal aspect gains in significance and can ensure that cities become more resilient in times of crisis. Nevertheless, temporary use of space and consequently temporary housing solutions are not yet widely investigated and discussed topics in strategic urban planning.

Based on a highly interdisciplinary research project on PopUp Housing Environments, this paper aims at addressing this knowledge gap by providing investigations on and solutions for the specific design requirements on temporary housing spaces and structures. The goal is to define framework conditions for affordable, flexible, sustainable and reusable concepts, that are easy to construct and swift to implement, in order to fulfil the requirements of environmental, economic and social sustainability. Researchers from the fields of spatial and landscape planning, architecture, building services engineering as well as energy and waste management have been collaborating with social and political sciences as well as humanities in order to develop scenarios and models for sustainable temporary housing environments.

In this paper the process for several scenarios will be presented in terms of their relevance for urban areas and use of space as well as examples of developed housing models, that can serve as an inspiration for architectural, technical and space-saving land-use solutions. The models have been developed with the aim of reducing the impact on land, resource and energy consumption, focusing strongly on de-constructability, reusability and the temporal aspect of the occupied space.

The initial results have been discussed with various stakeholders from the city administration and other related organisations in order to fine-tune the requirements and subsequent scenarios and housing models. The overall aim is to support the methodical development of temporary housing solutions so that these can form an integral part of long-term urban planning strategies.

Keywords: de-constructability, re-usability, pop-up environments, sustainable buildings, temporary buildings

2 REQUIREMENTS FOR TEMPORARY HOUSING

2.1 Urban planning

The urban population is growing with people incessantly moving towards conglomerated and dense areas. Currently already more half the world's people are living in urban areas with a rising tendency with more than 70% of global greenhouse gas emissions (GHG) attributed to those spaces. Life in cities is in large parts responsible for the causes of climate change but cities are also particularly vulnerable to the subsequent effects. Consequently, these densely populated areas must be assessed and optimised from different perspectives, combining geographical, economical and societal characteristics within a holistic and systemic viewpoint. Planning for regenerative and resilient urban systems of production, consumption, transportation and construction is key in reducing the effects of climate change and thus plays and important role in long-term urban planning strategies.

Spatial, infrastructure and construction infrastructure planning however are extensive processes, which follow long-term perspectives and are accompanied by long-term impacts. Urban planning in this context is

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often too slow and does not reflect the dynamics of uncertainties to effectively meet the current needs of society. Thus, in addition to the permanent structures, the temporal aspect can provide a meaningful ratio for cities to quickly respond to unforeseen events. From a construction and architectural perspective, the meaning of temporary can be summed up as being of short and intermediate use and of an interchangeable function. The former refers to the aspect of time, whereas the latter refers to the aspects of function. Both can be applied at the same time or individually within the meaning of temporary in architecture. The architecture for temporary constructions makes use of modularity, flexibility, speed of construction, simplicity of installation, affordability, constrictive reversibility and second-life management. Temporary housing can in an urban context and from an architectural perspective be differentiated into three aspects that include the (1) temporary erection of structures in response to an urgent need (e.g., a disaster), (2) temporary uses and strategies within a city and (3) the actual re-use of temporary structures. Including temporary uses and applications in urban planning strategies can subsequently provide readily accessible measures when they are urgently needed. This however necessitates the understanding, that a specific mind-set in urban planning is a prerequisite for the particular nature of temporary structures. If planned with care, temporary housing can support short-term and urgently needed requirements in a sustainable, flexible and integrative manner and can instigate a constructive impact on the overall urban system.

This paper presents and discusses the process and development of various scenarios and housing models for temporary living conditions with the aim to contribute to a positive discussion in the context of temporary urban housing solutions.

2.2 Definition of terminology and outset

Within the framework of the research project "*Urban Pop-Up Housing Environments and Their Potential as Local Innovation Systems*" funded by the Vienna Science and Technology Fund (WWTF), the interdisciplinary research team conceptualised sustainable scenarios and housing models for temporary living environments in the City of Vienna. The aim was to define and assess theoretical solutions within the three aspects of *people* (particular needs for temporary housing, demographic profiles, skills), *housing* (design, energy, waste, material and water) and *area* (location, infrastructure, open space, land-use). The key project aims include the following: (1) The scientific systematisation and development of a database on temporary forms of housing and international examples of implementation; (2) The compilation of adequate land types for temporary forms of housing in Vienna; (3) The development of six interdisciplinary selected scenarios with concretely described housing models for temporary housing in Vienna; (4) The evaluation and assessment of the scenarios and housing models based on a series of technical, ecological, spatial planning and social criteria; (5) Concepts for the use of the housing models as innovation niches and (6) a transfer concept for generalised "urban pop-up concepts" and support for practical implementation. Within the context of this text, the focus is on point 3 above providing a summary of research results on the scenarios and models.

In the following the key terminologies used within the context of the project are outlined. These include the terms *temporary, user groups, scenarios and models*.

Within the context of this paper, the term *temporary* refers to a duration from several weeks up to 5 years. The potential models include structures that are temporarily constructed for residential use and the re-purposing of permanent structures for temporary residential use. Given the fact that also temporary structures must follow the relevant norms and regulations related to the use of land (e.g., following the development plans) as well as the functionality of the buildings (e.g., related to disabled access or fire regulations), the scenarios vary in their degree of how much the actually follow the current legislative framework conditions. This evidently mostly refers to the use of un-occupied or unused land and less so regarding the relevant building regulations as the former allows experimental settings, but the latter is a requirement for health and safety of the occupants.

In order to develop suitable scenarios and models, in a first step the potential *user groups* have been identified. User groups differ in their requirements for temporary housing, but also in their needs and abilities and were thus defined based on the perspective of societal urgency (e.g., exponential increase in housing demand) or individual urgency (e.g., immediate need for shelter). For the City of Vienna, three relevant user groups have been identified. User group A comprises individuals with an urgent, immediate and unexpected need for temporary housing. User group B includes people without an immediate demand, but with expected urgency and limited alternatives. User group C relates to individuals without an immediate or urgent demand, but nevertheless limited alternatives.

A *scenario* within the project describes an application case for a temporary housing environment within the City of Vienna. The key aspect of each scenario includes the setting of the plot of land or building thus taking into account the availability of adequate areas or vacancies within the city and the user group that would be inhabiting this area, which related to the likelihood of decisive events taking place (e.g., heatwaves, earthquakes or similar disasters that initiate a sudden need for housing). In addition, the expected duration of inhabitation, adequate building equipment and open spaces, properties of the area and neighbourhood, available (technical) infrastructure, and particularities specific to the scenario are defined.

For each scenario, temporary housing units, so called *housing models*, are developed. A model is thus a concretisation and only one of many potential options of a scenario. Each model is defined in detail by its distinct architecture and overall setting thus including descriptions for construction, shape, size, setting, building services, materials as well as water and energy use. The final scenarios and models are subsequently assessed in the detail with a series of indicators that rate their quality related to their social and environmental sustainability.

3 METHODOLOGY

In this section, the overall process, which resulted in the development of the exemplary scenarios and housing models, is presented. The development was carried out in several phases and with different research teams. In addition, the process was supported by external stakeholder groups, that provided in different workshop settings valuable input on the definition and selection of relevant criteria and framework conditions. An external student group from the JASEC (Japan Austria Science Exchange Centre) at the TU Vienna also significantly contributed in the setting of a design studio over two semesters to the project, by developing a series of design ideas for the housing models. Overall, the development spanned a timeframe of over two years and involved a multitude of expertise. In the following the process and the various stages are presented in a summarized and shortened version in order to provide an insight into the *making of* the housing models.

3.1 Process Overview

As shown in Figure 1, the overall development of the final housing models took mainly place in three phases, that was divided into the (1) preparatory phase, the (2) scenario development and the (3) housing model development.

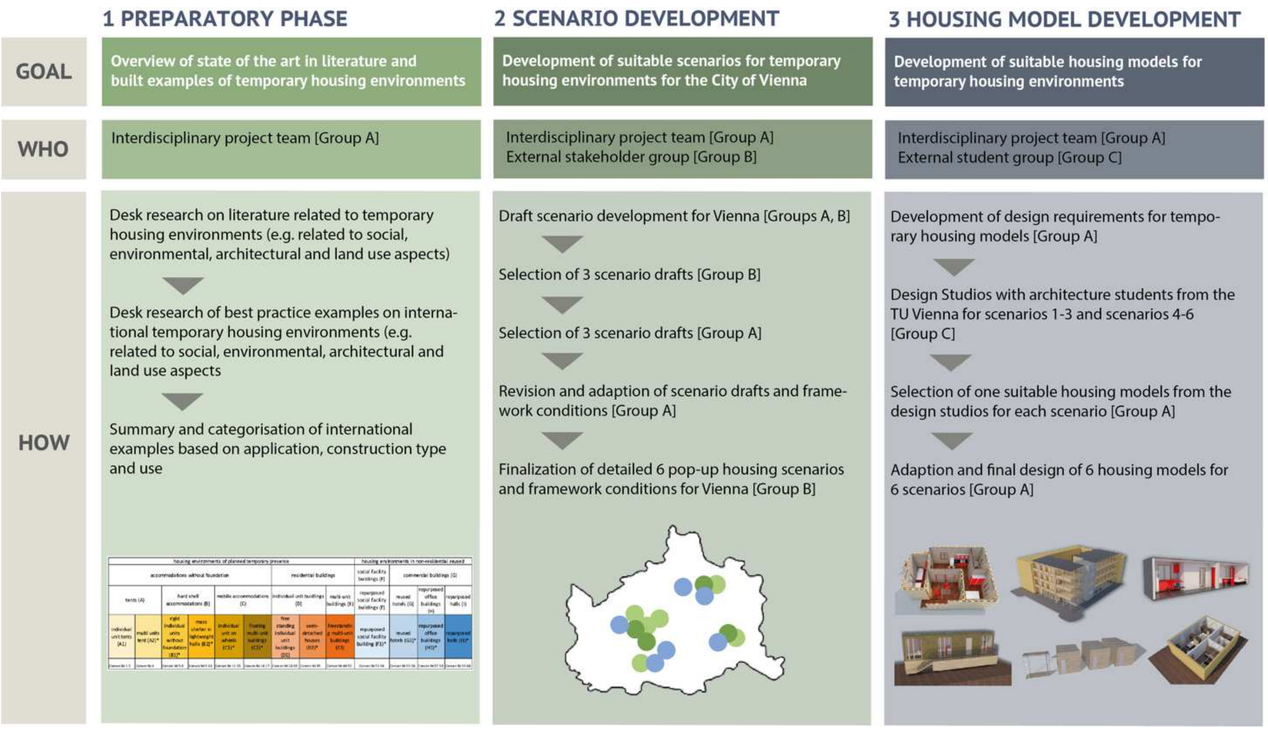

Fig. 1: Development of temporary pop-up environments; simplified process.

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For each phase a series of tasks supportted the goal of the process. In these phases, the project research team (group A) was supported by external stakeholder groups (group B) and a student design team from the architectural faculty of the TU Vienna.

3.2 Development phases

The initial preparatory phase mainly consisted in the basic research tasks with the goal to provide an overview of the state of the art on temporary housing environments. This entailed not only the collection of relevant literature related to the social, environmental, architectural and land use aspects within the topic, but also on the analysis of implemented examples related to temporary housing. The tasks resulted in a summary and categorisation of international examples based on application, construction type and use. This phase was carried out by the project research team in an interdisciplinary approach, with each research group providing the relevant state of the art and example analysis within their field of expertise and subsequently combining the results in an integrated manner.

In a second step, the scenario development, the main goal was to develop suitable scenarios for temporary housing environments for the City of Vienna. As outlined above, the scenarios not only relate to the actual building, but more importantly to the application cases, thus focusing on the availability of suitable land or buildings and the uses for the different potential options. The individual scenarios reflect the various possibilities, options and needs of the city. This phase started with the draft scenario development for Vienna, carried out by the project team with support of the stakeholder groups and was followed by scenario drafts from the research team as well as the stakeholders. The following task was to further develop the scenario drafts, revise and improve them and select the most suitable scenarios for the project. In the final tasks the selected scenarios were adapted and summarized in order to arrive at six different scenario settings. This phase was carried out by the project research team with the support of stakeholder groups in workshop settings in order to provide an external view on the framework conditions for the scenarios and on the selection of suitable scenarios for the Vienna case.

During the last key phase, the exemplary housing models for temporary housing environments have been developed. Following the initial task of the definition of the design requirements, a collaboration with the TU Vienna resulted in two design studios with architecture students that focused on the architectural development of various temporary housing models for the different use cases. The studio was part of a series of courses offered by JASEC at the TU Vienna, which focuses on disaster mitigation and security in buildings. During both one winter and summer term, three model types have each been developed for three scenarios, resulting in a multitude of different designs for the six scenarios and framework conditions. The students approached the design tasks with creative solutions that all followed the concept of sustainability in a temporary urban setting. Depending on the semester, they could each chose from three different scenarios for their architecture project.

Architectural quality	**Constructional quality**	**Sustainability quality**	**Urban planning quality**	**Social quality**
General design concept	Logistical aspects (transport)	Resource-efficiency	Urban district integration	Potential for social interaction
Flexibility of space	Ease of construction / deconstruction	Potential for renewable energy	Urban accessibility	Flexibility of uses (in the building)
Accessibility	Storage	Type of materials	Neighbourhood concept	Number of users
Types and size of living units	Logistical requirements for construction	Potential for reuse	Quality of external spaces	Area per person (private units)
Aesthetics	Type of foundation	Potential for recyclability	Mix of private / semi-private, public spaces	Area per person (total area)

Table 1: Housing model development; basis for selection of designs for housing models

Based on the student’s designs, the research team subsequently selected the most appropriate and relevant solutions following an assessment of various criteria related to architectural quality, constructional quality, sustainability quality, urban planning quality and social quality as outlined in Table 1. The objective of this process step was to arrive at a limited number of design solutions that could be further developed by the research team. The aim of the selection process was to choose the most appropriate design ideas for each of the six scenarios to merge, adapt and develop this further into the six final temporary housing models. The selection and adaptation processes have been carried out by the research team.

4 RESULTS

The final housing models provide a theoretical approach to the defined framework conditions and specific requirements of user needs for temporary housing within strictly hypothetical urban settings of the city of Vienna. The models are theoretical and exemplary and provide only one each of many suitable and relevant solutions. They must therefore be seen in the context of a highly theoretical approach and do not represent actual designs for buildings projects. They should convey what type of approaches and solutions could be feasible, if sustainability in temporary housing is at the core of the design development. In the following the potential temporary housing models are briefly presented to provide an overview of the development of the research project for pop-up housing environments. The housing models are one of a range of outcomes of the research project and should visualise the potential for temporal construction in an urban setting.

The first scenario "Gap module" as shown in Figure 2 shows a setting for temporarily vacant building lots within urban areas with a high density. Short-term shelter can be provided in these vacant lots, at times when the area is already emptied of previous buildings but not yet ready for new construction. These plots are considered to have a usable ground floor area of around 1000m^2 so that multi-storey structures could be erected on site. The idea is that the systems are made of highly modular, prefabricated units that are grouped together over several storeys. They can subsequently be constructed and de-constructed within a very short timeframe (i.e., less than two months on site) and with little disruption to the plot. The focus is on easily accessible plots within a densely populated area and an extremely well-established infrastructure, but to use these plots for a limited time only and with a high re-use capability of the modular elements.

Fig. 2: Example 1 temporary housing model for scenario "Gap module".

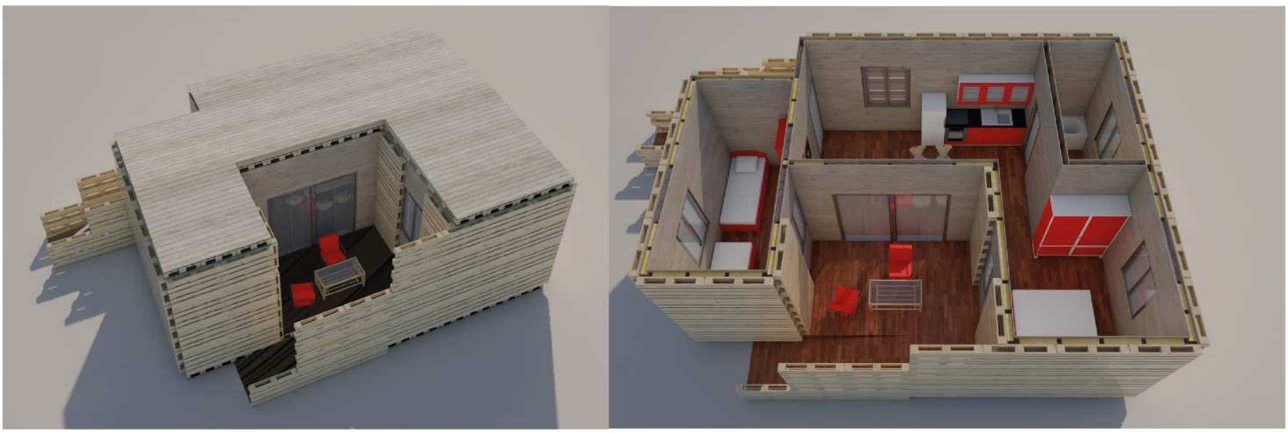

Fig. 3: Example 2 temporary housing model for scenario "Beat the heat".

In a second setting "Beat the heat", as shown in Figure 3, the urban heat island effect has been considered in the development of the scenario. The theoretical approach was, that during heat waves, vulnerable groups should be given the possibility to move from their potentially overheating homes into cooler and subsequent more appropriate environments. This addresses the growing concern that certain urban groups that live in buildings prone to summer overheating could be exposed to an increased health risk. Thus, in this scenario, temporary housing accommodation is provided for the duration of extremely hot summers. In a vacant area, that is preferably heavily shaded by trees and greenery. In this setting the reusable and storable light-weight housing pellet units could provide shelter in a cooler and more suitable environment.

In the third potential scenario named "Life sharing to go" unused industrial or open space office buildings have been chosen as suitable environments. The benefit of adapting existing structures lies in the overall reduced impact on resource and energy use for the construction of the units. The re-purposing of these existing structures has the objective to provide a flexible and open-space area that can house temporary, lightweight, prefabricated and modular units in existing spaces and subsequently reduce the requirements on raw materials since the main structures are already there. The units are designed as easily moveable modules for fast and easy mantling and dismantling, allowing flexibility of space in a series of private and semi-private areas as shown in Figure 4.

Fig. 4: Example 3 temporary housing model for scenario "Life sharing to go".

Fig. 5: Example 4 temporary housing model for scenario "DonAutonom".

A less stable and more flexible approach was considered in the scenario "DonAutonom" as this would involve the inhabitation of a redesigned and reused old cargo ship on the Danube. The ideas for the housing models involve common areas on a lower deck and three upper container decks with living units. On top of the containers a series of terraces and plant areas are foreseen in order to provide green and open spaces on an otherwise steel designed object as shown in Figure 5. The experimental setting is considered to be self-sufficient in terms of water and waste by using rain- and river water and the conversion of biogenic waste into biogas.

In another moving scenario called "Life on tracks" temporary housing solutions could be swiftly deployed when needed by using adapted old waggons on the existing rail infrastructure. This scenario has been specifically developed with user group C in mind, i.e., people without an imminent or urgent demand, but limited alternatives. This could include individuals participating on a voluntary basis and not currently affected by existential threats, for example members of NGOs (non-governmental organisations) or similar.

The highly flexible scenario can through its high mobility serve as a disaster risk management and resilience measure. The potential housing solutions as shown in Figure 6 shows a highly adaptable interior which makes use of the logic of container architecture. Similar to the previous model, the aspect of safety and connection to the existing infrastructure (urban networks, water, waste) must be specifically considered.

Following the logic of the scenario as outlined previously in Figure 4, the scenario “Shop-Hopping Box” makes use of existing structures and addressed high vacancy rates for ground-floor retail spaces. The small-scale stores could be adapted for families or other co-habituating groups. The scenario is foreseen as a simple approach as no construction works or severe adaptations would have to take place. In the potential housing model as shown in Figure 7 the retail space is provided with new modular room divisions to create separate entities for kitchens, bath- or bedroom areas. The units are designed for swift and easy assembly and disassembly and provide high flexibility regarding placement and arrangement within potential vacant stores.

Fig. 6: Example 5 temporary housing model for scenario “Life on tracks”.

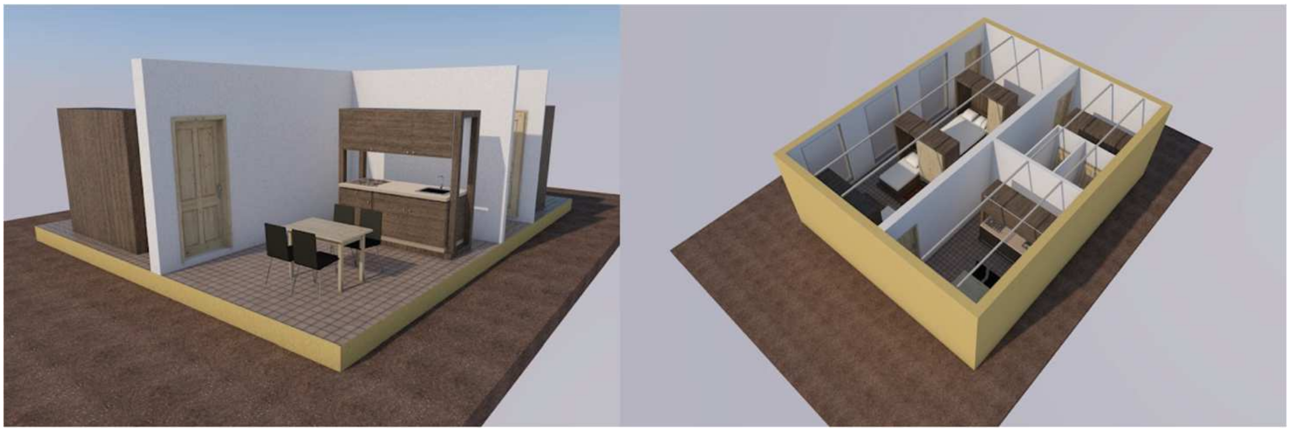

Fig. 7: Example 6 temporary housing model for scenario “Shop hopping box”.

In a subsequent step, all models have been analysed based on a series of over 50 environmental, technical and social indicators in order to simulate and assess the overall suitability and sustainability of the models. From an architectural perspective, aspects such as material (e.g., durability, embodied energy) and structure (e.g., constructability and de-constructability) as well as internal comfort parameters (e.g., daylight quality, ventilation, thermal comfort) have been specifically addressed. The potential ideas for the housing models are then discussed and reviewed by an external stakeholder group to critically assess the theoretical suitability for the application case of Vienna and to evaluate if and how temporary housing can form an integral part of future planning activities related to strategic development plans and to strategic risk and disaster mitigation aspects.

5 CONCLUSION

The developed scenarios and models show examples from a multitude of options for temporary housing for the City of Vienna. The theoretical scenarios housing models should serve as an inspiration for solutions that include sustainability aspects as an inherent outset for choices in terms of urban areas, use of space and architecture. All models have in common, that they are designed with a strong focus on the reduction of the impact on land, resources and energy by accounting for de-constructability, reusability and temporality.

The process has shown that there is a multitude of influencing factors that limit or allow the development and subsequent implementation of temporary housing within the urban environment of the City of Vienna. The scenarios and models have been created within an open and experimental setting, but with the current framework conditions regarding land use, design development and constructability in mind.

Even though the initial results have been discussed with relevant stakeholders from the city administration and other related organisations to fine-tune the requirements, the overall aim is to support the methodical development of temporary housing solutions in order to form an integral part of long-term urban planning strategies. In a next step it should be analysed how the project results could be used for the city as such. On a strategic level (i.e., relating the aspects of spatial planning and development) the project results could be integrated into the strategic development plans so that temporary uses can form an inherent part of planning processes for urban developments. Other aspects, such as cost constraints, conversion into permanent settings and societal aspects such as end of tenure and subsequent housing for the occupants should be further explored. On an experimental level a concrete implementation could support a detailed analysis regarding construction, optimisation in operation, dismantlability and storage as well as after-use concepts and recycling.

One of the goals of this research work is to contribute with an in-depth evaluation of potential solutions to a critical discussion on temporary housing environments.

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7 ACKNOWLEDGEMENTS

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The housing models as shown in Fig. 2-7 are based on and adapted from designs from students of the TU Vienna during design studios with JASEC (Japan Austria Science Exchange Center) as follows: Fig. 2 [Friedwagner, Pröpers]; Fig. 3 [Barbero Duran, Cuesta Urquia]; Fig. 4 [Tasevska, Dimitrov]; Fig. 5 [Dembski, Wossner]; Fig. 6 [Neudeck, Werni]; Fig. 7 [Verdugo Pelaez, Egido Rodriguez].

Text-based Discussion Environment using a Discussion Support System Enhances Participants' Engagement at International e-Conference: KICSS 2020 Online Experiment

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1 ABSTRACT

With the adverse effects on the global Coronavirus Pandemic on travelling, the scientific community has developed many tools to create a joint solution towards an environment that supports productive collaboration online. Thus, many scientific conferences in 2020 were conducted virtually,particularly using video -based communication such as Zoom. However, transition to these unconventional platforms posed challenges for conference related activities such as networking and intensive group-based discussion. To address these problems, online interactive discussion toolsthat support both text and video based discussion have become so essential. Towards this end, in this paper, a well-established conference on creativity in science and technology, called KICSS 2020, conducted a virtual experiment using blended approach with a video-conferencing platform, Zoom, and a text-based discussion platform, called D-Agree . This method of using jointsolutions to host conferences is envisaged to support conference related activities mentioned before, and to study performance metrics within used environments during Q&A session in order tosuggest an effective environment that might help to positively change collaboration among participants in the future . This study purports the first-ever to compare the effectiveness of online text and video-based communication tools during a research Q&A session while hosting an international conference in a synchronous virtual venue. The experimental results show thatthere was a statistically significant difference in the participation type and its engagement rate of conference attendees in Zoom and D-Agree. The findings give credence tothe viability of the D-Agree as a tool for active participation (participation with discussion) because of its relative low psychological costs and ease of use during Q&A sessions, while Zoom is more suitable for attracting passive participation (participation without discussion). Furthermore, the lessons learnt through organising this event and analysed results might offer a promising prospect that could enrich the hosting of virtual conferences,using blended approaches for both scientific and educational purposes in the future.

Keywords: online participation, discussion system, Civic engagement, Virtual conference, Online discussion

2 INTRODUCTION

2.1 Introduction and background of the study

On March 11, 2020, the World Health Organization (WHO) declaredthe COVID-19 a global pandemic, and in the weeks that follow, many countries issued a stay-at-home order. In more than 172 countries, the COVID-19 Pandemic had completely driven teachers and students from physical classrooms into Internet virtual classrooms.Indeed, since then online classes have become the new normal, and integrated into the educational information delivery methods of many universities around the world (Aihara et al., 2020). For example, Figure 1 shows that the total number of learners impacted by the Pandemic surged to more than 215 million as of May 20, 2021. This represents a decrease in the figure of impacted learners between March 25, 2020 and April 27, 2020, which stood at1500 million. However, to mitigate the impact, schools increasingly embraced a hybrid mode of education, using both conventional method and a virtual delivery of educational information, using e-learning platforms and tools. This hybrid mode of delivery educational instructions is expected to outlive the COVID-19 Pandemic, but what online tools (video-based, text-based or video and text-based) hold the most mutually beneficial outcomes to their educational institutions or conference organisers and end users (students and conference participants) remains a puzzle that needs to be unravelled.

Similar to educational activities, the COVID-19 Pandemic led many conference organisers to the decision to cancel face-to-face events and moved themto online platforms, using various tools (Bonifati et at., 2020). These tools were used to support conferences activities (such as networking and presentation) (Jarvis et al.,

2020) with a view to enabling participants to jointly listen to presentations, engage in live Q&A and attend other events associated with conferences. These online platforms, whichutilisevarious features and support to host quality virtual events have gained significant attention since the outbreak ofthe Pandemic (Haqbeen et al., 2020a). However, since conferences have traditionally provided a platformfor networking, information exchange, and intensive group-based collaborations,using video-conferencing tools such as Zoom may not be able to support all conference activitieson its own. For example, interactions and discussions, which are key features of conferences, particularly during Q&A sessions may be as effective as those in conventional conferences, using only video-based applications.

Conference organizers managed to address this shortcoming to a reasonable extent by adding text-based interactive platforms such as LinkdInas joint solutions to support conference activities (Haqbeen et al. 2020c), thereby facilitating interesting discussions during the Q&A sessions which often follow presentations. With better preparation andsupporttool, they believe thatgreater interaction can be fostered, using joint environments (video-based and text-based).

Therefore, a joint solution (video-based and text-based) online platform(s) requires interactivity that can provide more opportunities for networking (Boureal et al., 2020). Therefore, a good online conferencing should take into account the advantages associated with combining both. Based on this, online conferences might be better positioned to employ digital services and tools for presentation and collaboration than physical events. Thus, many conferences used at least two online platforms: (a) video conferencing applications such Zoom as the main tool (Zoom Video Communication Inc., 2016), and (b) online interactive platforms such as Gather town, underline, hopin, Linkdin and D-Agree as extra interactivity tools. This study is guided by the following two questions. First, what effect does the introduction of a text-based interactive platform have on promotinginteractivity in online Q & A research sessions while using a video conferencing tool?Second, between video-based and text-based discussion tools, which is moreeffective for facilitating interactivity based on the performance metrics of conference participants during Q & A research sessions?

In this paper, we share our experiences of organising an international conference, which was planned to take place in Tasmania, Australia. However, the rapid spread of the COVID-19 Pandemic led to the cancellation of the face-to-face event and in its place, an online conference was organised, using two platforms, Zoom and D-Agree, as a blended solution to support the conference activities. We also discuss our assessments of the potential usefulness of these tools for collaboration and networking during conference Q&A sessions. The lessons learnt through organising this event and comparing these platforms provide an outlook that could enrich using blended text and video-based approach to host virtual venues for both scientific and educational purposes in the future. To the best of our knowledge, no previous study has examined, explored orconducted experiments, whichfocused on differences inthe participation and discussion metrics of video conferencing tools and text-based discussion platforms in an international conference.

Figure 1 shows the global monitoring of school closures caused by the COVID-19 Pandemic.

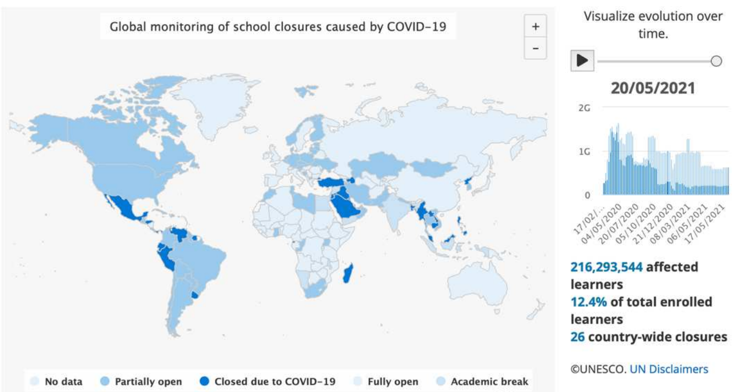

Fig. 1: Global Monitoring of school closures caused by COVID. Retrieved on May 20, 2021 from https://en.unesco.org/covid19/educationresponse

2.2 Authors' experiences from virtual conferences and their adopted tools

Due to the COVID-19 Pandemic, many scientific conferences in 2020 were conducted in the form of virtual events (Boureau et al., 2020), which posed a great challenge for conference-related activities. Organising a scientific event, specifically a conference, involves various tasks before, during and after the main sessions. Broadly, those activities can be categorised into: (1) networking (introduction and exchange of opinions among participants); (2) presentation (presentation of positions papers followed byquestion-and-answer session); (3) collaboration (social events to stimulate collaboration among participants) and (4) organisation (schedule preparing, reviewing, wrap-up and post-conference activities). Networking is probably the most adversely affected by this transition from conventional conferences to online ones, as the former typically provided a forum for information exchange, and intensive group-based collaborations. However, conducting conferences virtually presents inevitable barriers to experiencing full-fledged, in-person interactions and exchanges with colleagues(Boureau et al., 2020), although virtual formats also have some unique advantages. For example, there is no budget for travelling to participate in virtual conferences, making them more accessible and convenient for a broader range of interested participants.

In this section, we reflect on our experiences in sixvirtual international conferences that we participated in since last year (2020). These conferences, which were hosted on different platforms aimed to provide participants with experiences similar to in-person meetings (physical conferences) while making use of a digital online service for group collaborations. In particular, we elaborate on the toolsused, as well as their advantages and disadvantages ateach of the events attended.

We attended as correspondent authors and presented our research works in six international conferences between 2020 and 2021, namely; AAMAS 2020, JSAI 2020, ACM CI 2020, WI-IAT 2020, IJCIA-PRICAI 2020 and GYSS 2021. Initially, all these events were scheduled to be held as in-person events in Auckland, New Zealand; Kumamoto, Japan; multi-sited Copenhagen, Netherland and Boston, USA; Melbourne, Australia; Yokohama, Japan and Singapore, respectively. However, due to the pandemic, the venues were moved fullyto virtual venues, using online platforms and tools.The first conference which we attended virtually was the International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS), 2020. The conference was initially scheduled to be held in Auckland, New Zealand betweenMay 9 and 12, 2020, but was eventually hosted on virtual platforms (Underline and Zoom to be specific). Underline is the world's first digital library and virtual conference streaming venue for scientific events (Underline Science, 2021). The virtual conference venue, Underline, included participants' pre-recorded presentations, so interested participants can watch it in their spare time, while the full presentation was hosted on Zoom. Zoom is a collaborative, cloud-based videoconferencing service, which offers features such asonline meetings, group messaging services, and secure recording of sessions, used by most online conferences as virtual venues.However, the major observations made by the authors during the conference was that there was limited time, which made it difficult for several participants to collaborate and discuss with other participants during Q&A sessions and networking events.

Our second experience on online conference was the 34th Annual Conference of the Japanese Society for Artificial Intelligence (JSAI), 2020 (Haqbeen et al. 2020b). This second conference was scheduled to be held in Kumamoto, Japan from June 9 to 12, 2020, but was also moved to a virtual venue. Due to the COVID-19 Pandemic and the subsequent state of emergency that followed in many of Japan’s prefectures, the organisers decided to host a full virtual conference, using Zoom. Like the first conference, the authors observed that there was no interactive platform for networking and the time allotted to the Q&A sessionwas also limited.

Our third experience was with The Association for Computing Machinery Collective Intelligence Conference (ACM CI), 2020 (Haqbeen et al. 2020c). ACM CI was initially scheduled to be the first multi-sited international conference to be held in Copenhagen, Netherland and Boston, US. on June 18, 2020, but was also changed to a virtual venue, using three virtual tools, namely; Zoom, LinkedIn and YouTube. Zoom was used to host the full presentations in real-time (synchronous), while Zoom streamed, using Youtube service was used to expand the coverage out of Zoom’swebsite. By fully synchronous, we mean that participants jointly listened to presentations, had live Q&A, but with limited time constraints. The conference organisers created a LinkedIn group and posted all accepted papers in the conference’s link on the platform, so interested participants could read and post their questions in their spare time during the conference. Then, the corresponding author(s)of the paperscould reply to those posted questions. This resulted in participants’ inactivity, especially regarding networking. Moreover, since this kind of participation is often passive and devoid of active interactions among relevant participants, it often results in inaction and lack of initiatives to engage innetworking. Similarly, the disconnect amongst participants led to the proliferation of uncoordinated networking.

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The fourth conference which we attended virtually was the 19th IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology (WI-IAT '20), 2020 (Haqbeen et al. 2020a). Similar to the conferences discussed above,the 19th IEEE/WIC/ACM conference which was initially scheduled to be held in Melbourne, Australia from December 14 to 17, 2020 was moved to a virtual platform and hosted on Zoom. The authors also observed that there was no interactive platform for networking, which resulted in participants' inactivity.

The fifth conference in which we participated was the 29th International Joint Conference on Artificial Intelligence and the 17th Pacific Rim International Conference on Artificial Intelligence (IJCIA-PRICAI), 2020 (Haqbeen et al. 2020d). The IJCIA-PRICAI conference was originally scheduled for July 11 to 17 in Yokohama, Japan. Like other AI conferences, the COVID-19 Pandemic disruptedthe proposed physical gathering, thereby compelling the organisers to reschedule the conference to a virtual venue between January 7 and 15, 2021.The conference was hosted on Zoom and Gather.Town. The Gather.Townbolsteredthe efficiency and effectiveness of the events bystimulating interactions among participants. The organisers used both text and video communication on a large-scale. However, the virtual venues faced many challenges during the event, as the links went down, resulting in scalability challenges.

The final event which we attended was the Global Young Scientists Summit (GYSS2021). This summit was initially scheduled to be held as aconventional physical gathering, but was later hosted on a virtual venue, using Hopin. Although the Hopin (Hopin 2021) networking feature has the potential to broaden participation, during interactive sessions (networking), it may not support large-scale interactions, unlikethe one-to-one communication.

3 OBJECTIVE AND METHODS

3.1 Research objective and Hypothesis

The purpose of this study is to examine the effects of video-based and text-based toolson the performance metrics and interactivityof participants during Q & A session in online conferences/platforms.

To address the time-related or temporal and spatial obstacles in virtual venue tools, particularly during Q&A sessions, we conducted an exploratory experiment by setting a joint video-text virtual venue tool as a hybrid solution to support conference activities. In this way, we aimed to create an environment that is conducive to active participation (participation and discussion) activities. In light of the advantages of using multi-sited environments to increaseactive participation levels, we examined the following hypotheses:

H1: Using text-based discussion environments enhance the degree of active engagement during Q&A sessions.

H2: Participants who desire to express opinions are more active in text-only discussion than video-based forum. Hence, the threshold for expressing opinion in a text-based can be lower than that in a video discussion forum.

H3: Participants are more likely to express/exchange a wide-ranging opinion in a text-based discussion than in a video discussion forum. It is assumed that text-only discussion enables low psychological cost that video-based conversation.

The objectives of the study are to ascertain the performance metrics of text-only discussion and video-based forums in terms of stimulatingengagements in Q & A sessionsduring a-two-day conference period.

3.2 Method

This research is part of a broader study, which explores theeffectiveness of discussion platforms in hosting virtual events, such as town meetings (Haqbeen et al., 2020a), online COVID-19 discussion (Haqbeen et al. 2021c).)and online conferences.

We initially intended to host a conference by creating an efficient environment and using joint solutions to study the performance metrics of participation and discussion within each tool based on participants' subjective assessments of the participation and posted opinions. The sample of the study comprises27 participants whoconsecutively participated in two-days conference,using both Zoom and D-Agree. The study is based on data from the "Q & A sessions" of the above-mentioned conference. All participation via Zoom was video recorded, while that of D-Agree was retrieved as discussion annotation dataset files.Statistical analyses were conducted to ascertain the differences in arithmetic means and standard deviation, using STATA analytical software version 16.

All corresponding authors whose paperswere accepted at KICSS 2020 and who registered for the conference were requested to participate on two platforms. Our initial approach was facilitated through conference chairs and organisations which were interested in identifying an efficient virtual environment that could enhance participant engagement in activities within virtual venues. This was to be followed by a convenient strategy, using participating conference attendees.

3.3 Study Area

The 15th International Conference on Knowledge, Information and Creativity Support System (KICSS) which was initially scheduled to be organised by the School of Technology, University of Tasmania, Australia from November 25 to 27, 2020, was moved online and held between November 25 and 26, 2020. The KICSS aimed to intensively facilitate technology and knowledge exchange amongst international researchers/scholars in the field of knowledge science, information systems, system science and creativity support systems. The conference covered a broad range of research topics which cut across the fields of knowledge engineering and science, information technology, creativity support systems and complex system modelling. Although the conference was moved online, the organisers made efforts to preserve as much of real-life experiences as possible.Two authors of this paper functioned as the general and online chair persons, respectively. The conference was delivered virtually, using Zoom, as the video-conferencing platform while D-Agree was used as a discussion support platform. We tried our best to convey the in-person experiences in a multi-sited setting.

The paper submission deadlines for KICSS was August 31st, 2020. 29 full papers (based on average length and contents of the articles)were submitted to the conference. This figure was lower compared to the submissions received by the same conference in 2019. This decline in the number of articles (papers) submitted to the conference may have been informed by the COVID-19 Pandemic, leaving us with total of 27 submitted papers which represent the sample of this study (n =27). This figureseems more like the size of a symposium rather than a conference where several hundreds of persons usually participate. The main contact authors were from 5 different countries. The majority of the submissions was from Japan (52%), followed by China (24%) while the remaining 24% was from three other Asian countries: Afghanistan, Taiwan and Pakistan. The Technical Programme Committee which reviewed the various submissions consisted of 27 experts from different parts of the world. The review meeting took place online on October 3rd, 2020. The committee accepted 16 regular papers (~55% acceptance rate) and 11 short papers (~37% acceptance rate). The attendance at KICSS 2020 consisted of 27 correspondent authors and 12 other attendees. There were four experts who were invited from Australia, Japan, Thailand and USA to talk about various issues related to the theme of the conference.

The size of the previous KICSS conferences ranged from 80 to 150 attendees, which qualifies it to be a small/medium conference(according to IEEE and ACM standards) that can be accommodated using the Zoom meeting and discussion support platform. However, for this study, we used a Zoom webinar. More details about the instruments used for this study will bediscussed in Section 3.5.

As the size of the KICSS 2020 was relatively small (n = 39), it allows us to provide live presentations, using Zoom. We believed that live presentations will create more activities and attract more interactions than recorded videos. To keep the programme within the time frame that is acceptable to the majority of attendees, we asked the authors of the accepted full and short papers to prepare a 30- and 15-minutes slide presentation, respectively. We created 27 virtual spaces for each corresponding author on D-Agree, and then, the authorswere asked to create their accounts on D-Agree and upload their slides. Each author’s virtual space could be accessed by all registered attendees on the days of the conference.Each author of a full and short paper (manuscript) was expected to make a presentation lasting for 25 and 10minutes, respectively during the live session of the conference, using Zoom. Another 5minutes was allotted to Q&A at the end of each presentation, so that the audience could interact further with the presenters/authors. Similarly, an open Q&A sessionfollowed the presentation on D-Agree. The audience was given opportunity to ask questions during the live session and were allowed 5 minutes to do that or post questions on the corresponding presenters/authors’ virtual space during the live session of the conference.

As a result,, we were able to restrict each session to between 80 and 90 minutes. Day one of the conference started at 10:30AMand ended at 5PM. JST time. The award ceremony and social event started at 6PM and ended with a virtual social event (live music) at 9PM. We observed that the attendance was always above 18 and 8 attendees at any moment of the day throughout the entire programme on ZOOM and D-Agree, respectively. However, the participation was not quite steady on both tools.The two-days conference programme and presentation slots in each session are shown in Figure 2.

ZOOM-D-Agree (Virtual Hyrbrid) Japan Time (UTC+9) Thailand Time (UTC+7) Australia Time (UTC+11)	ZOOM 1 ID: 712 166 2793 Passcode: room2020	Zoom 2 ID: 853 8247 8586 Passcode: room2020	ZOOM-D-Agree (Virtual Hyrbrid) Japan Time (UTC+9) Thailand Time (UTC+7) Australia Time (UTC+11)	ZOOM 1 ID: 712 166 2793 Passcode: room2020	Zoom 2 ID: 853 8247 8586 Passcode: room2020
	D-Agree Dicussion Code: kicss2020			D-Agree Dicussion Code: kicss2020	
	25th November			26th November	
10:30 - 10:40		Opening			
10:40 - 12:00	Session 1 : Creative research environments and their performance	S1-1 S1-2 S1-3 S-4	10:00 - 11:30	Session 4: Idea Evaluation and Innovation	S4-1 S4-2 S4-3 S4-4; T4-5
12:00 - 13:00	Lunch time		11:30 - 13:00	Lunch time	
13:00 - 13:50		Invited Talk 1: AI in Medicine Dr. Sanparith Marukatat	13:00 - 13:50		Invited Talk 3: D-Agree: Crowd-scale Consensus Support System based on Automatd Facilitation Agent Prof. Takayuki Ito
13:50 - 14:00	coffee break		13:50 - 14:00	coffee break	
14:00 - 15:20	Session 2: Online Discussion and Cooperation	S2-1 S2-2 S2-3 S2-4 S2-5	14:00 - 14:50		Invited Talk 4: The AutoCoach Smart Agent Project: AI with a Personality Prof. Kwei Jay Lin
15:20 - 15:30	coffee break		14:50 - 15:00	coffee break	
15:30 - 17:00	Session 3: Machine Learning and Creativity	S3-1 S3-2 S3-3 S3-4 S3-5.; T3-6	15:00 - 16:30	Session 5: Education and Support	S5-1 S5-2 S5-3 S5-4 T5-5; TS5-6; TS5-7
17:00 -17:50		Invited Talk 2: Agent-based Influence Propagation Modelling: Methos and Applications Prof. Quan Bai	17:00 - 17:30		Closing : KICSS2021 Next host presentation
18:00 - 21:00	Award Ceremony/ Social Event				

Fig. 2: A Two-day Programme of KICSS 2020 hosted virtually on ZOOM and D-Agree.

3.4 Participants

The participants were from 8 different countries, which comprisecorrespondent authors (n = 5), and other attendees (n = 3). Eighteen (52%) participants were from Japan, making it the most represented country in KICSS 2020. This was followed by participants from China (n = 7; 24%) while the remaining 24% were from three Asian countries (Afghanistan =2; Pakistan =1; and Taiwan =1). The other 10 attendees were from Australia (n =1), Japan (n =7) Thailand (n =1) and the United States (n =1). The participants were signed up on Zoom (n =39) and D-Agree (n =33) based on their availability and consent to participate in the research during the KICSS. However, based on the authors’ decision, we considered only attendees who were registered as correspondent authors (n =27), and consecutively participated in the five sessions of the twodays conference. We excluded the data of the 12 attendees who loggedin, but were not present during the two days conference by our research team. Note that 27 participants who logged into Zoom and created accounts on D-Agree and engaged in online activity on the platform at least once as well as responded to one another during KICSS, using both Zoom and D-Agree were part of this study. The convenience data collection procedure was applied to collect the required data.22 (74%) of the selected participants were males while 7 (25.9%) were females. Based on their levels of education, 6 (22.2%) of them were postdocs or PhDs, and 5 (18.5%) were PhD students, and 16 (59.2%) others were master students. The agesof the participants ranged from 22 to 65 years.

3.5 Instruments

Zoom and D-Agree were the main instruments used for this study. Zoom is a video-conferencing platform on the internet that allows two-way synchronous method of audio and video communication. It is also known as Voice over Internet Protocol (VoIP) mediated technologies like Skype and FaceTime (Zoom Video Communications, Inc. 2021). It is a collaborative, cloud-based video-conferencing service, which offers features such as online meetings, group messaging services, and secure recording of sessions. It has become a very popular video-conferencing tool since the outbreak ofthe COVID-19 Pandemic, as its virtual platform provided a substitute for academic exchanges and business transactions outside their conventional settings.

On the other hand, the D-Agree (Ito et at., 2020) is a text-only discussion-processing platform, which is based on artificial facilitation (Hadfi et al., 2021) on the internet. The D-Agree allows for a large-scale synchronous and asynchronous method of text-based communication. It is used to host virtual meetings by gathering, facilitating, extracting, and visualising real-time discussion summaries. Technically, the system provides a vehicle that facilitates crowd-scale interactive deliberations to promote text-based discussions.

3.6 Procedure

We conducted the experiment in the KICSS 2020 conference's five main sessions, which had 27 presentations spread across twodays between 10:40AM and–17:00PM on 25 and 26 November, 2020, respectively.

We decided to run the event as a joint live mode to simulate Q&A sessions as much as possible. This was achieved by combining the webinar on Zoom video conference software with the D-Agree text-based discussion support platform. In line with the sessions of KICSS 2020, we decided to make the programme single track with five sessions, so that participation on Zoom and D-Agree could be simultaneously used during each Q&A session. Presentations on each session took place on Zoom webinar for each of the planned sessions, with an ID and password provided to attendees. Our five sessions generally spanned 80-min (n =2) and 90-min (n =3) with the net talk length for each full-length paper being 25-min (n =16) whilea short paper (n =11) was 10-min.A 5-minute Q&A session followed each presentation to allow the audience to interact with the presenters on Zoom and D-Agree.The discussion experiment was conducted during the Q&A sessions, using Zoom and D-Agree. Although Zoom offers two modes of online interactivity, the meeting and the webinar modes, the latter was used in this study. The webinar mode has a text-based Q&A facility that allows participants to type their questions and to upvote questions asked by other participants (Bonifati et at., 2020).

The process started with an open call for participation andforwarding of the Zoom passcode and D-Agree discussion space code to all registered attendees. We created a virtual discussion room within one virtual discussion space for each of the 27 presentations based on their session slots. This setting on D-Agree allowed us to connect the ID of each presenter's virtual discussion room with the recorded Q&A session presentations and discussions ofparticipants on Zoom.

Participants logged into Zoom and D-Agree via their own personal computers or smartphones to participate in the KICSS virtual conference. They then created their accountson D-Agree, using their email addresses. We asked the participants to use the same name that was registered in KICSS for this purpose to avoid anonymous discussion and facilitategenuine networking. The participants used their IDs and passwords to log into D-Agree and to post the start-up message: "Hello everyone. This is [author name], the author of the paper [correspondent paper ID] from [affiliation]. Thank you for taking interest in our work. I am happy to take any questions and address your comments about the content on the paper. Thank you!". We asked all correspondent authors to post their start-up message and upload their slides on D-agree platform from 11 to 24 November, 2020. Allpresentations across the five sessions of KICSSwas conducted in English.

The presentation slides were uploaded to each presenter's virtual discussion room. Based on their preference, attendees could join these rooms.In addition, all presentations were streamed-lived on D-Agree Facebook page link:https://www.facebook.com/DAgreeAFG/videos/372974633939103.

All the participants were allowed to ask video and audio-based questions on Zoom during synchronous Q&A session or could post a text-based question/argument on Zoom chat or D-Agree during each synchronous or asynchronous research presentation session.

Participants jointly listened to presentations, had live (synchronous) Q&A on Zoom and (a/synchronous) D-Agree, and attended other live events associated with the conference. Note that synchronous means that attendees can ask orally or post their questions in live mode, while asynchronous here means that they can post their questions once the presentation has finished but within a specific session and conference time. In other words, fully synchronous Q&A entailsthose online presentationscould be watched by participants while simultaneously participating in the Q&A session during presentationsin live mode. On the other hand, asynchronous Q&A on D-Agree requires participants to post comments and opinions during the conference session that best suit them.

We recorded the participants performance metrics (participation and discussions) during each Q&A session on Zoom and stored the discussion datasets files on D-Agree during the twodays conference. We also stored the questions and answers on Zoom chat. However, there was no text messaging during Q&A session on

Zoom chat. For this study, to enable us compare participation and discussion on Zoom and D-Agree, we only considered the data (video and text) called and posted during Q&A sessions on both platforms.

The user interface of D-Agree during our experimentation is shown in Figure 3. We used the following functions of D-Agree: display of discussion phases (1. divergence; convergence; evaluation; and conclusion), display of ranking, and display of discussion in tree structures. However, in this experiment, we adopted divergence phase since we were interested in collecting a diverse opinion from participants (Haqbeen et at., 2021a).

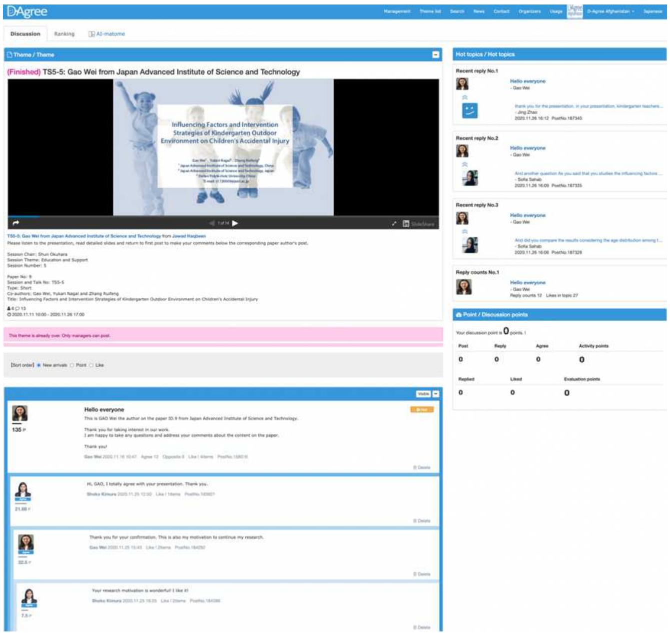

Fig. 3: User Interface of D-Agree during discussion on S5-5 Q & A session

3.7 Data analysis

For the analysis of participants' engagement, we used the footage from the recordedand stored Zoom chat, and the annotation files of each discussion space on D-Agree during each Q&A session.We used the following features of Zoom: Webinar and text-based Q&A facility.On the other hand, we used the following functions of D-Agree: divergence discussion phase, display of reply (including agree and opposite features), and "like " button. Since it was not necessary to converge opinions during the discussion phase at KICSS, only the divergence phase was used for this session.

For the indicator of engagement (participation and discussion) on Zoom, we analysed the following items from participants' logs in and posts on Zoom during the Q&A session of each presentation: the number of users who logged into the platform; the number of video-audio posts (including questions, answer and arguments); the number of characters in each post; and the number of Zoom chat (including questions, answer and arguments). However, as mentioned in Section 3.6, there was no text messaging during Q&A session on Zoom text-based Q&A facility.

For the indicator of engagement on D-Agree, we analysed the following items from participants' logs in and posts during the Q&A session of each presentation: the number of users who logged into the platform, the number of "likes"; the number of posts (including questions, answer and arguments) and the number of characters in each post. Although the discussion datasets and files included other items,which we intend to explore further in a different study, for this study, we restricted our analyses to the items mentioned above.

The mean scores of participations and discussion on Zoom and D-Agree were analysed, using t-test for comparative purposes. To analyse participation and discussion on Zoom, we watched the video recording of each presentation andlistened carefullyto all the Q&A sessions within each paper. These steps were followed by the transcription of the discussions. This enabled the authors to quantify and compare the means of participation rates and the frequency of engaging in discussion bythe participants across the attributes mentioned above on Zoom and D-Agree platforms.

To analyse the Q&A discussion on D-Agree, we downloaded the discussion annotation file of each presentation from the system. The annotation files consisted of the number of participation (users who logged into the platform), post, reply, time, points etc. Since it was not necessary to analyse all the discussion annotation datasets, with respect to the performance metrics, only the number of users whologged in, the number of likes, the number of posts (including replies) and the number of characters were used in this study.

To ascertain if there is a difference in the participation and number of posts on Zoom and D-Agree, we compared their rate of participation and frequency (rate) of expressing their opinions, using t-test on both instruments. We then analysed participation and discussion for each tool. To examine the validity of the analysis of the annotated discussion data within both tools, we used mean values of the parametric tests.

4 SETTING

We set up a discussion room for each correspondent author on Zoom and D-Agree before the commencement of the conference, so that each paper would get both a presentation spot on D-Agree and a dedicated time spot on Zoom. We used

session for the video and audio-based interactions. The access could be controlled through the Single Sign On (SSO) on Zoom and a discussion space on D-Agree, so that only attendees of KICSS 2020 who registered and logged in could enter the Zoom and D-Agree virtual venues. We decided on joint solution, using both Zoom and D-Agree. Each paper got both a presentation spot on D-Agree and a dedicated time spot on Zoom. The basic idea behind this hybrid setting was to support conference activities, particularlythe Q&A sessions. We aimed to compare the participants' engagement and their performance metrics (participation and posts) while looking at the number of those who logged in and posted messages during the Q&A session.

5 RESULTS AND DISCUSSIONS

The results of the analysed data on the participation and discussion on Zoom and D-Agree are summarised in Table 1 while the comparison of the number of times participants logged in during the online discussions, using Zoom and D-Agree during Q&A session is shown in Figure 4.

Based on the analysed results for participant engagement during the Q&A sessions, using both instruments (Zoom and D-Agree), the levels of engagement of the participants differed based on their number of participation (e.g., the total number of participants times participants logged in during the sessions), and engagement (e.g., the total number of postings by participants during the sessions). Thetotal number of times participants loggedinto Zoom platform wasn = 550, Mean = 20.37, SD = 3.49, whilethe overall number of participations in all sessions on the D-Agree platform wasn = 130, Mean = 4.92, SD = 1.85. The frequency of participation and their corresponding mean scores for all the sessions were higher on Zoom (n = 550; M = 20.37) than the frequency of participation and their corresponding mean scores on D-Agree (n = 133; M = 4.92; SD = 1.85). The findings suggest that people engaged and participated moreon Zoom than on D-Agree due to the video-based benefits as well as the convenience and interactivity offered by the former.On the other, the D-Agree is a text-only discussion platform,which does not support video-based communication. However, the participation on Zoom was often passive because participants seldom engage in active discussions and without active discussions, genuine participation cannot be sustained (Haqbeen et al., 2021).

The average number of posts (including questions and answers) during Q&A sessions on Zoom were (n = 75, Mean = 3, SD = 1.6) compared to that of D-Agree which was (n = 237, Mean = 9, SD = 7.8). The number of engagements (posts) and their mean scores for all sessions were higher on D-Agree (n = 237; M = 9) than those on Zoom, which were (n = 75; M = 3), respectively. The findings suggest that due to the text-based discussion benefit offered by D-Agree and its convenience, people tended to be more engaged, judging from their number of postings than on Zoom. This may have been informed by the limited time allotted to the Q&A sessions. It may also reflect the participants' hesitant psychological disposition towards video-based discussionscompared to text-based online environment. The frequency of participation and posts on each presentation are shown in Figure 3. The presentations are labelled as session [S]; number of sessions [1-5] and number of papers [1-7].

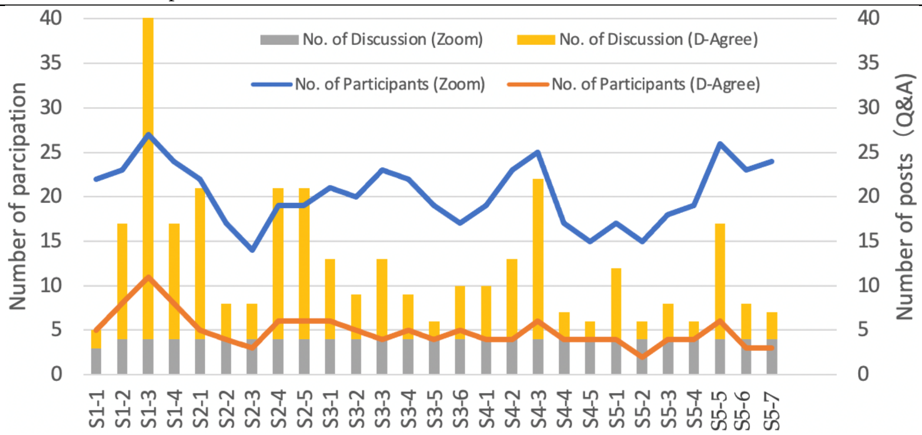

Fig. 4: Distribution of participants and posts for each presentation on Zoom and D-Agree: sessionslabelled as S1-S5 and their corresponding paper presentationslabelled as numbers for each session respectively.

We also compared the number of characters posted on Zoom (transcribed) and D-Agree and their corresponding mean scores. The overall number of posted characters and their corresponding mean scores on D-Agree (n =50,073, M =210.39) were higher than those of Zoom (n =14,422; M =192.29) during Q&A sessions.

In addition, the study also found a significant difference between the number of characters posted on Zoom and D-Agree on women discussion spaces. Further analysis revealed that there was a statistically significant difference between averagenumber of characters posted on Zoom (n =22029,M =286.09) and D-Agree (n =10717; M =206.09)in women discussion spaces.

Surprisingly, the highest average number of characters on D-Agree was submitted on woman discussion spaces (n =22029; M =286.09), while the highest average number of characters on Zoom was submitted in men discussion rooms (n =10717; M =206.09).

The number of posted characters were also compared between genders.The number of characters submitted in woman discussion rooms on Zoom was lower (n =3873; M =168.39). These findings suggest that text-based discussion environment may be more user-friendly, particularly along gender divides.

The results of the analysed data on the participation and discussion, usingZoom and D-Agree are summarised in Table 1.

5.1 Discussion

We anticipated that by using an online video-conferencing tool, Zoom, and discussion support platform, D-Agree, we might be able to replicate the experience of face-to-face conference. We also anticipated that such an online platform combination would allow participants to achieve a collaboration through both text and video-based networking. Thisinformed our believe that Zoom would be a feasible method for hosting presentations while D-Agree would be feasible for Q&A session, networking and collaboration.

The experimental results show that participantstook part in Zoom discussions, but their rate of opinion solicitation,as differentiated by questions and answers during the Q&A session was lower than the number of posts on D-Agree. Indeed, some previous studies (see Haqbeen et al., 2021a) have shown that this type of participation might be passive, butwithout active discussion participation cannot be sustained.

These findings could provide a guide to organisers of virtual venues, particularly those related to scientific events on how tofacilitate better and more interactive sessions during conference activities such as Q&A and social networking sessions. Moreover, the findings give credence to the potential of such a blended approach, which combines text-based discussion platform and video-conferencing application to stimulate greaterparticipants' engagement in virtual venues. Text-based environment is particularly important for enhancing collaboration and networking, as some reported in previous studies (Haqbeen et al. 2020b; Haqbeen et al. 2021b). In addition, a text-based Q&A facility allows participants to type their questions and to upvote questions asked by other participants (Bonifati et at., 2020). Consequently, itcan assist participants from various backgrounds to assemble, share experiences, and reciprocally enhance their knowledge and skills.

Session Theme	Paper No.	Paper Type	Session ID	No. of Participation; Posts;Characters (ZOOM)	Mean (Posts on Zoom)	No. of Participation; Likes; Posts;Characters (D-Agree)	Mean (Posts on D-Agree)	Gender
Creative Research Environment	10	Full	S1-1	22; 2; 354	0.09	5; 4; 8; 1552	1.62	Male
	18	Full	S1-2	23; 2; 320	0.08	8; 6; 13; 2638	1.62	Female
	16	Full	S1-3	27; 4; 879	0.14	11; 8; 38; 6486	3.45	Male
	10	Full	S1-4	24; 3; 643	0.12	8; 5; 13, 2413	1.62	Female
Online Discussion and Collaboration	11	Short	S2-1	22; 4; 698	0.18	5; 4; 17; 3310	3.4	Female
	28	Short	S2-2	17; 2; 380	0.11	4; 4; 4; 698	1	Male
	29	Full	S2-3	14; 2; 420	0.14	3; 3; 4; 810	1.33	Male
	3	Full	S2-4	19; 4; 543	0.21	6; 6; 17; 4349	2.83	Female
	6	Full	S2-5	19; 4; 597	0.21	6; 5; 17; 6533	2.83	Female
Machine Learning and Creativity	13	Short	S3-1	21; 2; 732	0.09	6; 4; 9; 967	1.5	Male
	14	Short	S3-2	20; 2; 796	0	5; 4; 5; 1409	1	Male
	12	Short	S3-3	23; 2; 540	0.08	4; 4; 9; 1357	2.25	Male
	15	Short	S3-4	22; 5; 895	0.22	5; 4; 5; 613	1	Male
	23	Full	S3-5	19; 7; 1494	0.36	4; 3; 2; 394	0.5	Male
	22	Full	S3-6	17; 6; 1350	0.35	5; 4; 6; 1091	1.2	Male
Idea Evaluation and Innovation	21	Full	S4-1	19; 2; 350	0.10	4; 0; 6; 1051	1.5	Male
	20	Short	S4-2	13; 2; 256	0.15	4; 3; 9; 2901	2.25	Male
	1	Full	S4-3	25; 2; 345	0.08	6; 5; 18; 3944	3	Male
	7	Full	S4-4	17; 2; 367	0.11	4; 3; 3; 1185	0.75	Male
	17	Full	S4-5	15; 2; 247	0.13	4; 4; 2; 466	0.5	Male
Education and Support	27	Short	S5-1	17; 4; 654	0.23	4; 2; 8; 1597	2	Male
	19	Short	S5-2	15; 0; 0	0	2; 0; 2; 511	1	Male
	25	Short	S5-3	18; 2; 245	0.11	4; 3; 4; 746	1	Male
	5	Short	S5-4	19; 2; 245	0.10	4; 4; 2; 476	0.5	Male
	9	Short	S5-5	26; 2; 432	0.07	6; 4; 13; 1701	2.16	Female
	24	Full	S5-6	23; 4; 640	0.17	3; 2; 4; 875	1.33	Female
	8	Full	S5-7	24; 2; 342	0.08	3; 2; 3; 687	1	Male

Table 1. Characteristic of participation and their submitted opinions (Mean) inZoom and D-Agree during Q&A sessionon KICSS2020

5.2 Instruments' limitation and challenges

Despite the advantages offered by Zoom, including its convenience and interactivity during presentations, using it to host virtual venues for scientific events came with some challenges, particularlyits inability to read non-verbal cues as a result of inconsistent and delayed connectivity during Q&A session.Indeed, Zoom does not currently have the ability to recover non-verbal messages whenone returns to the platform after losing a connection/network (Weller, 2015). In addition, the participants did not ask questions on Zoom chat, perhaps because they did not want to be distracted during theirpresentations, so asto keep the listeners focused on the presentations. Instead, they continued their questions and discussion onD-Agree. The D-Agree was a welcome technological addition, which both speakers and listeners used to post their questions and answers. In addition, speakers also used the D-Agree to post their slides before their talk. In the future, it is anticipated that the operators of the Zoom platform will improve upon current services by offering enhanced performance and functionality as well as an expanded suite of features. Compared to D-Agree, Zoom has higher potential to attract bettercommunication. Zoom also possesses a number of benefits that enhance its research utilitypotential. These benefits range from its security features, including user-specific authentication, real-time encryption of meetings, to the ability to backup recordings to online remote server networks ("the cloud") or local drives, which can then be shared securely for the purpose of collaboration. However, unlike D-Agree, Zoom do not have the ability to support non-verbal discussion. Therefore, discourse-centric collective intelligence cannot be maintained, using Zoom. This feature is particularly important in both synchronous and asynchronous discussions wheretext-based Q&A sessionsareexpectedto stimulate collaboration, as one would envisageatscientific events.

Note that Zoom is not comparable with D-agree at all, as Zoom is a video-conferencing tool and D-Agree is an online text-only discussion support platform. However, based onthe literature and our personal experiencesat participating invirtual conferences, several tools have been used together or as blended solutions to support conferences, as discussed in Section 2.2. To reiterate, this study aimed to study how a blended approach, which involves a mixtureof text-based discussion platform and video-conferencing applicationcould promote participants' engagement in virtual venues, and subsequently, assess the performance metrics of participation (number of times that participants' logs in and the frequency of engaging in discussions) within Q&A sessions, using both tools.

5.3 Research limitations

This is perhaps the first study that examined the differences between a video conferencing tool and a text-based discussion platform in terms of their participation and discussion metrics within in an international conference. However, we also identified some limitations that should be addressed in future works. First, as mentioned previously,the COVID-19 Pandemic adversely affected the number of papers submitted to the conference, which automatically also reduced the representation of correspondent authors and presenters. This in turn affected the sample for this study (n =27), unlike in a typical conference where several hundredsof persons usually participate. We expect that future works should address this challenge by considering online conferences with larger sizes. Also, in this study, we only considered two tools amid limited sample size which comprises participants in similar professional research (scientific) communities.This also should be addressed by adopting various text and video-based applications in a more controlled setting,using a more diverse and differentiated experimentation social blocks and participants/subjects. The reason is that a small sample size, which comprises participants/respondents/subjects with similar backgrounds may affect the online interactions and behaviours of members in a manner that impair generalisability from the sample, unlike larger and more differentiated sample sizes. These contextual conditions should be more elaborated and taken into account in future research.

5.4 Future perspectives

Avenues also exist for further analysis on this experiment. Our results indicate that both Zoom and D-Agree could be either be used for active (i.e., Factor I) or passive (i.e., Factor II) online engagements.We analysed active and passive behaviour on both tools, using analysed data on frequencies of discussions (the number of times participants/authors logged in and posted on both platforms). Our next steps will be to analyse the correlation coefficient of the number of participants who logged into Zoom and those who browsed D-Agree to find out whether the engagement received byvideo-conferencing application had any effect on the attention receivedtext-based discussion tool and whether there is any complementary relationship between the attention received by (or engagement in) video-based and text-based discussions. Furthermore, we will then conduct a principalcomponent analysis, using indicators of the participants' behaviours on Zoom and D-Agree throughout the sessions. We will assume two factors.Factor I might be depicted as the active use of Zoom and D-Agree in terms of the number of participants who logged in and posted questions or comments during the Q&A sessions as well as the number of words in the posts. On the other hand, Factor II will represent a relatively passive use of Zoom in terms of the number of participants who logged in, but did notparticipate in the Q&A sessions, while the number of views or "likes"would be used for D-Agree.

6 CONCLUSION

The present study investigated the participation rates of participantsand their responses (posts) in a real-world experiment on virtual conference, using a video-conferencing tool and text-based discussion support platform. The finding revealed that participation in an online text-based discussion environment is more likely to enhance participants' engagement (in terms of the frequency of exchanging opinions) during Q&A sessions than a video-based communication tool.The study also demonstrates that the number of posted characterswas higher during the Q&A session, using text-based environment. Thus, text-based discussion support environments are more likely to lead to greater participants' engagement. The main results were as follows: (1) participation in online conferences was associated with both video and text-based discussion environments. (2) Participants who had a desire to express opinions were more likely to join text-based discussion spaces than video-based discussion rooms. (3) The rate of active participants who joined and expressed opinions in the text-based discussion environment was higher than those of participants who joined and expressed opinions in the video-based discussion environment and those who did not express opinions in both environments. (4) The number of passive participants (participation without discussion) was higher in Zoom, while the number of active participants (participation with discussion) was higher in D-Agree. Hence, a text-based discussion environment may better enhance participants' engagement with discussion during Q&A sessions in a virtual conference. In addition, the number of participants who posted opinions via a text-based discussion environment was significantly higher than the number of participants who expressed their opinions/ideas in the video-based discussion environment. The findings ofintegrating both environments could provide a user-friendly hybrid discussion environment to support virtual conferences. This could offer better opportunities for networking and collaboration among virtual conference attendees.

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The Application of CityGML Food Water Energy ADE to Estimate the Biomass Potential for a Land Use Scenario

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1 ABSTRACT

Cities are undergoing rapid urbanisation throughout the globe. A common challenge amongst them is to provide food, water, and energy (FWE) supplies under sustainable and economically productive conditions. As a result, new tools and techniques must be developed to support domain experts and decision-makersto understand, simulate and visualise the nexus impact on the sustainable supply of the FWE resources. A critical part of such a development process is to eliminate data silos and move towards an integrated FWE based data model, which can then be used to connect domain-specific urban simulation tools to simulate FWE nexus scenarios based on changes in landuse, population, and climatic conditions.This paper demonstrates the CityGML FWE Application Domain Extension (ADE) application as a central data exchange format to connect different urban simulation tools. First, it gives an insight into the ongoing development of the FWE ADE to the standardised open city information data model of CityGML. Secondly, it demonstrates the role of the CityGML FWE ADE in exchanging datasets between a FWE based landuse simulator built with UD_InfraSim and an urban energy simulator SimStadt to estimate the biomass potential for a landuse scenario of Vienna based on its future population and climatic changes.

Keywords: Data Modelling, 3D CIty Modelling, Food Water Energy ADE, CityGML, Food Water Energy Nexus

2 INTRODUCTION

Food, water, and energy (FWE) are critical for human survival. In the 21st century, cities across the globe are pressing for natural resources more than ever before. They are undergoing rapid urbanisation, and together with population growth and climate change, they are continuously challenged to provide FWE resources under healthy, sustainable and economically productive conditions. To help face such a challenge, solutions should not beproposed in their silos, as these three domainsinteract with each other. For example, according to an estimate[1] from the United Nations, by 2050, the world population will increase by 2 billion, entailing the global food production increase by 60%, which will require 40% more water and 50% more energy.[2] Such an increase in food production will demandmore significantland, water, energy, or their combination.A critical challenge here would be finding a balance between the supply and demand of such critical urban infrastructures.Understanding and finding solutions within the individual domain silos of food, water, energy, land management, climate change would no longer be helpful. Thus new tools and techniques that can support domain experts and decision-makers to understand, analyse, and visualise the entire urban infrastructural system as a whole must be developed and prioritised.

The past decade has shown a rapid rise in the use of information and communication technology in sustainable urban development. Computer science and geo-informatics experts from both public and private sectors have developed manyopen and proprietary geospatial tools (e.g. ArcGIS, QGIS, ERDAS Imagine, GRASS GIS, and others), whichprovided new digital methods for city planning and decision making. Conventionally, a two-dimensional method of analysing the built environment has now been upgraded to three dimensions by developing the digital twins of cities. While geospatial tools and techniques allow users to generate and analyse geo-datasets, various urban simulation tools have also been developed to use geo-datasets to simulate different present and future built environment scenarios. With such a hand in hand development between geospatial technology and urban simulators, a commonly adopted and standardised city informationmodel to store and exchange datasets related to different built environment objects (e.g. buildings, roads, vegetation, landuse, water bodies and others) became crucial for data interoperability

[1] https://population.un.org/wpp/
[2] http://www.fao.org/news/story/en/item/275009/icode/

between tools, domain experts and decision-makers.In 2008, the Open Geospatial Consortium (OGC) standardised and released an open city information data model called CityGML.CityGML is a commonly adopted standardised open city information data model, which has been used in more than 100 cities[3] publicly or privately. Moreover,it offers flexibility to extend its original data model with domain-specific objects and attributes. Therefore, it shows promising signs for developing a CityGML based Food Water Energy Application Domain Extension (FWE ADE). The development process of the FWE ADEhas been led by an international group of domain experts from the food, water, energy, urban design and geoinformatics domains as a part of IN-SOURCE (INtegrated analysis and modelling for the management of sustainable urban FEW Res-SOURCEs) project (2018-2021). An integrated urban data model can become a vital software infrastructure for the planning, operation, and maintenance of present and future cities (Eicker et al. 2020). FWE ADE will not onlyallow FWE related data storage and exchange across different bottom-up or top-down urban simulation tools since it provides a data frame from building stocks to the regional level. But, it will also allow the domain experts and decision-makers to visualise the integrated FWE datasets driven by population, land use and climate change.

With this background, first in section 3, CityGML and its extension mechanism in developing the FWE ADE is explained in detail. Later as an example concept in section 4, the role of CityGML FWE ADE to connect the FWE land use simulator based on UD_InfraSim with an urban energy simulator SimStadt to estimate the biomass potential for a landuse scenario in Vienna is documented. Having such a data exchange setup can allow connecting domain specific simulation tools to simulate FWE resources based on changed population, land use and climatic conditions.

3 SHARED DATA MODEL: CITYGML AND FWE ADE

3.1 CityGML and its Extension Mechanisms

CityGML is an XML-based open city information data model standardised by OGC in 2008. The encoding standard documentation[4] for its last release, version 2.0, is available from the OGC website. The CityGML standard document uses Unified Modelling Language (UML) diagram and its XML schema definition (XSD) to describe data models, which explains how to model virtual 3D city models, also called CityObject, such as buildings, vegetations, land use, roads, bridges, tunnels, street furniture and water bodies in terms of their geometry, topology, semantics and appearance in five different Level of Details (LoD). For example, a building in CityGML can be represented as a 2D building footprint in LoD0, an extruded building block model in LoD1, while LoD2 includes additional roof geometries. Moreover, LoD3, in addition to LoD2, includes building openings, e.g. doors and windows, while LoD4, in addition to LoD3, also includes building interiors. Different use cases have shown the usefulness of CityGML globally with the development of various CityGML based tools and workflow pipelines. For example, its use in city planning (Agugiaro et al., 2020), disaster mapping (Kilsedar et al., 2019), urban energy demand (Padsala et al., 2020), urban water demand (Bao et al., 2020) and many such urban modelling and simulation related use cases.

CityGML is a domain independent city information data model. Hence it does not contain domain specific objects and attributes. However, CityGML offers two official ways to extend its original data model 1) generics and 2) a formalised mechanism to develop domain specific extensions called Application Domain Extension (ADE). Generics, which can also be called "CityGML extension during the run time", is the easiest way to extend the original data model of CityGML. Using generics, users can add an arbitrary number of extra attributes, known as genericAttribute, to any CityObject without preparing a new data model or its application schema. Users can also define a new CityObject known as genericCityObjects, which can have arbitrary geometries with genericAttribute for its every LoD. Both genericAttribute and genericCityObjects are given an XML namespace of "gen" to differentiate themselves from the original XML namespace of CityObjects. XML namespaces are a set of unique element names which prevents conflicts between elements of the same name. For example, Bao et al. (2020a), in their biomass workflow of SimStadt, extended the CityGML CityObject of LandUse by adding land use area, soil type, crop type as some of the many other generic attributes for its later use in estimating biomass and its derived bio-energy for the counties of Ludwigsburg, Dithmarschen and Ilm-Kreis in Germany. Figure 1 shows a typical

[3] https://3d.bk.tudelft.nl/opendata/opencities/
[4] https://www.ogc.org/standards/citygml

workflow of adding genericAttributes or genericCityObjects using Feature Manipulation Engine (FME) [5] to extend CityGML. FME is a commercial extract, transform and load (ETL) tool commonly used for data conversion, integration and manipulation.

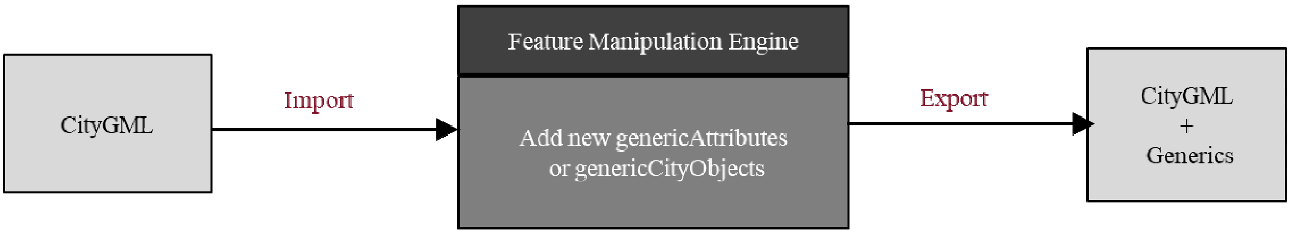

Fig. 1: A typical workflow to extend CityGML with generics using FME

On the other hand, application Domain Extension, or ADE, is a formalised way to extend the CityGML data model for a specific domain. Like generics, ADE is also an extension mechanism to CityGML for introducing domain-specific objects and attributes, which is often the case as specific applications require specific objects, attributes, and relationships that are not available in the original data model of CityGML. However, unlike generics, which 1) does not change the original CityGML XML schema, 2) have the same XML namespace and 3) can be specified at run time, ADEs 1) can change the original CityGML XML schema with domain specific new objects, attributes and relationships, 2) must have ADE specific unique XML namespaces to allow using multiple ADEs and prevent conflicts amongst the same CityGML document and 3)must be specified using UML diagrams or XSD.Such advantages over generics allow domain experts to adopt ADEs as a commonly adopted data model to support specific domains and applications. Though initially, using XSD as the only way to model ADEswas described in the CityGML encoding standard, van den Brink et al. (2012), in their article and later, OGC in their CityGML best practise document (OGC, 2014), described modelling an ADE using UML diagrams. Since then, a commonly adopted process to implement an ADE includes 1) Using software such as Enterprise Architect[6] (EA) to create a UML diagram to represent a data model 2) converting UML diagram to XSD either using EA's inbuilt XSD converter or open source tool such as ShapeChange[7] and 3) validate the ADE injected CityGML document against the original XSD of CityGML using tools such as FME validator, val3dity[8], CityDoctor[9]. Validation will make sure that it satisfies the CityGML's standardised specifications and definitions set by the OGC. Figure 2 explains a typical ADE implementation workflow using FME.

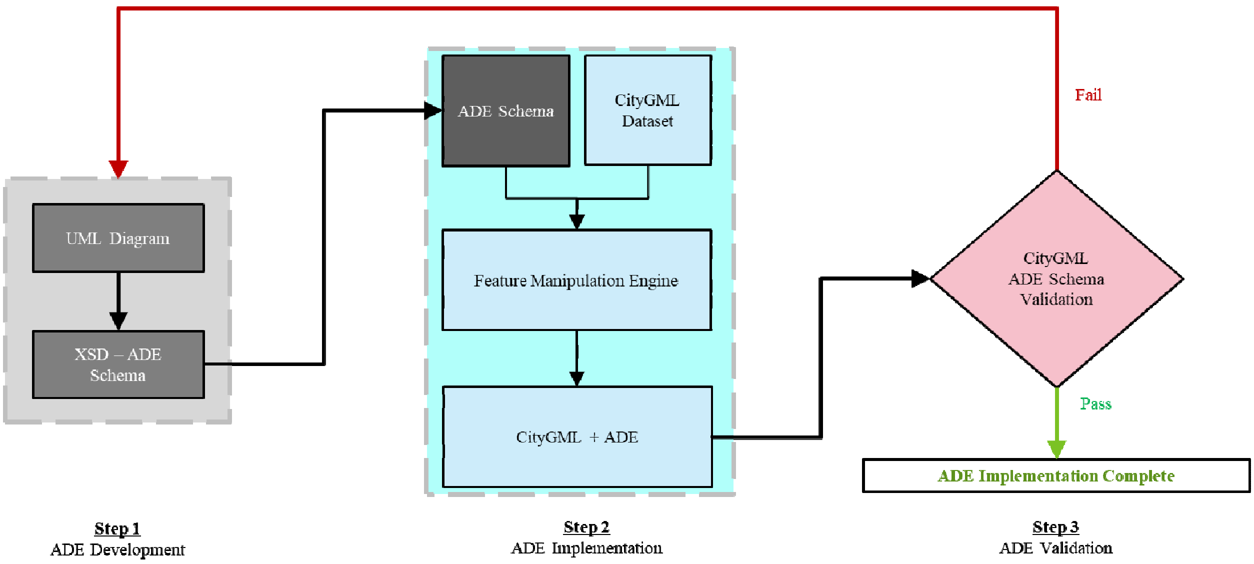

Fig. 2: A typical workflow to extend CityGML with ADE using FME

[5] https://www.safe.com/
[6] https://sparxsystems.com/
[7] https://shapechange.net/
[8] https://github.com/tudelft3d/val3dity
[9] https://projekt.beuth-hochschule.de/citydoctor2/

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Because with ADEs, a formalised domain specific objects, attributes, and relationships can be modelled, it is commonly used amongst the domain experts to store and exchange their datasets amongst different tools and simulation workflows.Biljecki et al. (2018) found that until 2018, around 44 ADEs supported a wide range of domains and applications. Some of the regularly used ADEs are Energy ADE (Agugiaro, 2018) and its use in building stock energy demand simulations (Geiger et al., 2019; Rossknecht and Airaksinen, 2020), Utility Network ADE (Becker et al., 2011) and its use in modelling below ground utility networks (Duijin et al., 2018; Fossatti et al., 2020), Noise ADE (Groger et al., 2012) and its use in noise mapping (Czerwinski et al., 2006; Kumar et al. 2017) and Dynamizer ADE (Chaturvedi et al., 2015) to store time dependent variables in CityGML (Chaturvedi et al., 2019;Chatzinikolaou et al., 2020). However, despite different ADEs supporting different individual domains, a single integrated data model supporting multiple domains such as food, water, and energy, that can be used for FWE nexus related simulations is still missing. Hence, as one of the IN-SOURCE project outcomes, a new FWE ADE is under constant development. Its first version extending the CityGML version 2.0 was recently made available using the project's GitLab page.[10]

3.2 The CityGML Food Water EnergyADE

In its current version, the FWE ADE is divided into four modules, each representing a spatial level 1) FWEBuilding, 2) FWELanduse, 3) FWEArea, and 4) FWESystem. FWEBuilding targets building stock level and extends the original CityGML CityObject of Buildings with FWE related parameters. FWELanduse targets land use polygons representing land use (e.g. residential, commercial, vegetation) and extends the original CityGML CityObject of LandUse with FWE related parameters. Finally, FWEArea and FWESystem are introduced as two new CityObjects with multi-surface geometry in the CityGML data model to store FWE related parameters at administrative boundaries. A multi-surface geometry is a two dimensional geometry collection of surfaces representing a feature boundary. Using multi-surface geometries,FWEArea represents zonal or municipality boundaries, FWESystem represents city or regionallevel boundary. Two main reasons behind dividing FWE ADE into these four modules are 1) to cover different spatial level of any study area as shown in figure 3 and 2) to introduce FWE parameters specific to a spatial level that might not be available on other spatial levels.

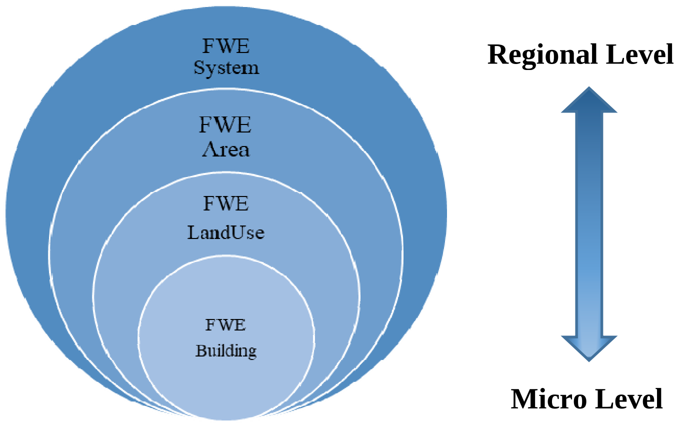

Fig. 3: A conceptual diagram showing the FWE ADE at different spatial levels

The complete documentation of FWE ADE, UML diagrams and its XSD schemas are available through the project's GitLab page as referenced before. In the context of this paper, because the biomass workflow of SimStadt using the CityGML CityObject of LandUse as its input, the FWELanduse module is explained further.

As mentioned before, the FWELanduse module is an extension to the CityGML CityObject of LandUse. CityGML LandUse is defined as a multi-surface geometry describing areas of land dedicated to a specific use. To indicate land use attributes,class, function, and useare already part of the CityGML LandUse data model. While the class attribute is used to classify land use objects, like settlement area, vegetation, water body etc., the attribute function defines the nature of the land use object, e.g. residential, commercial, institutional etc. The attribute use can be used for more detailed classification such as single-family houses, multi-family houses, hospitals, schools, etc. As an extension to the CityGML LandUse data model, FWE

[10] https://transfer.hft-stuttgart.de/gitlab/in-source/fwe-ade

related parameters such as population, survey year, land use area, crop type, soil type, irrigation demand, transpiration loss, biomass primary energy potential are introduced as a part of new FWELanduse objects for CityGML LandUse CityObejct. These new parameters, along with the CityGML LandUse geometry, are required as an input to the SimStadt’s biomass workflow.

4 FWE ADE APPLICATION: BIOMASSPOTENTIAL FOR A LAND USE CHANGE SCENARIO

In the following section, as an example concept showcasing the role of FWE ADE in connecting two different urban simulator tools to achieve a data flow amongst them is explained in detail. A high level workflow of the data exchange setup between UD_InfraSim and SimStadt via FWE ADE capsulated inside 3DCityDB is shown in figure 4.

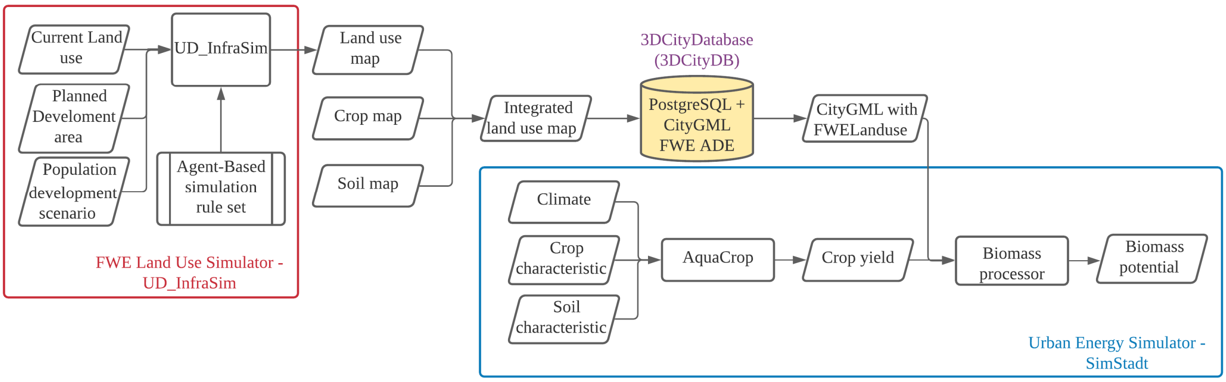

Fig. 4: Workflow Diagram

4.1 UD_InfraSim and its FWE Land Use Simulator

The UD_InfraSim is a simulation platform that enables urban planners to estimate the impact of infrastructure costs, for example, for road and water networks, in relation to changes in land uses (growth patterns) in the urban region[11] (Gebetsroither-Geringer et al., 2015). It is built upon earlier 'urban development simulation tools' (Gebetsroither-Geringer and Loibl, 2007; Gebetsroither, 2009; Gebetsroither and Loibl, 2014). Within the IN-SOURCEproject, the simulation platform was used, adapted and extended to build the FWE Land Use Simulator[12].

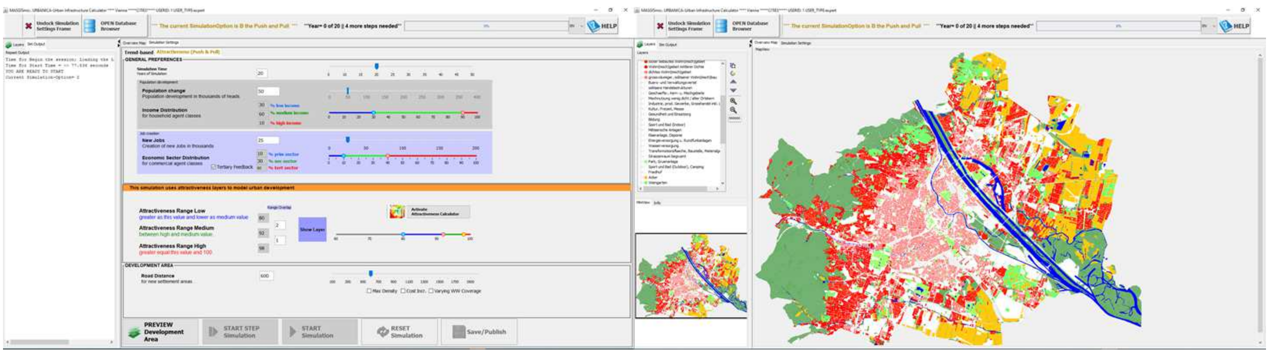

Fig. 6: Screenshot of the FWE Land Use Simulator

Different data sources have been used for the case study in Vienna.For example, open government data regarding the current land use in Vienna and remote sensingdata for crop type classification to derive the spatial crop distribution for different crop types (Vuolo et al., 2018). For the biomass calculation with Aqua Crop, the soil type was needed, which was gained from BFW.[13] Using the FWELand Use Simulator, the current and a scenario for future land use were simulated. For the future land use scenario, an additional population of 150,000 new inhabitants in Vienna was assumed.The scenario also uses information about the future development plan of Vienna to estimate the loss of arable land due to new settlements and the

[11] https://www.ait.ac.at/en/research-topics/digital-resilient-cities/projects/ud-infrasim
[12] https://drc.ait.ac.at/sites/insource/fwe-land-use-simulator/
[13] digital soil map, the 1km raster data set is open source and can be downloaded here https://bodenkarte.at/

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corresponding loss of biomass. This assumed population increase is lower than the official prognosis show[14], but as it is assumed that the growth concentrates on the already planned new development areas in Vienna,it is reasonable. The chosen scenario frameconditions depict just one possible city development pathway. However, in the context of this paper, itisnot necessary to derive the most likely development scenario as the goal of the paper is to demonstrate the concept of connecting different domain specific tools using CityGML FWE ADE. As a final output from the UD_InfraSim based FWE land use simulator, an integrated map showing the land use scenario merged with crop type, and soil type dataset is produced in the shapefile data format. Using FME, shapefile is converted to the CityGML LandUse dataset,which is then imported to 3DCityDB.

4.2 3DCityDB and its connection to FWE ADE

3D City Database or 3DCityDB is an open source software to store, manage, analyse and visualise CityGML datasets (Yao et al., 2018). It is built on top of spatial relational database management system Oracle Spatial/Locator or PostgreSQL with PostGIS. For the present work, 3DCityDB with PostgreSQL is used. It consists of SQL scripts that comply with the CityGML standards to generate required database tables, functions, procedures and views that allow users to store, manage and query CityGML datasets in PostgreSQL. For easy operation of 3DCityDB, a free importer Importer/Exporter tool for 3DCityDB is also distributed as a part of the 3DCityDB package. Importer/Export tool is available in both graphical user interface and command line interface version. Apart from allowing users to import, manage, query and export CityGML datasets, the tool also allows users to export their CityGML datasets to other data formats such as KML, COLLADA and glTF, which are some of the commonly used data formats to visualise 3D city models on the web using digital globes. The complete list of its functionalities, along with its source code and documentation, is available on their GitHub[15] page. An important feature of the tool used in the present work is its ADE manager plugin. Using the ADE manager plugin, new database tables related to the FWELanduse module of the FWE ADE and its required operational SQL syntax, also called Data Definition Language (DDL) statements, could be generated automatically. The DDL statements are required to define the data structure and modify the datasets inside PostgreSQL. By default, 3DCityDB does not allow importing and exporting CityGML datasets enriched with ADEs. Hence, two custom FWE ADE based java modules, 1) citygml4j and 2) ADE specific importer-exporter extension for 3DCityDB,are in development. While citygml4j will be used by the Importer/Exporter tool toparse and write ADE specific CityGML datasets, the ADE specific importer-exporter extensionwill be used to read and write datasets to ADE tables in the PostgreSQL/3DCityDB. An example implementation to develop such ADE specific importer/exporters to 3DCityDB is available on its GitHub[16] page. Figure 7 shows a typical workflow for importing, managing and exporting FWE ADE enriched CityGML datasets in 3DCityDB.

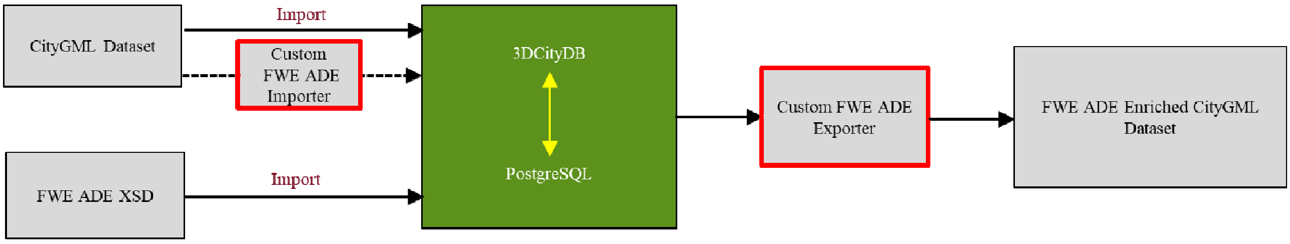

Fig. 7: 3DCityDB's FWE ADE Importer/Exporter workflow

After importing the CityGML LandUse scenario map from UD_InfraSim to 3DCityDB, an internal mapping of the required FWE parameters of land use polygon area, crop type, soil type was made between the imported CityGML LandUse datasets converted from the UD_InfraSim's integrated land use map and the FWELanduse ADE schema using SQL scripts in PostgreSQL. With this, the imported CityGML land use data is made to comply with the FWE ADE's module of FWELanduse and exported as an FWE ADE enriched CityGML LandUse dataset. This dataset is then used as an input to SimStadt's biomass workflow.

[14] https://www.wien.gv.at/statistik/bevoelkerung/tabellen/bev-2048.html
[15] https://github.com/3dcitydb
[16] https://github.com/3dcitydb/extension-test-ade

4.3 SimStadt and its BiomassWorkflow

The assessment of energetic biomass potentials from agriculture is based on an existing biomassworkflow that has been introduced before in section 3.1, validated, and applied at the example of three German counties as case studies. The workflow was reconfigured from accepting inputs using genericAttributes to complying with the FWE ADE schema. The workflow is now compatible with and transferable to other regions, as long as (i) land use information was provided under FWE ADE schemain CityGML format, (ii) information on new land use/crop types is available and is added to an existing SimStadt's XML library and (iii) the new crop/soil types are described and written in standard inputs crop/soil files for the yield simulation software AquaCrop (Raes, 2016). The workflow is part of a versatile regional energy system modelling environment, SimStadt[17], that aims to compare different renewable energy resource potentials and contrasts these with local energetic demands in a given region. SimStadt, which is under constant development at HfT Stuttgart since 2012 (Nouvel et al., 2015), comprises modular workflow management, with each workflow serving a specific purpose. To date, it can assess building-related demands (cooling and heating (Weiler et al., 2019), residential electricity (Kohler et al., 2010), water (Bao et al., 2020b) and renewable energy potentials (rooftop photovoltaics (RomeroRodriguez et al., 2017) and biomass (Bao et al., 2020c) on a single-building or single-field level using 3D city models or digital landscape models in the CityGML format.

For the biomass workflow, a key input is the FWE ADE's FWELanduse enrichedCityGMLLandUse object having multi-surface geometries.Besides geometric and attribute data from theFWE ADE, meteorological data of Vienna's current climate, i.e. the average over the past 10 years, and forecasted climate data in 2040 in TMY3[18] format, was provided by Meteonorm[19].

To calculate the biomass yield based on local climate, soil characteristics, land management pattern, and irrigation pattern for most crops, a validated external crop yield and water simulation tool named AquaCrop, developed by the Food and Agriculture Organization of the United Nations (FAO, 2018) was integrated with SimStadt. The key characteristics of the crop and soil files that were generated as inputs for AquaCrop were collected based on statistical literature values (KTBL, 2018).The specific yields in fresh mass (tFM/ha/yr) of selected key crop types under average climate between 2000 and 2010 were validated with the statistical yield in 2015 and 2016 fromthe Vienna Agriculture Report(Wiener Landwirtschaftsbericht, 2017).The specific yieldresulting frombiomass workflow is based on the dry mass of the above-ground biomass. To compare with the fresh yield from the Vienna Agriculture Report, the harvest rate and water content (KTBL, 2018) were applied to convert the dry mass to fresh mass. The validation result is shown in table 1.

	Specific yield in t_{FM}/ha/yr		Area in ha	
Crop type	Simulation	Statistic	Simulation	Statistic
Maize	7.0	6.8 - 8.4	293	121 - 138
Potato	28.1	43.4 - 26.5	84	66 – 88
Soybean	3.1	1.5 - 2.2	132	54 – 81
Sugar beet	48.9	65.1 - 76.7	254	219 – 230
Sunflower	3.1	2.5 - 2.8	189	11 - 21
Wheat	5.8	4.9 - 4.4	2776	2172 - 2200

Table 1: Areas and specific yields of selected crops from simulation and literature.

Table 1 shows that the area allocation of potato and sugarbeet aligns with the statistical values. However, for sunflower that occupied less than 0.4 % of the agricultural area, the difference of area between simulation and statistic can be up to 17 times, as a part of the polygons were either overlooked or misplaced due to the limitation of the method of satellite image recognition (Vuolo et al., 2018). For the main crop type, i.e., wheat, the deviation is less than 10 %. At the aspect of specific yield, the error of the input map was isolated; only the accuracy of the biomass workflow was shown. According to table 1, the yields of most crops fall within the range from the statistic, except for sugar beet and wheat. The crop map did not differentiate the

[17] https://simstadt.hft-stuttgart.de/de/index.jsp
[18] https://www.nrel.gov/docs/fy08osti/43156.pdf
[19] https://meteonorm.com/

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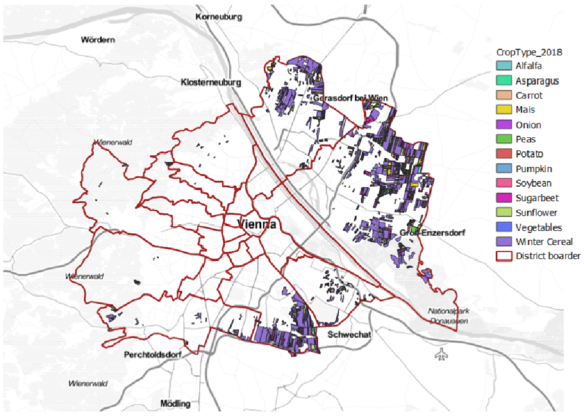
subtypes of wheat; therefore, winter cereal was applied to represent the family. The statistical yield of winter cereal was 5.5 to 6.3 tFM/ha/yr compared with the simulation result of 5.8 tFM/ha/yr, verifying the yield simulation result. As for sugar beet, the deviation might be brought by the inaccurate crop characters input for AquaCrop. Therefore, the standard sugar beet growing characteristic combined with the typical growing period in Vienna was applied, which might bring the yield difference.

4.4 ApplicationResults



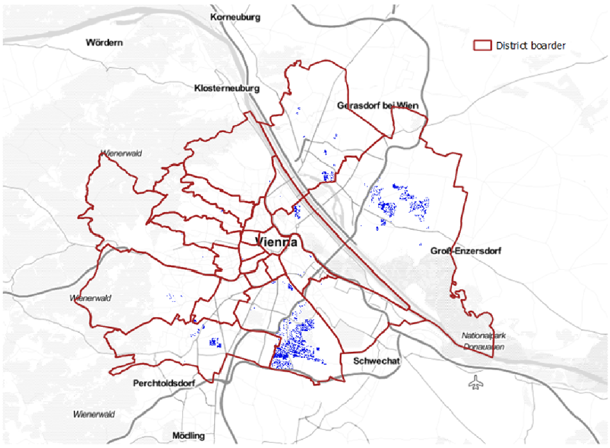


Fig. 8:Crop map 2018 depicted from remote sensing (left image)and a future settlement scenario2038 (right image)

Figure 8 shows the crop distribution map gained from remote sensing on the left side and a population growth scenario within the next 20 years on the right side. The images show that, especially in the south and northeast of Vienna, arable land and thus crop biomass production is affected. In this scenario, the destruction of arable land is not extreme because many of the planned new development areas already are not anymore used for agriculture, and it was assumed that the population density for new settlements is relatively high.

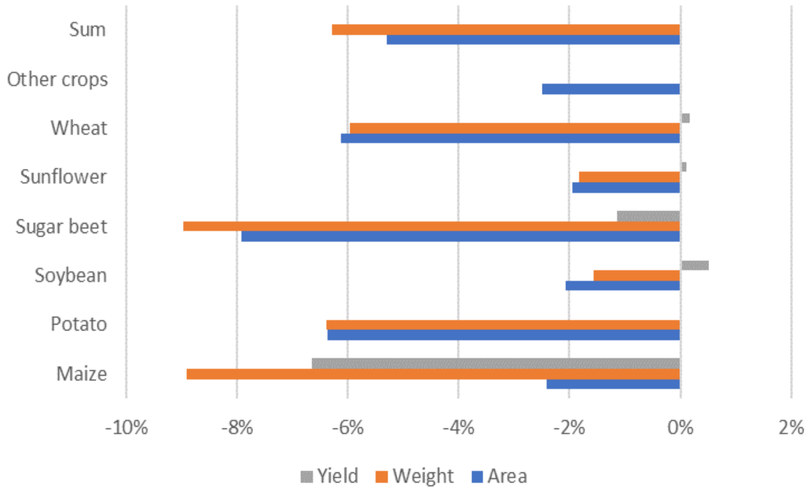


Fig. 9: Percentage change of area, weight, and yield of selected crops in the current scenario and 2038 scenario.

Figure 9shows the development of the agricultural area, the amount of biomass produced, and the specific yield of several crop types. Climate difference, i.e., the annual average temperature dropped from 11.8 °C to 11.6 °C, and precipitation increased from 608 mm/yr to 618 mm/yr, influenced specific yields to various extends depending on the crop types. Maise acted most negatively to the climate change with a yield drop of 6.7 % following by sugar beet with -1.2%. For other crops, i.e., potato, soybean, sunflower, and wheat, the yield increase by 0.5 %. In the term of the total agricultural area according to the scenario setting of the FWE land use simulator, there would be 2.1% to 7.9 % less land for crop growing in 2038 comparing with the current case (2018). The most significant area decreases were estimated for sugarbeet (7.9 %) and wheat (6.1 %). Even though few crops would be more productive, i.e., up to 0.5 %, under the 2040 climate, combined with the more significant drop of the agricultural areas, the total biomass weight was estimated to drop from 1.6 % to 9 % varying from crop types.

5 CONCLUSION

This paper introducesthe concept of data exchange between two simulationtools in two domains using a shared FWEADEextended from thestandardised open city information data model of CityGML.Unlike the genericsextension methodof CityGML, whichcannot have a formal data structure or schema, afull ADE can be formally specified, has a well-defined data structure, and its realisation can be validated against its schema, which is not possible with generic attributes and objects. Translating the use of ADE in a complicated real life application involving several domain specific tools, an ADE can providea well structured data framework to store and exchangedatasetsbetween different tools. Moreover, CityGML being a city information model and ADE being its domain specific extension mechanism was proved to be very helpful in translating integrated urban infrastructural systems such as the FWE nexus domain to an object oriented data model.Such an integrated data model provides data interoperability between different urban simulation tools in the FWE nexus domainsand helps develop simulation workflows that can analyse the entire urban infrastructural system as a whole and not just in their silos.

In terms of spatial and temporal detail levels, FWE ADE defined data at different spatial levels, i.e., building stocks, land field, community, or region, and additionally introduced time as a variable, i.e., the value of an attribute in a specific year. In the context of this paper,due to the fine spatial resolution down to land use polygons, bottom-up simulation tools can directly take geographical inputs or store outputs at the corresponding level achieving a high level of data accuracy and detail. For example, with such information,a trade-off between an open-field PV system and food production can be determined according to the potential simulation results.The top-down analysis method can also find inputs through the FWE ADE, i.e., by aggregating the values of land field polygons in the study region and store output at the regional level. The temporal variable enables the FWE ADE to present the changes in attributes over a certain period, i.e., the yield change in 10 years due to climate change.

Within the application of linking two tools addressing different issues within the FWE nexus, the proposed FWE ADE alsoproved its usefulness.UD_InfraSim simulated the land use change, i.e., the expansion of residential area at the expense of arable lands. A workflow from SimStadt simulated the biomass potential of arable lands. The accuracy of the final results wasdefinedby several factors, including the quality of the crop distribution map, the crop rotation, and the yield simulation tool. The nature of seasonal and annual agriculture rotation makes it difficult to estimate the exact crop distribution. Regardless, the decentralised crop map (with a resolution of 5 m) and soil distribution map (with a resolution of 200 m) served as the input of FWE ADE, later applied in the FWE Land Use Simulator and the bottom-up biomass workflow in SimStadt. The geographical resolution in the presented applicationis 25 meters.As already mentioned above,the elaborated scenario is just one possible scenario of how Vienna can developbased on “forecasted” frame conditions, i.e., government policies, forecasted population growth and climate change.The established connection can be used to easily calculate other development scenarios. It enables urban planners and sustainability experts to compare future landuse scenarios and evaluate its effect on the biomass potential to find scenarios with less reduction in the region’s biomass production. Furthermore, it supports spatial energy planning to estimate the renewable bioenergy production potential in the region to increase the local share of renewable energy supply.

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The Digital World of the Future as an Evolution of the Past

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1 ABSTRACT

This article presents an extension of a discussion of ideas related to the upcoming global digitalization and the role and place of a person in the digital world. The digital environment of a human being and society was discussed in a number of reports at previous CORP conferences. This work makes an attempt to determine possible forms of our future society based on an example of historical development of human society and taking into account growing digitalization of all aspects of life. The work of N. Berdyaev “The Origins and Meaning of Russian Marxism” was used as a guide on historical retrospective.

Keywords: digital world, modern society, digitisation, human society, modernisation

2 INTRODUCTION

People have always tried to understand what human society is. Historically, the following eras stood out: primitive communal system, slave-owning and capitalism. The attempt to build communism (socialism) was unsuccessful, although it had a strong influence on the social development of mankind. The classics of Marxism distinguished the following main classes of a modern society: the peasantry, the proletariat and the bourgeoisie. Nowadays, such a classification does not seem to be a good one. The stratification of modern society is based on other grounds, such as the attitude to property and the level of financial capabilities of an individual and/or a family. From this perspective, in the modern industrialized state, the following social segments can be distinguished: the super-rich class, the middle class and the poor. It is believed that the sign of a healthy society is the presence of a stable “middle class” (see Fig. 1). But the presence of the middle class is based not only and not so much on the attitude to property and the presence of certain financial opportunities. Fundamental social principles also play an important role, they allow a specific group of people to live as a whole, as a state. The basis of the slave-owning system is the “slave”, which is the main productive force of this society. The concept of “slave” is of interest both from the retrospective (historical) point of view and from the point of view of prospective development of modern society. In the materials of the CORP 2019 conference, you can find a number of ideas that notice the current real danger of sliding of modern society into “digital slavery”. It is noted that now there are signs that were already witnessed at the dawn of human civilization.

Nowadays we are facing a new era of civilization and it is not clear what we should expect from the new digital world. The analysis of social revolutions shows that revolution does not always lead to progress. Sometimes, revolution pushes society to the previous cycle of evolution to repeat it. This effect has already occurred in the attempt to incorporate Marxism in the Russian Empire. The main objective of this work is to find out if revival of the digital Marxism is possible in the future digital era. It is stated by N. Berdyaev that “Marxism” comes very close to “Fascism” (in its historical realization). This topic is currently highly relevant and very important.

It is necessary to note that the history of mankind evolves in a spiral, and therefore we should expect re-occurrence of past historical events in one form or another. These days, human kind is entering a digital era. Any new era, whether it is the transition from manual labour to mechanical labour, development of capitalism, or the attempt to spread communism, was always followed by a social disruption of a certain magnitude.

Let us analyze the variant (past) of social development in Russian Empire in as an example, relying on N. Berdyaev’s work. This genius Russian scientist very clearly demonstrated the essence of Russian society, of Russian state and their interactions, and their role as a source of progress and a contributing factor in annihilation of the old Empire. This example illustrates the ideological basis on which a new era of future society, i.e. a new digital world, can be constructed.

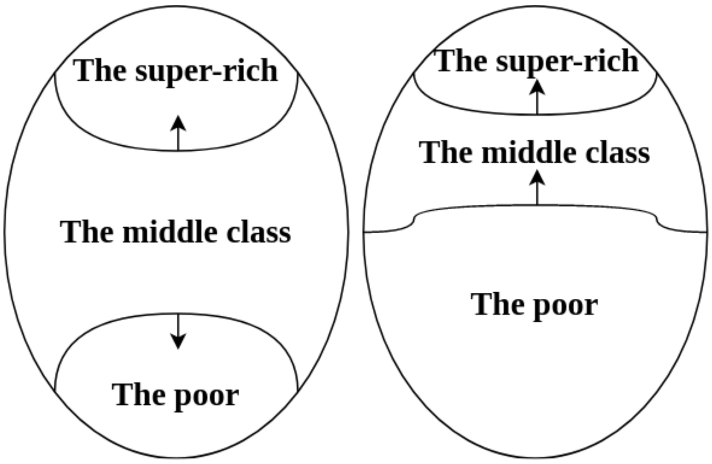

Fig. 1: Modern society: (a) a healthy society, (b) a revolutionary society.

3 REVIEW OF N. BERDYAEV'S WORK "ORIGIN AND MEANING OF RUSSIAN COMMUNISM"

In his work N. Berdyaev tried to answer this question: from where and how Russian Marxism came to be? His work goes far beyond Marxism as a doctrine and Russian Empire as a State, and has universal human significance as a fundamental theoretical study of Russian society as a whole. N. Berdyaev began to explore Russian society from the beginning of the Moscow kingdom, that means he explored it on the global historical scale. Such global scope and analysis enabled him to articulate his two famous questions: from where and how Russian Marxism came to be? Completely different from the Western version and very much different from its author's version (Marx).

According to N. Berdyaev, Russia went through an entire era of transition from the Moscow kingdom to the Stalin period. Kyiv Rus was not considered by the philosopher because, after its collapse, the civilization on the territory of Modern Russia, Ukraine and Belarus shifted its direction of development. The doctrine of Moscow as The Third Rome became the ideological basis of the Moscow kingdom's formation. Under the symbol of this messianic idea of Moscow as A Third Rome, sharp nationalization of the Church took place against the background of the Byzantine Empire's destruction. Religious and national merged together just as in minds of ancient Jews. But in the powerful State, the church began to play a service role and the Moscow kingdom became a totalitarian state. In the 17th century the most important event in the Russian history took place – a religious rift. Folk Orthodoxy severs its ties with the Church leadership and hierarchy.

The second blow to the idea of Moscow as a Third Rome was inflicted by reforms of Peter the Great. In the 19th century the conflict had taken on new forms: Russia, searching for social truth, collided with the Empire, searching for power. During that period, in the second half of the 19th century, a new cultural layer emerged in Russia. Later, that layer will be named "Intelligentsia". Raised on western teachings like Hegel, Kant, Schelling and others, that group was very much withdrawn and distant from common people. Liberal ideas were always weak in Russia. As a consequence of the divide of life in Russia, the fear effect was always present in Russia's ruling class. After the emancipation of peasants, the fear effect became predominant in the ruling class. Despite the great importance of the reforms, everyone was overwhelmed. Frustration and the divide of life in Russia were particularly clearly articulated in the work of the Great poets like Lermontov, Pushkin and others, who predicted the horrors of the forthcoming revolution almost 100 years in advance.

Catastrophic world view became typical of the majority of talented people. Russian writers of 19th and 20th centuries' felt themselves hanging over the edge. Infiltration of the West caused a critical turn in Russian soul, but in a completely different direction than in Western civilization. Russian literature and Russian thought indicate that in Imperial Russia there were no unified, cohesive culture. There was a rift between the cultural layer and the people, the old regime had no moral foundation. Everything was lining up to a revolution. Marx's doctrine of Marxism emerged from this background. The basic idea in Marxism: economy is the basis, ideology is the add-on. Marx's economic determinism exposes western man's illusions. It is very much similar to what Z. Freud did in his psychoanalysis. Marxism is not only science and politics, it is also faith, religion and this was its strength. Lenin and the Bolsheviks set for themselves Marxism as the only orthodox, i.e. totalitarian.

Bolshevism proved in 1971 to be the most loyal to the original Russian traditions: the search for a universal social truth, Russian methods of governance and domination by violence. For Lenin, Marxism is primarily a doctrine of dictatorship of the proletariat. Lenin did not assert the principle of the majority but the principle of a selected minority. Lenin denied freedom within the party and his principle applied to all of Russia. Lenin understood that a coherent doctrine, a coherent world view and binding symbols are needed. The doctrine of Lenin justifies a totalitarian doctrine that covers the totality of life. It covers not only politics and economics, but also thought and consciousness, all the creativity of culture. Such doctrine can only be matter of faith. The revolution in Russia led to the old kingdom being replaced by a new kingdom. The totalitarianism and demand of a holistic faith as the basis of the kingdom correspond to the deep religious instincts of the people. The soviet State was very similar in its spiritual construction to Moscow's Orthodox Kingdom. It, too, was suffocating. Socialism is quietly morphing into a kind of Russian fascism. Its features are: a totalitarian state, state capitalism, nationalism, chieftain, and, as a base – a militarized youth. The mission of Russian people is the realization of social truth in human society. The concept of freedom in Russia refers exclusively to the collective, not to the individual. The value of N. Berdyaev's work is that he clearly showed how easily false prophets can play on the instincts of a whole nation by changing names and slogans, but, in fact, not changing anything, can lead the society back where it tried to escape from. This historical example should be a handbook for anyone trying to understand what awaits our society in the near digital future, which is almost inevitable.

4 CONTRADICTION BETWEEN SOCIETY AND STATE

The modern world undergoes a process of dehumanization, just as it did at the dawn of the Christianity. In F. Engels' work "The Origin of the Family, Private Property and the State" a scientific approach and analysis of the development of human civilization is outlined. F. Engels clearly showed that the foundation of such phenomena as family, private property and state, is an economic basis. This foundation seems to be the foundation of a modern society today. But as the Bible states: "Man shall not live by bread alone…".

As N. Berdyaev showed, the ideological superstructure begins to play a decisive role in determining historical truth. Nevertheless, one can wonder whether F. Engels' ideas about the basics and N. Berdyaev's ideas about the superstructure in the era of complete digitalization, i.e. the digital world of the future, are still relevant. It can be assumed that in a digital world the basic human values, society and state will remain. But the devil is in the details. What would be the leading ideology of such a society that will allow to organize life in such society? An analysis of numerous literature shows that human nature, its essence, has remained virtually unchanged throughout human history. Therefore, as in the past, humanity will be driven by two fundamental things: economics (as the basis) and ideology (as a superstructure). That is why, in the digital world (DW), the main issue will remain the same as before: the attitude of man to property.

In this aspect, we already have three layers of people with huge contradictions between them. Here we are talking about a smaller layer of super-rich people, the middle class and the poor. And under such circumstances, the ideas discussed in N. Berdyaev's work are more relevant than ever. We need the clear understanding of the following:

- What is the fundamental idea of the whole society that can unite all three layers?
- What power is and what are its methods of control?
- What is faith or what is its equivalent?

As a derivative from all the above concepts we get the concept of "freedom". What is individual freedom, whether there is one at all, what is collective freedom and the reciprocal relationship of these freedoms.

In such a society, as N. Berdyaev showed, contradictions are inevitable, and the main task is to prevent these contradictions from becoming antagonistic and leading to a social explosion on one hand and modern slavery on the other.

There are already some very bad trends in modern society. The main one is the blurring of the concept of ownership and the "sagging" of the middle class and its reduction. Continuation of this trend will inevitably lead society to destruction.

5 THE "SELECTED MINORITY" PRINCIPLE

Historically (for objective reasons), all socio-historical formations had a relatively small ruling elite. Small in number, compared to the rest of the population of a particular state. This is objectively due to the simple fact that there is not enough wealth for everyone. Moreover, the ruling elite always tries to accumulate in their hands the maximum of material and public goods and wealth, which can be used as levers to control the main mass of the population. But it is difficult, almost impossible, to manage the society only with material resources and the leverage of power. That is why at all times in the history of human development, there has been an ideology that came in various manifestations and forms. The most common form of such ideology is religion. Implementation of religion in the society has taken many forms. In Western Europe, it is represented by the Holy See, headed by the Pope, with Catholicism as the religious basis. In this case, Religion is clearly separated from the State. This way, the State power and the Church hierarchy were separated. In Byzantine there was another form, in which religion was united with the state, with state power, and was practically in the service of the state. In this case, as was noted by N. Berdyaev, happens an acute nationalization of the Church and, as a result, two fundamental essences of society, ideology and economics (as the basis of the state) merge into one, one serves the other. This leads to a totalitarian state in which the religious side and the nationalist one merge.

On one hand, this situation is very convenient for the ruling elite, but on the other hand, it is a source of deadly danger and great opposition. It creates a chronic effect of fear of the ruling elite and suppression of the grass roots. And yet, despite objective shortcomings and threats, the principle of "selected minority" continues to work, even under the guise of democracy. It is just harder to detect and trace here.

6 THE CONCEPT OF FAITH

The concept of "faith" continues to play a fundamental role in the history of human civilization. Since the birth of the concept of "state" all rulers and the ruling class have used the concept of "faith" as a symbol of a particular religion in their own interests. A new concept of "faith", a new religion, usually appears at a time of total dehumanization and degradation of human society.

This is how Christianity emerged, practically on the ruins of the Roman Empire, and how the relatively young religion "Islam" gains an incentive against the background of the degradation of Christianity.

The concept of "faith" is not necessarily tied only to religion in its classical form (if we may say so).

This idea (the idea of "faith") was also successfully used by the Bolsheviks in Russia, who turned Marx's teachings into a new kind of Religion. The Nazis did the same in Nazi Germany. That way, we have sufficient reasons to believe that the "Digital world" or rather the transition of modern society to the DW will be accompanied by the rise of a new religion and new faith, capable to unite the society, the individuals and the collective.

An important observation arises: how to avoid the inevitable contradictions to which N. Berdyaev drew attention. How the elites, who run the society, "the selected minority", can govern the DW of the future? Unlike the former times, today's digital society has a fundamental difference from previous eras. First of all, currently almost every individual has the ability to receive and give information about themselves and also has many other opportunities. Under these conditions, a "faith" crisis can happen almost instantaneously.

7 INTRODUCTION OF THE CONCEPT OF "HERMENEUTIC TRIANGLE"

The permanent presence of the "fear effect" in the ruling class and the dissatisfaction of the lower classes require continuous ideological work to maintain a stable social situation. This is with the proviso that the economic situation is relatively stable. No ideological "lotions", will save a society, except for the despotic regime. One of the recent examples is the collapse of the USSR. Apparently, for the modern DW the old ways of ideological work are clearly not enough.

Therefore, one should address the framework of a person's perception of information. Today, a person consumes basic information from computer networks. And it is very important to figure out: is it the very same information that a person has gotten used to over a thousand-year history, or is it a little bit of everything and of something else. Information in a modern network, on a computer, can take various forms: it can be data, measurements, knowledge systems and much more. At the same time, a person has an important property—an ability that is called "understanding". In philosophy, the problem of understanding is studied by its special branch – hermeneutics, which emerged from the science of understanding texts. The basic idea of hermeneutics may be reduced to the scheme of a "hermeneutic triangle" (HT, Fig. 2)

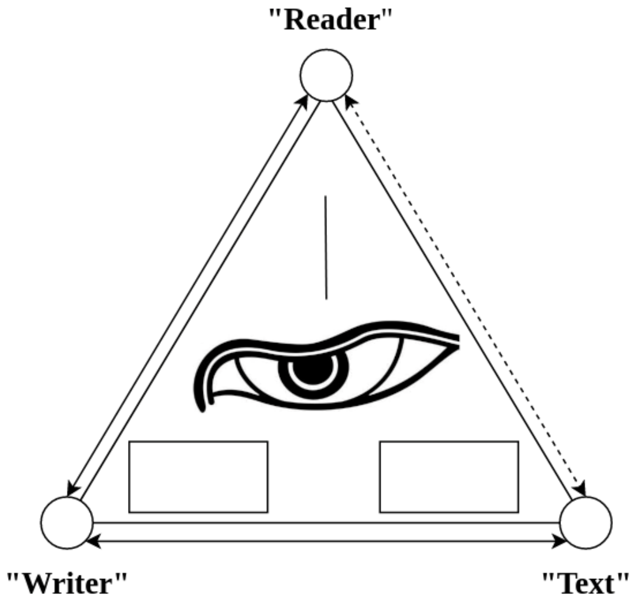

Fig. 2: Hermeneutic triangle

Figure 2 presents the interaction of three entities: "Writer", "Text" and "Reader". We will use this idea (HT) as a metaphor, as a fundamental principle. Everything that circulates in the World Wide Web (WWW) can be reduced to this principle. Through the new information entity (text), the "Writer", that created this entity, acts willingly or unwillingly upon the "Reader", who reads, watches or uses the "Text". (The text is a collective name, that may present everything that is produced in the WWW and that carries any information). Thus, it makes sense to say that the Writer influences the Reader through the Text.

In the light of the above, such a metaphor as HT can be perceived as a new mechanism for concentrated ideology expression, in the ideal case brought to the level of religion. The History of Russia, expounded by N. Berdyaev, serves as the historical example that represents the use of ideology by a ruling class. N. Berdyaev depicted that kingdom based on power and orthodox religion was reborn (very rapidly for a historical scale) into the kingdom of power based on Marxism as a new religion. And from this we can deduce that future DW may prove to be the perfect medium for new "digital slavery" formation. It is possible to achieve unprecedented controllability of modern society using and/or uniting under the concept of DW all the set of modern computer tools, technologies, methods of artificial intelligence. For that to happen, it is essential to find the opportunity (the need) to justify the fusion of authoritarian power and new religion based on the concept of "faith" in order to avoid problems with open discussions and demands for proof. In this case, the meaning and the content of new religion do not matter. Recent color revolutions and different grass-root movements show that "proper" tuning of HT provides stunningly quick results. And there is no need for serious ideological training or construction of different theories, in other words for creation of theoretical and/or ideological basis for a new religious theory. Nowadays there is an eternal number of ideas about how to form a "new religion". Potentially, new DW kings may set up a new religion or upgrade an old one rather quickly. There is also a probability of fairly quick replacement of one religion with another, taking into account the fact that human society is fixed historically on searching for social truth, while any state seeks power that can sustain this state both from the inside and the outside.

Consequently, future DW can not avoid contradictions between society and government power, between different population classes: the super-rich class, the middle class, the poor. The concern of authorities that serve the upper class will be the process of sustaining an "illusion" of some kind of unifying idea for the whole society. Although, in reality, it is not possible to find such an idea besides global cataclysms and wars. In a peculiar way, this illusion may be projected through the middle class and also through different power structures, whose main activity will shift into cyber domain. However, the fear effect in the ruling class will not disappear. The level of this fear will be determined by the number and capacity of power structures and the degree of their activity. If it is not possible to avoid antagonistic contradictions between classes of future

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DW, then creation of one whole cultural and spiritual space is out of question. In this case, the ruling class will always retain the feeling of loss of the moral lever, religious apparatus (democracy, church eparchy) will also start to degenerate at full speed, resulting in serious stratification. Since the question of the attitude of each individual to property will remain the main issue of the DW, the economic platform and the ideological superstructure implemented through the HT system will begin to turn into a mind illusion, which means that the same situation will appear as in the psychoanalysis of Z. Freud.

8 IDEOLOGICAL AND ECONOMIC FOUNDATIONS OF THE FUTURE DIGITAL WORLD

Modernization and improvement of the HT inevitably leads to a complication of the hierarchy and complexity of mathematical support (MS) and software, which, in turn, results in an increasing number of vulnerabilities and various kinds of “holes” and “rabbit holes”. That enables members of various segments of society to “travel” through that holes, provided they are able to understand that they are dealing with two types of illusions: economic and ideological.

At the same time, both illusions are controlled by the same elite. The concept of “faith”, that is fundamental for whole conscious life of the DW, will inevitably begin to erode. The inevitable crisis will hit, making all segments of the society equally dissatisfied. The upper layer understands that it is unable to control and adequately evaluate all the processes that are taking place. The lower layers understand that they live in a world of illusions, and not in the real world, and that they are simply being exploited for the unknown benefit. Also, every individual starts to understand that he has nothing to do with real property, and the real owners are hidden for him. It will be more and more apparent to the masses of the people that there is a real danger that digital society can become an orthodox and totalitarian system. Old methods of governing and dominating through violence (and there can be no other in a totalitarian state) will inevitably begin to fail. Once again, a critical problem of reorganization of society and transfer of power will arise. But, first of all, it will be necessary to solve the issue of property. And the process of power transferring is not a trivial moment itself. In any case, at least at the intermediate stage, the power will belong to the “elected minority”. And after that it is crucial for real democratic transformation to happen, a true one, not the disguised version that led to the Russian revolution in 1917. It is also very important for the politics and the economy to be separated from thought, consciousness, creativity, culture and religion. Only in these circumstances evolutionary transformations in DWs are conceivable. Politics and economics should not be subjects of “faith”, namely a new religion. Otherwise, the “old kingdom” will be quietly replaced by the “new kingdom” and society will be doomed again.

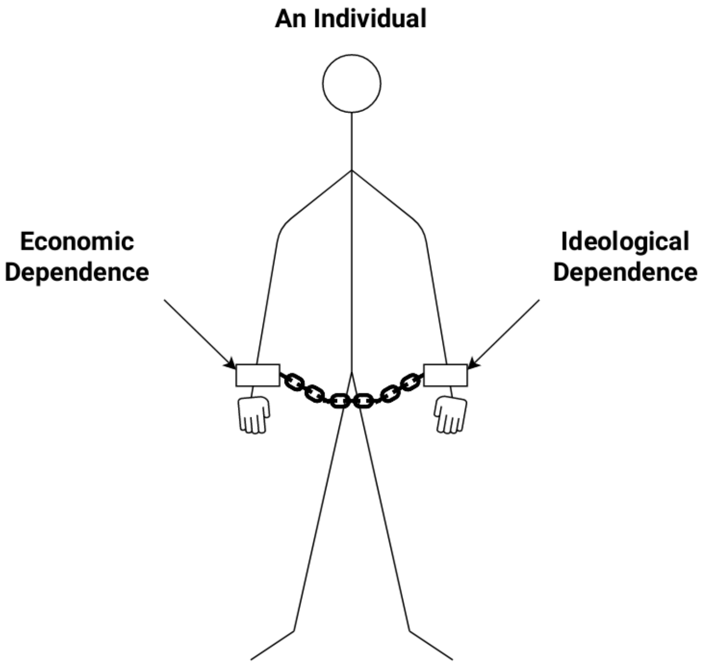

Fig. 3: The basis of slavery.

Special attention should be paid to the following signs of the kingdom: totalitarian state, state capitalism, nationalism, leadership mania (cult of the leader), militarized youth. One also needs to pay attention to the concept of "freedom". This concept should apply only to the individual. A shift of an individual freedom into collective freedom should be prevented. Otherwise, the process of dehumanization of DW will inevitably start, as it happened time and time again throughout the history of mankind.

9 PRECONDITIONS OF DIGITAL SLAVERY FORMATION

In our opinion, a very successful definition of slavery is given in the work of B. Spinoza: "Man's lack of power to moderate and restrain the affects". There are a number of factors or conditions that are necessary to form a platform to create slavery, the main of which are (see Fig. 3):

- Ideological (spiritual, religious) dependence.
- Economic dependence. The ideal option is the absence or illusion of property.

The essence of the slave was described very properly by F. Nietzsche: "The Enlightenment causes revolt, for the slave desires the unconditioned, he understands nothing but the tyrannous, even in morals, he loves as he hates, without NUANCE, to the very depths, to the point of pain, to the point of sickness—his many HIDDEN sufferings make him revolt against the noble taste which seems to DENY suffering".

Let us consider in more detail the conditions for the formation of slavery:

(A) Ideological dependence.

The digital world allows to increase significantly the influence on person's spiritual world to almost unprecedented levels. It is due to the fact that the HT forms and adapts very quickly. Examples of this phenomenon are: the organization of colour revolutions, various public mass movements, sects, the organization of riots, etc.

This fact also determines the sustainability and danger of ideas of the Islamic State (IS) and similar phenomena. Digital opportunities allow not only to spread ideological, religious and other forms of propaganda, but also serve as means of organizing and managing various events (strikes, rallies, terrorist acts, etc.).

(B) Economic dependence

The economic dependence of the individual can be realized through deprivation of property. There are various ways to deprive a person of property:

- By force: property is simply taken away on a pretext, or without it.
- Bank lending system, including long-term (up to 25 years or more). Nowadays loans are issued for almost everything. Loans for single housing (real estate) are considered to be especially dangerous. In this case, the individual becomes "bank's serf", tied also to this real estate and to the job that pays for the loan.
- A system of cashless money, electronic financial instruments that attach the individual to a specific banks. It is not only about the person being controlled completely, but any minute for various reasons his access to financial resources and tools can be blocked, and he will remain with absolutely nothing, "an ideal slave".
- Stock and securities markets. The owners of these specialties are the owners of virtual property, which can be lost almost instantly, for various reasons: market fluctuations, the decision of law enforcement agencies and/or other departments, etc.
- Precious metals and jewellery, which can be officially evaluated and traded only in special organizations (banks) with state control.

Under certain conditions, the above dependencies turn a person into a modern slave. Conditions for the small and a part of the medium-sized business are approximately the same. The life span of such business is extremely limited, and it has a very small chance of survival in a totalitarian (and even in a democratic) state. This type of business plays a role of plankton in a democratic state. In a totalitarian one it is simply not needed. In most cases, it can function normally only in the form of affiliated structures of state-owned companies or large private companies. The probability of vertical growth of small and medium-sized businesses is almost zero. In other words, development plan from small to medium to large business is practically impossible. Small and medium-sized businesses can emerge as a source of serious business only

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artificially, in someone's interests. Spontaneously, such an opportunity exists only if at some point the owner of small business is replaced, which makes a vertical elevator phenomena only a formal illusion.

10 CONCLUSION

This work presents an attempt to shape the challenges of the future human society, based on the example of evolution of man, community and state. Analysis of N. Berdyaev's work allowed us to pinpoint a number of important issues:

• The essence of a human in a global historical scale remains practically unchanged.

• Human society conceals in itself a set of challenges and contradictions.

Consequently, it can be easily assumed that the future digital society will not avoid “old” problems associated with both an individual and a society.

New technological means, the development of digital technologies, systems and methods of artificial intelligence, act undoubtedly as catalysts for scientific and technological progress and the development of society as a whole.

Nonetheless, they also lead us to old problems. And the problem of “digital slavery” is by no means mythical. The emergence of this threat has objective preconditions, and the task of progressive humanity is to avoid the sliding of the future society into this shameful development spiral. N. Berdyaev showed an example of such a metamorphosis of human society. His work surprisingly logically shows how the 1917 revolution degraded back into the “new-old Moscow kingdom”. Slogans mingled, but the deep essence, the fundamental basis of the old kingdom remained.

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The Effects of City Fabric on Urban Strategies in Pandemic Time – Case Study Rome City (Italy)

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1 ABSTRACT

One of the most important aspects of studying the consequences of Covid-19 pandemic in cities is urban form and public spaces, particularly the central cores of cities because of their high population density which relates to their touristy, commercial and office functions. The aim is to review the strategies for restoring urban life and safe living by examining the relationship between dwellers and urban spaces. The city form which the movement is taken are going to be like a body which has no blood flow, as a result of those vital arteries will be disrupted and all the current economic, social, psychological and even political dimensions will be damaged. The methodology involves personal natural observation. In general, the proposed solutions in dealing with the destructive effects of pandemics classified into short-term and long-term approaches. Some strategies like Review of rigid and regulations in architectural design with the aim of mandatory natural ventilation could be related to future and Coloring of street urban walls based on high risk / low risk/ no entry areas for children and elderly people can help governments to face the corona pandemic and trying to take preventive measures, control and planning to return in normal life.

Keywords: Rome, pandemic, strategy, fabric, city

2 INTRODUCTION

2.1 The relationship of the city fabric with people's lives

Cities, as the essence of human life, have a fundamental role in creating satisfaction, and in fact, they are the creator of human lifestyle and determiner of the quality of life. Therefore, the governments and planners emphasize the ability of cities to to improve the human lifestyle at both international and national levels. The historical fabric of cities in terms of antiquity, physical heritage, and contexts appropriate to cultural performance is the most important physical-spatial context of cultural values. Cities, because of services and distribution of co-operations, are the economic, social, and political core in any country.Those that can be considered a suitable place for making income, work, and innovation.

Quality of urban life is one of the most important fields of urban studies in different countries with multiple social, environmental, and economic factors. Attention to this index in cities has increased due to its role as an effective tool in urban management and planning and in general, in determining the viability of cities. Paying attention to the quality of the artificial environment, in addition to encouraging people to participate in it, is effective in inducing a sense of satisfaction in people. Quality of life reflects the general characteristics of the environment in an area which can be used as a powerful tool for monitoring development planning of community. It is also defined as a measure of the extent of the spiritual, psychological, and material needs of society and the family. Environmental quality is a part of the quality of life and includes all the factors that form parts of human satisfaction with the involvement of the environment.

2.2 Explain the general changes in cities during the COVID period and a brief definition of it

Many countries, regardless of geographical location and the degree of development, are facing the Corona pandemic and trying to take preventive measures, control, and planning to return to normal life. The effects of this attack are not the same in different countries, but the most obvious variance is in the type of government plans to regulate the situation, maintain public health, and how to support the interaction between people and authoritiesIn general, the pandemic has reduced the economic standards at all levels. Jobs such as restaurants and shops are generally in a slump and unable to pay taxes to the government. As a result, the administration has faced a decline in revenue. On the other hand, the economic support for the people has been another factor that pressured the government. These all have induced decreasing their abilities to implement urban development programs. Given the budget deficit in cities, a good solution is to pay attention to new investments. It may be possible to mobilize people, even remotely, by allocating funds to innovate in more creative investments instead of fewer important programs. COVID-19 has disrupted the lives of us all, not just as a disease, but as a whole. This pandemic may no longer be a threat to human life in the next few months or years, but it provides an opportunity to think and actively work on the challenges facing preventive action in cities.

COVID-19 has disrupted all of our lives, not merely for a few months, but in a far more profound way. Nevertheless, the pandemic offers an opportunity to conceive of, and actively work towards, a better future for cities and their inhabitant.

3 ROME CITY AND THE FABRIC

Rome (or Roma in Italian), is the historic capital of the Rome Province, in the Lazio region, In the central-Western portion of Italy which is constructed and has grown on both sides of the Tiber river, which leads to the Tyrrhenian sea (Mediterranean). Rome is a compact city with a dense culture that can walk people through history by crossing its streets and alleys. Although Rome cannot be considered an industrial city, its economy is dependent on the tourism industry, which receives about 9 million international tourists each year. Despite its profitability, the need for the government, in the Corona pandemic which has led to the abolishment of touristic trips, to anticipate and control critical situations is more than before. The zone of the city is about 1285 km2, while the province is about 5352 km2.

Rome's 2021 population is now estimated at 4,278,350. About 9.5% of Rome's population is non-Italian. Half of which is the immigrant population of European origin, most notably Romanian, Ukrainian, Polish, and Albanese, comprising a total of 4.7% of the population. The other 4.8% is comprised of immigrants with non-European origins, particularly Filipinos, Bangladeshis, Peruvians, and Chinese. In 1950, the population of Rome was 1,884,065 which has grown by 21,294 since 2015, representing a 0.50% annual change. These population estimates and projections, come from the latest revision of the UN World Urbanization Prospects. These estimates represent the urban aggregation of Rome, which typically includes Rome's population in addition to adjacent suburban areas.

Fig. 1: Spanish Steps, before and after Covid-19, photos by authors.

Permeability, diversity, readability, flexibility, visual proportions, sensory richness, color belonging are the characteristics of urban tissue studyUnder these conditions, cities are in a long-term effort to improve themselves, manage, and plan for an immediate response to the COVID-19 epidemic. These experiences discussed how cities respond to the epidemic and how they work to reduce lock-in measures and welcome long-term recovery. The historical context of the city of Rome also has valuable elements that are considered to be its ancient heritage and even culturally very important for the people of this country.

The outbreak of the COVID-19 pandemic has profoundly impacted Rome city and raised fundamental questions about urban development. Rome Urban fabric is the congestion, compaction, and integration of spaces and elements of a city that depends on the conditions of the natural environment, climate conditions and land conditions, and topographic characteristics of the region.

As previous pandemics changed urban approaches and planning, Covid-19 causes structural changes in the relationships, neighborhood, economy, health, and urban spaces to develop plans.One of the areas with the highest number of people with Covid-19 positive cases over the past year in this city is the Torre Angela area, located in southeastern Rome, on the edge of the second ring. This high number of positive cases may be caused by some factors such as insufficient attention to health issues, and environmental pollution, such as waste and high population density, especially in the immigrant inhabitants with low financial capacity for health care.

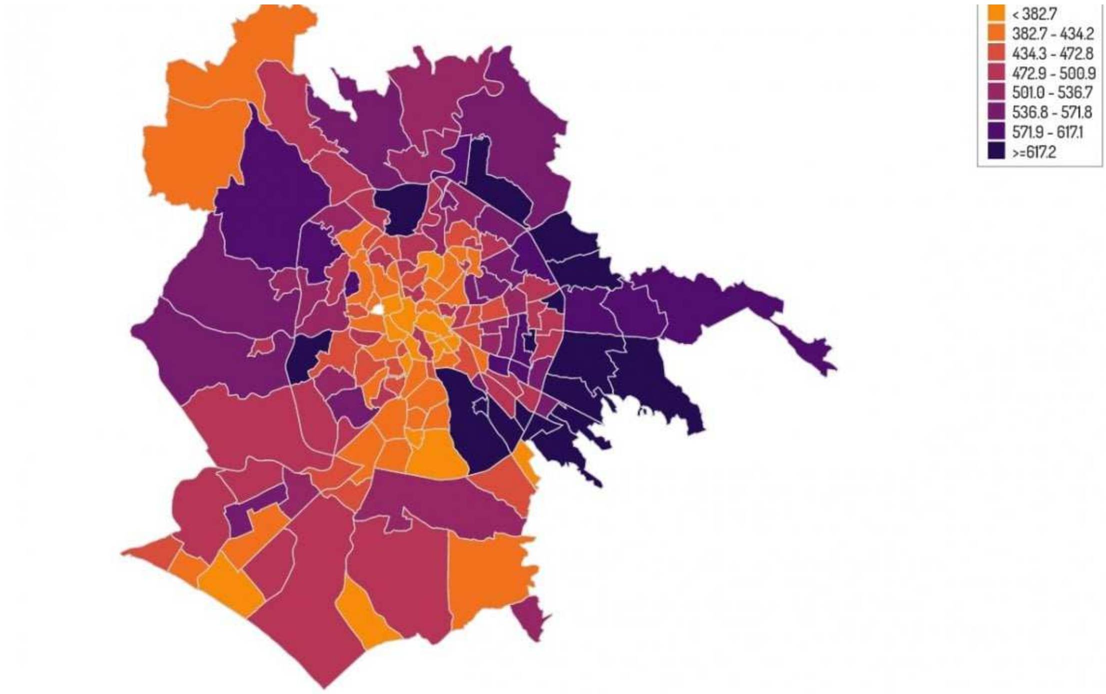

Fig. 2: The map of infection in the neighbourhoods.

4 NOW AND FUTURE STRATEGYES

In the meantime, some cities are more reliant on the tourism industry, due to their geographical, cultural, or historical knowledge, which is significantly damaged by Covid-19, as such are usually expanded either on the coastal areas or in the central core of the city. Streets, large squares, and historical fabrics, which have played an effective role with their urban character in dynamiting and increasing the sense of satisfaction with the urban space, suddenly underwent unprecedented tranquility. Restaurants with street-sitting areas play a significant role in the perspective of the central streets and Roman neighborhoods. People could sit and enjoy the street view for a few minutes and it increases a dynamic sense regarding local places. Today, they have all closed the doors and turned off the lights.

now	**future**
Using of electronic scooters	Teleworking and virtual training
Smart free mask distribution stations in city	Review of rigid and regulations in architectural design with the aim of mandatory natural ventilation
Changing in mobility system in different scales, from the highest crowded to less crowded and suburb	Utopian city
"20 minutes of ‘green time’	The nexus between, infectious diseases and architectural green space
Equipped hospital units built in city area can change their use after a disease crisis	Design approaches for infection prevention and control

Table 1: now and future strategies according to Rome fabric

(1) Safe transportation for citizens in the current situation is considered one of the basic needs and a safe window to return people to the community in the urban structure. One of the most popular and recently accepted methods is to encourage people to use non-motorized vehicles such as electric scooters and bicycles on short distances, which can provide health to some extent.

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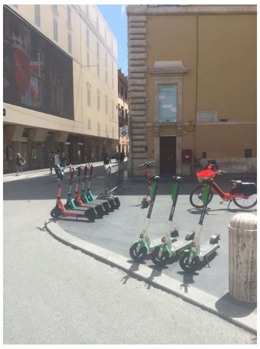

Fig 3: scooter station in Rome, photos by authors

(2) The use of masks for citizens can be considered in terms of social effects, the effects of people's views on the use of face masks, the reason for not using masks, the most important and practical methods to solve the problems of utilizing face masks. The performance of research centers and Health centers indicated the factors and executive strategies for using the mask.

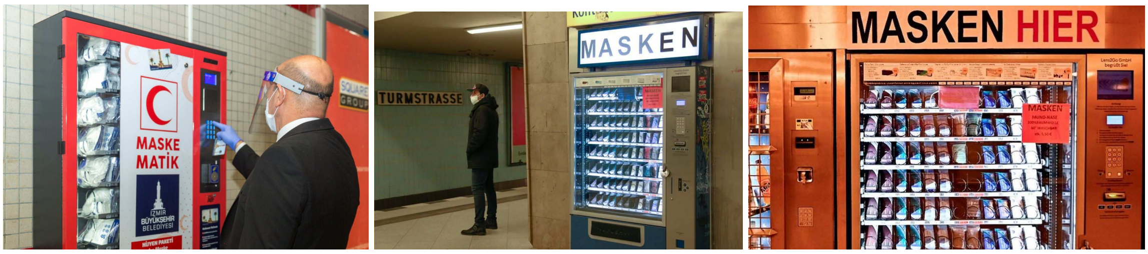

Fig 4: Mask station in Europe

(3) By zoning the city according to the amount of traffic, the number of reforms in central tourist or office areas that have peak hours of traffic, population, and working hours will find. The possibility of disease transmission and air pollution is higher. The urban planning model is also effective in providing conditions to reduce unnecessary traffic. Changing in mobility system to light non-motor vehicles in the scale of a neighborhood can be helpful to control the traffic. The possibility of pedestrian access to daily urban services reduces the need to use the means of transportation. As it is clear in the map below the central core of the city is the most traveled area, due to the presence of tourist places.

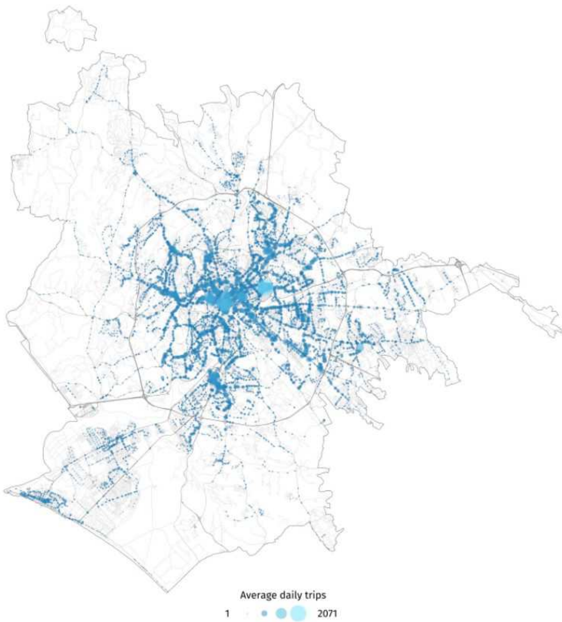

Fig 5: Average daily trips in Rome

(4) Urban green spaces will play a significant role in urban planning. In addition to the effect of lowering the temperature, allocating green paths or green spaces has many social, visual, and environmental benefits. Proper distribution of green space and health services in critical situations will lead to a reduction in

mortality. Suitable landscape criteria for a green space or neighborhood are the proper distribution of routes, access, granulation, suitable urban furniture, and the form of the landscape. The human-nature interaction examines the amount of need or communication needed for a healthy and sustainable urban environment in each district. In an area like Torre Angela with a high number of positive cases during the Covid-19, the Presence of adequate but unorganized green space is also a potential option. With reorganize and equip those green areas, the sense of satisfaction could be increase and motivate the dwellers to spend some minutes walking every day. It is possible to help raise the level of health by allocating urban furniture, defining the sidewalk, and establishing adequate health services along the way.

Fig 6: Organizing and completing green lines in high-risk area and Equipping residential centers and creating local parks

(5) The presence of three hospitals at a distance of fewer than eight kilometers (Tor Vergata, Casilina, and Rome American Hospitals) in the surrounding districts, indicates the presence of health centers close to there, but does not seems enough in an emergency. Some urban open spaces with the ability to become a temporary hospital will be one of the solutions. Uncovered parking lots near metro stations or in the open areas allow temporary locations to be built.

Fig 7: Locating and Establishment of mobile hospitals in the main squares of the city

The strict measures implemented in Lombardy and surrounding areas and shortly thereafter extended to the whole of Italy have made a measurable impact in reducing the progression of the Covid-19 epidemic. We estimated that the time lag between the start of the implementation of the restriction measures and the measurable reduction of the Covid-19 CI growth rate was approximately 7–10 days. In general, the proposed solutions in dealing with the destructive effects of pandemics classified into short-term and long-term approaches.

5 CONCLUSION

The concept of quality of life is considered to be a comprehensive reflection of the personal level of health, including all the factors that standard human life. It is largely influenced by the social, economic, and environmental quality of the city. On the other hand, it must be concluded that quality of life can be identified in a direct concept with the quality of the environment in which we live. Streets, large squares, and historic fabrics with their urban form create the content of a dynamic city. They provide a clear picture of the urban space, a city that today experiences unprecedented tranquility. Impressive street restaurants, public hangouts, urban green areas were considered a sense of presence in the community, achieved by increasing safety and prevention for future conditions. In general, in times of natural disasters such as floods, earthquakes, and infectious diseases, all cities face serious challenges and suffer serious human, economic, industrial, and infrastructural shocks but resilient cities can overcome these crises and survive. They pay the price for their weaknesses by investing more in the goals of sustainable development and urban sprawl and move through the crisis to become more resilient, healthier, and more successful cities.

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The Influence of Users' Socio-Economic Background on the Perception and Involvement of Urban Spaces

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1 ABSTRACT

opportunities in their daily lives. Arguably, recreation and socio-economic status have always had a longstanding relationship. However, spatial perception is seen as the criteria which decides whether architecture succeeded at delivering a certain message, or satisfied a certain role within a specific context. In fact, perception is a highly creative process; although people relate to the same reality, they will perceive it in a different way according to what the environment means to each of them. Different environments will have different perceptual influences. These differences are derived from various personal backgrounds (knowledge, experience, culture, and physical). Furthermore, some studies suggest that low level of physical and recreational activities is more prevalent among lower income, less educated, and unemployed populations compared to higher income individuals. In turn, this could cause dissatisfaction with the living condition in the low-income neighborhoods and many of the associated issues can be traced to the inability of the city to meet the basic needs of its inhabitants.

Neighborhood space in many contemporary residential communities, particularly in Third World countries, often has the appearance of no man's land. This is because public spaces in the contemporary city, in all their tidiness, are thought of as a secondary space, owned neither by the city nor by the individuals. It does not invite one to be or remain. This paper focuses on studying the manner in which people, with different visit purposes, perceive the space they visit, how and why users change their environment. This paper concludes that a large number of neighborhood park users are not neighborhood residents, they are indeed derived from lower-income neighborhoods where the access to open spaces is very limited. It is necessary to study the needs of the user groups with the least number of people in order to boost their visits to the park.

Keywords: open spaces, interaction, recreation, perception, Egypt

2 INTRODUCTION

The communal dimensions of a neighborhood are stated by social planners and sociologists (Canter, 1977; Keller, 1968; Lee, 1970). They consider the neighborhood as per its symbolic and cultural features, they also stress on shared activities and experiences, common values and loyalties, and resulting social groups. (Abu-Ghazzeh, 1996) A large extent of social and cultural factors affect the spatial and temporal systems of neighborhood urban spaces which generates perceptual inputs, the material for cognitive schemata, and the effective responses. (Rapoport, 1976) In fact, meanings, ways of communications and social relationships are linked to the design od spaces where certain activities take place. These aspects support the psychological variables studied by the paper.

It is obvious for planners nowadays that creating new residential projects and neighborhood environments is not sufficient, what is more important indeed is the way in which they work. (Corbet, 1981; Lang, 1987). The unpredictable usage of environments by people is finally realized by designers and planners. This behavior may occur because the built environment does not match the living pattern of the users, or else due to unpredicted new opportunities generated by the surroundings. Hence, for better future designs, designers must study the way in which people use a certain space and most importantly the reason behind such a behavior. A lot of studies call attention to the importance of both social and psychological factors, these factors are indeed of great influence yet they are underestimated during the planning and designing phase. (Brower, 1980; Herting & Guest, 1985; Sommer, 1969) The well-being of the city can be maintained through high quality urban life created by a proper planning for urban spaces.

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3 THEORETICAL BACKGROUND

3.1 Spatial Perception

Modern psychology describes perception as being the highest level of complication in collecting and analyzing information. It has the capability to recognize physical items in the communal surrounding, at the same time it comprises as well the image created based on events, other individual or even items that are connected to experiences which the end-user has lived in the past. However, geography gives us a wider image on the term ‘perception’, consisting of the global scope of percepts, impressions, convictions and preferences, therefore it covers the full information which is linked to an environment or even features that can be assembled under the expression of ‘environmental cognition’. (Stea, 1973) Moreover, sensations are the one who form the base of the perception process. This process creates an image that comprises information related to some significant attributes concerning the perceived elements as: textures, colors, sounds, smells, time of the day, time of the year, weather etc. However, sensations provide single and simple information. Thus we may consider that perception is created through multiple sensations. (Pomerantz)

According to Grutter, all judgements consist of two key elements: an object and a subject. The object is to be defined as the physical item which is perceived, the objective. The subject on the other hand, is the one who exerts the operation of perceiving, the subjective. (Grutter, 2006) Additionally, one’s personal experience along with the incident evaluation of a certain situation influence directly the environmental perception. Although human perception can be influenced by the tinniest difference and cognition. (Gifford, 2007) By way of explanation, when feeling take control over the created mock-up, perception will act exactly the same, it will dominate not only the formed mock-up but also expectations, factors concerning emotions and cognitions, inspirational conditions, decisions and perceiver’s self-determination.(Ghasem, 2001)

Presuming that architecture is a sign system, it is important the analyze these signs and sort them into categories. One of the most interesting approaches is the “semiological triangle” discussed by O.K.Ogden and I.A.Richards. This approach was initially developed from Ferdinand de Sassures’ theory, a well-known leader in the field of semiology. Sassure in his book Course in General Linguistics proposes that a system of signs form language. Each sign is consisted of a two-party object: a “signifier” and a “signified”.(Saussure, 1916) A consistent approach concerning the human-environment relationship was distinguished by psychologist James Gibson. His ecological theory of perception presumes a certain association between the observer and his environment, this association usually takes place over movement and visual perception. (Ingold, 2011) The environment is therefore considered as an ‘affordance’: it is not treated as a visual object or a ‘thing’ anymore but rather as a stimulus capable of providing the observer with meaning, and consequently pushing him to interact and respond to his surrounding environment

3.2 Quality of urban spaces

Parasurman stated that the ‘gestalt’ concept is what defines quality (Parasuraman, Zeithaml, & Berry, 1985), he also presumed that what achieves high quality service in outdoor recreation is the fulfilment of users’ needs. With that being said, the achievement of high quality recreational services would be much less challenging if decision makers consider users’ desired expectations from the services they offer. (MacKay & Crompton, 1990) Furthermore, what gives urban spaces additional value is their potential to improve the urban well-being in regards to offered opportunities, physical settings, sociability and cultural diversity. It is also debateable that people and their behaviour is what shape quality. (Burgess, Harrison, & Limb, 1988) In fact, quality is represented by people who use and manage the techniques or procedures given to them at what is called ‘total quality management’. Moreover, physical elements which enhance the quality of a community are appraised by (Smith, Nelischer, & Perkins, 1997). The term ‘quality community’ refers to a community where inhabitants needs and desires are fulfilled. This could be reflected on open spaces or neighbourhood parks. The author also describes quality as being the unique properties that advocate a certain level of excellence. Needs can be shared among a certain group of people, however each person in this group also processes his own particular needs that he aspires to be satisfied in a special way. The primary question of why people tend to use a specific space can be answered by understanding all the purposes of people’s visits and the additional factors that will boost their visits frequency. Based on these answers, researchers can conclude a pattern of personal preferences. (Hester, 1984) These patterns translate the desired needs that neighbourhood residents expect to be answered. Hester proposes a checklist of needs which neighbourhood park's users may aspire such as settings, safety, aesthetic appeal, convenience, and psychological comfort, and symbolic ownership, policy in use, cost and interaction with natural environment.

On another hand, (Jacobs, 1961) made planners pay attention to people who have a direct access to urban spaces in order to generate a sense of security in the neighbourhood they inhabit. She also highlighted other important factors for a neighbourhood space quality, such as the need for neighbourhood open spaces to support contact, safety, and child use. Another master in urban planning (Lynch, 1960) suggests rights for public spaces, these rights include presence, use and action, appropriation, modification, and disposition. Lynch also declared that besides people's right to access public spaces, they also have the right to use, change and modify it. (Sommer, 1969) highlighted the importance of involving users and sociologists in the decision-making process. He also stated that while designing, it is important to always remember that planners are working with people and not for them.

4 METHODOLOGY

The aim of this study is to find the influence of different users' backgrounds on their use pattern, satisfaction, needs and interaction with urban spaces in districts which have different socio-economic typologies in Alexandria, Egypt. This will be achieved through studying the manner in which users, with different backgrounds, perceive the space they inhabit, how and why users change their environment. The study focuses on three different urban spaces, which belong to poor-middle-high income groups. However, this paper studies only one space as a pilot study. A more extended survey will follow encompassing two more spaces as to ensure a broader scope and more representation of different types of open spaces.

This research will adopt an inductive methodology whereby the initial problem and its dimensions are firstly examined through literature review. An analytical study is to follow utilizing questionnaire-based survey, observation survey and correlations analysis techniques, to: (1) identify main user groups based on their motivations to visit a neighborhood park; (2) examine and compare spatial distribution patterns of different user groups, (3) identify preferred park settings for different user groups, and (4) explore the perceived qualities and needs of each user groups. Theoretically, the study provides empirical evidence on how visitors' motivations may influence their spatial distribution and use patterns in neighborhood parks. Methodologically, by utilizing questionnaire-based survey and observation survey, the study proposes an objective approach to analyze users' desire for certain needs. Practically, the study identifies preferred settings of different user groups, which can shed light on future park planning. This study also explores the perceptions of quality and its significant impact on access to recreation from local communities. The result would help to highlight the problems and needs of users with different backgrounds and visit purposes towards these parks and to propose design criteria that seek to improve the quality of the recreational aspects of parks.

5 CASE STUDY

5.1 Setting: Allenby neighbourhood park

This paper focuses on one space as a pilot study among three others which will be discussed in a further research. This space was chosen in one of the wealthiest neighborhoods of Alexandria: the Kafr Abdo neighborhood. Hence this site represents the urban space which is situated in the high-income level context. Located in the heart of Alexandria and surrounded by embassies, historical villas, and reparable architecture, Allenby Park is considered as one of the oldest and the finest parks in Alexandria. (Fig.1) It dates back to 1920s, referring to Lord Allenby, the British high commissioner in Egypt. Many wealthy British and other foreign businessmen built their villas along the same street. Though it has been known as a park used mainly for walking dogs for some time, it is now an important node for several activities which attract a number of users with different backgrounds, perception levels and motivations. Many events are often held in the park by the kafr Abdo community in collaboration with NGOs and many other organizations.

Fig. 1: (left) the chosen site of Allenby Park, Kafr Abdo, Alexandria. (right) the surrounding context of the site.

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5.2 Data Collection and Analysis:

The study was conducted in March and April 2021, when the climate was encouraging for outdoor activities. For the selected park, data collection occurred at random timings between 9:00 am and 11:00 pm during work-days as well as weekend-days over an eight weeks period from a convenient sample of park users. Park users were invited to participate in the study through an on-site questionnaire-based survey along with an online survey addressed only to the park's users. This survey was administered to collect data on demographics, user motivations for parks visit and desired needs. Participants were enrolled throughout the day, therefore the time of their participation varied from morning, afternoon and until evening. An observation-based survey was used to collect spatial position information from study participants, their circulation and favorite settings. According to the questionnaire's results, users tend to visit the park mostly in the afternoon and evening that's why the observation survey took place mainly between 12:00 and 8:00pm.

The survey questionnaire was designed to understand the participation of the residents in relation to the use of the park, their perception and satisfaction of their experience in the park and finally their needs. Part 1 of the questionnaire used socio-demographic background such as gender, age, marital status, occupation, and monthly income to identify the characteristics of the participants. Part 2, related to participation of the residents based on information such as park visitation, frequency of visit, time and duration of visit, activities. Part 3, is to identify the additional factors that would motivate users' visits. Part 4 is mainly on the perceived quality; the park's cleanness and maintenance, the location, quality and number of seats (Likert-scaled questions). Lastly, Part 5; is to investigate users aspires and needs.

The analysis included three main parts. First a descriptive statistic was performed to identify the main user groups and explore their use patterns. Then crosstabs analysis was applied to examine the differences in use patterns among the user groups, the motivation of their visit, the perceived qualities translated into their satisfaction and aspired needs. Finally, the collected data from the observation survey was illustrated into maps to highlight park's accessibility, users' concentration and favorite settings for each user group.

6 RESULTS AND DISCUSSION

6.1 Descriptive statistics

6.1.1 Users' demography

In Allenby Park, 85 users took part in the study; 30 (35.3%) users from online questionnaire and 55 (64.7%) from on-site questionnaire-based survey were completed and included in the analysis. More than half of all participants were between 20 and 30 years old and had college or higher education. (Table 1). Two thirds of the users live in families with less than five members. The majority of respondents came to the park either in groups to spend time with family members or friends, or alone to enjoy nature and relax. Only (27.1%) chose to visit the park alone. Furthermore, (47.1%) worked in the private sector, while (31.7%) earned more than 7,000 EGP (446 USD). Most participants stated that they don't spend money while visiting the park (43.5%). In fact, visitors who claimed to visit the park with family and friends tended to spend the most money during their stay in the park, with 17 (20%) users declared that they spent more than 20 EGP per person in one visit. Followed by 15 (17.65%) users who came alone to enjoy the nature. Participants were asked to identify how often they visit the park and to specify the time of their visit. The results showed that almost half of the questionnaire respondents visited the park 1-3 times a month (71.8%). It is worth mentioning that none of the participants visited the park for the first time which proposes that they were all familiar with the park and its features. Regarding the park's time of visit, it was detected that people come most regularly during the period of afternoon hours from 12-4pm and evening hours from 4-8pm. These results include both weekdays and weekends. In fact, more than half of the respondents (55.3%) usually go to the park on foot. Most users (45.9%) visited the park for approximately 1-2 hours per visit.

A crosstabs analysis was used to identify the respondents who worked in the private sector were the group who visited the park most frequently (2.35%) sometimes even twice a day (2.35%), 1-3 times per week (7.0%) and 1-3 times per month (35.3%). Followed by students' group who visited the park less frequently 1-3 times per week (7.0%) and 1-3 times per month (28.2%). Putting into consideration the travel mode and the time users take to arrive at the park, and using the same crosstabs analysis, it can be detected that almost half of the users were neighborhood residents (47%) came to the on foot in less 30 mins and (9.4%) drove to the park in less than 15 mins. The other half came via public transportation, including bus and tram. Hence, it can be assumed that despite the size and location of the park, both non-neighborhood residents and neighbourhood residents visited the park equally.

1	Gender	41 of the participants were Males (48.2%) and 44 Females (51.8%).
2	Age	2 users were between 15 and 20 (2.4%), 34 between 20 and 25 (40.0%),36 between 25 and 30 (42.4%), 8 between 30 and 40 (9.4%), 4 between 40 and 60 (4.7%) and 1 more than 60 years old (1.2%).
3	Marital Status	54 of the participants were single (63.5%) and 20 in a relationship (23.5%). 10 users were married (11.8%) and only 1 was divorced (1.2%).
4	Educational Level	none of the participants had no formal education or went to a primary school, 4 users went to middle/high school (4.7%) and the other 81 users were enrolled in college or higher education (95.3%).
5	Occupation	30 of the participants were students (35.3%) and 3 were self-employed (3.5%). 6 users worked at public sector (7.1%) and 40 worked in private sector (47.1%). 2 users were unemployed (2.4%),3 were housewives (3.5) and only 1 was a retiree (1.2%).
6	Monthly income (EGP)	18 of the participants didn't have a monthly income (21.2%), 16 earned less than 3,000 per month (18.8%). 12 users had a monthly income between 3,000 and 5,000 (14.1), another 12 between 5,000 and 7,000 and 11 users earned between 7,000 and 10,000. 16 users made more than 10,000 per month (18.8%).
7	NO. of family members	60 of the participants had a family of less than 5 members (70.6%), 18 had families of 5 members (21.2%) and 7 had families with more than 5 members (8.2%).
8	visit purpose (N=128)	34 users went to the park to enjoy the nature (26.6%), 8 went to exercise (6.3%). And 4 went to play with children (3.1%). 54 users had the purpose to meet family members and friends (42.2%), 19 went to walk dogs (1408%) and 9 participants went for other purposes (7.0%).
9	Companion (N=95)	38 of the users visited the park with less than five family members and friends (44.7%), 34 were accompanied with more than 5 people (40.0%) and 23 chose to visit the park alone (27.1%).
10	mode of travel	47 users reached the park on foot (55.3%), none went by bicycle and 29 went by driving (34.1%). 5 users used public transportation like the bus (5.9%) and 4 used the tram (4.7%).
11	Duration of Travel	26 users took less than 15 min to reach the park (30.6%), 42 took between 15 and 30 minutes (49.4%) and 12 users took between 31 and 60 minutes (14.1%). Only 5 users went to the park in more than 61 minutes (5.9%).
12	Frequency of Visits	4 users visited the park on a daily basis (4.7%) and 2 other users visited it twice a day (2.4%). 18 participants went to the park between one to three times a week (21.2%) and 61 went between 1 to 3 times a month (71.8%).
13	Time of Visit (N=109)	26 users went to the park in the morning (30.6%), 28 in the afternoon (32.9%) and 35 in the evening (41.2%). Only 20 users went at night (23.5%).
14	Duration of Visit	30 users visited the park for less than one hour (35.3%), 39 for a period between one to two hours (45.9%) and 15 spent between two and four hours per visit (17.6%). Only one participant stayed for more than four hours (1.2%).
15	Average Money spent per Visit	37 users didn't spend money during their visits (43.5%). 3 users spend 5 EGP (3.5%), 8 users spent from 5 to 10 EGP (9.4%) and 10 spent between 10 to 20 EGP per visit (11.8%). 5 users spent an amount between 20 and 40 EGP (5.9%) while 12 users spent between 40 and 60 EGP (14.1%). 10 users spent more than 60 RGP per visi0t (11.8%).

Table 1 Users‘ profile, visit purpose, companion and frequency of visit of the visitors

6.1.2 Park visit purpose and user groups

In order to measure users' perception of the park's features, their experiences, preferences and needs, the assembled data was classified according to the reason behind people's visit to the park. Thus, the data analysis and the deducted relationships from the visit purpose of each user group would determine how people with different motives and backgrounds would perceive and use a certain space as per what initiates their visits in the first place. A multiple-choice question was addressed to identify participants 'purpose for visiting the park, the top three categories with the largest numbers of visitors (including more than the half of the total visitors) are considered as the main user groups. Meeting family members and friends, enjoy the nature and walking dogs were the most frequently mentioned purposes for park visit. Participants who came to meet family members and friends outnumbered other groups (42.2%), followed by the ones who visited the park to enjoy the nature (26.6%) and users who came to walk their dogs (14.8%). Meanwhile (16.4%) of all users came for exercise and to play with children.

6.2 Differences in use patterns among user groups

The collected data was classified according to the five user groups interpreted from the visit purpose of the participants. A crosstabs analysis was applied to further explore how each questionnaire element related to the user groups. At first, the data was analyzed according to the number of users in each element. The calculated percentages (P) indicate the number of participants in each user group (N2) in accordance to the total number of users of all user groups (N1) in each element (P=N2/N1). (Table 2). The results indicate that the main age group who visits the park is consisted of participants between 25 and 30 years old (50 user). Half of these participants go to meet family members and friends, (26.0%) visit the park alone to enjoy

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nature, (14.0%) walk dogs, (6.0%) go to exercise and (4.0%) go to play with children. On the other hand, the age group who visits the park the least is consisted of users between 15 and 20 years old. These users are divided between groups who spend time with friends and people who go to exercise. Moreover, the majority of the users went to the park on foot (62 user), they can also be considered as neighborhood residents. Among these users, (48.4%) went in groups while none of them went to play with children. From the on-site observation and interviews, it was interpreted that families who visited the park with children were derived from a lower socio-economic background. In fact, open spaces, greenery and parks in general are very few in Alexandria city especially among the lower-income neighborhoods. That also explain why none of these families took less than 15 mins to reach the park. On another hand, only 3 users tended to reach the park by bicycle. This can also be interpreted through the lack of cycling lanes, facilities and culture in general in Egypt. Cycling which is the most easy, sustainable and affordable way of transportation is of a great danger in the city especially for long distances.

However, the duration which users tended to spend in the park was between one and two hours (59 users) and the least duration was more than four hours. This may indicate that seats condition and number were suitable for a medium stay but not for a long period of time. Furthermore, participants chose to visit the park the most in the evening. That can be due to the hot climate Egypt processes most of the year especially during the day. Only 30 users declared using the park during the night period, the park has actually a quite bad lighting system during the night, in fact a lot of the park's areas are in complete darkness and this may affect the sense of security of the users.

Use Patterns	Total N	Meet Family and Friends		Enjoy Nature		Walk Dogs		Exercise		Play with Children	
Number of Users	**119**	**54**		**34**		**19**		**8**		**4**	
	N1	N2	P	N2	P	N2	P	N2	P	N2	P
Age											
Between 15 and 20	2	1	50.0	0	0.0	0	0.0	1	50.0	0	0.0
Between 20 and 25	48	23	47.9	16	33.3	6	12.5	3	6.3	0	0.0
Between 25 and 30	50	25	50.0	13	26.0	7	14.0	3	6.0	2	4.0
Between 30 and 40	10	3	30.0	3	30.0	3	30.0	0.0	0.0	1	10.0
Between 40 and 60	5	1	20.0	1	20.0	2	40.0	0.0	0.0	1	20.0
More than 60	4	1	25.0	1	25.0	1	25.0	1	25.0	0	20.0
Mode of Travel											
on foot	62	30	48.4	15	24.2	12	19.4	5	8.1	0	0.0
bicycle	3	0	0.0	0	0.0	0	0.0	3	100	0	0.0
driving	41	19	46.3	14	34.1	6	14.6	0	0.0	2	50.0
bus	4	1	25.0	1	25.0	0	0.0	0	0.0	2	50.0
tram	6	1	16.7	4	66.7	1	16.7	0	0.0	0	0.0
Time of Travel											
less than 15 min	38	17	44.7	11	28.9	8	21.1	2	5.3	0	0.0
Between 15-30 min	59	29	49.2	16	27.1	8	13.6	4	6.8	2	3.4
Between 31-60 min	13	5	38.5	4	30.8	2	15.4	0	0.0	2	15.4
More than 61 min	9	3	33.3	3	33.3	1	11.1	2	22.2	0	0.0
Frequency of visit											
everyday	7	1	14.3	2	28.6	3	42.9	1	14.3	0	0.0
2 timed per day	4	2	50.0	1	25.0	1	25.0	0	0.0	0	0.0
1-3 times per week	27	10	37.0	7	25.9	5	18.5	5	18.5	0	0.0
1-3 times per month	81	41	50.6	24	29.6	10	12.3	2	2.5	4	4.9
Duration of visit											
less than 1 hour	37	16	43.2	12	32.4	6	16.2	2	5.4	1	2.7
1-2 hours	59	27	45.8	17	28.8	11	18.6	2	3.4	2	3.4
2-4 hours	21	10	47.6	4	19.0	2	9.5	4	19.0	1	4.8
More than 4 hours	2	1	50.0	1	50.0	0	0.0	0	0.0	0	0.0
Time of visit		**N=73**		**N=48**		**N=27**		**N=12**		**N=4**	
Morning	44	16	36.4	15	34.1	9	20.5	3	6.8	1	2.3
Afternoon	43	17	39.5	14	32.6	7	16.3	3	7.0	2	4.7
Evening	47	24	51.1	13	27.7	6	12.8	4	8.5	0	0.0
Night	31	17	53.3	6	20.0	5	16.7	2	6.7	1	3.3

Table 2: Relationships between use patterns and the total number of users. Note: Cells shaded in light red indicate the maximum number of users while cells shaded in blue indicate the minumum number of users. Cells shaded in darker red indicate the maximum number of users in each questionnaire element. This color coding applies on each questionnaire element.

The collected data was then analyzed according to each of the five user groups. The following table shows the number of participants (N2) in each user group and their relation to the questionnaire elements. The calculated percentages (P) indicate the number of participants in each questionnaire element (N2) in accordance to the total number of users (N1) in each user group (P=N2/N1). (Table 3) The results show that the first two user groups are those who go to the park to spend time with family members and friends (54 user) and people who visit the park alone to relax and enjoy the nature (34 user). The first group is mainly consisted of young adults between 25 and 30 (46.3%) while the participants of the second one has between 20 and 25 years old (47.1%). Most users of these two groups reached the park on foot (55.6%) and (44.1%) consequently, while none of them used a bicycle. They normally spend from 15 to 30 minutes on their way to the park (53.7%) for the first group and (47.2%) for the second one. The users of these two groups go between one to three times per month (75.9%) and (70.6%). Only (1.9%) of the first group tended to gather in the park on a daily basis. They usually spend from one to two hours per visit (50.0%) for both groups. It is worth mentioning that despite the reparable similarities of the use pattern of these two user groups, they are way far from being alike. The gatherings of the first group are based on social activities while participants of the second group prefer calmness and relaxation. That's why, users who visit the park to meet their friends mostly go in the evenings (30.1%) after work hours, meanwhile people who visit the park to enjoy the nature and relax tend to go in the morning (31.3%), when there is the least presence of the first group (21.9%).

Use Patterns	Meet Family and Friends		Enjoy Nature		Walk Dogs		Exercise		Play with Children	
N1	54		34		19		8		4	
	N2	P	N2	P	N2	P	N2	P	N2	P
Age										
Between 15 and 20	1	1.9	0	0.0	0	0.0	1	12.5	0	0.0
Between 20 and 25	23	42.5	16	47.1	6	31.6	3	37.5	0	0.0
Between 25 and 30	25	46.3	13	38.2	7	36.8	3	37.5	2	50.0
Between 30 and 40	3	5.5	3	8.8	3	15.8	0.0	0.0	1	25.0
Between 40 and 60	1	1.9	1	2.9	2	10.5	0.0	0.0	1	25.0
More than 60	1	1.9	1	2.9	1	5.3	1	12.5	0	0.0
Mode of Travel										
on foot	30	55.6	15	44.1	12	63.2	5	62.5	0	0.0
bicycle	0	0.0	0	0.0	0	0.00	3	37.5	0	0.0
driving	19	35.2	14	41.2	6	31.6	0	0.0	2	50.0
bus	1	1.9	1	2.9	0	0.00	0	0.0	2	50.0
tram	1	1.9	4	11.8	1	5.3	0	0.0	0	0.0
Duration of Travel										
less than 15 min	17	31.5	11	32.4	8	42.1	2	25.0	0	0.0
Between 15-30 min	29	53.7	16	47.2	8	42.1	4	50.0	2	50.0
Between 31-60 min	5	9.3	4	11.8	2	10.5	0	0.0	2	50.0
More than 61 min	3	5.6	3	8.8	1	5.3	2	25.0	0	0.0
Frequency of visit										
everyday	1	1.9	2	5.9	3	15.8	1	12.5	0	0.0
2 timed per day	2	3.7	1	2.9	1	5.3	0	0.0	0	0.0
1-3 times per week	10	18.5	7	20.6	5	26.3	5	62.5	0	0.0
1-3 times per month	41	75.9	24	70.6	10	52.6	2	25.0	4	100
Duration of visit										
less than 1 hour	16	29.6	12	35.3	6	31.6	2	25.0	1	25.0
1-2 hours	27	50.0	17	50.0	11	57.9	2	25.0	2	50.0
2-4 hours	10	18.5	4	11.8	2	10.5	4	50.0	1	25.0
More than 4 hours	1	1.9	1	2.9	0	0.0	0	0.0	0	0.0
Time of visit	N=73		N=48		N=27		N=12		N=4	
Morning	16	21.9	15	31.3	9	33.3	3	25.0	1	25.0
Afternoon	18	24.7	14	29.2	7	25.9	3	25.0	2	50.0
Evening	22	30.1	13	27.1	6	22.2	4	33.3	0	0.0
Night	17	23.3	6	12.5	5	18.5	2	16.7	1	25.0

Table 3: Relationships between use patterns and user groups. Note: Cells shaded in light red indicate the maximum number of users while cells shaded in blue indicate the minumum number of users. This color coding applies on each user group.

The third user group represents dog owners (19 user), they are mainly between the age of 25 and 30. Basically they walk their dogs to the park (63.2%) and take from 15 to 30 minutes (84.2%). Users of this group frequently visit the park from one to three times a month (52.6%) and spend a period of one to two hours per visit (57.9%). They prefer visiting the park in the morning (33.3%) when there is less people and more space for playing with their dogs. People who visited the park to exercise formed the fourth group, they were young adults between 20 and 30 years old (75.0%). Basically, they reached the park on foot as some sort of exercising (62.5%), it took them from 15 to 30 mins to arrive there. They were the user group who visited the park more frequently from one to three times per week (62.5%) and who spend the longest period of time from two to four hours per visit (50.0%). This may be due to the consistency of the exercises which take place regularly and for a specific duration. They prefer visiting the park in the evenings (33.3%) before it turns out too dark. The last user group is consisted of parents who go to the park with their children (4 users) and which are generally between 25 and 30 years old. They reach the park either by driving or using the bus. This user group take the most time to reach the park from 15 to 60 minutes, this shows the importance of these visits for the children who rarely find an open green space to play in the city of Alexandria.

6.3 Users' perception of the park

6.3.1 Additional factors to motivate the park's visits

Allenby Park has a unique location, it is situated in the heart of a lot of recreational, cultural and social attractive nodes. In order to identify the surrounding magnets which exist within the park's context, participants were asked to indicate all the additional factors which motivate them to visit the park more frequently The calculated percentages (P1) indicate the total number of users who chose each factor (N1) regarding the total number of the users in the five user groups (Total N=188), meanwhile (P2) indicate the number of participants in each user group (N2) in accordance to the total number of users of all user groups (N1) in each element (P2=N2/N1). (Table 4) The results show that what motivates all the user groups in general the most to visit the park are nearby food outlets and restaurants (34.0%), almost (42.9%) of the participants who chose the food outlets were among the group who meet family and friends. It is clear that this specific user group tend to have more social engagements and activities than the other user groups. On the other hand, participants considered organized events and fares the least attractive (40%). Both users who visited in groups and dog owners were the main two user groups who were motivated by the organized events (35.0%) and (27.5%) consequently. Prearranged appointments were basically chosen by users who meet their friends (53.5%) and the least chosen by people who go alone to enjoy nature (9.3%) and those who go with their children (7.0%). Finally, the surrounding facilities mainly attract users who go to the park alone and who were consisted mainly of neighbourhood residents, they declared to be motivated to visit the park after attending appointments at the bank or cultural facilities facing the park (39.0%).

Motivations	Total N		Family and Friends		Enjoy Nature		Walk Dogs		Exercise		Play with Children	
Number of Users	188		84		45		37		15		7	
	N1	P1	N2	P2	N2	P2	N2	P2	N2	P2	N	P2
organized event (fares/exhibitions/etc..)	40	21.3	14	35.0	10	25.0	11	27.5	4	10.0	1	2.5
prearranged appointments (with family or friends)	43	22.9	23	53.5	4	9.3	8	18.6	5	11.6	3	7.0
nearby food outlets/restaurants	64	34.0	36	56.3	15	23.4	8	12.5	3	4.7	2	3.1
nearby magnets (bank/ facilities/cultural centres/etc..)	41	21.8	11	26.8	16	39.0	10	24.4	3	7.3	1	2.4

Table 4: additional motivation for park visits for all users. Note: Cells shaded in light red indicate the maximum number of users while cells shaded in blue indicate the minumum number of users. Cells shaded in darker red indicate the maximum number of users in each factor. This color coding applies on each factor.

Speaking from the user groups perspective, the additional motivation factors were then analyzed according to each of the five user groups. The following table shows the number of participants (N2) in each user group and their relation to the motivative factors. The calculated percentages (P) indicate the number of participants in each factor (N2) in accordance to the total number of users (N1) in each user group (P=N2/N1). (Table 5) Results show that the user group who visited the park to meet family members and friends found the food outlets the most important attraction as well (42.9%), followed by the prearranged appointments (27.4%). Participants of this user group didn't find nearby facilities appealing (22.2%). This can be interpreted that users who visit the park in group pay little attention to the surrounding facilities and care the most about social gatherings where food is considered a primary element, prearranged appointments with friends and at last the organized events which don't take place more often (16.7%). Moreover, users who visited the park alone to enjoy nature and relax were mostly attracted by nearby facilities (35.6%) and least attracted by the prearranged appointments since they tended to avoid gathering in the first place (5.9%). Furthermore, dog owners were encouraged to visit the park by organized events (29.7%) and equally the least attracted by prearranged appointments and nearby food outlets (21.6%) for both elements. Users who visit the park to exercise were mostly motivated by prearranging appointments with their colleagues and trainers (33.3%) and equally the least attracted by food outlets and nearby facilities (20.0%) since they were precise in their motivation to visit the park in the first place. Finally, families who visited to the park to play with children went in groups so they were mainly motivated by the prearrange appointments (42.9%).

Motivations	Meet Family and Friends		Enjoy Nature		Walk Dogs		Exercise		Play with Children	
N1	84		45		37		15		7	
	N2	P	N2	P	N2	P	N2	P	N2	P
organized event (fares/exhibitions/etc..)	14	16.7	10	22.2	11	29.7	4	26.7	1	14.3
prearranged appointments (with family or friends)	23	27.4	4	8.9	8	21.6	5	33.3	3	42.9
nearby food outlets/restaurants	36	42.9	15	33.3	8	21.6	3	20.0	2	28.6
nearby magnets (bank/ facilities/cultural centres/etc..)	11	13.1	16	35.6	10	27.0	3	20.0	1	14.3

Table 5: additional motivation for park visits for each user group. Note: Cells shaded in light red indicate the maximum number of users while cells shaded in blue indicate the minumum number of users.

6.3.2 Satisfaction of users' experience at the park

Great experiences are generated from great spaces, each one of them give the user a chance of experiencing unique feelings such as admiration, belonging or exploration. A checklist was given to the participants in order to measure the satisfaction level of their experience at the park, on the scale from 1 to 5 (1 being very dissatisfied, and 5 being very satisfied). Users were mostly satisfied with the park's cleanness (3.48), they also found the number of seats (23 bench) so unsatisfying especially that most of the lawn area is also fenced. Table (6) From the user groups 'perspective, users who visited the park in groups were also highly satisfied with its cleanness (3.44) but needed more shaded seats (3.02). people who visited the park alone were equally satisfied with the park's cleanness, maintenance and the seats 'quality. Furthermore, dog owners were satisfied with park's maintenance but not with the seats 'number (3.05). on the other hand, users who came to exercise were the only group which is satisfied with the number of seats as they don't actually use them more often (4.25), however not with their location (3.13). Finally, families who visited the park to play with children were satisfied with the park's maintenance but not with its safety (2.8) nor with the seats' quality or the number of shaded seats (2.40 for both).

User's Satisfaction	Total N	Family & Friends	Enjoy Nature	Walk Dogs	Exercise	Play with Children
N	85	54	34	19	8	4
	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score
Park's Safety	3.25	3.20	2.30	3.53	3.88	2.80
Park's Cleanness	3.48	3.44	3.50	3.58	4.00	3.40
Park's maintenance	3.42	3.39	3.50	3.79	3.38	3.60
Seats number	3.07	3.19	3.06	3.05	4.25	3.00
Seats' location	3.32	3.33	3.41	3.47	3.13	3.00
Seats' quality	3.39	3.30	3.50	3.68	3.63	2.40
Shaded seats	3.15	3.02	3.06	3.32	3.50	2.40
Mean Satisfaction Score (1 to 5 Scale)						

Table 6: user's satisfaction mean scores of their experience in the park from questionnaire based suvey. Note: Cells shaded in light red indicate the highest satisfaction rate while cells shaded in blue indicate lowest satisfaction rate.

6.3.3 Needs of each user group

This particular question is to get opinions on several desired facilities which users need during their visit. (Table 7) The results are based on the list of statements where respondents were asked to indicate the extent to which they agree with the statement, on the scale from 1 to 5 (1 strongly disagree, and 5 strongly agree). The majority of the participants chose the animal friendly zone as their primary need (3.4). this can be interpreted through the large number of dog owners who visit the park, side interviews showed that locals call Allenby Park "dogs park". In fact, dog owners were the user group who agreed the most on the necessity of an open lawn zone for their dogs (4.26). Participants agreed that indoor activities are not needed in the park (2.84), they enjoyed open spaces more since the amount of open liveable space in Alexandria is very limited. The user group who desired the indoor activities were people who came to exercise since they sometimes need closed areas for the workouts especially in cold weather (3.25). From the user groups perspective, users who came in groups and alone both desired an animal-friendly zone the most (3.89) and (3.94) consequently, they didn't care much about the existence of public toilets. On another level, people

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who came to exercise also appreciated the presence of WIFI (3.38) but not the public toilets (2.25). Finally, families who came to play with children appreciated the existence of children playground the most (3.60).

User's Needs	Total N	Family and Friends	Enjoy Nature	Walk Dogs	Exercise	Play with Children
N	85	54	34	19	8	4
	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score
Public Toilets	3.40	2.19	2.29	1.21	2.25	3.00
Animal friendly zone	3.94	3.89	3.94	4.26	3.38	2.60
WIFI	3.84	3.91	3.59	4.05	4.00	2.40
Indoor activities	2.84	2.65	2.85	2.58	3.25	3.00
Exercise equipment's	3.61	3.72	3.79	3.47	3.63	2.60
Children playground	3.35	3.00	3.06	3.11	3.63	3.60

Table 7: users' mean scores of the desired needs of each user group. Note: Cells shaded in light red indicate the highest satisfaction rate while cells shaded in blue indicate lowest satisfaction rate.

6.4 Park's accessibility

Allenby Park is accessible through 6 entrances, the number of people who use each entrance was calculated through indicating the number of visitors who access the park through each entrance in ten minutes throughout 5 different times of the day. (Fig 2) The results indicate that entrances located on the main roads are the mostly used. The highest number of users (72-84 user/hour) access the park using entrance (1) that is located on the neighborhood's main street which connects the park to the city's main road in the north. Followed by entrances (2) and (6) that are both located on main streets and which also attract a large number of users (24-48 user/hour). However, from the on-site interviews that were held during the collecting data phase, users who came to the park by driving (34.1%) declared that they usually use these specific entrances because of the nearby parking lots located on the two main streets. Furthermore, entrances (3) and (4) which are situated on the eastern side of the park attracted the least number of users (13-24 user/hour) and (0-24 user/hour) consequently. People who use these entrances, especially entrance (4), come generally from a nearby low-income neighborhood. Due to the low usage of these entrances, the eastern area usually attracts users who want to sit alone and dog owners. Finally, the least active entrance is entrance (5) which is blocked as well as entire southern street due to diplomatic reasons. The surrounding context didn't only block accessibility to the park from the south, but most importantly due to this blocking, it created a calm and shaded area along the southern side. In fact, this specific area is most of the time occupied by users who go picnicking on the lawn and who are usually accompanied by friends or children.

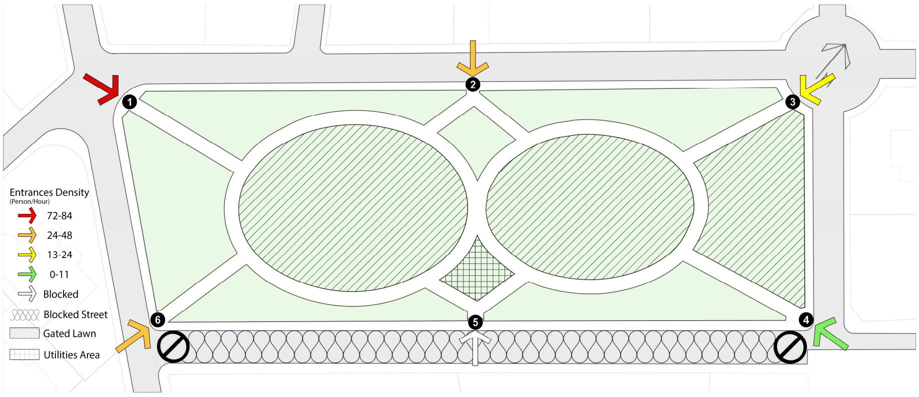

Fig. 2: Park's accessibility and context.

6.5 spatial distributions of the user groups and Density of settings' occupation

The spatial distribution patterns of different user groups at overall park level were detected through an observation-based survey. The clustering of each group's spatial distribution was detected to identify which group tends to explore a larger area in the park and which group tends to stay concentrated. Based on the results, it was interpreted that user who come to enjoy nature are more spatially dispersed and explore larger areas in the park. This might be because in contrast, users motivated to have social interactions usually have a specific activity that they would like to engage in and a specific park setting in mind to visit. For instance, those who come to play with children may prefer to spend time in shaded settings or play with children in a lawn area. Users who come to meet family members and friends may prefer to have direct access to entrances leading to nearby facilities such as food outlets, thus they tend to stay near the park's entrances. In contrast, visitors who come to enjoy nature may not have a specific activity in mind, and instead are more interested in exploring the park. Hence, this group tends to have a larger walking area side by side with people who visit the park to exercise and dog owners. Observation also indicated that nature-oriented visitors usually stay longer, walk a longer distance and are spatially more distributed.

Approximately 80% of the park's total area is a fenced lawn, which leaves only 20% for circulation and seating. Fig (3) During the on-site interviews, visitors who belonged to different user groups manifested their desire to access the deprived zones. They were very upset with the concertation of all users within a small area which caused great crowdedness. Due to the lack of open lawn areas along with the unsatisfactory low number of seats (3.07 on Likert scale), visitors who came alone, with friends or with children tended to benefit from the small shaded open lawn area in the south to picnic. During the observation survey, it was detected that some users came to the park with their own portable seats, especially evenings when the park was mostly crowded (41.2%).

Fig. 3: (left) large fenced lawn area. (middle) well-maintained greenery. (right) small pathway left for seating and circulation.

6.6 Favourite settings for each user group and shared hotspots

In order to calculate the density of users, an observation-based survey was held whereas the number of users that occupy each seat in the park along with to which user group they belonged was detected. Then, the number of users location points during 5 different times a day throughout the whole observation period were calculated to illustrate the user density for different user groups and the occupation level of the park's settings. Fig. (4) The results suggest that users were concentrated in both northern and southern areas. Shaded settings resulting from large trees are mainly what these two areas have in common. The northern zone has high accessibility from main streets while the southern area tends to be private and quieter. On another hand, users were more evenly distributed on both sides of the intersecting ellipse shaped pathway. This distribution may result from the uncomfortably users get from sitting in a place which is exposed to a very high circulation such as the above-mentioned area.

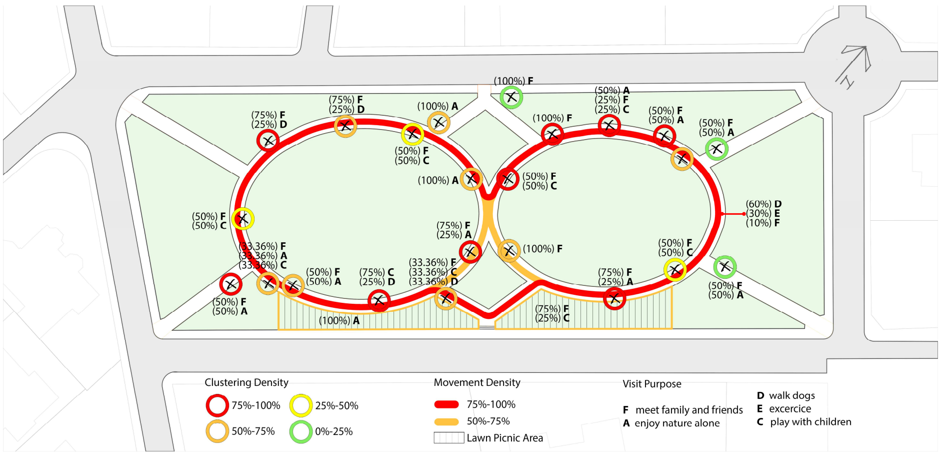

Fig. 4: Concentration density and favourite setting for each user group.

Following up to the previous clustering analysis, park areas that are frequently visited were detected in order to investigate the park 's favorite settings that attract different user groups to stay. Then a comparison of preferred park settings of different user groups was made by examining the shared hotspots to investigate whether different users prefer the same areas to stay in during their visits. The results indicate that users who came to meet family members and friends preferred shaded seating benches on the main streets near the

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park's entrances. Areas further from the park busy entrances were visited more frequently by users who came to have contact with nature and relax. Meanwhile, users who visited the park to walk dogs preferred open lawn areas along with paved circulation paths. Those who visited the park to exercise also chose the paved circulation paths for jogging. Finally, the group who came to play with children chose shaded seats, open lawn and settings far from main streets and entrances.

Moreover, since conflicts often occur when different user groups use the same site at the same time, users who aim to enjoy the nature and relax are more sensitive to disturbances from other groups. Thus, they tend to choose areas with lower usage mainly in the eastern side of the park away from the main road Fig. (5) and in the southern area where both the park's entrance and the road are blocked as previously mentioned. Conflicts may arise because of crowdedness, blocked views or noise disturbances. For instance, this study suggests that a group of seats facing each other may be located on both the western and northern sides of the park to attract users who come to engage in social activities and meet their friends. That way users who go alone would enjoy nature peacefully.

Fig. 5: (left) passage leading from low-usage entrance 3. (middle) passage leading from low-usage entrance 4. (right) low-usage entrances produced quite seating areas suitable for enjoying the nature and relaxing.

6.7 Public interaction and involvement

6.7.1 Social activities

Great spaces encourage its visitors to interact and take part of its greatness. Urban spaces can affect its user in both a good and a bad way; it may encourage them to take part of social and cultural activities or at the opposite it may boost vandalism and crime. Further activities were noticed within the park; a nearby school used the park as an excursion to its student. The teachers drew animal figures on the trees so the children may later on identify them as a sort of an outdoor activity. Fig (6) One of these excursions actually visited the park in the same time of one of the observation surveys. Children were notably very excited and delivered their joy to all the other users who visited the park. The school wouldn't have taken such an action if the park wasn't appealing enough for the children or safe and clean for them.

Fig. 6: (left) outdoor school activities for children. (middle) example of school activity. (right) example of school activity.

6.7.2 Neighborhoud residents' sense of community

Neighbourhood open spaces work appropriately when people feel a sense of control over them. Conversely, open spaces fail when people perceive them as belonging to the city. The residents of kafr Abdo neighborhood founded an organization called the "Kafr Abdou community ". This organization's main aim is to make kafr Abdo a better livable neighborhood. From the on-site interviews, residents stated that a small amount of money is collected from each dwelling per month in order to keep the neighborhood clean and well-maintained. They placed garbage bins all over the neighborhood (fig. 7), paid gardeners to keep the park at the best shape they could and organized seasonal events/fares for small crafts, events to raise awareness about a certain topic or even to encourage social engagement of the residents. This had a direct effect on the users ‘experience while visiting the park, as they were mostly satisfied with the park's cleanness. see (Table 6)

Fig. 7: (left) garbage bins placed by the neighbourhood community. (right) Park's cleanness and maintenance.

7 CONCLUSION AND RECOMMENDATIONS

In summary, when designing or renovating urban spaces, planners should pay great attention to the users of the space they are designing, whether they were residents or non-neighborhood residents. Decision makers must understand users' socio-economic status, cultural background, interests and motives. These factors will later on have a direct influence on users' behavior, on how they perceive the space's features and most importantly whether it fulfills their needs or not. The study found that despite the location of Allenby Park, which is situated in a high-income level neighbourhood, almost half of the users came from different parts of the city and took more time to reach the park.

According to the study findings, people who visited the park for different purposes had different use patterns, users who went alone to enjoy the nature stayed the longest (from two to four hours per visit). None of the participated families who came to play with children reached the park on foot, they were all derived from lower-income neighborhoods were greenery and open spaces in general are very limited. The user group who visited the park more frequently was consisted of users who go to play sports and that is mainly due to the consistency of their exercises. Both users who go with friends and those who choose to go alone to relax have a similar use pattern, however they visit the park at two different times of the day to avoid conflicts.

The findings also show that what motivates people to visit the park more frequently are basically the food outlets which are located nearby the park, they attract more often the group of users who go to meet friends and engage in social activities. People who go alone to enjoy nature and who are also mainly neighborhood residents, are attracted by nearby facilities such as banks. Finally, families who go to play with children stated that the pre-arranged appointments are what motivate them the most, that can be explained because they are derived from far districts and tend to visit the park in groups. Moreover, users are mostly satisfied with the park's cleanness which is resulted from the organization founded by the neighborhood community to help in maintaining the park.

The surrounding context had a great impact on the areas which each user group prefer; the diplomatic building which caused the blocking of the southern entrance and street made that zone suitable and safe for children. Furthermore, the eastern side of the park included low-usage entrances that people from a nearby low-income neighborhood used to access the park. This generated a calm and relaxing zone for those who preferred going alone to enjoy the nature. The findings of this study emphasize the necessity of allocating additional park settings to satisfy users ‘needs. It is also important to reduce the amount of fenced lawn areas and open them to the public, this way the circulation pathways would be less dense which would give space for exercising and walking dogs. Following users' needs, a segregated animal-friendly zone would be highly appreciated due to the large number of dog owners who visit the park.

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The Liveable Life in Slums

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1 ABSTRACT

More than 1 billion people of the world's urban population lives in slums. One in eight people. The locus of global poverty moves to cities, with the majority in the developing world. Low incomes, poor infrastructure and rising exclusion are just minor stimulators that contribute to a poor quality of life. Long since nations, governments and local administrations recognised the need for higher living standards for each and every citizen. The focus on creating worldwide sustainable livelihoods peaked in 2015, with the international acceptance of the Sustainable Development Goals (SDG), followed by the New Urban Agenda (NUA) in 2016. Liveable areas became a priority and the concept of liveability evoked a new sense for sustainable improvements of human life. Still, liveability remains a complex concept that includes a variety of elements and can be measured through a set of sub-dimensions and encompasses objective indicators , as well as subjective indicators . Problematic is the fact that in most cases liveability indicator's are measured and quantified for whole regions, rather than individual neighbourhoods, "you can live in a city that ranks high in terms of quality of living and still suffer from a low quality of life because of unfortunate personal circumstances […]" . The extent of disparity in perceptions of a liveable life is mostly limited to formal settlements, whereas in countries, as India a large proportion of the population lives in informal settlements.

The aim of this paper is to provide an overview of the holistic approach to identify liveable life indicators within the framework of a fieldwork study in slums of Bhubaneswar (Odisha, India). The identification of indicator's aim to act as a lever within participative slum upgrading through the formulation of a Liveable Life Index. It hypothesizes that community perceptions of a liveable life are the most influential indicators and they perform weakest in slum upgrading. The area of research is Bhubaneswar, the capital of the Indian state Odisha and centre of pilot projects of "Odisha's Liveable Habitat Mission". The method developed includes focus group discussions in slums of Bhubaneswar to identify liveable life indicators. Further, it includes Expert Interviews with slum upgrading experts to identify perceptions of liveable life indicators and anticpted best practices for upgrading. The study's primary research framework enables slum upgrading strategies to be viewed from two different perspectives. Splitting perspectives is important as congruent and divers perspectivies can be analysed to transform hidden potentials into sustainable opportunities.

Keywords: liveable life, slums, upgrading, quality of life, safety

2 INTRODUCTION

Transferring liveable life perceptions to the guidance of slum upgrading, mainly emphasises the interplay between top-down and bottom-up approaches. Lack of studies for informal settlements often lead to the assumption that upgrading tasks, such as building improvements, basic service provision or access to water automatically lead to improved local living conditions but a lack of local comprehension, along with upgrading assumptions are deeply intertwined, this paper argues, so are their solutions. Liveability is mainly calculated to take a quantitative approach, rarely differentiating between social classes or focussing on individual perceptions.[1] The concept of a liveable life goes one step further and focuses mainly on perceptions at a defined community level. Lining the trend of raising global liveability to the papers' informal settlement context, the liveable life at the urban slum level is investigated to define a "liveable life" from a slum neighbourhood perspective. Subsequently, a "Liveable Life Index" (LLI) is developed, based on identified liveable life indicators and aimed to identify relevant locally rooted liveable life components, which can be translated into priorities and strategies in slum upgrading at governmental level.

3 BACKGROUND - ODISHA'S LIVEABLE HABITAT MISSION

Odisha's Liveable Habitat Mission can be split into two components, "The Odisha Land Rights to Slum Dwellers Act" and "Jaga Mission". In 2017, the government of Odisha enacted the landmark legislation "the

[1] Kovacs-Györi, A.; Cabrera-Barona, P.; Resch, B.; Mehaffy, M.; Blaschke, T. (2019): Assessing and Representing Livability through the Analysis of Residential Preference. Sustainability, Vol. 11, No. 18, p. 4934.

Odisha Land Rights to Slum Dwellers Act, 2017".[2] The "act [provides the assignments] of land rights to identified slum dwellers, for redevelopment, rehabilitation and upgradation of slums, and for matters connected therewith or incidental thereto"[3] in 114 Notified Area Councils and Municipalities. In the course of the act, the use of high-resolution drone imagery enabled Odisha to map slums and become the only state in India with a spatial database of every slum in every city and town.[4] The database created, facilitated the identification of dwellers eligible for the Land Rights Act and by the end of 2019, already 60,000 slum dwellers in Odisha received land titles.[5] Subsequent to the granting of land rights, "Jaga Mission" was implemented. The Mission aims at transforming informal settlements into liveable habitats by improving the standard of infrastructure and access to livelihood opportunity services at par with the better off areas within the same urban local body.[6] The focus of upgrading are six general habitat services: road, drain, individual household latrines, pipe water supply, in house electricity and streetlight. Local agreements to planned approaches display a prerequisite for upgradation, as well as local resident participation.

4 THE LIVEABLE LIFE

Focus Group Discussions disclosed that informal settlements can be categorised as economic powerhouses where cleaners, drivers, sex workers, servants, leather workers, metal workers, waiting staff and many other trades flourish. This sector displays a type of informal parallel economy, outside parties often declared as a problem; but people tend to forget about the fact, that informal workers are the ones supporting the comfort of the middle and upper class. It is important to take responsibility for them and keep this sector upright, ensuring a fair, equitable treatment and liveable life conditions. Indeed, supporting institutions would do better in developing slums, when they refrain from prejudices about settlements and view them for what they are: not just areas of misery, but a place where many people have been living for generations, a place which they call home.[7]

In order to identify liveable life indicators in slums and use this perspective as a guideline for sustainable slum upgrading, a Liveable Life Index (LLI) has been developed. From the identification of individual sub-elements to the local LLI, three essential steps are required. It is a simple, flexible and adaptable procedure.

(1) In a first step (identification), liveable life indicators are randomly identified in neighbourhoods of a specific area. These indicators are aggregated and reduced, based on frequency and relevance.

(2) In a second step (test run), the filtered out liveable life indicators are again randomly analysed in the same area but in other neighbourhoods with regard to their weighting and priority. The test run is crucial: This way it is ensured that only generally accepted and relevant indicators become part of the index. So to speak, the index displays the "bible of upgrading".

(3) In a third step (implementation), the LLI is constructed and locally implemented. At governmental/ aid agency level the LLI is transformed into guidelines for upgrading orientation. The resulting measures of the guidelines are then transferred to an entire area and applied across the slum neighbourhoods in that area. In exceptional cases, slum neighbourhood-specific individual factors can be added or subtracted afterwards for optimal adaptation. This is important, as it helps to prevent irrelevant measures and to highlight neighbourhood specific thematic fields to focus on.

With reference to the upgrading approaches under Jaga Mission, a unique attempt for slum upgrading in Odisha can be identified. Still, this approach does not cover all relevant upgrading areas. During the research different neighbourhoods were selected and analysed. It follows that the different slum neighbourhoods

[2] Social Services India (2018): Jaga Fellows for World's largest slum land titling Programme, retrieved from https://socialservicesindia.com/wp-content/uploads/2019/06/Jaga.pdf (27.03.2020).
[3] The Odisha Gazette (2017): The Odisha Rights to Slum Dwellers Act, 2017, Cuttack, p. 3, retrieved from http://govtpress.odisha.gov.in/pdf/2017/1652.pdf (10.09.2019).
[4] Tata Trusts (2019): Odisha: Land Rights to Slum Dwellers, Observations on detailed work flow process maps, p. 10, retrieved from http://www.jagamission.org/pdf/Compendium%20Land%20Rights.pdf (19.09.2020)
[5] Chakrabarty, A. (2020): COVID-19, JAGA Mission and the value of already existing solutions, retrieved from https://www.iied.org/covid-19-jaga-mission-value-already-existing-solutions (26.08.2020).
[6] Paty, S. (2019): Re: Questions to Jaga Mission, Personal E-Mail, sradhapaty@gmail.com, 14.11.2019.
[7] Mehra, C. (2020): From Dharavi to Sao Paulo's favelas, a Covid-19 response must engage the communities that live there, retrieved from https://scroll.in/article/960980/from-dharavi-to-sao-paulos-favelas-a-covid-19-response-must-engage-the-communities-that-live-there (09.05.2020).

analysed face similar liveable life perceptions, but location specific priorities for certain liveable life indicators can clearly be noted at the individual locations. Considering slum development under the Liveable Life Index, implies that areas are aimed to improve to the extend of local dwellers perception of satisfaction. How it will exactly develop is dependent on the local situation and the clear set of priorities in the LLI. These differences need to be taken into account, in order to ensure sustainability in realised approaches.

In comparison, Jaga Mission focusses on a firmly structured plan, whereby the LLI relates to a flexible framework. Further, the reduced scope of action, can also be traced back to the fact that it is a state program, where standardised methods and procedures dominate for faster implementation. As a result, not all relevant liveable life indicators are taken into account at Jaga Mission. Further, field research proved that participation and inclusion into upgrading projects is highly demanded. In general, slum dwellers seek out for participative strategies; they are willing to contribute personally to the development of their living environment; they want to feel a sense of ownership and they prefer dialogues in all directions to top-down approaches and monologues in one direction.

As mentioned above, the local upgrading strategy pursues a fixed set of approaches, which are mainly of a physical nature. As the local research – in non-upgraded slums – verified, non-physical elements exceed the physical ones and locally perceived liveable life components surpass the six upgrading areas. Based on the Focus Group Discussions, 15 liveable life indicators were identified and categorised under four topics, here called elements:

(1) Safety - Neighbourhood Safety (Crime & Environment), Tenure Security, Employment Security (Working Contract);

(2) Social - Respectful Behaviour & Trust, Sense of Belonging & Community Relations, External Neighbourhood Relations;

(3) Physical - Basic Services, Adequate Housing, Parks & Green Spaces, Neighbourhood Cleanliness, Community Centre;

(4) Service - Proximity to Public Transport, Proximity to Doctors, Proximity to Schools, Proximity to Employment.

4.1 Safety Element

The safety element refers to a community's sense of safety from crime, protection against environmental risks, ownership of legal land rights, as well as employment security. Based on primary and secondary research it is important for dwellers that living in a crime free neighbourhood is a prerequisite for selecting living sites. With regard to tenure security, land rights are of high relevance only in specific cases. In periphery areas where land is less in demand, dwellers rarely require land rights. The granting of land rights is accompanied by the provision of personal data to governmental institutions and some dwellers fear to be on the authoritative radar. On the other hand, slums located in the urban centre prefer the possession of legal land rights, as areas close to centres of economic activity are popular and expensive. The high demand for urban land is well known and, in many cases, private land owners evict slums to build lucrative complexes, such as offices or hotels. In this case, tenure security prevents the fear of eviction, allows families to settle down and invest in home constructions. Next to a safe neighbourhood and tenure security, dwellers highlighted contractual work environments. Usually, dwellers manage several workplaces per day, which are irregularly paid and permanence is insecure. Contract work provides additional experience, knowledge, skills, ensures a regular income, and gives dwellers more control to approach productive daily routines.

4.2 Social Element

The social element refers to a community's sense of behaviour patterns, social integration and interactions with individuals within their settlement, as well as connections to neighbourhoods in the direct vicinity. Relationships to communities beyond slum boundaries display a crucial aspect of a liveable life, as they ensure social inclusiveness and a stronger feeling of belonging. Slum residents' value trustful relationships with all people they are or would like to be in contact with. In their opinion socialising displays the basis to initiate community thinking and strengthen a sense of belonging within the community, which is crucial in periods of crisis. Further, mutual tolerance, respectful interactions and the acceptance of social responsibility are another part of the slum dweller's personal perception of a liveable life. Many dwellers are familiar with oppression. They know how it feels to be neglected, discriminated and governed by the formal sector. For this reason, they welcome any individuals entering their territory, as they do not want to convey the impression that individuals are not accepted or tolerated, just because they have different religions, political views, nationalities, social origins or other distinguishing features. Dwellers compare respectful behaviour to a gift. It is barely possible to show gratitude or appreciation through dinner invitations or small souvenirs, when neighbours or other visitors enter the slum, but they can offer respect, which displays the highest of their social values. At Nala Muha Sahi Basti the slum leader stated: “We cannot offer you drinks, food, or a comfortable chair, but we will always welcome you with and show respect.”[8]

4.3 Physical Element

The physical element refers to the functioning architecture of a community’s direct environment and identifies fundamental amenities indispensable for a liveable life from a slum dweller perspective. These include basic services, adequate housing, parks & green spaces, neighbourhood cleanliness and meaningful communal areas with a high quality of stay. Most identified physical elements are in par with Jaga Missions upgrading agenda and will be improved within each slum in Bhubaneswar, such as sanitation and drinking water, which fall under the category “basic services”. Further, parks & green spaces, clean environments and community centres are highly valued to enhance cohabitation and especially enable the younger generation to eexercise, encounter friends and participate in other outdoor activities. Residents also claimed that green spaces have a cooling effect and can reduce the temperature in inner-city areas, which is particularly important during the hot summer seasons. Lastly, the physical element is of particular importance, when categorising a certain area as a slum area, as the identified components display vital parts of the UN-Habitat’s definition of a slum, where the absence of one or more of these indicators defines a slum.[9]

4.4 Service Element

The service element refers to a community’s proximity to vital services and development prospects, such as public transport, health care centres, education facilities and job opportunities. This dimension builds on the physical dimension and illustrates, how the physical environment meets local requirements from a service perspective. Still this element rather displays a crucial determinant in the personal development of individuals, as opposed to the physical element, which focuses on improving the external environment. In particular, the proximity to and affordability of health care services is high in demand, as insufficient waste management, the lack of sanitation facilities and broken drainage systems impair hygienic environments, contributing to poor health conditions. In addition, maintaining physical and mental health are one of the main prerequisites, to join school and guarantee an established education or access job opportunities to finance expenditures. Access to any of the four services mentioned ensures a balance between personal well-being, future interests and the achievement of other components that contribute to a liveable life from a personal point of view on a daily basis.[10]

5 CONCLUSION

Comparing the local upgrading strategies and focus areas with expectations of realistic necessities from a dweller perspective in slums, discrepancies in perceptions can be determined. Upgrading work under Jaga Mission follows a strict guideline, which might be the determining factor for high success rates and rapid implementation measures in Bhubaneswar. Still the upgrading focus is mainly based on a pre-defined plan, which covers some, but not all components identified as decisive factors to live a liveable life in slums. In the short run, current upgrading might have positive effects, but in the long run the sustainability of upgrading approaches neglects local needs in its entirety and settlements easily revert back to old patterns. Within upgrading it is important to employ strategies that focus on the interdependencies of liveable life indicators and indicators, residents consider most influential for a better liveable life.

[8] “Quotation of Personal Correspondence“ (Slum Leader of Nala Muha Sahi, Personal Correspondence, Slum Dweller, Bhubaneswar, 20.11.2019).
[9] UN-Habitat (2006): The State of the World Cities 2006/7, United Nations Human Settlements Programme, Kenya, p. vi.
[10] Murza, G., Laaser, U. (1994): Gesundheit und Schule. Theorien zur Verbesserung der Lebens- und Lernqualität bei Kindern und Jugendlichen, IDIS, Bielefeld, p. 35.

Local slum dwellers idea of a liveable life and participatory strategies go not hand in hand with Odisha's Liveable Habitat Mission. Odisha's Mission claims to act participatively, but its implementation admits difficulties, especially in times of Corona. Addressing this weak interface is where the research intervenes, making recommendations at authority level for optimal upgrading design according to local needs. With the developed Liveable Life Index, a tangible tool is established which supports the identification of locally rooted liveable life perceptions and the coordination of associated key stakeholders. This constitutes the basis and can be further developed at governmental level into a feasible project.

A lesson learned is that there is no construction plan for optimal upgrading. Various slum upgrading plans have conducted countless surveys, invested considerable sums and applied the concept of "participation", but still failed because anticipated best practices and perceptions of optimal solutions overshadowed realistic demands at local level. It seems a challenge to break the separation of perceptions and realities, top-down and bottom-up, and clichés and abstractions. What and how something is achieved needs to be tailored to local conditions and requires iterated cycles of learning and feedback. Slum upgrading involves time to embed solutions at local level and instead of rushing to reach outputs, the focus should be based on processes with steps that keep to the local pace and ensure sustainability in approaches.

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The Parametric Design to Foster Cross-Border Governance

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1 ABSTRACT

Ongoing research intends to develop a new planning tool to foster cross-border governance. It is a conceptual model that employs parametric design and new forms of communication. Its application can go beyond administrative boundaries.

Today in the world, there are increasingly complex problems that need to be addressed in a multiscalar and interdisciplinary way, as the pandemic and the environmental crisis are demonstrating.

Territorial planning is called to face challenges that require new tools integrated into territorial governance and without administrative limits. We must also help make decisions in a tight time frame and comply with the financial resources used.

The research intends to create a tool to involve local actors in the future design of the area. The method consists of using 3D images, in addition to traditional forms of representation. The parametric design permits to evaluate design alternatives better as it is more realistic. The tool must be integrated with communication forms capable of stimulating bottom-up processes and creating cross-border networks with medium to long term effects.

The problem is addressed in Chiasso, in the cross-border region between Canton Ticino (Switzerland) and the Lombardy Region (Italy). It is a relevant hub of north-south flows and has recently been affected by two projects: a new highway layout and the commercial custom's adaptation. These will have repercussions in the area and involve the social, economic, and environmental challenges for the future. There is no lingusitic barrier long this border, but no strategic planning is shared between the countries, and in the same area, there are four different planning tools.

The desired result is the recognition of a new tool for territorial planning. The first test carried out with students of the Master's Degree at SUPSI in Mendrisio (CH) underlined a greater interest by participants when using this parametric design alternatives.

Keywords: parametric design, informal planning, cross-border governance, communication, bottom-up

2 INTRODUCTION

The doctoral research, still in progress, focuses on conceptual models that can help the actors involved in participatory processes to formulate problems in the cross-border region. Therefore it is necessary to rethink the vision of the cross-border context, the way of dealing with problems, and the tools to be adopted.

First, the boundaries must be rethought. They must no longer be understood as static limits of national sovereignty. A new perspective is needed in the narration of these places. As Brambilla describes, the border should be considered a paradoxical structure that became an expression of culture and territory multipolarity, generating a transnational flow of narrations and images. Adopting this perspective, borders are created and creative space. [1]

As for the problems, in a world where there are increasingly complex problems to face, as pandemic and environmental crisis, the methods for elaborating shared solutions must necessarily be more structured than in the past. Therefore, the procedures consolidated over time must be revised to cope with the new challenges. Complex problems include different disciplines that consider various approaches. They also have modifiable and external elements whose variation is beyond those who deal with them. All these things mean that a planning problem must be tackled both at the large scale where the problem arises and at the local level where the solution proposed will be located. "(...) In planning practice, there are numerous understandings of the term "planning approach", planning can, for example, be understood as urban design, land-use management, social practice, landscape ecology, traffic management, etc. what is common to all these is that planning is never neutral or an activity that can be taken for granted."[2] The current problems

[1] "Borders: paradoxical structures between essenzialization and creativity", pp.582, 2009.
[2] "Planning Approaches or Nothing Comes from Nothing", pp.161, 2018.

need to be addressed in a multiscale and interdisciplinary way and with the involvement and awareness of local actors and citizens. Territorial planning is called upon to make its contribution. It is necessary to equip it with new tools capable of being effective in a tight time frame thanks also to the integration with new technologies, and comply with the financial resources used.

Therefore, the goal is to adopt tools that use creativity. In particular, the research refers to informal planning. Bern Scholl argues that the set of instruments and procedures do not underlie the fixed procedures of planning law so that they can be designed flexibly and matched to the conditions according to the occasion, the topic, or the constellation stakeholders. Informal planning is not regulated (in its accuracy) as much formal planning. Informal planning is indispensable for the preparation of formal planning as well as for many others.[3] Creativity must necessarily be included in a broader planning process, also composed of the rules of formal planning. This approach makes it possible to act in compliance with cross-border governance. It makes it possible to maintain relations with national governments and incorporate visions on an international scale (top-down). Furthermore, informal planning allows bottom-up involvement thanks to the collaboration with stakeholders (bottom-up).

One of the advantages of this approach is to be able to adapt to changes in the context. The recent pandemic crisis, for example, has highlighted the relationship between the complexity and the shorter time to respond and intervene. Therefore, it is necessary to have tools to return an integrated vision of the problem that one wants to face in the shortest possible time.

Informal planning also has limits. As Papamichail and Peric argue, informal planning cannot be taken for granted - it is strongly interwoven with the planning culture influenced by the historical and political background, and the current socio-economic conditions.[4]

3 THE CONCEPTUAL MODEL

The aim of the research is the creation of a conceptual model to foster cross-border governance. The research focuses on a conceptual model that introduces the parametric design and communications forms that enable an honest discussion and shared solutions.

A conceptual model is “Result of the processes leading from the task to the specification of the conceptualisation of the ontological structure of the problem domain, comprising assumptions and constraints on all relevant modeling decisions.”[5]

The conceptual model is not a phase of the process but the set of procedures necessary to coordinate a participatory planning process. In accordance with Tolk's interpretation, conceptual modeling is not a limited activity in the initialisation phase of a simulation system, but a perpetually reoccurring process that drives the design of experimentation, the providing of necessary data, the evaluation and presentation of results, and many more activities conducted within the life cycle of the system.[6]

According to Wagner, the purpose of a conceptual model is capture a sufficiently large, and sufficiently complete, part of the real world problem domain, for which a simulation study is to be performed, in such a way that all kinds of research questions concerning this domain can be investigated.[7]. Furthermore, in agreement with Arbex and Birta, the conceptual model should enable all stakeholders to discuss (...) and it must be sufficiently comprehensive to serve as a specification for a computer program.[8]

During the participatory process, there must be respect for the ideas and opinions of others. Only in this way is it possible to create a climate of trust between planners, designers, and stakeholders. Grams argues that planning also means building an atmosphere of trust. (…) Through a carefully designed planning process, all actors are encouraged to accept and play their role. An ambiance of trust among decision makers allows fast decision-making when a window of opportunity opens.[9]

[3] “Formal and informal instruments and procedures”, pp.2, 2016.
[4] “Informal planning: a tool towards adaptive urban governance”, pp.2089, 2019.
[5] “Conceptual Modeling: Definition, Purpose, and Benefits”, pp.2823, 2015.
[6] “Conceptual Modeling: Definition, Purpose, and Benefits”, pp.2821, 2015.
[7] “Conceptual Modeling: Definition, Purpose, and Benefits”, pp.2823, 2015.
[8] “Conceptual Modeling: Definition, Purpose, and Benefits”, pp.2823, 2015.
[9] “Attisholz: From Switzerland’s Largest Industrial Brownfield to a Reserve of Euroean Relevance by Planning”, pp.127, 2018.

The benefits of the conceptual model, according to Tolk are: building trust by unambiguously documenting the model – which is the foundation of the resulting simulation – which is pivotal in case of reuse or composition. [10] Finally, Arbez and Birta add that the conceptual model ensures that key SUI features (e.g. behavior, granularity) evolve from discussion with all stakeholders rather than from a programming bias. [11]

The conceptual model focuses on increasing the level of engagement of the stakeholders and creating territorial processes in the immediate and medium to long term.

3.1 Parametric design and communication

The combination of parametric design and communication allows to design and focus on inclusion and creativity. It is a tool that make possible to translate different plans and projects into the same language and helps to understand problems and make shared decisions. This approach lets have the governance of the territory but go beyond the existing administrative limits.

3.1.1 Parametric design

The research intends to introduce parametric design in the conceptual model because it allows evaluating design alternatives and their effects on the area. Fusero and other argue that the use of parametric software in urban design, it is not only for the three-dimensional representation of projects at the urban scale but precisely in the process of forming urban planning tools, as a tool to help the planner to evaluate diversified scenarios and make motivating decisions. [12]

Moreover, its introduction help the planner coordinate the territorial transformations and coordinate them in a short time. Garagni and Bravo say that parametric technologies make possible to embed information into urban digital models, intended as sort of data collectors browsable in real-time. [13]

Galli defines parametric design like an innovative approach based on the use of computational tools to optimize the performance of the system in relation to the goals of the project. [14]

It can systematise rules (based on different parameters) and a large amount of data from different disciplines. Lee argues that each algorithm in this process has two components, parameter and rule. (…) In mathematics a parameter describes a range of variation, whereas in design, it defines the scope of design possibilities. (…) In contrast, a rule describes the resultant algorithmic functions as well as the relationships between components. [15]

The application of parametric design in urban planning can be various. In accordance with the research goal, the use of parametric design is to aid participatory planning. Lee asserts that decision-making in design is a cognitive process where in alternatives are generated and evaluated, potentially enabling a more creative design process. In recent years parametric design's heightened capacity for automatically generating and evaluating options has been celebrated by researchers and designers, but it has also placed an increased emphasis on decision-making activities. [16]

Furthermore, Rollandi argues that the parametric representation captures the attention more than other forms of visual model. The tools available to planners are the same as in the gaming world with which highly realistic settings are created. Good results can be obtained quickly, which significantly affects the entire participatory planning process's overall costs. [17] The parametric drawing involves the viewer with all the senses and, therefore, increases his curiosity and participation. Bosselmann said that the experience of watching a film involves visual, kinesthetic, spatial, temporal, and aural senses. As the scene starts, the motion captures the eye, and viewers cannot help becoming part of it. Objects pass by, allowing viewers to get their bearings. Once they have watched a few frames, they can sense the space, understand its boundaries, and gauge the distance to other objects within it. [18] Furthermore, the administrative limits are not

[10] "Conceptual Modeling: Definition, Purpose, and Benefits", pp.2823, 2015.
[11] "Conceptual Modeling: Definition, Purpose, and Benefits", pp.2823, 2015.
[12] "Urbanistica parametrica: una nuova frontiera delle Smart Cities", pp.4, 2013.
[13] "The parametric representation of the city", pp.125, 2010.
[14] "Urbanistica parametrica. Open data, strumenti e tecniche per la progettazione della città di domani", pp.26, 2013.
[15] "Creative Decision-Making Processes in Parametric Design", pp.2, 2020.
[16] "Creative Decision-Making Processes in Parametric Design", pp.2, 2020.
[17] "A conceptual model to promote engagement in participatory planning in the cross-border region between Switzerland and Italy", pp.6, 2021.
[18] "Representation of Places. Reality and Realism in City Design", pp.92, 1987.

constraints but are an area under consideration. The representations also make it possible to "translate" different plans and projects into the same language. In this regard, in 1976, Lynch argued: a unified language appropriate to the sensory form of cities will be a long time developing if indeed a unified language is possible. Meanwhile, we must deal with the many different aspects of this issue in diverse and sometimes not entirely compatible ways. Language in some form, whether graphic, verbal, gestural, mathematical, or whatever, is indispensable to thought. [19] It is clear that there is a greater engagement level with effects that last over time by adopting a representation. Oxman and Gu assert "Instant visualisation in 3D brings ideas to life and fuels creativity, both in professional designers/planners and untrained participant citizens, particularly so when designs can be interactively changed during the co-design sessions. The activity of visualisation helps participants to assess and reflect deeper on the spatial properties and qualities of their ideas. It facilitates comparisons of alternative designs and places these, literally, into the larger urban context. Being able to immediately review design alternatives in 3D contributed positively to the engagement of the workgroup." [20]

In the following figure there is an example of using parametric design in partecipatory planning. City of Zurich presented these building candidates in a competition for a new public school in the Allmend neighbourhood.

Fig. 1: The application of parametric design. Source: Esri web site.

Parametric design has many advantages, it is a support of addressing current challenges and changes. Its use should not replace planners and stakeholders because they have the necessary knowledge, an exhaustive vision, and the necessary sensitivity to tackle complex problems. Still Oxman and Gu write “However, there should also be an informed balance between pure parametric tool manipulation and the utilisation of a broad understanding of architectural knowledge in the parametric design process.” [21] Therefore, it is necessary to find a good balance able to relate all the conceptual model elements.

3.1.2 Communication

We live in a world where people are willing to define new rules, a world where new communication forms bring research and society closer. The analyses conducted over the last decade show that people are closer to disciplines they are not specialists in: this is due to the desire for new content and the fact that we immediately have an unlimited amount of information and insights thanks to technologies. The use of new tools and the method to communicate content appears essential to creating a topic's involvement. The physicist and humanist John Ziman wrote about the close relationship between science, society, and communication: the fundamental social institution of science is therefore its communication system. [22]

As has already been written, the research aims to create an environment of trust and respect. To do this, inclusive communication will be used “Inclusive Communication is an approach that seeks to 'create a supportive and effective communication environment, using every available means of communication to understand and be understood.” [23] It relates to all modes of communication: words and sounds, written

[19] “Managing the Sense of a Region”, pp.120, 1976.
[20] “Effectiveness of Virtual Reality in Participatory Urban Planning”, pp.5, 2018.
[21] “Theories and Models of Parametric Design Thinking”, pp.478, 2015.
[22] “An Introduction to Science Studies”, pp.58, 1984.
[23] https://www.rcslt.org/

information, online information. “Inclusive communication makes services more accessible for everyone. It will help to achieve successful outcomes for individuals and the wider community. It enables people to live more independently and to participate in public life.” [24]

The conceptual model intends to improve the use of new technologies for communication in the planning field. They are an essential instrument for each of us. The company We Are Social conducted the annual report for 2020: it shows that 60% of the world population is online and 90% of the time spent online is on apps where we spend an average of 2 hours and 24 minutes a day. Cowley and Hollander argue that the popularity of Facebook, Twitter, Google, Instagram, Youtube, Blogspot and other social media has spurred a demand for new forms of participatory planning and self-organising governance by citizens. Unlike with many conventional methods, citizens are keen on using social media tools to engage with planners. [25] More and more users use social platforms all over the world. They are a tool that connects and involves people of all age and different social groups. On social networks, there are no barriers; they allow us always to feel connected with the world. It is for this reason that the conceptual model intends to make use of them. Clark writes that mobile participation is expected to attract a much wider interest group than conventional participation tools, in particular youths and young adults who are difficult to engage in public affairs or participation schemes. [26]

Also, about the effects, Leeuwen asserts that the device used influences the engagement level or that smartphones users are more likely to engage with local policy. [27]

It will also be essential to know how to create new networks and strengthen existing ones affect in the territory even in the short and medium time.

4 CROSS BORDER REGION BETWEEN SWITZERLAND AND ITALY

The context for applying the conceptual model is the cross-border region between Switzerland and Italy with particular attention to the cross-border axis composed by Lugano (CH), Chiasso (CH), Como (IT), and Varese (IT).

"A cross-border region is a territorial entity that is made up of several local or regional authorities that are co-located yet belong to different nation-states. Cross-border regions exist to take advantage of geographical conditions to strengthen their competitiveness." [28]

This area is important on an international scale as it is at the centre of relations between northern and southern Europe. Indeed it is involved by the CODE24 strategy approved under the INTERREG IVB NWE European programme (2010-2015). Ticino is in the middle of the connection Zurich-Milan. On the one hand, recent projects in mobility and innovation make it possible to strengthen synergies in Zurich. On the other hand, Ticino has always had a strong relationship with Milan. According to Torricelli and Stephani, Canton Ticino today is an urban agglomeration that wedges into the valley floor up to the shores of the lakes, open in Mendrisiotto on relations with Como and Varese, the neighboring cities, but above all with Milan, which it exercises the attraction of a global city or rather of a Global City Region. [29]

The relations between Switzerland and Italy have a long tradition. Torricelli and Stephani argue that in southern Ticino, the border has always been permeable to traffic and markets, political ideas, fashions to costumes, and then, already in the post-war period, to the industrialisation process from the South. [30] The absence of a language barrier favours all this, as it also claims Economic Research Institute of University of Lugano “frontier labour markets will be “permeable,” given the common language, to frontier workers.” [31]

Despite this, the analyses conducted during the PhD highlighted some problems in the field of spatial planning.

[24] https://inclusivecommunication.scot/

[25] “The new generation of public participation: Internet-based participation tools, Planning Practice and Research”, pp.1, 2010.

[26] “Coproduction of government services and the new information technology: Investigating the distributional biases”, pp.2, 2013.

[27] “Effectiveness of Virtual Reality in Participatory Urban Planning”, pp.3, 2018.

[28] “Encyclopedia of the City”, pp.155, 2004.

[29] “La cooperazione transfrontaliera in Svizzera”, pp.3, 2009.

[30] “La cooperazione transfrontaliera in Svizzera”, pp.3, 2009.

[31] “Approfondimento della situazione del mercato del lavoro ticinese negli anni successivi all’introduzione dell’Accordo sulla Libera Circolazione delle Persone”, pp.62, 2015.

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First of all, a problem concerns the tools because there is no strategic planning shared between Switzerland and Italy. Therefore on the same territory, there are four different tools, two structural and two operational. They are different in terms of definition, competence, and characteristics. Canton Ticino has a strategic plan on a cantonal scale and uses zoning on the local scale. Lombardy Region instead has a strategic tool at different scales, and it has the regional law about urban and territorial regeneration. These tools must be "converted" to the same language to understand the possible outcomes.

The second type of problem of the cross-border region regards projects. There are many sectoral projects, but there is no integrated vision of territorial development and insufficient stakeholder involvement. For example, there are many INTERREG projects develop along five different axes. They intend to improve relations with local actors "(…) to improve the participation processes of stakeholders - businesses and civil society of the territories involved." [32] This aspect is essential to understand citizens' needs to create bottom-up processes and obtain good results in the territory. Regarding the work in the cross-border region between Sweden and Norway "The Sweden–Norway INTERREG-A subprogramme has assisted in boosting the cross-border collaboration process between Värmland Province and the Norwegian side of the border area since the mid-1990s, which has produced a positive effect on the territory in most of its development domains. However, beyond the Interreg programmes, the main policy agenda regarding current cross-border collaboration strategies has mainly centred on promoting economic growth (Region Värmland). Instead, the implementation of a broader cross-border policy development vision, based on a CBPS (bottom-up cross-border planning strategy), takes into consideration all domains of territorial development and the participation of the border residents – a bottom- up CBPS. The need for a CBPS makes even more sense in cross-border areas with long and strong historical collaboration ties, such as the border area comprising Värmland, Hedmark, Akershus, and Østfold." [33]

An excellent example of a cross-border project was the Regional Trains Ticino Lombardia (TILO). It is the first collaboration project ensuring regional and cross-border traffic. The company's shareholders are 50% of the Swiss Federal Railways SBB, and 50% of Trenord. [34]

Concerning the settlement model, the analysis of the territory highlights the use of sprawl. This model is no longer sustainable and generates lifestyles that prefer cars for daily journeys. The investigations conducted on the settlement units (understood as the sum of the resident population and the number of employees) in the cross-border region have shown that just under 70% of people do not live and work near the railway stations. In Switzerland, the settlement units near the stations are 48%, while in Italy, they are 25%.

All this generates two other problems. The first one concerns mobility and it is represented both by internal movements due to the growing number of frontier workers. In the 4th quarter of 2019, there were 67,878 cross-border commuters in Canton of Ticino, which increased 9.7% compared to the same quarter of the previous year. [35] A portion of the workers use the TILO for their daily movements. The average number of people on weekdays in the Lugano station during 2018 was 26.000 people, which increased 8.3 compared to the previous year. [36] The second problem is environmental and acoustic pollution. Low-intensity settlement development models and congestion of the main roads increase that, although all this does not correspond to the criteria of recent global trends.

In this cross-border region, the railway does not reach even half of the settlement units compared to other contexts such as northern Switzerland. [37] Consequently, the possibility of applying a policy for modal share will not have the same results. In this sense, greater efforts are needed to solve the sustainability of the settlement in this area.

In general, there is a discrepancy between the settlement model, the infrastructure network, and the local scale environment. For this reason, a survey was conducted in the cross-border region to understand urban

[32] https://progetti.interreg-italiasvizzera.eu/it
[33] "The importance of Swedish–Norwegian border residents' perspectives for bottom-up cross-border planning strategies", pp.13, 2019.
[34] https://www.tilo.ch/
[35] https://www.bfs.admin.ch
[36] https://www.sbb.ch
[37] "Gesamtperspektive Basel", 2020.

design and territorial dynamics. Attention is paid to the transformation areas because they are an opportunity for the future of this cross-border region.

All these problems can be tackled with greater collaboration on different scales "(…) This context provides a framework for thinking about how cross-border processes can operate more efficiently between governance levels that mediate and interconnect urban, local, regional, and national territorial planning processes." [38] According with Fossa, governance means "direct interaction between public bodies of different levels and stakeholders, outside the institutional hierarchies, aimed at projects or policies" [39] There is nobody with cross-border expertise, it is necessary to consider an involvement that starts from the bottom and considers the stakeholders already present in the area. A fundamental role is played by an informal instrument that fosters cross-border governance.

Another fundamental point concerns the context. The use of the same language and cultural affinities will be a positive element. According to an analog project in the Danube Region "It is clear from the case studies that a shared ethnicity and / or linguistic homogeneity tend to strengthen the intensity of cooperation." [40] To better understand cross-border problems and dynamics, we should analyze the territory on an intermediate scale. The studies conducted in Central Asia underline that it is necessary to move from a supranational to a subnational vision. According to Breslin and Hook, this vision is called microregionalism and refers to numerous interconnected processes "below" the national level across borders. [41] An example is in the study for the Hong Kong - Zhuhai - Macau Bridge. Also in this case there are no linguistic and cultural barriers. The great expansion of the area makes sure that people work in one country but live in the others. This generates continuous congestion of roads, boats, and customs. It was necessary to start a cross-border governance process for the construction of a new bridge. The process took many years and also involved stakeholders. Unlike the cases in the European Union the situation was: absence of authority at the regional level, transfer of power from the central government to the local governments and stakeholders. Also, in the cross-border between Switzerland and Italy, it could be considered to analyze the territorial context on a micro-regional scale. For example, there are different relations in the cross-border axis composed by Lugano (CH), Chiasso (CH), Como (IT), and Varese (IT). Recent events, such as the pandemic and climate crisis, have highlighted the close relationship between Como and Mendrisio. It is a micro-region within the cross-border region. Thanks also to the conformation of the territory, there are close work, commercial and family ties that need to be better analyzed, especially to overcome some of the problems previously described.

The research aims to create a conceptual model for the cross-border region. An informal planning tool that creates involvement beyond administrative borders, but it recognises the governance of Switzerland and Italy. For this reason, the research introduces a bottom-up tool that favours long-term processes. "A bottom-up based CBPS (bottom-up cross-border planning strategy) rationale can serve as a mechanism to implement an effective multilevel governance process, while combating persistent nation-state mentalities and border barriers. In summary, the main advantages of a bottom-up CBPS are that it takes into consideration the position of the residents in the border region." [42]

Ambus and Hoberg note the need to ‘‘devolve more authority to communities to create the space for meaningful participation and to encourage more novel and adaptive approaches’’ [43] Furthermore, Bixler said that in a world of uncertainty and complex social–ecological interactions, understanding cross-scale dynamics that affect decision making, adaptive capacity, and resilience across institutional levels is a critical endeavor and polycentric governance provides this framework. [44] The European Commission promotes that since 1997 "Such a bottom-up approach to spatial planning requires the recognition of the intersection between people and place, while embracing measures to co-ordinate municipal, regional, and national

[38] "The importance of Swedish–Norwegian border residents' perspectives for bottom-up cross-border planning strategies", pp.6, 2019.
[39] "Real estate registry", 2019
[40] "Crossing the Borders. Studies on cross-border cooperation within the Danub Region", pp.4, 2016.
[41] "Microregionalism and World Order", pp.8, 2002.
[42] "The importance of Swedish–Norwegian border residents' perspectives for bottom-up cross-border planning strategies", pp.13, 2019.
[43] "The evolution of devolution: A critical analysis of the community forest agreement in British Columbia", pp.945, 2011.
[44] "From Community Forest Management to Polycentric Governance: Assessing Evidence from the Bottom Up", pp.159, 2013.

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territorial development visions and interests, in a common decision-making process based on joint efforts in which common policies and guidelines are adopted.” [45]

4.1 Chiasso

In recent times, a good opportunity for cross-border planning is in Chiasso. Together with Mendrisio, in recent years, he has been interested in various cultural projects with a cross-border character.

Fig. 2: Chiasso. Source: Municipality of Chiasso

Fontana argue that it is a highly competitive region, thanks also to its well-established geographical position, at the centre of an entire mobility network for Europe, the axis that connects the Mediterranean with the North Sea, the axis with the highest population density of the continent. EU-supported new track and tunnel projects favor strengthening links between major European cities within a high-speed network, where the topography is no longer a limit. Travel times have halved: Milan, Zurich, Malpensa, and the interconnected Alpine passes. [46]

Chiasso is the southern terminus of the Gotthard railway and is the northern end of the Milan-Chiasso line. The station is one of the customs posts and constitutes the border point of Swiss and Italian railway networks. The other customs offices are near Ponte Chiasso (Italy) and the biggest one is Brogeda crossing on the highway.

Currently, there are two important projects under discussion. The first proposes moving part of the Chiasso-Como highway route into the tunnel. This new layout also involves moving the customs grounds and digitising them. In addition, the Swiss Federal Railways is preparing the new layout of the railway yards of Chiasso. It involves the decommissioning of part of those and frees up an area to be redeveloped. As regards the areas currently occupied, these are an excellent possibility of conversion through a cross-border project. Together with the transformation areas present in the Chiasso Town Plan, they could change its layout. Furthermore, given the Chiasso railway station's importance, a project could be implemented with a centripetal concept. It consists of the concentration of qualitative development in a limited space, preserving free spaces, and increasing the quality of existing centres. Moving the route would also enhance the green areas present along the Faloppa river in Chiasso and the Breggia river banks as far as Lake Como.

These visions must be managed beyond administrative boundaries. Furthermore, only with local actors' involvement will it be possible to make a paradigm shift in the territory's choices and define a new concept of quality.

[45] “The EU Compendium of Spatial Planning Systems and Policies”, pp.75, 1997.
[46] “Pianificazione transfrontaliera per lo spazio funzionale di Chiasso”, pp.10, 2019.

In recent months, the first application of the conceptual model is being carried out with a class of students at SUPSI (University of Applied Sciences and Arts of Southern Switzerland). The students were divided into five groups, and each represents a different actor who intervenes in their ways and times. As for the characteristics, both the multiscalar and the interdisciplinary approach are taken into consideration. In addition to the difference in the scales of intervention, different methods have been envisaged to represent the design solutions: freehand, software as desired by the designers, and CityEngine, a software application developed by Esri R&D Center Zurich. In this way, it will be possible to evaluate the effects of the students' different representations.

The project proposal's development will have to consider the aspects of settlements, mobility, and the environment. A reflection was made on the complexity of emergencies (climatic, pandemic) that this historical moment requires. Finally, particular attention must be given to the communication of design solutions: the method and tools used to illustrate the project were evaluated as an integral part of the project.

At the end of the course, a debate was organised to evaluate the effects of the representations. Compared to the traditional representations used in the first part of the test, parametric design, thanks to CityEngine, has changed the ongoing discussion. It contributed to creating a climate of dialogue and comparison on the various project solutions proposed.

Then, the second ongoing test of the research involves stakeholders' participation to obtain a shared vision for the area.

Fig. 3: The first result of the test with the students, by A.Rollandi

5 CONCLUSION

At the end of this examination, three aspects appear evident. The first aspect concerns the problems: they must be faced in an interdisciplinary and multiscalar way. The second concerns borders: they must not be a limit. In compliance with cross-border governance, different scales of intervention and informal tools: using constantly evolving techniques adapt more quickly to citizens' needs than traditional planning tools. Finally, tools must favor bottom-up approaches. With the help of parametric design and appropriate communication tools, the conceptual model will also be possible to have higher engagement levels in the cross-border project.

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The Relationship between Information and Communication Technology and Travel: a Compendium of Literature

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1 ABSTRACT

Over the years, the focus of transportation planners has only been on physical travel; neglecting the fact that information and communication technologies may influence travel demand. However, with the advent of telecommunications and other advanced technologies, modern telecommunications are rapidly increasing the accessibility to activities that previously only could be reached by physical transportation. The integration of Information and Communication Technologies (ICT) is an essential element for the success of transportation planning. ICTs provide access to information on where, when, and how to make trips thus reducing the negative externalities associated with transportation. In recent years there has been progress in mobile technologies that have influenced and necessitated the growth and development in the transport sectors in all the three worlds; the developed, transitional and the developing worlds. Various scholars have contracting views on the relationships that exist between telecommunication and transportation. Consequently, this study reviewed literature on these relationship as well as examine the impact of information and Communication technologies on travel. The study adopted the Prisma approach by extracting relevant information from peer reviewed journal articles and proceedings. Although the outcomes of these interactions are complex as they both highly depend on each other and there are conflicting views on the relationships; the latest developments call for the need to address the relationships between ICTs and transport. The study recommends that ICTs offers a possibility to increase the efficiency of the existing infrastructure supply and such functions includes Intelligent Transport Systems (ITSs), a technology aimed to directly increase the efficiency of the traffic system and as well influence the passenger demand in such a way that the road capacity is optimally utilized.

Keywords: Information and Communication Technology; Travel Demand, Intelligent Transport System

2 INTRODUCTION

The growth and continuous increase in population of a society has led to the performance of different activitiesand functions (shopping, recreational, health, religious among others) thereby resulting in changes and different travel behaviour. Transportation often serves as a means of achieving this interaction among people and activities in space; however, despite the numerous roles being performed by transportation, its negativities as a result of externalities poses some threat to the people and the community at large and this includes traffic congestion, accident, poor transport infrastructure due to over dependence on the available ones (Bannister, 2002, Aderibigbe and Gbadamosi 2019). Base on this, there is need to generate alternative means of reducing or altering physical movement in space so as to reduce some of the transport difficulties encountered by people. One of the ways this can be achieved is the use of information and communication technologies such as mobile phones, personal computer, drones among others which will either serve as a substitution or complementarity effect.

As distinguished by Geurs and Van Wee (2004), the relationship between telecommunication and transportation is multidimensional and difficult to comprehend. They share similar trait as both help to overcome challenges of physical interaction in space. With the era of Information and Communication Technology (ICT), travel pattern and dependence on physical movements in urban and rural centres are highly influenced by telecommunication systems. The potential impact of ICT on travel behaviour is complex and difficult to understand as it either substitute or complement physical activities. The development of the internet and electronic gadgets such as computers, mobile telephones and personal digital assistants has changed the travel pattern of individual in cities across the world. This is being corroborated

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by the studies of Golob and Regan (2001) which asserted that the use of ICTs has altered the way we conduct business, work, bank, shop, seek knowledge among others. It is now possible to engage in most of these activities from a remote location without necessarily changing location by way of physical movement. Similarly, Yuan, Raubal and Liu (2012) reiterated that telecommunication provide their users with more flexibility in respect of when, where, and how to travel. The use of ICTs has the potential of reducing individual travel demand, hence reducing traffic on the highways.

De Souza (2005) noted that the understanding of the influence of ICTs on our society is essential for updating environmental policies and maintaining sustainable mobility and transportation. Through this, stakeholders in the transport sectors will be able to plan for future growth and development with respect to proper transport planning of a community or city. It will provide information on the available transport infrastructures and how to utilize them in a judicious way so that it doesn't impact the society nor its inhabitants negatively. The main thrust of this study is to assess the impact of ICTs on the mobility pattern of people.

3 AN OVERVIEW OF LITERATURE ON INFORMATION AND COMMUNICATION TECHNOLOGY AND TRAVEL

3.1 Telecommunications and Urban development

One of the paramount goals of land-use and transport policies is to improve accessibility. It is believed that the combined land-use and transport system should allow people to travel and participate in activities, and firms to transport goods between locations (Wee, Geurs, Chorus 2013). However, despite the crucial role of accessibility in transport policymaking throughout the world, the concept is generally poorly defined.According to Song (2013), telecommunications has expanded greatly over the past few decades from primarily landline telephone service to the use of fiber optic, cable, and wireless connections offering a wide range of voice, image, video, and data services. Telecommunications provides a technological foundation for societal communications. Communication plays a central role in the fundamental operations of a society-from business to government to families. In fact, communication among people is the essence of what distinguishes an organization, community, or society from a collection of individuals. Communication-from Web browsing to cell phone calling to instant messaging-has become increasingly integrated into how we work, play, and live.

Telecommunications enables participation and development. Telecommunications plays an increasingly vital role in enabling the participation and development of people in communities and nations disadvantaged by geography, whether in rural areas or in developing nations in the global society and economy.

Telecommunications provides vital infrastructure for national security. From natural disaster recovery, to homeland security, to communication of vital intelligence, to continued military superiority, telecommunications plays a pivotal role. There are potential risks associated with a reliance on overseas sources for innovation, technologies, applications, and services. It is difficult to predict the future impact of telecommunications technologies, services, and applications that have not yet been invented. It can therefore be asserted that telecommunication is very pivotal to the development of the urban areas as it helps in sustaining the growth and development of the people and economy at large.

3.2 Information and Communication Technology and E-activities.

An activity can be referred to as an interaction with the physical environment, it involves a continuous interaction with a person, land use, or within the socio spatial environment. It includes any pure waiting (idle) times before or during the activity (Axhausen, 2000; Lila & Anjaneyulu 2016). Most of the activity travel behavior studies followed the activity typology employed by Reichman (1976)cited in Lila & Anjaneyulu (2016), divided activities into three categories: subsistence, maintenance, and discretionary (leisure) activities. Most studies related to ICT impact on travel behaviour has fragmented the ICT-enabled activities like mandatory activities(non-discretionary trips/activities) into tele-commuting, tele-conferencing tele-work;maintenance activities into tele-shopping, tele-banking, tele-medicine and discretionary activity to tele-leisure. Mokhtarian (1990) listed eight tele-activities where ICT is applied to commuting, conferencing, shopping, banking, entertainment, education, medicine, and justice. According to Harvey (2003), in the context of transportation research, differentiation between travel and non-travel related activity is needed. As seen in the table below, the following physical activity were identified and the virtual activity that can be carried out to replace it.

Physical activity	Virtual activity
Work • Going to office • Going for a business meeting	e-Work(Tele-work) • Tele-work or work from home or any center • Tele-conferencing
Shopping (In-store shopping) • Going to shop for daily item • Going to shop for non-daily items	e-shopping(e-commerce) • Shopping online, selling online • Browsing or searching for product information
Maintenance • Paying bills (electricity, water, phone) • and any other payments like tax etc. • Banking transactions	e-Maintenance • Online Payment of bills • Online Transactions/ e-banking
Leisure(Recreational) • Going to theater/clubs • Going out for food • Games	e-Leisure • Online movies • Recoded movies • Play online or offline games • Delivery of food at home

Table 1: Physical and alternate Virtual activities. Source: Lila and Anjaneyulu (2016)

As seen from the table above, the virtual activitiesserve as replacements to physical travel or movement; this in turns reduces physical movement or alter movement in space by determining when, where and how to make trips. For instance, e shopping can provide information to people on the availability of certain goods in store, which helps to avoid embarking on unnecessary trips thus reducing transportation problems as well as reducing the number of trips embarked upon by households.

In general,the hypothesis relating the relationship that exist between travel behaviour and the use of ICT comprehend the following relations (Salomon, 2000,Mokhtarian& Salomon, 2002; Aguilera et al.,2014; Silva, Ona &Gastropovic 2017):

Substitution: The substitution impact of telecommunications on travel assumes that the more advanced and widespread the telecommunications system becomes, the smaller will be the demand for travel. This implies that the use of ICT can lead to a reduction in the number of trips or trip frequency of households. For instance, online shopping can substitute for in store shopping

Generation: either by complementarity or by inducement; The second type ofinteraction is that ICT and trip generation complement each other.Complementarity comprises of two distinct types of interaction. The first, according to Aderibigbe and Gbadamosi (2019), is that one system increases the efficiency of the other. For example, unnecessary trips will be eliminated as better coordination is achieved and the second is that an increased use of one system causes increase in the useof the complementing system. For example, the introduction of telecommunications system which makes possible the generationand maintenance of social or economic interactions between individuals or businesses located in different places may increase the travel between the two locations

Modification: Modification relationship between telecommunication and travel according toSenbil and Kitamura (2004) refers to change of spatial and temporal characteristics of existing travel patterns.

Neutrality: This simply implies that the use of ICT does not have any impact on travel or trip making behaviour of households.

From the studies on the relationship between ICT and travel, it portrays more complex picture that shows that the relationship between ICT and travel is multidimensional. A study byTilahum and Li (2015) found effects of substitution,by mail,phone or other communications reduce face-to-face meetings. It was established from the study that theuseof ICT equipment displaced household physical movement hence reducing the number of trips being embarked upon. Contrarily, Kamargiani and Polydoropoulou (2014) found thata more intense use of social media leads to more social travel; this implies that the use of telecommunication can lead to additional trips. Moreso, Wang and Law (2007), Nobis and Lenz (2009) and Van der Berg etal(2012) found evidence of a complementary relationship between contact by different modes. Vander Berg et al.(2013) in its study also found evidence of substitution between ICT usage and Travel.

Contrary, Yuan et al.(2012) found that people with higher cellphone usage have alarger activity spaces and their spatial behaviour is more random. The study of Kenyon (2010) asserted the neutrality effect of ICT on trip making, the study found no evidence of a link between virtual andphysical mobility.Schwanen and Kwan (2008) found that internet and mobile phone enhance spatial flexibility, although ICTseems to create some constraints. Carrasco and Miller (2009) found that the effect between social activities and the use of ICT ismode specific, telephone is complementary, but email appears to have no effect; it argued that it could have a substitution effectfor long distance social contacts. The findings of Thulin and Vilhelmon (2005) corroborated the earlier research by carrasco and miller (2009)which opined that ICT usage complements both physical contacts andphone calls. Lee-Gosselin and Miranda-Moreno (2009) found that mobile phone usage was positively associated with activity andtrip levels and internet usage had the opposite effect.

These mixed results and findings from scholars highlighted above supports the argument that ICT affects travel in different manners, since some travel determinants are notinfluenced by ICT,or are influenced in ways that do not reduce travel (Aguilera et al.2012). Studies by Ren and Kwan (2009)and Schwanen and Kwan (2008) found the gender variation in ICT usage and travel behaviour, findings from the study revealed that contrary to women, men take advantage of the Internet to perform more new activitiesand they show a complementarity between Internet leisure usage and leisure travel (Ren and Kwan, 2009).Pawlack et al.(2015) presented a serieschallenges about the relations between ICT usage and travel. Theseinclude issues related with:

Causality, in a society where ICT is becoming omnipresent, the decision to use ICT devices could be strategic to increase theefficiency of travel, thus muddling the causal relations between ICT and travel behaviour;

ICT as a moving target, the way ICT technologies change and evolve and its availability in different socialand spatial contextschange its relations with travel.

Measurement issues, it is not clear what would be the best ways to measure ICT usage.

Context specificity, there is a low number of cross-national studies, and since different social groups and different countries willrelate ICT and travel differently, socioeconomic, cultural and geographical contexts matter and transferability of results mightbe problematic;

The highlight of the studies above reflects that relationship exist between information and Communication Technology as both helps to overcome the challenges experienced in space or during physical movement. Further to this it can be asserted from the studies that the relationship that exist between ICT and Travel depends on some factors such as socio-economic characteristics of the respondent or household, location, mode of transport to mention just a few and this relationship can either be substitution, complementarity, induction or generation and neutrality.

4 INFORMATION AND COMMUNICATION TECHNOLOGY AND INTELLIGENT TRANSPORT SYSTEM

It has been observed that the world is industrializing and urbanizing on a global scale thatfollows consistent patterns. Currently 54% of the world’s population live in urban areas, thus creating many challengesrelated to urban living among which are urban transportation problems. The United Nations has projected that two thirds of the world’spopulation will be urban by 2050 or an increase of 2.5 billion to current urban communities. This calls for a need to plan not only for the present generation but also include future generation in order to achieve sustainable development. One of the ways this can be realized, is the adoption of information and communication technology for intelligent transport system. ICT can be understood in terms of two technologies: telephony (particularly mobiletelephony) and the Internet. With the advent of ‘third generation’ (3G) mobile technologyin the early years of the millennium, and ‘fourth generation’ (4G) a decade later, telephonyand the Internet have become increasingly interlinked. ICT enables improved efficiencies in performing tasks, allows for decentralised work and gives firms in remote locationsopportunities to involve themselves in global value chains. Of special relevance to Africa, ICTalso compensates, to a degree, for the lack of other infrastructure.Intelligent Transportation Systems (ITS) is the use of Information Technology, sensors andcommunications in surface transport applications (GSMA connected living programme 2015).

For any country or country to grow to a smart city, there is need to adopt or use intelligent technology to sustainably enhance the quality of life, this can only be possible using information and communication technology. The study of Gossling(2017) revealed that information and communication technology are the base of intelligent systems by fostering and supporting sustainable transport choices. Traffic and transportare areas that are directly related to the spatial relations, in terms of which they arelonger able to manage efficiently or maintain the system without adequate infrastructureand database GIS (Geographical Information System) character. In the assertion of GSMA (2015), road and other infrastructure building is expensive andenvironmentally unfriendly; therefore, to make better use of the available infrastructures especially in the developing countries, there is the need to use a broadrange of electronic technologies which can make the transportation systems safe, efficient, reliable, andenvironmentally friendly.Knowledge and use of ICT in the modern world is one of the basic elements of the literacy and the culture of man. ICT offers a wide range of specific advantages:increased efficiency and productivity, sharing and storing of information, communication,faster accumulation,dissemination,and application of knowledge.In Africa, ICT systems are inadequate thus preventing its fulfilment in the areas of transportation and other aspects of the economy. A study by Corrigan (2020) revealed that only 26.3% of Africans were Internet users in 2018. This representedan almost threefold increase over 2010 (9.9%), and a tenfold increase over 2005 (2.7%).There is considerable diversity among Africa’s societies in terms of Internet usage.

Tunisia	64.2%
Gabon	62.2%
Morocco	61.8%
Cape Verde	57.2%
South Africa	56.2%
Senegal	46.0%
Nigeria	42.0%
Kenya	17.8%
Central African Republic	4.3%
Guinea-Bissau	3.9%
Burundi	2.7%
Somalia	2.0%
Eritrea	1.3%

Table 2: Internet Usage in some selected African countries, 2017. Source: Corrigan, 2020 Adapted from ITU statistics.

As seen in table 1 and 2, most African countrieslagbehindworldaverages and other regions. Globally, Internet usersaccount for 51.4% of thepopulation; nearly double the proportion in Africa. In the Arab States, the equivalentnumber stands at 49.5%,46.2% in Asia and the Pacifc, 69.9% in the former SovietUnion states, 80.1% in Europe and 74.6% in the Americas. It can thus be asserted that development interms of ICT usage has been low or falls below average in selected African countries, which can be linked to the development in terms of infrastructure. This may inhibit the achievement of smart mobility and intelligent system because the base for achievement of this can be linked to development in Information and communication technology.

The use of intelligent transportation systems in work zones, traffic jams and location of accident-prone areas or points has brought about significant improvement in managing the traffic system of towns and cities. This system offers newways to increase through input capacity of roads and traffic safety in critical areas. The main advantages are that system provides information to the people about work zones, traffic accidents and congestions.

World regions	Population (2021 Estimation)	Population (% of the World)	Internet users (31 March 2021)	Penetration population(% of the world)
Asia	4,327,333,821	54.9	2,762,187,516	63.8
Europe	835,817,920	10.6	736,995,638	88.2
Africa	1,373,486,514	17.4	594,008,009	43.2
Latin America	659,743,522	8.4	498,437,116	75.6
North America	370,322,393	4.7	347,916,627	93.9
Middle East	265,587,661	3.4	198,850,130	74.9
Oceania/Australia	43,473,456	0.6	30,385,571	69.9
World total	7,875,765,587	100	5,168,780,607	65.6

Table 3: World internet usage and penetration, 2021. Source: International Telecommunications Unions, 2021

Table 3 revealed the rate of internet usage across the globe, from the table, it can be deduced that Africa ranked the lowest among other continents in internet penetration with 43.2% of their total population. This indicates that less than half of the population in Africa is yet to adopt the use of internet for carrying put of their activities. This table has further established the fact that internet penetration and usage in the developed countries such as North America and Europe is high compared to other continents. As shown in the table,

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93.9% and 88.2% of the population in North America and Europe used the internet for carrying out their activities respectively.

4.1 Some of the ICT technologies that relates to Intelligent Transport System includes

The connected car:

Connected vehicles are the ones with the ability of communicating with each other and their surroundings. They are equipped with internet access, cellular radio, radar and other communication links including DSRC and an internal wireless local area network, allowing internet access to other devices both inside and outside the vehicle. Benefits to the driver include prevention or automatic notification of crashes, speeding and congestion. Increasingly, connected cars use smartphone apps to interact with the car from any distance. Users can unlock their cars, check the status of batteries on electric cars, find the location of the car, or remotely activate the climate control system.

As indicated earlier, the market size for the connected car is expected to increase dramatically.According to the GSMA (2015) the global connected car market will be worth €39 billionin 2018, up from €13 billion in 2012. There will be a sevenfold increase in the number of newcars equipped with factory-fitted mobile connectivity to meet demand among regulators andconsumers for safety and security features, as well as infotainment and navigation. This rapidgrowth will be driven in part by positive regulatory action in Europe, Russia and Brazil.

Connected vehicle technology assist road users in the following ways:

Fleet telematics: This allows emergency services and commercial fleet operators to increase utilisation factors for their vehicles thus improving driving standards, fuel efficiency, reducing emissions and vehicle wear.

Links to infrastructure systems which manage traffic flows on roads, including urban traffic management & control, roadside variable message signs to inform drivers of reduced speed limits, traffic jams and other safety messages. This infrastructure helps to relay safety measures

Communication with public transport measures including selective vehicle detection, traffic light control and real time passenger information.

Vehicle to Vehicle systems (V2V), where vehicles interact with each other using wireless networks, sending information about weather, speed, location, direction of travel, braking, and loss of stability, typically using Dedicated Short-Range Communications (DSRC) at 5.8 or 5.9 GHz, and/or a mesh radio network.

Vehicle to Infrastructure systems (V2I) allow wider area dissemination of traffic and safety information, as well as vehicle tracking and recovery, emergency call (e-Call), the set-up of WiFi and 3G hot-spots, reservation of and guidance to parking spaces.

4.2 Factors influencing the use of Information and Communication Technology

Information and communication technologies go beyond mobile phones which is the commonly used and highly recognized by people. It ranges from mobile phones, internet services such as e-shopping, e-banking,e- busimessetc, emails, among others. Individuals access mobile telecom service for personal communication and other uses. Usually, before any form of telecommunication service can be used, an individual has to subscribe to a mobile telephone or an Internet Network. According to Verkasalo (2008), subscription to a mobile telecom network requires decision making on the part of the individual who decides whether or not to use mobile telecom service. The subscription decision is usually based on the perceived benefits and costs associated with subscription. It is assumed that when the perceived benefits associated with subscription are greater than the costs of subscription, individuals will subscribe and use mobile telecom service. However, if cost of subscription is more than the perceived benefits, individuals will not subscribe and use mobile telecom service. Verkasalo (2008) also indicated that the consideration to access mobile telecom service is based on how the service meets the needs of individuals. It was discovered from the study that needs are inborn in individuals and tends to direct their behaviour. One way of fulfilling these needs is to purchase a good or service and use it. Loebbecke (1995) asserted that the cost of using mobile service is a critical factor that influences the use of mobile service. Costs of using mobile service include cost of acquiring the line, price of the mobile phone, and cost of usage per minute. Cost of mobile usage can also be viewed in terms of the price for calls within the same network and calls to other networks. A number of studies have looked at the demand for access to telecommunication services, however much of these studies have focused on developed countries.

In another study by Kyeremeh and Fiagborlo (2016), telephone service subscriptions were analyzed using household level data. It employed the logit model to examine the relationship between telephone service subscription and socio-economic and demographic variables. The results from the study showed that the probability of subscribing to telephone services was related to a number of socio-economic and demographic factors. Access price, income, education and employment level were significant in explaining demand for access to telephone service. The findings from this study confirmed the results of similar studies by Duffy-Deno (2001), Sung and Cho (2001), Rodriguez-Andres and Perez-Amaral (1998), and Salvason and Brodnar (1995). They found that income and education positively influenced household's telephone service subscription. The impact of access price on telephone service was negative. They argued that when access rates charged by telephone service companies are reduced more people get connected to telephone services. In the same vein, households with higher incomes were more likely to subscribe to telephone service than those with relatively lower income.

The study opined that lower income earners should be given subsidies as a way to achieve universal telephone service. In United Kingdom, Gassner (1998)modeled household telephone subscription decision in a discrete choice framework in which the telephone service decision was related to cost of connection, income, and a host of other socio-demographic factors. The binary logistic regression approach was used, the study found that cost of connection, income, education, and employment status significantly determined the usage of information and communication.

Further to the studies above, Ahn (2001) investigated demand for subscribing to mobile network based on a survey data. The study analyzed the characteristics of mobile subscribers and how these characteristics influenced their mobile subscription decisions and intentions. It was discovered that age, gender and education had significant impact on mobile telephone services subscription behaviour. Income was used as a control variable and for that matter its impact on mobile telephone service was not directly looked at in the study. The results for age and gender were in contrast to the findings of Narayana (2005) who found insignificant results for age and gender. In a similar study, Rodini, Ward and Woroch. (2003), on the impact of individual household demographic profile on the demand for mobile telephone service in a discrete choice framework based on household survey data. Household mobile telephone service subscription was modeled using logistic regression. They found income, age, gender of the household head and size of household as important determinants of mobile telephone services subscription. For levels of income, individuals in the highest-income group had subscription rate of almost 40 percent higher than individuals in the lowest-income group. Also, women were 9 percent more likely to subscribe to mobile telephone services than men. They discovered that subscription probability among oldest households was 20 percent lower than for the youngest households.

In Nigeria, Olatokun and Bodunwa (2005) analysed mobile telecommunication demand by examining usage of Global System for Mobile Communication (GSM), emphasizing the factors that promote or hinder its use, usage benefits and quality of services provided by operators. Using a sample of 456 staff and students of University of Ibadan, the study found that social activities (e.g. contacting friends and relations) accounted hugely for the use of mobile telecommunication services. Mobile telecom services were less used in research and academic activities. The study identified that limited network coverage and poor quality of service (i.e. unstable network and difficulty in making and receiving calls) inhibited effective use of mobile telecom services. The study concluded that mobile telecom networks that provided quality service to customers stand a better position to acquire more subscribers.

Another study by Huang (2007) investigated demand for mobile telecommunication services under non-linear pricing in Taiwan. Using cross-sectional expenditure survey data, the impact of nonlinear price schedule on consumer behaviour was analyzed with preference-based structural model. The study found that consumers differed vertically in the utility of using cellular services even after controlling for income variations. Demand for mobile telecommunication services was found to be positively related to income. Moreover, Barrantes (2008) examined mobile telecommunication services use, subscription and call patterns among the urban poor in three selected cities in Peru: Lima, Trujillo (north) and Puno (southern highlands).

An individual utility maximization model was adopted to econometrically test reasons for mobile telecommunication services subscription and usage.

The results showed that the probability that an individual will access and use mobile telephone service was explained by individual characteristics such as age, education, occupation and type of employment; characteristics of household and use (or non-use) of other communication technologies. In India, Narayana (2009) studied determinants of demand for telecom services using household survey data. Demand for telecom services was estimated using binary logit model with socioeconomic and demographic data.For all the variables included in the model, education, occupation, size of total income and location of friends and relatives were found to be the important determinants of demand for telecom services. The literature has shown that demand for access to telecommunication network is influenced by so many factors, chief among this is socio-economic characteristics of the user; income, age among others and quality of service (accessible and good network).

4.3 ICT innovations in transportation can help in the following ways:

In the last decade, there has been an increased use of computers and information technologies in transport infrastructure. Continued development and implementation of these systems comes from the belief that intelligent transport system promise an increase of capacity and productivity of traditional transport infrastructure as well as contribution to achieving of other goals such as security. Intelligent transport systems include wide area of information based on wireless technology. Incorporated into infrastructure of transport system and the vehicle itself offers numerous benefits to its users and the community at large. These includes but are not limited to:

Controlling and managing of traffic flows,

reducing of traffic by finding alternative routes

saving of the environment and save time and many.

The main reason for the development of mobile application is to enable information about the road conditions for all participants in the traffic at the proper time with intention to reduce costs, loss of valuable time as well as reduction of congestion in urban and suburban areas. There is also intention to reduce pollution by harmful gases and reduce noise level enabling pleasant and healthy environment for all citizens. The benefits of ICT to transport is highlighted below.

4.3.1 Travel information, planning and routing

In recent times,transport information systems have witnessed major advances and travellers have benefitted from a wide range of applications developed to facilitate travel and to make public transport systems more reliable. One of the most important innovations is the integration of different transport modes(e.g. train, subway, bus), with applications informing passengers/ road users about the closest departure location, departure time, arrival time, and cost. In this way, travellers can navigate their trips by using their smartphones thus reducing delays and cost. (Gössling 2010).ICT also provides real time information to private transporters through google digitalization of world transport infrastructures: this application allows calculation of physical distances, identification of public transport connections, and comparison of travel times. Information includes transport flows and the speed of movement in specific road sections in real time. This has been further developed into routing advice, for instance ‘Waze’ an application which informs road users about the ‘best’ route, including police alerts, accidents, road hazards or traffic congestions based on information shared by drivers. Theapplication also shows the progress of other (fellow) travellers and allows co-ordination of arrival times or track-keeping of friends.

4.3.2 Payment and price

Transponder-based automatic toll charging and vehicle recognition technology in combination with customer billing systems for cars have been in use for decades (Gossling 2017). These systems collect fees for road, ferry, or bridge use. Recent advances in payment technology have mostly been made in public transport, where the use of information and communication technology can be used to coordinate different transport modes while simultaneously allowing for payment. Further to this, there have been inventions of Platforms and applications focusing on the comparison of cost structures of different transport modes and increasingly integrated. Overall, payment options are thus increasingly standardized, while price comparisons have become relevant in new areas, such as fuel purchases.

4.3.3 Safety

ICT is of growing importance for safety. Sites devoted to traffic safety include for instance Velodossier, a Belgian website allowing cyclists to upload videos that show dangerous traffic sections or inadequate urban transport designs. Through the videos, the situations faced by bicyclists become more urgent, influencing perceptions of transport systems. In other cities, platforms have been created to report transport infrastructure problems (e.g. broken glass on cycle tracks) or to recommend improvements Often, these allow traffic participants to use smartphones to add markers at their location. Recently an application (Metrocosm) provides information on accident distribution pattern, The zoomable map shows the geographical distribution of fatal traffic accidents in the US, categorized by transport mode (car, walking, bicycle), victim type (adult/child), and factors involved (alcohol, speeding, distractions).

4.3.4 Convenience

Convenience innovations for car drivers include a wide range of apps devoted to parking. This includes informational apps, comparing parking opportunities about opening times, restrictions, payment options and cost, parking spot reservation and pre-payment opportunities to rent parking space privately. Illegal parking can be reported using an app designed for pedestrians and cyclists encountering wrongly parked cars on cycle tracks/lanes. This app allows drivers to choose less crowded alternatives.

4.3.5 Health

A growing number of apps address health issues, measuring physical activity. For instance, ‘Moveapp’ calculates distances, and can be used for walking, running, skiing, or bicycling. The app measures the distances covered, while also visualizing routes on maps, and estimating calories burnt. Internet sites linking transportation with disease have implications for perceptions of transport systems. As apps increasingly address health issues, including air pollution or noise, this can affect transport mode choices. For instance, on days when air pollution is high, Moovel grants half-price travel on buses and trains in Stuttgart, Germany, thus discouraging the use of private cars. (Gossling 2017). In summary, ICT assist road users in the following ways;

Supports the choice of drivers and passengers: This is usually possible by providing information to drivers and road users about upcoming congestion areas and zones thus providing advice on alternative routes or route application to avoid delays.

Reduce options or limit the driver’s behavior: This helps in maintaing and limiting the speed limits on approved routes thus reducing the risk of accidents.

It is used to take the drivers decision, in whole or in part as the intelligent fuel consumption. With the use of ICT in transport, drivers and road users are provided information on fuel consumption and energy use.

Health management by providing information on physical activity that can improve their health while walking or engaging in other physical activities.

5 CONCLUSION AND RECOMMENDATIONS

This paper has examined the relationship between ICT and travel from different categories globally. Based on the review of literatures, it was discovered that the relationship between ICT and travel is multidimensional as they both interact and benefit from each other. It has been asserted that this relationship can be in terms of trip substitution, reduction, complementarity or neutrality and the use of information and communication technology by individuals and households depends on several factors, which ranges from the socio-economic characteristics of the individual or household (age, income, level of education, occupation), the quality of service being provided, availability of ICT infrastructures to mention just a few. However, several studies opined the ICT usage in many developing countries is low compared to its usage and adoption in the developed countries of the world. the reason is not farfetched as the ICT infrastructures available for use in the developing countries are few and not available thus preventing people from exploring the potentials of telecommunication at reducing physical movement. Further to this, households in the developing and third world nations have not really explored the use of ICT beyond call making. The study also established that ICT usage can help in achieving smart mobility and development through the adoption of intelligent transportation system thus improving the transport system efficiency. To improve the use and adoption of ICT, people should be enlightened on the culture of use by educating them that its usage extends beyond call linkages as other benefits should be explored. In addition to this, both transport and ICT infrastructures should be provided in the developing countries of the world so that they can compete favourably with their counterparts in the developed nations. To further encourage the adoption of ICT, telecommunication subscribers should provide quality service to all member of the society irrespective of their status and as well reduce telecommunication cost in terms of subscription fee to lower income households and rural dwellers. Overall, the use of information and communication technology assist both road users in selecting the best routes, to avoid some negative transport externalities such as delay among others, improve their health condition and safety management.

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The Role of the Public Municipality in Urban Regeneration: the Case of Genoa

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1 ABSTRACT

The conditions why processes of urban regeneration can be developed in modern-day cities have changed enormously over the last decade. Unlike the recent past, where the reuse for urban uses of former industrial areas was only based on maximising the amount of space, after the housing bubble began in 2008 and the pandemic crisis, the profit margins for operators were reduced, and today, they faced to a sharp contraction in demand and a surplus of supply. Consequently, the framework within which we carry out the investment decisions is increasingly complex and is characterised by the opposition of a potential conflict between two forces. On the one hand, the public administration which seeks to take full advantage of the urban transformation processes to improve the quality of life for citizens; on the other, the private entity that has the aim of maximising the profits obtainable from the intervention and to minimise business risk. Therefore, to ensure the overall feasibility of an intervention, urban viability must correspond to economic and financial sustainability. The paper analyses the role of public strategies in urban regeneration interventions through the analysis of a case study in the city of Genoa. Currently, in the city some urban transformation interventions are being implemented; most of them (and the most relevant) are all aligned along the border between the city and the port. The role of the public administration is not limited to that of regulation, but the local municipality also acts as a financier (of public works) and as owner of the areas (which it makes available in concession). In this way, an attempt is made to make the city more competitive in the international real estate market. It is essential to reduce risk and cost factors compared to the private investor. The question then arises of how to evaluate the potential public benefits of these transformation operations.

Keywords: Real Estate, Urban Policies, Urban Regeneration, Urban Planning, Italy

2 INTRODUCTION

Contemporary Dynamics in Urban Regeneration Processes, Balance between Public and Private Requirements.

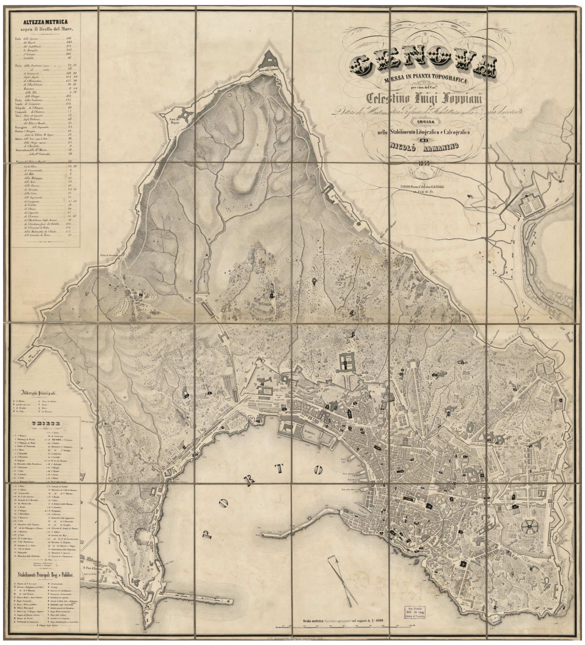

Figure 1. Map of the city and the port of Genoa, 1853. Source: Millard Fillmore, public domain.

After the intense urban transformation that characterized Genoa between 1992 (the year of the Columbian Celebrations and the opening of the ancient port front to the city) and 2004 (the year of Genoa European Capital of Culture), there has been a long slowdown in urban transformation operations. It then merged into

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the crisis of the real estate market and led to a drastic reduction in urban reorganization interventions. In recent years, however, some perspectives of urban transformation have been consolidated. These new perspectives lie along the problematic port-city hinge and foreshadow a substantial reinterpretation of the sea waterfront, along an ideal line that connects the Porto Antico area, located in the center of the old town, to the western Fair. In all the examined cases, the preventive public availability of areas and buildings or, in any case, their acquisition by the Civic Administration, is the first step to give substance to the hypotheses of feasibility of the operations, in a framework characterized by a strong mixture of functions and a particularly complex physical and urban morphology. The financial commitment, the repercussions on the urban structure of an entire strategic sector, the redevelopment of important public spaces, the rethinking of the role and functions of the entire "historical" port basin and, last but not least, the opportunity to establish in the various areas, important residential and tertiary-commercial activities, make these projects the driving force on which the city is aiming for the future of urban development.

The result of the particular process of urban transformation in Genoa, is embodied in the "thin blue line" between port and city, which is characterized by an unusual (and sometimes conflictual) mix of activities. This mix gives shape to a new urban landscape bordering the sea, composed of office towers, advanced tertiary sector, production and logistics areas, accommodation facilities, residences, large commercial areas and public spaces. This new scenario is characterized by a high accessibility value (all the areas are located near the main multi-channel infrastructural axis, that crosses the city in the east-west direction), by the radical change in the destinations of use (from industrial-port to tertiary, commercial and residential), and by the huge amount of public investments it has attracted and it is still attracting.

What these interventions have in common is the pre-eminent importance of the role assumed by the public entity which initially started as a regulator and then has gradually become the fulcrum of the feasibility of operations, as owner of the areas and also as direct investor. While the coincidence between the regulator and the owner role makes it possible to affect the future uses, the additional role of investor, ended up overturning the traditional "urban planning logic" for which the (private) implementing bodies should be at least partially responsible for the urbanization and for the sale of public areas and equipment.

In the most recent cases we face a situation in which investments in public works (ranging from the demolition and reclamation of the areas to the preventive construction of a significant number of urbanizations) are the prerequisite for the (private) feasibility of investments. The public actor therefore acts as a real promoter of urban development, offering the external real estate market opportunities for localization.

2.1 Large-scale Transformations and Complex Systems

Waterfront Projects between the City and the Port

Among the most interesting large-scale transformations in the contemporary city are those involving complex systems, i.e. groups of territories sharing the same infrastructures and, above all, the same development dynamics. Some of them concern the processes of abandonment and subsequent decommissioning of large urban areas, often in the centre of the city or in a hinge position between the centre and the suburbs, such as railway yards or former industrial areas. In other cases, it is a question of territories located on the administrative border between several public authorities and which have been subject to waves of transformation for many years. This is the case of the borders between the city and the port, which are characterised by a high degree of complexity in both operational and identity terms. Such systems hold latent opportunities to reactivate a cycle aimed at exploiting the multiplicity of potentials offered.

The evolution of urban issues involving the interface between cities and ports is intimately connected, in first place, with the alteration of the balance between the coastal city and the port environment, provoked by the rapid growth of docking and warehousing structures that took place in the great European ports in the mid-19th century. Following these radical changes, the urban-port waterfront acquires a double connotation that defines the very roots of the meaning of its physical components and its spatial nature: formed by land and water, it is a dual organism that belongs both to the realm of land and to the maritime or river realm, and that is totally new from a physical point of view.

Even today, the evolution of the waterfront affects the port-city relationship due to several urban factors, resulting in different scenarios within the European context. Among this wide range, it has been possible to identify new approaches providing perspectives on the city-port relationship, intervening in a prioritized manner on the common border. In these contexts, the capacity of port systems to engage with the city and, while still maintaining their operational aspect, to mitigate the effects of the demarcation and isolation generated by property borders can be seen.

Some processes, such as divestments, technological adaptations, and economic-commercial logics, in fact, were the occasions for local urban planning, supported by public initiatives and/or private contributions, to transform the areas between the city and the port, generating a varied collection of examples and a significant number of projects and strategies.

In Marseille, the Euroméditerranée program has worked since 1995 in the reconstruction of an ancient alignment between port and city. In this context, the redevelopment of the 400 meters of the Docks de la Joliette (2015-2016) is exemplary and based on the concept of a "narrative sequence". With this strategy, strongly embodied between the city and the port, the design of the shared waterfront is accomplished gradually, increasing its wideness by intervening on spaces and artifacts as they become available for change.[1]

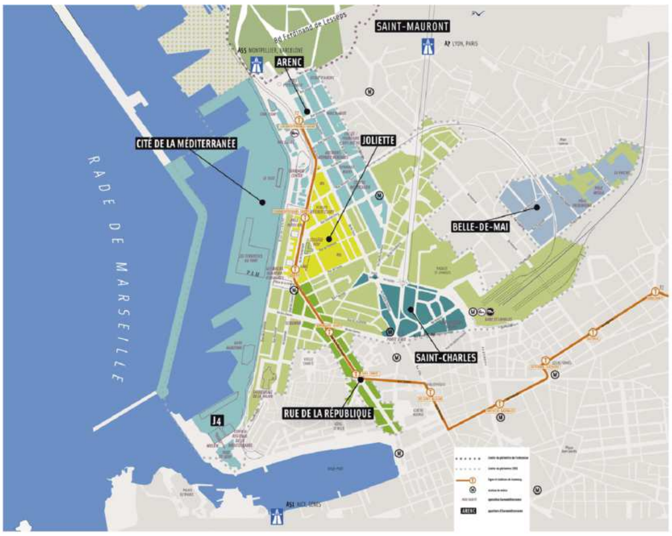

Figure 2. Marseille's Euroméditerranée Project (www.euromediterranee.fr).

Differently, in Copenhagen, important maritime-commercial transformations of the second half of the 20th century influenced the morphology of the three peninsulas (Prøvestenen, Refshaleøen, Nordhavn) on which most of the port is located. This has generated very different degrees of relationship and approaches to the urban-port project that are led by the subsidiary company CPH City & Port Development.

In Prøvestenen, the presence of the port is absolutely predominant, while in Refshaleøen, even if the port is no longer active in most areas, the reconversion was based on a more modulated and non-intensive re-functionalization that has not deleted the operative character of the area. Confirming the hybrid nature of the site, the outermost portions of Nordhavn, in fact, are still occupied by the port and the construction of the urban district[2] proceeds in parallel with a new landfill, for a cruise terminal, of about 100 hectares stretching out towards the open sea.

In Hamburg, then, the HafenCity (1997–2030)[3] is a large urban project that replicates the his- toric city through the transformation of 157 hectares of former port territory. The first formal proposal was Vision HafenCity (1997), which established a Special Fund for City and Port dedicated to the first infrastructure proj- ects on the site, but, above all, financed the new container terminal along the southern part of the river. The development of the area was preceded by a competition for the drafting of the master plan (1999/2000): the first buildings were realized in 2005, and the first district was completed in 2009. In 2012, the U4 metro line went into operation and, in 2014, the HafenCity university campus was opened. At the beginning of

[1] Cf. Port of Marsiglia-Fos (www.marseille-port.fr), Euroméditerranée (www.euromediterranee.fr)

[2] Among the most recent projects, The Silo by Cobe (2017) (www.cobe.dk), the Portland Towers by Design Group Archi tects A/S – Denmark (2014) (www.dga.dk) and Park'n'Play by JAJA Architects (2016) (www.ja-ja.dk) come to mind.

[3] Cf. HafenCity (www.hafencity.com).

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2017, the building, a symbol of regeneration, was inaugurated: the Elbphilharmonie was erected on the decommissioned Kaispeicher A port depot. Inspired by the Spatial Vision of the Port Development Plan drafted in 2007, the HafenCity is an exemplary project in terms of scale, the involvement of public and private operators, and its experimentation in the field of residential building types that, however, has been carried out to compensate the city for the port.

Figure 3. Masterplan HafenCity Hamburg, ASTOC Architects and Planners (www.astoc.de)

Abandoned Railway Yard Projects between Centers and Peripheries

The transformation of disused large railway areas has been one of the most interesting urban renewal strategies in recent years, redefining the urban marketing strategy starting from the regeneration. Among the most decisive reasons, it is worth mentioning their location in the most central parts of the cities, accessible and already highly infrastructured, but also their undivided ownership regime.

In many cases, from Paris to London, Barcelona and Antwerp, the degradation resulting from the abandonment of railway yards had affected, over the years, the value of nearby districts and the social, environmental and economic quality of entire portions of the city. Because of this, public action has focused on urban regeneration processes, targeting areas and the communities that live in them, with the aim of triggering processes for new urban centralities of international significance.

A case of undoubted interest is the one still underway in the city of Milan, which began in 2007 with the identification of seven areas no longer used for railway operations with the aim of enhancing them by assigning urban planning parameters.

Together with the area that hosted Expo 2015 in the north-west of Milan and the system of disused and underused barracks, the seven railway yards (Farini; Greco-Breda; Lambrate; Porta Romana; Rogoredo; Porta Genova; San Cristoforo) represent the last reserve of large areas available for transformation, covering a total surface of more than 120 ha. A system of public areas, connected by tracks that are for the most part still in use and owned by Ferrovie dello Stato that has acted with private logic and strategies.

Since the first years of negotiation with the public administration, the seven railway yards have been considered as real estate valorisation tools, functional to promote urban development actions without further land consumption. They are areas that can increase public facilities, especially green spaces, and cycle networks, also by reconnecting parts of the city that were previously separated by them. In addition, the reuse of these areas introduces new resources to rail transport in the Milan node and to the regional railway system as a whole.

Following the Programme Agreement signed by the City Council and Ferrovie dello Stato in July 2008, in 2011 the new council of Mayor Giuseppe Pisapia advocated greater transparency and legitimacy in the management of public-private relations, seeking to ensure the public benefits of private transformations. The focus shifts to the reuse of abandoned spaces scattered throughout the urban fabric, relaunching a policy of green spaces and large urban parks. At the planning level, the seven railway yards are classified as Urban Transformation Areas (ATU) in the Piano di Governo del Territorio (Pgt) adopted in 2011.

Still in progress, the process[4] of converting the seven areas is very complex and has different timelines. Among the first sites subject to an international competition, it is important to remember the Milano Farini

[4] For further information, see Scali Milano (www.scalimilano.vision) and FS Sistemi Urbani Scali Milano (www.fssistemiurbani.it/content/fssistemiurbani/it/scali-milano.html)

and Milano San Cristoforo yards, for which the “Agenti Climatici” project by the OMA and Laboratorio Permanente team was the winner in 2019. In short, the proposal envisages two new environmental devices: one green (a large linear forest in the Farini yards capable of cooling the hot winds coming from the south-west and purifying the air of the most toxic particles); the other blue (a long linear system in San Cristoforo for water purification, defining a landscape for human and non-human realities).

Aware of the changes in the city, which is now responsible for a vast urban region and an increasingly multicultural population, the project for the railway yards has a great ambition, that of “making Milan through the railway yards”, i.e. to be part of a fundamental infrastructure system, aimed at connecting and encouraging the implementation of effective settlement, demographic, environmental and socio-economic processes.

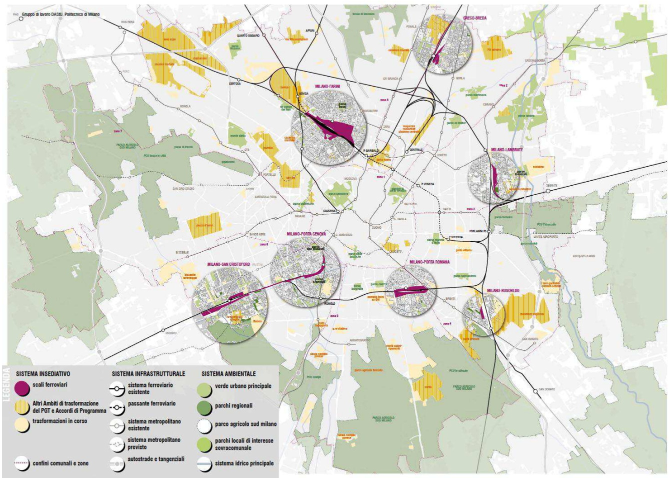

Figure 4. Map of the Milan railway yards. Source:“TRASFORMAZIONE DEGLI SCALI FERROVIARI MILANESI. Definizione di linee di intervento”, Gruppo di lavoro DAStU Politecnico di Milano, 2014.

3 METHODOLOGY

Two contemporary Urban Regeneration Interventions in Genoa

In the light of these international examples, the role of public strategies in urban regeneration interventions in Genoa is undertaken by exploring two different case studies currently under implementation. One of the common traits is that the selected urban transformations are connected along the coastal margin line between land and water: in the Waterfront di Levante the interventions are all aligned along the boundary between the city and the port, in the case of the Polcevera Valley, instead, the winning project of the international competition concerns the spaces along the river and valley course.

3.1 The Waterfront di Levante. Operations along the border between the city and the port.

A Continuous and Public Waterfront

The project of the Waterfront di Levante (WdL) derives from the proposal called Blueprint that was donated to the city of Genoa in 2013 by architect Renzo Piano along with the architectural firm Renzo Piano Building Workshop (RPBW). Intended as a basis for the development of discussion activities with the institutional subjects involved, the Blueprint has been revised mainly in the light of the evolution of the city’s urban dynamics and the development of production and nautical activities in the port area.

The WdL proposes an overall design aimed at developing and harmonising the urban and industrial activities present in the eastern areas of the port of Genoa from Punta Vagno (to the east) to Porta Siberia. This strip of land along the sea borders the city and sectors of the operational port occupied by ship repair industries, dry docks and areas dedicated to pleasure and nautical sports, in particular the headquarters of the Italian Yacht Club. At the eastern end, there is a trade fair area characterised by the presence of several pavilions almost entirely used for temporary functions and events with large attendance.

The overarching aim of the project is to enhance the relationship between the city and the sea in terms of environmental sustainability and the social and economic attractiveness of settlement activities by connecting the waterfront in a west-east direction. The new waterfront is in fact the completion of the work carried out for the 1992 Colombian Expo, with which the city converted large areas no longer used for port

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functions into a functional programme with an urban, cultural and tourist vocation. This connection is implemented through the construction of a navigable "urban canal" close to the ancient city walls, adjacent to the causeway. The waterway, of infrastructural character and variable width, is obtained by excavating portions of the existing piers under the city walls. This action provides a new Waterfront Urban Park of approximately 16,000 square metres, extended along the waterfront and connected to a panoramic lift with appropriate landings above and below the historic walls.

Although in continuity with the Porto Antico, the WdL witnessed a different strategic approach towards the city-port relationship, the enhancement of the operational component of the place and the design of the border between the two territories. Due to the lack of space, the area presents widespread criticalities in the management of logistics and port flows, urban accessibility and, in general, difficult coexistence with functions that are not always compatible with production activities. In addition, the underuse or abandonment of some buildings has put the trade fair sector in crisis, and it has been called upon to reinvent its position in the overall urban economy. With this in mind, the WdL proposes the construction of a double operational peninsula, the so-called "Factory of the Port", which can be reached thanks to a reorganisation of the port road system, under the elevated site, which becomes an urban road system with punctual access via four new bridges. In this way, the new "port-channel" acquires greater autonomy and optimisation of some industrial sectors that will be extended towards the sea. The project is currently underway, particularly in the far eastern areas where the municipal administration has put in place, at least since 2019, an intense programme of demolition of the existing pavilions in order to free up the area for the new works.

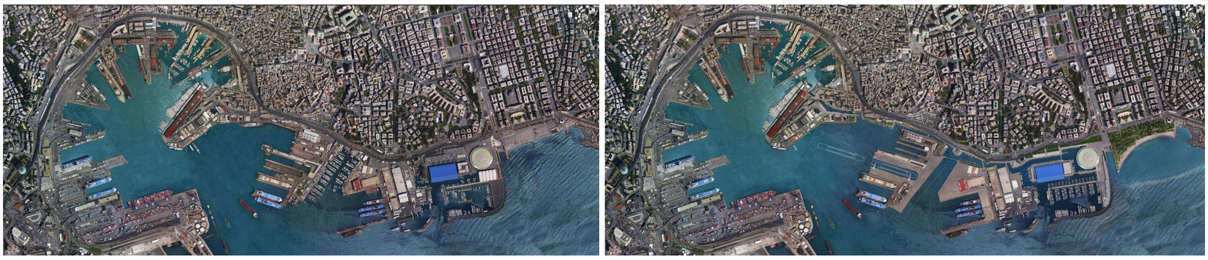

Fig. 5. Waterfront di Levante, 2017.

Functional Program and Architectural Aspects

Overall, the WdL covers approximately 83,300 sqm of public areas. Of these, only 53,000 sqm will be converted according to a functional mix, while the remaining 30,000 sqm will remain in Pavilion S.

The functional programme envisages a part for receptive and residential buildings (15,000 sqm), a portion dedicated to the service sector (24,000 sqm) and two portions of 7,000 sqm each for commercial and multipurpose fairgrounds. Part of the nautical clubs will be relocated to the larger Darsena, in front of the sports hall, and in a position adjacent to the new Pilots' Tower at the end of the pier entrance to the port. In the same position a new branch of the Italian Yacht Club should also be built, with a more sporting vocation, maintaining the building and the historic quay as the main headquarters. In addition to the construction of the Waterfront Urban Park and the Darsena, the project envisages a new urban beach in front of Piazzale Kennedy, with a view to re-naturalising and making new public use of the river Bisagno estuary.

From a mobility point of view, the WdL is confronted with an extremely complex situation due to the overlapping of public, private, urban and port flows. It is planned to replace the elevated carriageway with a path at the level of the quay, which will be flanked by the navigable water channel for operational use. Through this operation the edge acquires depth and mixed functionality and the new activities join the rich pre-existing heritage.

In terms of volume, the project envisages the release of the areas behind Pavilion S, which has been retained and converted into a sports hall. Demolition will involve the former Ansaldo-Nira building (2020) and Pavilions C, D, M, and the former heating plant (2021). The residential volumes will be positioned along the new canal, at the water's edge, and elevated on pillars so as to maintain the physical and visual continuity of the Urban Park in which they are immersed. Most of the exhibition centre will remain on the quay in front, that is pavilion B or "Jean Nouvel" on whose sides new buildings will rise, dedicated to the tertiary sector or to the multipurpose exhibition function.

Thanks to the “New Guidelines”, updated by architect Piano at the beginning of 2021, the project acquired further detail in the realisation of its components. Particular attention is devoted to the identity and connective value of the Waterfront Urban Park and the Darsena with the rest of the city, the aspect of accessibility and public continuity is repeatedly stressed as essential. As an integration, Piano provides specifications related to the architectural features with which to complete the single portions of the WdL.

Planning Tools and Ownership Layout

After the publication of the Blueprint donated by Renzo Piano to the city in 2013, the Urban Master Plan (PUC), approved in 2015, incorporated the proposal within the Transformation District no. 20 “Fiera Kennedy”, in turn divided into 5 sectors. At the same time, the then Genoa Port Authority (also the subject of the Genoese architect's donation, together with the Region and the Municipality) took on the project’s indications within the documentation that was supposed to constitute the emerging Port Master Plan (PRP), which was then being drafted.

In January 2016 the City Council approved the general guidelines for its implementation, which included, among other things, the provision for a design competition to be held on the areas owned by Genoa City Council and S.P.I.M. (the vehicle company indicated as the guiding entity for the transformation). In July 2016, the call for tenders was issued, with the participation of over 70 international groups. The work of the appointed Selection Committee leads to the conclusion of the procedure without any winner.

Following an update and further donation, again by Renzo Piano, the Blueprint takes on the name and features of the WdL. At that point, the conception of the design imposed a unitary intervention on the buildings of the compendium as essential elements of a single design vision. The operation requires a considerable amount of investment, which can only be partially borne by public funding, and it is therefore essential to attract private capital. For this reason, the Municipality of Genoa, which owns only a portion of the areas involved in the project (those furthest to the east), chose to proceed with the development through the sale of the entire property. The call for tenders for the sale confirms that the demolition of the former exhibition halls will be the responsibility of the buyer, who will also have to carry out the excavation for the navigable canal (excluding the inlet, which will be built at the expense of the municipality after the demolition of the former Ansaldo-Nira building). In 2018, the commission assessed the proposals received and deemed only that of the EM2C company of Lyon, which signed the preliminary purchase and sale contract at the end of 2019, eligible for the second phase (the more project-specific one).

The implementation phase began in 2020 with the drafting of an Urban Operational Plan (PUO) whose purpose is to implement sector 2 of Transformation District no. 20, "Fiera - Kennedy", i.e. the disused portions of the fairgrounds, up to the Quarry walls, including the first section of the causeway and the so-called Batteria Stella fortress. The final approval of the Operational Urban Plan (PUO) and the “Design Guidelines” took place in July 2020 and, subsequently, CDS Waterfront Genova s.r.l., designated by CDS Holding as the purchaser, signed a public deed with the municipality for the transfer of the areas.

Through a preliminary operation, during 2020 the area began its transformation. The first step was the removal of the long-abandoned former Ansaldo-Nira office building located at the junction between the trade fair area and the industrial area. Its demolition is functional to the completion of the unified WdL project and, above all, of the urban canal, the route of which insists on the site of the building.

At the beginning of 2021, the demolition of the fair pavilions, in particular pavilions B and C, became fully operational. Finally, in April, the Municipality approved the “New Guidelines” for the subsequent development of the interventions envisaged by the PUO, which replace those previously drawn up by Renzo Piano with a view to safeguarding the development of the site in harmony with the high quality objectives of the site redevelopment interventions. On this occasion, CDS Waterfront Genova s.r.l. donated the “Detail Masterplan” document which has already been favourably evaluated by the Superintendency of Archaeology, Fine Arts and Landscape for the Metropolitan City of Genoa. Meanwhile, the final deed for the sale of the remaining parts of the former fairgrounds to Cds was signed and the town-planning agreement regulating the reuse of the areas was signed.

Finally, it is important to underline that the WdL project falls within a set of areas with a heterogeneous ownership layout. The portion to the east, from Piazzale Kennedy to the areas adjacent to the former Ansaldo-Nira building, belongs to the municipality with some existing concessions, while the portion that connects to the Porto Antico is port territory, with the exception of part of the road system at the interface with the city, which only partially falls within the urban area. The multiplicity of owners highlights the complexity of implementing the operation, especially in the light of the unitary realisation of the design.

The completion of the whole operation by the Municipality and the Port System Authority will therefore be of fundamental importance, in particular the welding up to the Old Port through the Urban Park and the navigable canal from the Darsena to Calata Gadda.

Fig. 6. Waterfront di Levante, 2017.

2.2. The Polcevera Valley.

A productive park in the river valley. The competition.

In 2018 Genoa was shocked by the tragic collapse of the Polcevera Viaduct, commonly known as Ponte Morandi, named after the engineer Riccardo Morandi, author of the project in the 1960s.

The collapse caused the loss of human life and damaged residential and productive properties and part of the infrastructure systems throughout the area under the viaduct. The transport system has suffered repercussions on an urban and national scale. Val Polcevera, the scene of the collapse, suffered the greatest economic and structural repercussions. The ruins of the Morandi viaduct were demolished and on the 4th of August 2020 the new San Giorgio Bridge was inaugurated. The design of the new bridge was built on the basis of the design idea given as a gift to the city by the architect Renzo Piano, contacted by the Region in the days following the tragedy.

A fundamental theme for the city of Genoa was also to rethink the area damaged by the collapse, taking advantage of the opportunity to regenerate a complex and problematic part of the city. On 13 April 2019, the international design competition "Il Parco del Ponte. Regeneration of the Quadrante of Val Polcevera” was presented.[5]

The Polcevera valley is a particularly complex and fragmented territory. It is crossed longitudinally by important infrastructural systems, railways, roads and motorways, which have made it an important link between the city of Genoa and the rest of Italy and Europe.

The Polcevera river axis crosses the valley, dividing it into two parts with different vocations. On the right bank, the presence of production settlements and large commercial settlements has historically consolidated. The left bank is instead characterized by a predominantly residential vocation, developed along the main roads and railway infrastructures. The subway line arrives in this area and will be extended over the next few years, along disused railway tracks.

The notice of competition had as its main objective the launch of an urban regeneration process relating to the territorial and infrastructural system of Val Polcevera, the social community and the heritage of productive and economic activities established in the area.

The design of a public park, sports facilities, public square, pedestrian walkways and a memorial was required. Other objectives were the improvement of the quality of urban mobility, through the creation of

[5] Further information on the presentation and on the schedule of the competition is available on the institutional website of the municipality of Genoa (smart.comune.genova.it) at: https://smart.comune.genova.it/comunicati-stampa/presentato-milano-il-concorso-di-progettazione-%E2%80%9Cil-parco-del-ponterigenerazione

interchange poles and slow mobility systems, and making the territory attractive from a socio-economic point of view, developing services and improving their quality.

The competition required the development of a masterplan relating to the entire area of the Quadrante; the second requirement was a project of technical and economic feasibility of the new public space (public park, sports facilities, public square, pedestrian walkways, memorial) to be built in the lots adjacent to the new bridge, with a size of approx. 120,000 sqm.

To achieve the required objectives, the entire project area was divided into different sectors with six different themes: the Production Park, the Square and the District, the Boulevard of Via Fillak, the Panoramic Park of Campasso, the hill of the hillside district and the cycle path.

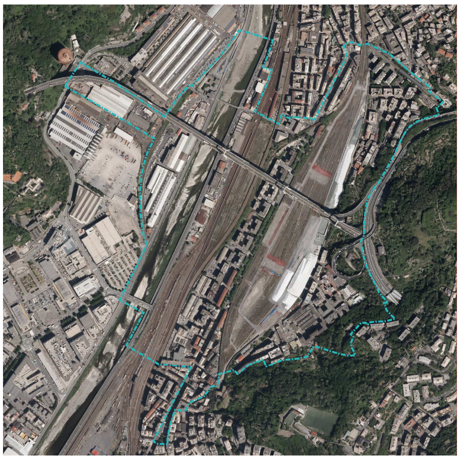

Figure 7. Borders of Quadrante Area. Source: Municipality of Genoa.

The Polcevera Park and the Red Circle. Functional Program and Architectural Aspects

The winner of the competition was the group made up of: Stefano Boeri Architetti (Group leader / urban projects), Metrogramma Milano (Architectural Design), Inside Outside, Petra Blaisse (Landscape Design). The group collaborated with MIC-Mobility in Chain, Studio Laura Gatti Agronomist, Transsolar Energietechnik, Geologist Antonio Secondo Accotto, H&A Associati, Studio Luca Vitone, Tempo Riuso, The Big Picture and 46xy.

The functional program proposed is grouped into 4 macro-themes: production, residential, commercial and sports. The Boeri group's project outlines 7 main elements within its project: the Red Circle, the Polcevera Park, the Green Factory, the widespread Square, the redevelopment of existing buildings, the redevelopment of green hills and the improvement of mobility. The element that mainly characterizes the winning project is the Red Steel Circle, a large infrastructure that is at the same time a cycle-pedestrian walkway, a system for distributing the renewable energy produced within the project. The red circle, which is 1570 meters long and draws a large circle with a radius of 250 meters, aims to connect the different sections of the project

The Polcevera Park includes the arrangement of public parks and the construction of a sports centre managed by private entities. The project pays particular attention to the management of rainwater through surface treatment, with dense planting, draining pavements and water accumulation systems. The construction of a Water Park, with rain gardens and water collection system, is planned on the western side. Within the Polcevera riverbed, the intervention provides, in a small area, the creation of a slope and the consequent lowering of one of the banks of the stream, in compliance with flood regimes.

The Green Factory, located on the left bank of the river, is conceived as an innovative technological hub. The productive use is the one to which most of the planned buildings are going to be characterized; the construction of 100,000 square meters of buildings for productive use is expected.

Productive is intended with reference to the technology sector, linked to a mix of uses between logistics, technology and craftsmanship 4.0. Both at urban and at port level, there is a need and a request for more space by companies already established in the area. For the adaptation of the final project, a reformulation of the Green Factory is hypothesized, in a version that assumes less square footage dedicated to the green park space, which can become the site of a new innovation park with high-tech production activities.

In the area adjacent to the Green Factory, a mix of logistics, commercial activities and services related to the life of the neighbourhood is envisaged. The creation of the widespread square is intended as a space of connection and meeting between the different project areas and as the place of the main cultural and social activities. The redevelopment of existing buildings is planned to be a residential and commercial mix, while for the redevelopment of the green hills, the interventions involve the creation and improvement of pedestrian paths and scenic walks.

The improvement of the mobility system is planned through the creation of interchange poles, the implementation of the public service and the creation of new parking lots. A section of the roads that now run along the river will be partially removed from the embankment, by exploiting a part of the existing railway area to the east. The goal is to redevelop the Polcevera embankments and better integrate it within the overall urban project. The project also provides for the implementation of the cycle and pedestrian network.

On March 8, 2021, Radura della Memoria was inaugurated, an artistic project by Luca Vitone, in memory of the 43 victims of the collapse of the bridge. The memorial, consisting of a semi-circular wooden amphitheater, in which trees are inserted, was conceived as a temporary square; this need emerged during the participatory process "Il Tavolo del Polcevera 2.0", which identified the need for a cycle of public meetings.[6]

Planning Tools and Ownership Layout

A two-phase design competition was the tool identified by the City of Genoa to address the urban transformation of the Val Polcevera area, renamed Quadrante. Thirty-one multidisciplinary groups participated in the first phase, among which the 6 groups that had access to the next step were then selected. The entire operation was the most important design competition ever launched by the Municipality of Genoa. The ACE-UIA, Council of Architects of Europe-International Union of Architects recognized the “Parco del Ponte” as one of the four best practices worldwide on the theme of the architectural competition as a tool of urban renewal.[7]

The infrastructural scenario within the area is complex and includes various projects already planned: the construction of the “Terzo Valico Ferroviario” – Third railway Pass, the reorganization of the Genoa railway junction, the construction of the Alessandria-Genoa metropolitan railway service, the reorganization and strengthening of the motorway junction and the construction of the “Gronda di Ponente”– Western Rim. In addition to these, as mentioned above, the extension of the subway is planned. The infrastructural interventions are regulated by the current Municipal Urban Planning Plan (PUC) and by the Urban Sustainable Mobility Plan (PUMS).

Selecting activities with a high technological production content, which is the main strategy of the project, is also recognized within the PUC, which identifies the strengthening of existing activities and the inclusion of innovative activities, as necessary.

The Production Park covers zones classified as areas of industrial production requalification and as areas of redevelopment. To build the project a modification of the existing PUC is required to eliminate the identification of the services of the Special Waste Disposal System from those areas.

To realize the Campasso railway park a program agreement is necessary between the Municipality and the Railway Administration, which allows for functions of equipped green areas and sports for these lands. The regulation of the external west and east bands of the dismissed railway must therefore be changed from “Railway and public transport in existing premises” to “Territorial and neighbourhood public services and public parking” - “Public green services, play, sport and public spaces provided.”

The technical-economic feasibility report of the project considers the combination of three actors: private investors or developers, public entities for the infrastructural endowment and the urban park and, finally, the utilities, for aspects related to public mobility and the energy needs.

[6] Further information on the project and on the program of the events is available on the institutional website of the municipality of Genoa (smart.comune.genova.it) at: https://smart.comune.genova.it/comunicati-stampa-articoli/completata-l%E2%80%99area-della-radura-della-memoria

[7] Further information is available on official website of the Order of the Architects of Genoa (ordinearchitetti.ge.it), at: https://ordinearchitetti.ge.it/il-parco-del-ponte-designato-tra-i-quattro-migliori-concorsi-di-progettazione-al-mondo/

The feasibility project planned the construction of the “Parco del Ponte” in four phases, for a total duration of eleven years. In the first phase the municipality will have to take care of the land remediation of the entire lot and the remodelling of the soils. Private investors, in this first phase, will purchase the areas to be built and will be responsible for the demolition costs of the buildings not subject to transformation. During the second phase, which has been planned for 2022-2024, public administration will be responsible of the landscape project, the Water park, the right bank under the bridge, the Piazza, the redevelopment of the hillside environments, the renovation of the local market and the main part of the mobility system realization. In this phase, the construction of the Red Circle is planned. The costs for the construction of it will be shared between the private promoters and the public administration.

Private investors will be responsible for the construction of the Green Factory, spaces for commercial, artisanal and office use, as well as for primary urbanisations of these areas and the renovation of the gym of the district. The total expenditure foreseen in the second phase is €39,685,700 for private investors and € 22,580,000 for public administration. During the third phase, 2025-27, a second part of the mobility project, the Campasso Panoramic Park and West sector of the park will be developed by the Municipality, for a total cost of € 7,670,000. In this phase, private investors will be responsible for the creation of spaces for residential, commercial, artisan and directional use, for a total of € 23,107,200. In this last phase (2028-2030) it is expected that the administration will be responsible for the construction of the sports park, for an estimated cost of € 5,335,000. Private investors will still be responsible for the construction of the spaces for commercial, artisanal and office use (estimated expense: € 13,259,200). In each of the four phases proposed by the project, and in the related expenditure forecast, costs related to temporary uses are planned. For temporary uses the winning project intends events by local associations to involve the community in the development of the area.

Even if the Polcevera Park and the Red Circle tries to balance public and private investments, the remediation works, the cost of which in the project is not estimated, and the first urbanizations are left to the responsibility of the public.

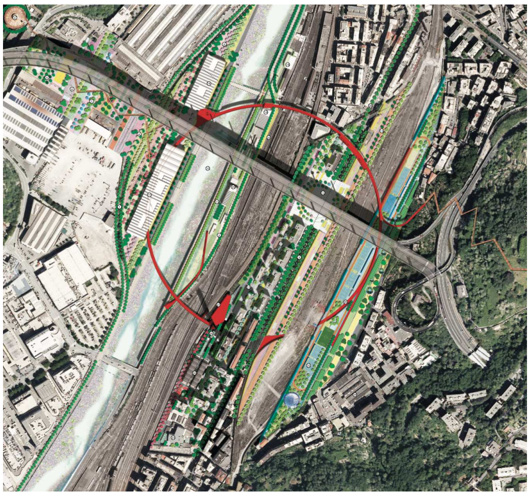

Figure 7.The Polcevera Park and the Red Circle, plan, 2019.

The area of the Polcevera Quadrante has been divided into two Sections (A and b) based on the properties of the soils, and therefore on the immediate availability of the areas. For the entire area of the Quadrante (680,000 square meters), the development of an overall masterplan was requested. The area subject to technical economic feasibility design (identified as Area B - about 120,000 square meters) is almost entirely owned by the State and the Municipality (with the exception of an area owned by IRETI). These areas have in fact been indicated in the preliminary tables for the competition, drawn up by the Municipality of Genoa and by Urban Lab, as “Immediate availability areas.” The remaining areas of the Quadrante (identified as Area A, of approximately 430,000 square meters), were included in the general masterplan of the competition, but not subject to the technical-economic feasibility project, and are indicated by the same tables as “Areas available conditioning”. The ownership structure of Area A was in fact mixed and included lots owned by RFI, ANAS, Filse, IRETI and Autostrade.

The role of public ownership was therefore essential to quickly and effectively start the design process and the competition procedures on the surfaces immediately available.

4 CONCLUSIONS

The Role of Public and Private Investors in Regeneration Processes in Genoa.

Models of Regeneration and Cooperation within Public Authorities.

The great urban transformations of the last thirty years (and even more evidently in the last ten), in Genoa, have been concentrated in the spaces located on the port-city limit, as the Waterfront di Levante and the Polcevera Park and The Red Circle clearly demonstrate working on a coastal context, on the one hand, and in a river and valley context on the other.

In this context we are witnessing a radical transformation of the actors. The figures of the owner and the operator , in fact, have long been distinct from each other, so that today the latter assumes the connotation of a highly specialized real estate investor, linked to large financial resources and coming from the external. The search for partners with those financial resources and managerial skills, that have not been found at the local level for some time (and for some aspects they had never been involved in intervening in Genoa), is a characteristic feature of recent years and goes in the direction of the entrepreneur city.[8]

Taking up the theoretical hypotheses that offer an explanation to the processes of urban renewal, it can be said that Genoa represents an emblematic case of transition from a phase characterized by “parochial capitalists” and local rentiers (which spanned the whole short century) to a phase in the which external actors, more closely linked to the extra local and international financial dimension, have appeared on the local scene.[9]

The predominance of the actors who hold control of the large national and international networks (physical ones, such as infrastructures for the transport or transmission of data flows, or intangible ones, such as large online service platforms) is decisive both in using the existing space of the physical city, both in modifying some pre-eminent features, where such networks find or generate new localization advantages, new polarities, new ways of using the city. By contrast, the actors who operate directly on the physical city (in the first instance, therefore, those who own land and buildings) act as facilitators of these processes (which arise according to increasingly extra-local logics, and this represents an important caesura compared to the history of the city) and, at the same time, they adapt to it, reorienting their interests in the changed geography of urban values.

The public actor (owner of strategic urban areas) makes the areas available and proposes them to interlocutors interested in urban transformation as a partner and, at the same time, as a guardian of values of public interest (uses, heritage, accessibility).

In this changing geometry of institutional relations, then, the public entity keeps the role of regulator and guarantor of the overall public interest and is thus intended as a necessary interlocutor. In the meanwhile the private subjects take the initiatives by selecting the activities to settle and, through participation in design competitions, they guide the conception and development of urban and architectural projects.

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Figure captions

Figure 1. Relief shown by hachures. Depths shown by soundings. Includes indexes and list of altitudes. Available also through the Library of Congress Web site as a raster image. LC copy sectioned into 20 and mounted on cloth, folding to 20 x 13 cm. Signed on printed title label on verso: M. Fillmore. Dec. 3, 1855. Signed on manuscript title label on verso: Millard Fillmore. Dec. 3d, 1855. Signed on publisher's label on verso: M. Fillmore. Dec. 3, 1855.

Available at: https://commons.wikimedia.org/wiki/Category:Old_maps_of_Genoa#/media/File:Genova_messa_in_pianta_topografica_LOC_2018588007.jpg

Figure 2. Marseille's Euroméditerranée Project.

Available at: www.euromediterranee.fr

Figure 3. Masterplan HafenCity Hamburg, ASTOC Architects and Planners for HafenCity Hamburg GmbH Freie- und Hansestadt Hamburg, completion 2030.

Available at: www.astoc.de

Figure 4. Map of the Milan railway yards. Source:"TRASFORMAZIONE DEGLI SCALI FERROVIARI MILANESI. Definizione di linee di intervento", Gruppo di lavoro DAStU Politecnico di Milano, 2014.

Figure 5.Waterfront di Levante, prima e dopo. Credits: Renzo Piano Building Workshop (RPBW), Fondazione Renzo Piano per la Regione Liguria, Comune di Genova e Autorità di Sistema Portuale del Mar Ligure Occidentale, 2017.

Figure 6.Waterfront di Levante, functional program. Credits: Renzo Piano Building Workshop (RPBW), Fondazione Renzo Piano per la Regione Liguria, Comune di Genova e Autorità di Sistema Portuale del Mar Ligure Occidentale, 2017.

Figure 7.Borders of Quadrante Area. Extract from the Preliminary Design Document. Guidelines for the Parco del Ponte International Competition. Source: Municipality of Genoa, 2019.

Figure 8.The Polcevera Park and the Red Circle, plan. Credits: Stefano Boeri Architetti. Source: Municipality of Genoa, 2019.

The Role of Zoning in Cross-Border Industrial Land Transition: Lessons from Tokyo Metropolitan Area

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1 ABSTRACT

Tokyo Metropolitan Area (TMA) is one of the most developed urban regions in the world. It consists of about 200 municipalities across Tokyo prefecture and the adjacent prefectures of Kanagawa, Saitama and Chiba in the Kanto Plain. The region has witnessed drastic socio-economic transformation during the last half century. As the growth of TMA and deepening of globalization, secondary industrial sectors in the inner city have kept decreasing while moving to the metropolitan suburbs and the suburban municipalities have benefited from inflow of industries for local jobs and revenue. Meanwhile, the cross-border industrial development has caused massive land use change, however some of the constructions were unplanned in terms of zoning. So, the questions arise on how it could happen in a developed country like Japan which has a mature land use planning system, what were the driving forces under the surface, and what was the impact has caused in the sense of sustainable development.

As a common policy instrument in urbanisation and land use management, zoning plays a key role in regulating the socio-environmental impact of land use change, especially cross-border industrial land transition. However, implementation and the effects of zoning may extensively depend on supply and demand in land market as well as from stakeholders' collaboration. It is also difficult to manage a zoning system at different scales initiated for different policy goals. Hence, this study aims to investigate the industrial land transition and the adequacy of industrial land location in the suburb of TMA by using temporal-spatial analysis of industrial and demographic statistics to clarify the gaps and driving forces between zoning and land use.

Keywords: Temporal-spatial analysis; Industrial land transition; Zoning; Spatial pattern; Adequacy

2 INTRODUCTION

2.1 Regional Governance in TMA and the Position of Zoning

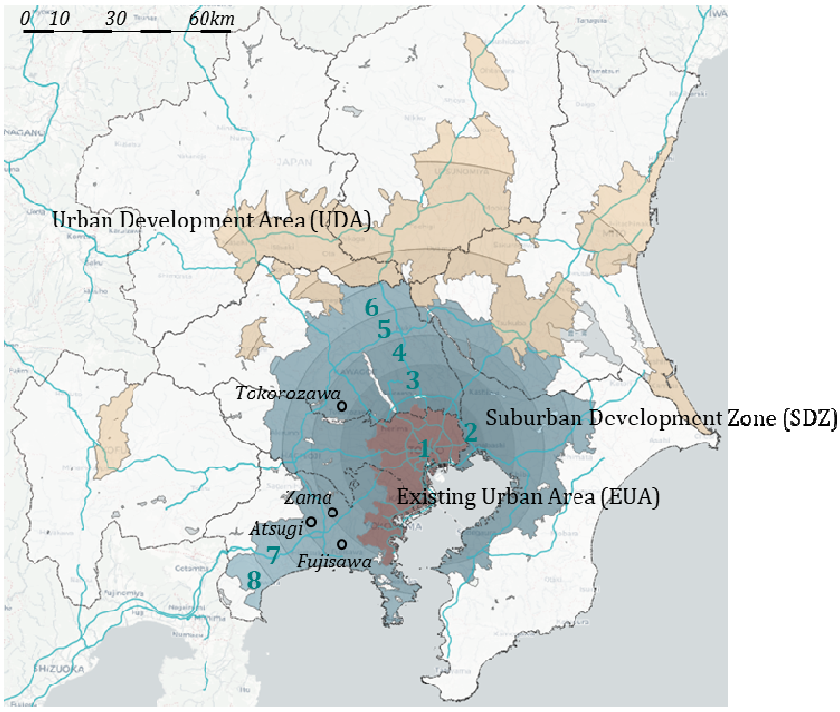

Figure 1: Governance area based on Tokyo Metropolitan Area Development Law.

In the 1950s, the deterioration of the environment in the existing urban areas and the problem of overcrowding became a serious issue in The Tokyo Metropolitan Area (further TMA), due to the

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concentration of industries and the accompanying rapid population influx from rural areas during the post-war period of high economic miracle. For this reason, the Tokyo Metropolitan Area Development Law was enacted in 1956 in order to prevent excessive concentration of industries and population in the existing urban areas of TMA, to prevent disordered sprawl and promote planned infrastructure development. According to the Law, the areas that have already been urbanised are considered as Existing Urban Area (further EUA, area #1 in Figure 1). It is an area that maintains or promotes the infrastructure necessary for the capital while suppressing the extreme concentration of industry and population. The areas that surround the EUA targeted in this study are the Suburban Development Zone (further SDZ, area #2-8 in Figure 1). It is an area in the suburbs of the EUA where green spaces are preserved and planned urban development is promoted. The areas outside SDZ are partially planned for future development as Urban Development Area (further UDA, area coloured beige in Figure 1). It is designated as an area that eases the concentration of industry and population and promotes development for the purpose of proper allocation of industry and population throughout TMA. Since the UDA is almost 60km and more away from the centre of the TMA and it is identified as a destination of industrial transfer from national perspective, in this study, we survey only the secondary industrial land in the SDZ and in the EUA (Figure 1). The SDZ was to preserve the environment of the urban area and to function as a buffer zone between the existing urban areas and the natural environment (Akita, 2017).

Zoning is based upon the foundation of regional governance area. In Japan, zoning was a main part of the new city planning system introduced in 1968 by a new City Planning Act, and it is a key instrument in development and conservation of land resource in the metropolitan suburbs (Nakai, 1988). The representative task of the macro zoning, literally "Senbiki" in Japanese, means drawing the line or delineation. It divides City Planning Areas (further CPA) into mainly 2 parts (there are also small parts of CPA having not been divided, known as other zoned area or blank CPA, in the outer suburbs or rural area, but in tiny proportion): Urbanisation Promotion Area (further UPA) and Urbanisation Control Area (further UCA). The UPA includes both existing built-up area and the area where urban development is encouraged over the next 10 years, while the UCA includes both strictly conserved areas, such as agricultural land, forests and other natural landscapes which should not be developed at all, and the area where building is strictly limited for the time being (Sorensen, 2000). The benchmarks of UPA delineation are mainly: (1) population size and density, (2) ratio of built-up area, (3) plan for local infrastructure development, and (4) plan for middle and large-scale development. Meanwhlie, the Land Use Zones, defined as micro zoning in this study, are the areas which are also regulated by the City Planning Law and designates the possible usage of land and properties in that area (MLIT, Japan). There are 13 zone categories in total: 8 residential zones including Quasi-Residential zone (QR), Neighbourhood Commercial zone (NC), Commercial zone (C), Quasi-Industrial zone (QI), Industrial zone (I), and Exclusively Industrial zone (EI). Land Use Zones are designated in the UPA but not in the UCA, and in the least number of situations, they are designated in other area of CPA (neither UPA nor UCA).

2.2 Industrial Land Use and its Policy Environment

First, there was a national comprehensive development plan based on the National Land Planning Law. In the early 1960s, when Japan was in the period of rapid growth, the goals of the national plan at that time were: to prevent the over-expansion of large cities, to avoid the over-concentration of industries and population, to narrow the development gap between cities and towns, and to achieve a balanced development. The Tokyo Metropolitan Area Development Law at that time was also one of the results of this national consideration. Theoretically, the allocation of industrial land was expected to be directed away from large cities to small towns, thereby increasing jobs in outer suburban or rural areas. The UDA, 60 km north of the TMA, was such a major regional industrial catchment area. It was expected that if there were enough jobs, the labour force did not have to settle in the big cities, and the development gap between the big cities and small towns or rural areas would not be too big as industries prospered. In special areas for industrial development, factories are encouraged and rewarded for moving in, while in the EUA, the core part of the TMA, factories that newly moved in are restricted. This is a top-down force that manages industrial land use, shaping the pattern of industrial land use throughout Japan and the TMA. However, with the overseas relocation of manufacturing industries that began in the late 1970s and the industrial upgrading of metropolitan areas, new domestic industrial land was drastically reduced. The policy framework for the domestic allocation of industrial land gradually receded from the stage of history, and in the 21st century, the

macro control of industrial land at the national level has practically ceased to exist (Aiba, 2021).
Second, urban planning controls and guides industrial land use. Specifically, the Quasi-Industrial zone (QI), Industrial zone (I) and Exclusively Industrial zone (EI) in the UPA are the main zones that were planned for the location of industrial land. By 2010, the area of the three zoning districts designated nationwide was growing at the annual rate of about 1% (calculation based on national land survey data from MLIT, Japan) and almost stagnated after 2010, which coincided with the population peak in Japan. This is reflected in the reduction of new factories and the conversion of factory brownfields into residential or commercial sites. The stock of industrial lands is unlikely to be growing significantly in the future, and will tend to decrease because of the ageing and low birth rate issues of Japan and the development of AI and ICT technologies.

Third, the basic principles for industrial construction and operation are determined by the Industrial Land Siting Law (1959). However, in the 1990s, because of the bursting of the bubble economy and the slowdown of industrial land growth, how to promote industrial development and how to encourage the metabolism of industrial land became an issue. Therefore, local governments with autonomy gradually eased these regulations and restrictions according to their own circumstances, which points to the unregulated industrial land location in the metropolitan suburbs to some extent.

2.3 Demographic and Land Use Change in the Metropolitan Suburbs

Japan has experienced a rapid change in socioeconomic conditions since 1960s and has undergone fast urbanisation. City planners and policy makers were not able to predict the frontier boundaries in advance (Usui, 2019). As a transition zone between urban and rural area, the suburbs of TMA, or the SDZ, has witnessed a serious issue with zoning due to changes in population and land use.

Now the TMA faces a saturation or terminal stage urbanisation (Mulligan, 2013) with an urbanisation level above 90% of the population. The population of the TMA is undergoing some subtle changes. The most densely populated areas are roughly distributed in a 0-20 km radius area. However, the latest statistics and forecasts show that the population is returning to the metropolitan centre. The residents who moved to the metropolitan suburbs during the period of rapid economic development gradually became old and rely on well-established urban services. On the other hand, the urban renewal projects in the metropolitan centre encourage the mixing of commercial and residential land use, which increases housing supply. Therefore, the elderly and high-income groups have replaced their real estate and moved back to the EUA from the SDZ.

In TMA, the further away from metropolitan centre or local central station, the faster the population are decreasing. According to the estimates of the National Institute of Population and Social Security Research (NIPSSR, 2018), population of the TMA will decline approximately by 6% until 2045 compared to the 16.3% decline for Japan nationwide. Since the EUA of the TMA is expected to increase by nearly 4.6%, the SDZ and other periphery areas of TMA can be expected to decrease by 10% to 15% or more. And within the SDZ, the degree of population decline would be severe in some areas and insignificant in the others. It may bring many new challenges to urban planning and management. First there is the dilution of urban area. Although residents of some areas decrease, the built-up environment including housing cannot change easily back to non-urban land use, responding to the population decrease in the SDZ. Second, urban public services have to be re-allocated. The issue of vacant facilities and community centre relocation are expected to be more serious and because of these two issues, the maintenance cost of public infrastructure might increase. Moreover, population decrease will also reduce the revenue source of the suburban municipalities.

2.4 Research objective

The urban land use in suburbs of metropolitan increases and decreases in number and typologies, which makes their planning a challenge for sustainable development (Geneletti et al., 2017). In the case of the TMA, the manufacturing shipping value and employees keep decreasing after 1980s, while the industrial land stocks remain unchanged in some places and increase at lower pace in others (Aiba, 2021). Additionally, the population growth in the metropolitan suburbs slowed by 2010, after which the population gradually declined and will decrease more until the 2050s according to population projections (MLIT, 2018). How zoning could adapt to such demographic and land use changes is questioned. Recent zoning enactments are mainly densifying into compact city areas around local rail hubs with guidance for residential and commercial land but not for industrial land, and the relationship between zoning and demographic-industrial changes is not well understood. Therefore, this study aims to investigate the land use changes and the

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adequacy of industrial land location in the suburbs of the TMA through temporal-spatial analysis. The results are expected to reveal the importance of industrial land planning for the urban peripheries within a decremental planning system under compact city and population decrease circumstance.

3 METHOD OF TEMPORAL-SPATIAL ANALYSIS

This study combines quantitative and descriptive research methods to interpret industrial land transition and the features and reasons for zoning in the outer area of one of the biggest metropolitan areas in the world. The study used land use data from 1980 to 2010 every 10 years, Densely Inhabited District (further DID) data from 1980 to 2010 every 10 years as secondary data. The study area is the region located about 60 km away from the centre of the TMA, which consists of 198 municipalities, sharing about 85% population, 80% industrial sector employees and 75% industrial shipping value of the whole TMA. The land use data is from 1980 (after two oil shocks), 1990, 2000 and 2010 (after the peak of average land price in the metropolitan and the peak of national population). Spatial statistical analysis of the industrial land transition was conducted across the study area at different distances to the centre of Tokyo. Eight spatial patterns of industrial land in the SDZ are observed based on land size and form of coalescence. By using macro zoning delineation data of 2010, the adequacy of industrial land location was interpreted in the 3 dimensions: (1) built-environment, (2) work-live proximity, and (3) land use zones.

City planners and practitioners usually rely on top-down approaches to deal with the urban area, which depends on predetermined basic spatial units (DID as one of them) provided by census or statistical bureaus (Jiang & Liu, 2012). Both the area size and population percentage of Densely Inhabited District (DID) are considered as factors of land use transition in the metropolitan suburbs (Hoshino, 1997). Distance from DID and population size were exerted opposite developed land during the phase od? rapid growth and population decline respectively (Kobayashi et al., 2020). Even though there are deficits in zoning when relying only on DID, because of the gap between it and the built-up area (Usui, 2019), it is used in this study as an important indicator for description of population distribution and density.

4 RESULTS

4.1 Industrial Land Transition Trend at Metropolitan Level

Industrial land inside the 20 km radius of the metropolitan centre decreased and that outside a 20 km distance from the metropolitan centre increased during all three ten-year periods from 1980 to 2010. In most radial directions, the critical point of industrial land use decrease in the inner city is in the region at around 20 to 30 km distance, while, in the southwest part of the TMA it is in the region at around 40 km distance while in the west part no increment is observed. The region at 30-50 km to the metropolitan centre is the largest receptacle of cross-border industrial development with a 56% increase of industrial land use of the whole study area from 1980 to 2010. Especially the industrial land use density in the 30-40 km distance region went to 6.8ha/km2 of buildable area (with a slope below 11 degree). The inner-city area of 0-10 km and 10-20 km from the centre face both absolute and proportional decrease in industrial land use (Table 1 and Figure 1). The most noticeable industrial land transition happened in the 30-40 km and 40-50 km distance in the SDZ by either increments or overall increased rate.

Serial number and Area			1980	1990	2000	2010	1980-2010		2010	
							Changes	Rate	Proportion	to Buildable land
1	Existing Urban Area (EUA)		6009	5594	6075	5139	-870	-14.5%	16.5%	5.8/100
2	Suburban Development Zone (SDZ)	10-20km	1680	1749	1596	1884	204	12.1%	6.1%	6.9/100
3		20-30km	2256	2613	2664	3198	942	41.8%	10.3%	3.3/100
4		30-40km	8685	9506	9579	11221	2536	29.2%	36.1%	6.8/100
5		40-50km	4648	5316	5992	6222	1574	33.9%	20.0%	3.9/100
6		50-60km	1541	1925	2202	2627	1086	70.5%	8.5%	3.8/100
7		60-70km	445	469	532	536	91	20.5%	1.7%	5.5/100
8		>70km	216	215	226	243	27	12.5%	0.8%	7.8/100
Total			25480	27387	28865	31070	5590	21.9%	100%	5.0/100

Table 1: Industrial land transition in suburbs of TMA from 1980 to 2010 (unit: ha)

4.2 Industrial Land Transition in the area at 30-50km distance from the centre and Spatial Pattens

The agglomeration types of industrial land in the selected study samples of areas at 30-40 km and 40-50 km distance are divided into 8 spatial patterns of industrial land transition (Figure 2). The parameters are: (1) with mainly large-scale industrial lands or with mainly small and middle-scale ones, (2) areas with a planned concentrated industrial park, (3) areas with local big foundries in a leading position, and (4) clustered or dispersed type of industrial land transition based on multiple-distance spatial cluster analysis. This shows that regardless of size, industrial land tends to be distributed along the National Road and Prefectural Road. As seen in patterns III to VI, the distribution of industrial land is more concentrated in the sample with the industrial park and large regional enterprises, but not limited to a single agglomeration. As seen in patterns I and II, the distribution of industrial land is more dispersed in the sample of mainly small-scale industrial enterprises, which is not necessarily related to the existence of a centralised industrial park. As seen from pattern VII and VIII, the samples with more dispersed distribution of large enterprises, with or without an industrial park, have a more dispersed overall industrial land location. All of them have an oversized UPA designation range.

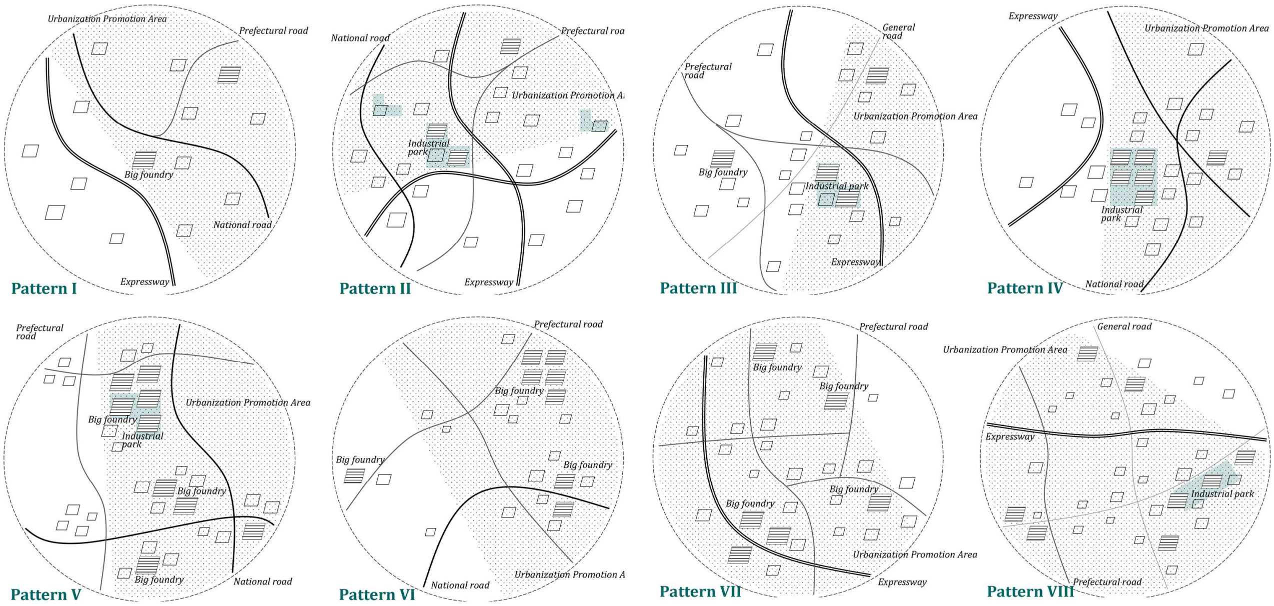
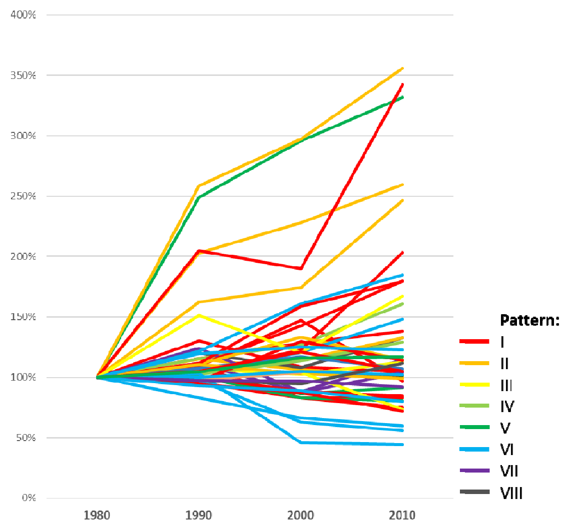


Figure 2: Spatial pattern of industrial land.



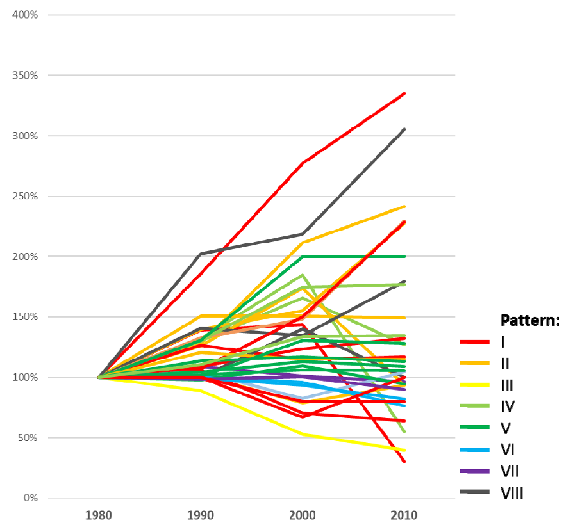


Figure 3: Samples in the 30-40 km area (1980 as 100%). Figure 4: Samples in the 40-50 km area (1980 as 100%).

For seeing the industrial land transition in the 30-50 km distance area of SDZ from 1980 to 2010, we designated 83 3-km-radius study areas based on municipalities as standard samples. Figure 3 and Figure 4 show the rate of increase/decrease in industrial land every 10 years in 83 study areas with 1980 as 100%. We can see that areas of significant increase in industrial land outnumbered areas of decrease between 1980 and 2010. Among the 45 sample areas of the 30-40 km distance area, industrial land increased by 50% or more in

12 areas, and decreased by 25% or more in 7 areas (Figure 3). Among the 38 sample areas of 40-50 km distance area, industrial land increased by 50% or more in 13 areas, and decreased by 25% or more in 4 areas (Figure 4). In terms of industrial land change in the different spatial patterns of the samples (Figure 2), Pattern II tends to have a large increase of industrial land. Pattern VII has a stable industrial land change within plus or minus 10%. Pattern IV and V samples mainly show an increase in the range of the 40-50 km distance area. The samples of Pattern I and VI do not show any significant tendency of industrial land increase or decrease.

4.3 Features and Reasons of Industrial Land Transition

4 typical examples from the 83 3 km-radius study areas of the 30-50 km distance area - 2 samples in the 30-40 km distance area and 2 samples in the 40-50 km distance area (location shown in Figure 1) are selected to show details of industrial land transition at a community level.

4.3.1 Industrial land transition in 4 samples of the 30-50 km radius area

In general, industrial land in all four samples increased from 1990 to 2000 and then decreased, with one sample being similar to the regional average and the other 3 samples being much lower or even opposite to the regional average (Table 2). By 2010, the end of the survey period, the industrial land in Tokorozawa and Zama at 30-40 km distance decreased, while the industrial land in Fujisawa and Atsugi at 40-50 km distance increased, and all of them belonged to pattern V mentioned above.

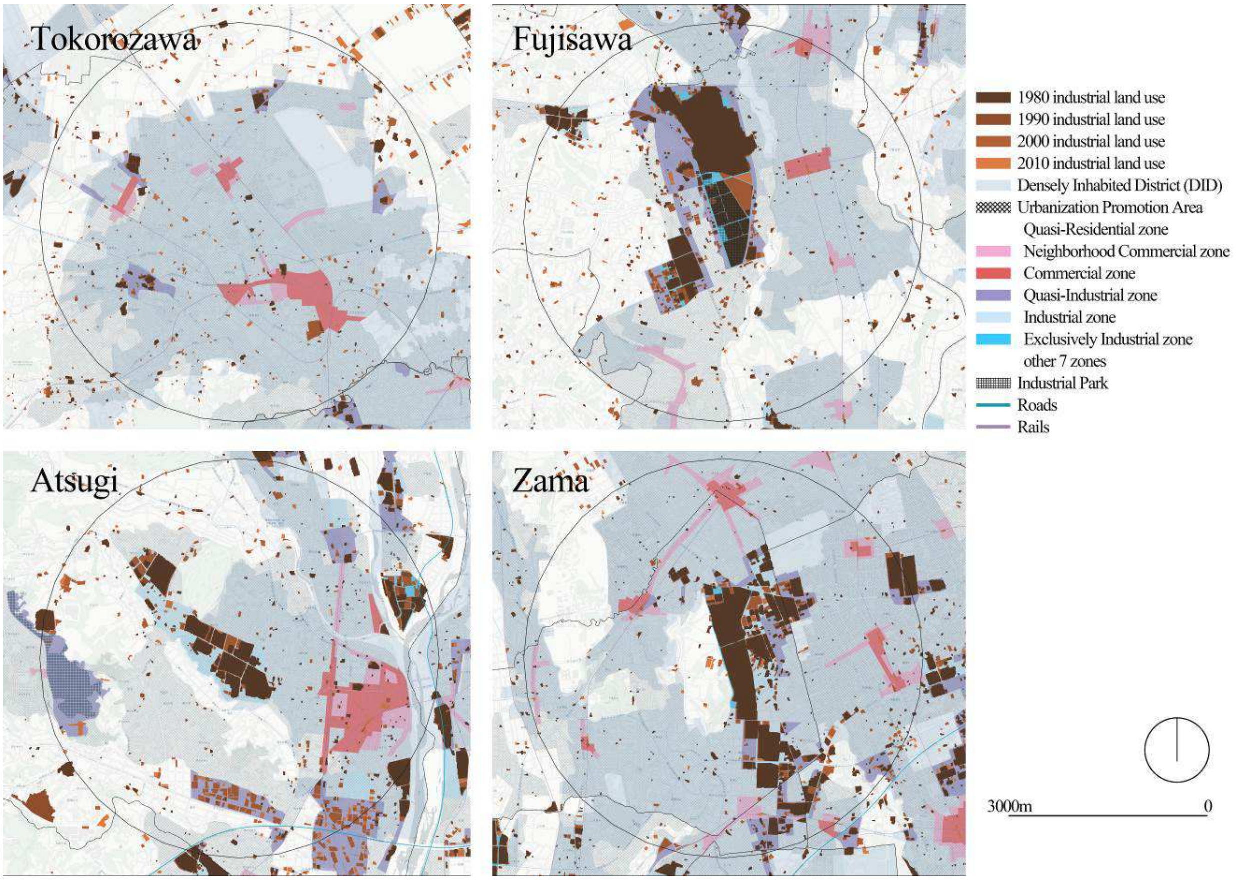


Figure 5: Industrial land location and zoning.

Region	3km-radius sample of City	Spatial pattern	1980	1990	2000	2010	1980-2010	
							Changes	Rate
30-40km	Tokorozawa	I	34	37	50	32	-2	-5.9%
40-50km	Fujisawa	V	233	243	264	255	22	9.4%
40-50km	Atsugi	V	140	142	185	181	41	29.3%
30-40km	Zama	VI	250	232	224	200	-50	-20.0%

Table 2: Industrial land transition (unit: ha).

In terms of overall land use structure, Tokorozawa has no large industrial enterprises and industrial park, and the industrial sites are scattered; Fujisawa has large industrial enterprises and an industrial park, and industrial sites are relatively concentrated; Atsugi has both large industrial enterprises and an industrial park, and the industrial sites are scattered, but relatively concentrated in each industrial cluster area. Zama has large industrial enterprises but no industrial park, with a relatively concentrated industrial land cluster. In terms of the location of the industrial land transition, Tokorozawa has mainly sporadically increased in the border areas along the main roads. Fujisawa has mainly increased in the areas with good road conditions around the existing industrial clusters. Atsugi has mainly increased in the newly developed areas near the regional residential centre and away from the earlier developed industrial clusters. Zama is mainly partially metabolised within the existing industrial clusters. In terms of zoning context, Tokorozawa has only a Quasi-Industrial zone, and its industrial land changes mainly outside the planned zone. Fujisawa has all, a Quasi-Industrial zone, an Industrial zone and a designated Exclusively Industrial zone and its industrial land has increased mainly in the Exclusively Industrial zone. Industrial land changes in Atsugi and Zama mainly occur in the Quasi-Industrial zone (Figure 5).

4.3.2 Transportation convenience, built-up environment and the industrial park

In the total area of the TMA suburbs, 32% industrial land use was located in places at more than 5 km away from the interchange of the expressway in 2010 and before 2000 increasing speed of industrial land was higher in places far away than in places at 5 km to interchanges. The reason why the industrial land changes in the 4 cases are so varied can firstly be seen from the comparison of the difference in their freight traffic conditions and built environments (Table 3). In terms of the spatial relationship with the administrative centre of the municipality Tokorozawa and Zama, where industrial land use is decreasing, are within 1500 m distance to the city hall, while Fujisawa and Atsugi, where industrial land is increasing, are further away from the centre of the municipality. Fujisawa is located in the sub-centre of the municipality and Atsugi is at a distance of about 2000 m to the city hall. In terms of the spatial relationship with the central station of the municipality all 4 samples are within an approximately 1500-2000 meters range. In terms of the spatial relationship with the expressway interchange Tokorozawa, where industrial land has reduced and is dispersed, is 6600m away from the nearest station, while both Fujisawa and Atsugi, where industrial land is growing, are less than 5000 m from the expressway interchanges.

3 km radius samples in	Spatial pattern	Distance to (m)				Number of roads		
		City hall	Centre station	Expressway interchange	Industrial park	National	Prefectural main	Prefectural general
Tokorozawa	I	1000	1900	6600		1	2	
Fujisawa	V		1500	4600	0	1	2	1
Atsugi	V	1900	2100	3200	2200	2	2	1
Zama	VI	1400	1500	4700		1	2	

Table 3: Features of transportation convenience and built-up environment of the 4 samples.

In terms of road conditions within the sample regions, Atsugi with an increase in industrial land has one more national road than the other samples, but there is not much difference in the number of roads above the level of prefectural road.

4.3.3 Population changes and work-live proximity

In terms of the demographic context of the municipalities in which the 4 samples are located, we analysed the area, density and population share of the Densely Inhabited Districts of the 4 samples (Figure 6). During the observation period from 1980 to 2010, the DID area, DID population and DID population proportion of the four sample municipalities continued to increase. The largest proportion of DID population was 93.9% of Zama city in 2010, and the smallest was 50.8% of Atsugi city in 1980. The population density of DID is higher in Tokorozawa and Zama, where industrial land use has decreased, but the proportion of DID area in buildable land in Tokorozawa is less than 50%. while Fujisawa and Atsugi, where industrial land use has increased, both had a higher proportion of DID area in buildable land than Zama and Tokorozawa after the 1980-1990 period.

In terms of the industrial land transition in and outside the DID, 17% industrial land use was located at 1 km to DID and 17% located in places more than 1km to DID across the TMA suburbs. In the 4 samples industrial land outside DID increased even though total industrial land is decreasing in Tokorozawa and Zama. In Tokorozawa, where the industrial land is mainly small-scale and scattered, industrial land outside DID accounts for more than one-third of industrial land.

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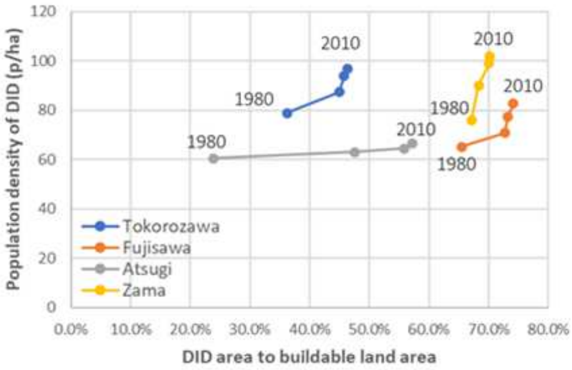

DID Pop.	1980	1990	2000	2010
Tokorozawa	81.7%	87.5%	88.0%	88.7%
Fujisawa	88.8%	91.8%	93.5%	93.5%
Atsugi	50.8%	77.3%	84.3%	86.3%
Zama	92.5%	93.3%	93.5%	93.9%

Figure 6: Demographic urban growth in the 4 municipalities of each sample and the DID population proportion

5 DISCUSSION

5.1 Industrial Transition and Features

Most industrial land was transferred from the inner city to the suburbs as a consequence of the downtown area shifting to the service sector. Meanwhile, the surplus of increment over decrement of industrial development in the suburban municipalities occurred when suppliers and subcontractors emerged after the industrial inflow. UCA shares 23% industrial land, and in all 3 time periods it contained more industrial land increment than UPA did in the 30-50 km distance regions. 5 out of 8 spatial patterns based on locational factors show fragmented small and medium-sized industrial development. The common piecemeal development in the controlled urbanisation area is affected by the transportation accessibility demands of different types of industry. The industrial transition relies more on transport accessibility after 2000 especially. In addition, industrial land use moved far away from where people lived. In the 30-50 km distance regions, increase of industrial land far away from inhabitants is greater than that near inhabitants in absolute value across all 3 time periods. And the 4 samples of the 30-50 km radius area revealed that 1) industrial park is not the necessary means of industrial land aggregation when there is large-scale factory, 2) in the absence of large-scale factory, industrial parks significantly cluster fragmented industrial land, and 3) it takes years or decades for the clustering process and it could be interrupted due to the economical enviroment.

In the TMA, industrial land is mainly located in the east, south, and north parts. It can be seen as an obvious spreading effect of industrial land in the surrounding areas in the past. The distribution of industries in the SDZ of TMA is not independent in each region, but interlinked on the balance of industrial land transition. So, a cross-border large-scale industrial cluster area covering the entire TMA is formed. In the 5th Tokyo Metropolitan Area Basic Plan of 1999, the government hoped that a multi-radius, multi-centre spatial framework of industrial land along the expressway network would be strengthened. However, uncertainty exists in the trends of industrial land transition. It comes from the location demands of each company or manufacturer. Some manufacturers focus on locations near rivers and oceans, while others focus on distribution hubs such as expressway interchanges. Some manufacturers emphasise the availability of workers, while others focus on the relationship with the parent manufacturers as subcontractor. The priorities and the way these conditions combine each other vary from manufacturer to manufacturer (Aiba, 2021).

5.2 Delineation and Implementation of Zoning for Suburban Industrial Development

In terms of micro zoning, industrial land transition shows different structures for the 4 samples (Figure 7). Almost all industrial land in the four samples is located in the Quasi-Industrial zone, Industrial zone, Exclusively Industrial zone, and Urbanisation Control Area, but only Tokorozawa has no designated Industrial zone and Exclusively Industrial zone. From the zoning perspective, firstly, the growth of industrial land in UCA is observed in all 4 samples; secondly, the decrease of industrial land in the Quasi-Industrial zone is present in Tokorozawa and Zama, which happen to be the samples with decrease of total industrial land; and in the other zoning with very little industrial land, industrial land is decreasing in all 4 samples. The increase in industrial land in Fujisawa is mainly in the Exclusively Industrial zone, which has the largest share of the zoning area, while the increase in industrial land in Atsugi is mainly in the Quasi-Industrial zone, which has a smaller share of the zoning area. In Tokorozawa where industrial land is mainly small-scale and scattered, industrial land in the UCA accounts for more than one-third of industrial land. It reveals that the zoning that controls the expansion of urban land is not as effective as it should be, and its implementation needs to be improved, while the use of zoning that regulates the use of specific urban land use varies greatly in different municipalities. Besides, the increase or decrease of industrial land use is also commonly seen among different urban land uses, which indicates that unmissable leniency exists in the land use zoning.

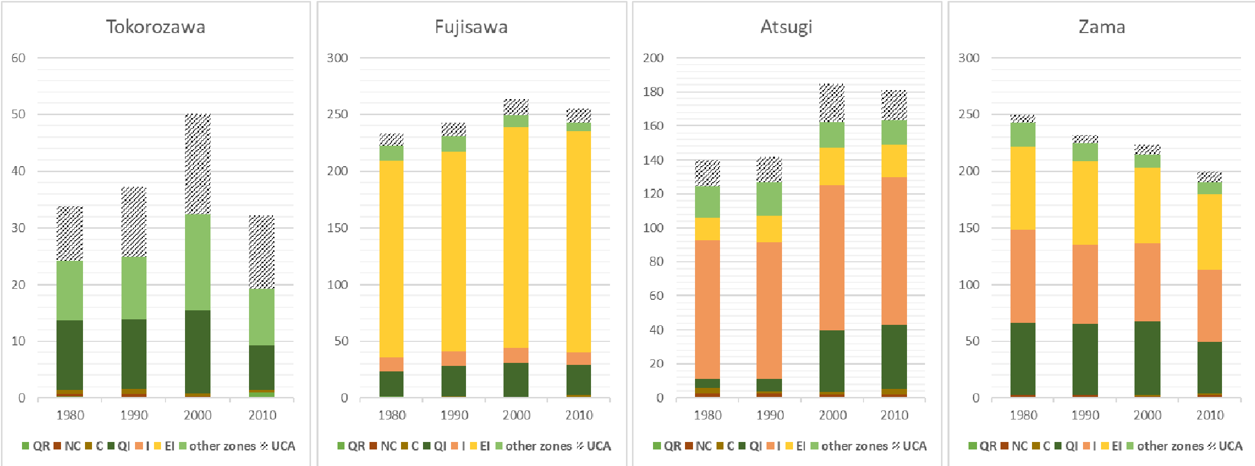

Figure 7: Industrial land transition in planned zones (2005 zoning as criteria).

Zoning should play a key role in land use transition. Among all policies regulating the relation between urban land and its hinterland, the most notable ones are regulatory and economic measures taken under the "zoning" law (Tsubota, 2006). However, conflict has occurred between two administrative ministers for identifying the priority between urbanisation promotion and natural environment protection in Japan (Moreno, 2011). Unregulated urbanisation due to flexible local implementation of zoning is a key cause for land use transition and commonly occurs in the area zoned as UCA (Saizen et al., 2006). Besides, there are requirements of supplying infrastructure or other municipal services in the UPA based on the law (Sorensen, 2001), but uncertainties about landowners' intention for land use transition, and therefore the delineation of zoning is challenged over time.

Conversely, because of the high traffic dependence of some industrial land, it will be laid out closer to regional transportation facilities such as expressway interchange, national highways and prefectural roads. And these areas are not necessarily the gathering place of nighttime population. In this case, the zoning, which is mainly based on population, does not include these industrial sites, thus presenting unplanned industrial land expansion outside of the planning control in the data. However, in order to intensify land use, improve land use efficiency, and protect suburban land resources, industrial land, as a kind of urban land, should be fully included in the control and guidance of urban land zoning. That is to say, zoning needs to consider industrial land use planning away from Densely Inhabited District based on built environment factors such as transportation facilities.

Because of the complex demographic and industrial land use changes in the area, both urban growth and shrinkage are witnessed in the suburbs of the TMA. And in the near future, underused and vacant urban land use would be seen more and more frequently in the urban peripheries because of the national depopulation and the concentration to the centre area of the TMA. In order to keep the vitality of the suburban municipalities, the government issued plan and policy based on the compact city concept. Base on the new policy, dwell and commerce activities are guided to some limited areas which are near the station. However, the new policy has not made the regulative and incentive measure clear outside of the plan area, and the existing suburban manufacturing land use, as receptor of local jobs and revenue, was not taken into consideration in the planning. For sustainable urbanisation, it is necessary to consider industrial land use changes and improve the planning approaches.

6 CONCLUSION

Depopulation of the metropolitan suburbs in the future gives opportunities to suburban land use in TMA. The lessons of industrial land use transition in TMA tell us that: 1) the industrial park could become the main

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carriers of the industrial transition to save the land resource; 2) the implementation of zoning needs to be improved for land resource conservation; 3) the delineation of zones needs to be based on not only population size and density but also on the built-up environment and transportation infrastructure.

The adequacy of industrial land location can be one of the perspectives to evaluate cross-border land use transition. Considering that many other factors, such as socio-economic factors exist during industrial land transition, the analysis of the industrial land location provides insights of the planning approach, together with the analysis of demographic urban growth and its built environment. A temporal-spatial analysis approach is used in this study to identify the effectiveness of zoning in suburban industrial land transition. Through the context-specific research in the TMA using a quantitative and descriptive method, this study revealed that the restriction of zoning on industrial land transition in the suburbs of TMA has been gradually mitigated since the economic bubble exploded in the early 1990s. In addition, the features of industrial land transition of each local municipality differ significantly. The effect of built-environment and work-live proximity in the outer metropolitan peripheries is significantly greater than that in the inner suburban area. This indicates that the existing zoning in different peripheral municipalities varies in terms of lineation and implementation. This method can be used for all other samples at municipality level in the metropolitan suburbs.

Several issues need further research for a way forward. First, this study focused only on secondary industrial land use, without specifying whether it is used for warehousing or small-scale workshops. There are also other driving forces of industrial land transition, such as shipping value and employment of manufacturing. Second, the future population projection in TMA needs to be simulated for providing zoning proposals in the future.

7 ACKNOWLEDGEMENT

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Together we are Stronger – Examining Thematic and Procedural Entry Points for Multidisciplinary, Integral Spatial Planning Approaches to Confront Climate Change

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1 ABSTRACT

Due to climate change, meteorological phenomena can occur with changing frequency and intensity. As a result of these changes, different thematic challenges arise, depending on the geographical location, topographical and climatic conditions, as well as other influencing factors such as land use. Spatial planning can contribute significantly to the prevention or mitigation of climate change-related risks through the creation of visions and integration of objectives, as well as through spatial research and the support of planning decisions (e.g. Hurlimann and March 2012).

Urban and in particular metropolitan areas and their surrounding sub-urban structures are particularly prone to climate change impacts, such as increasing and longer-lasting heat waves due to its high share of impervious surfaces (Morabito et al., 2021). Consequently, they need to urgently consider resource scarcity (e.g. related to droughts) and complex planning decisions caused by multiple land use changes and diverse pressures accumulating with intensifying climate change impacts. Among others, Matthews (2012) addresses the key role of metropolitan areas in coping with climate change as a "transformative stressor". Besides these challenges, several authors highlight the multiple co-benefits (e.g. for health, recreation and/or nature conservation) that can result from a precautionary and proactive approach to climate change adaptation in urban and sub-urban areas (Floater et al. 2016; Raymond et al. 2017). Similarly, Biesbroek et al. (2009) already discussed the potential to combine adaptation and mitigation efforts to create joint benefits in planning.

To achieve these aims in adapting to climate change and creating positive synergies, horizontal cooperation across planning borders is often required. Such an approach allows for an early consideration of planning alternatives and enables planners to specifically and appropriately implement further climate proofing measures, all of which are considered essential steps in the climate proofing of spatial plans and programmes (Hurlimann and March 2012). To consider climate change along horizontal planning boundaries in an integrative manner, it can be highly relevant to consider information and planning objectives from adjacent or complementary sectoral instruments, as Matthews and Baker (2021) point out. Similarly, Widmer (2018) highlights the importance of addressing the „cross-cutting nature of adaptation" within integral planning processes.

This paper, based on a large case-study in the eastern part of Austria, funded by the "Planungsgemeinschaft Ost – PGO" (Planning Association East) and involving three different federal states – each with its own legal system – discusses specific entry points and barriers that need to be overcome in order to foster an integrative, multidisciplinary consideration of climate change in and around cities including also large metropolitan areas. Based on a theoretical framework (Jiricka-Pürrer et al. 2020), which helps to approach the complex challenges of climate proofing in an integrative way across planning borders, the authors undertook a systematic review of the thematic and procedural entry points for cooperation across planning units. Nineteen expert interviews were carried out with spatial planning units, as well as departments of forestry, geology and water management across the three Federal states of Vienna, Lower Austria and Burgenland. They review, among other aspects, the cross-institutional communication and coordination of targets, as well as data-related challenges and measures for climate change adaptation. Additionally, opportunities to increase co-benefits for climate change mitigation, public health and nature conservation are discussed, particularly in the light of procedural entry points. The complex challenges of this case study area in Eastern Austria showcase the variety of options for integral planning and cooperation at various planning levels (federal, regional to local) and the need for multidisciplinary perspectives.

Keywords: cross-sector cooperation, cross-border cooperation, climate change adaptation, climate proofing, integral planning

2 INTRODUCTION

Growth of cities and suburbs is a European and world-wide phenomenon (UN 2019). Re-densification and the associated loss of urban green infrastructure (UGI) and unsealed soils accumulate with impacts of climate change such as heat waves, and droughts. Urban expansion and urban sprawl is a widely known phenomenon also in Austria, particularly concerning its capital Vienna and surrounding areas in Lower Austria and its neighbouring Federal state Burgenland. The Austrian Conference on Spatial Planning – ÖROK has forecasted a large population increase by 2040, especially in the outer districts and suburbs of Vienna and the neighbouring districts (ÖROK 2019). This entails the deterioration of relevant green infrastructure and consequently means that regulating ecosystem services are endangered in areas, where they are urgently needed. In addition, climate-induced stress and biological invasion, as results of global change, are intensifying the pressure on existing green spaces with their related biodiversity (Martinson and Raupp, 2013).

Efforts for climate change adaptation encounter partly opposed objectives for climate change mitigation related e.g. to densification. On the contrary, nature-based solutions for climate change adaptation can enhance multiple benefits for biodiversity, human health and partly also climate mitigation purposes (EC, 2015; Bush & Doyon, 2019; Raymond et al., 2017).

Spatial planning on its own has limited capacities for achieving these beneficial goals. Knowledge and data from other sectors, such as forestry, water management and geology are, in most cases, required to assess the upcoming cumulative impacts of climate change in combination with other drivers of change. Effects of land scarcity and pressures on the green areas/green belts of urban and peri-urban areas (thus the UGI) deserve long-term strategies to foster cross-sectoral adaptation and to maximise the potential for climate change mitigation at the same time. The actors-based interdisciplinary project CLIP-OST, funded by the "Planungsgemeinschaft Ost – PGO", aims at identifying approaches for integral and strategic planning to confront climate change in the light of specific challenges in urban and sub-urban areas. Findings from the case study area in Eastern Austria are compared with international experiences. The project investigates opportunities for cross-sectoral cooperation based on expert interviews from spatial planning as well as other relevant sectoral planning institutions. Subsequently, we discuss the following thematic aspects in the context of the presented case study and compare the results with those of other international case studies:

(1) thematic and procedural entry points for a multidisciplinary perspective to approaching climate change in spatial planning in the urban-sub-urban planning context

(2) opportunities to foster integral approaches for climate change adaptation as to create positive synergies and minimise conflicts of interest

(3) entry points for climate proofing and climate change adaption across planning boundaries in metropolitan areas

3 PARTICULAR CHALLENGES OF CLIMATE CHANGE FOR URBAN AND SUB-URBAN AREAS

3.1 Challenges specific to densely populated areas affected by climate change

Urban and in particular metropolitan areas and their surrounding sub-urban structures are particularly prone to climate change impacts, such as increasing and longer-lasting heat waves (Morabito et al., 2021). The urban heat island effect (UHI) is amplified by the reduction and fragmentation of urban green space. Competition for land-uses like housing, transportation, energy conversion and the like, are also clearly associated with habitat fragmentation and isolation in urban areas (Gaston, 2012).

A key but increasingly scarce resource, not only but particularly in urban areas, is space. Climate change mitigation targets impose additional pressure in sub-urban areas, for example when planning to implement large-scale energy production. While climate change mitigation purposes foster the densification of settlement structures, awareness of essential areas (e.g. unsealed structures, small to large scale green structures,...) for climate regulation is a key asset at the same time.

For some metropolitan areas also water resources will become seriously endangered during periods of heat wave and drought. In this context, fostering nature-based solutions for climate change adaptation can be limited in case this effect is not recognised at the initial planning phase and during the development of measures which involve water storage for instance.

Urban areas and their related sub-urban surroundings, consequently, need to urgently consider resource scarcity and complex problems caused by multiple land use changes and diverse pressures accumulating with climate change impacts. While spatial planning strategies, programmes and plans normally involve a review on the natural assets in a planning area, this assessment in the regular spatial planning procedures does, in most cases, not consider future trends and implications for these natural resources so far. Accompanying instruments of environmental planning such as the Strategic Environmental Assessment (SEA) are discussed as relevant to integrate these perspectives into spatial planning processes. Often, this potential is, however, counteracted by the late or limited application of this instrument (Posas et al. 2013). Some countries, such as Germany, established instruments of landscape planning, which are supposed to deliver essential information to tackle climate change (Heiland et al. 2008, Heiland et al. 2016). In Austria, efforts to implement, respectively strengthen these instruments remained rather unsuccessful.

3.2 Urban-suburban cooperation – enhancing opportunities for strategic climate proofing

Besides the challenges mentioned in the previous sub-section, several authors highlight the opportunities to create multiple co-benefits (e.g. for health, recreation and/ or nature conservation) that can result from a precautionary and proactive approach to climate change adaptation in urban and sub-urban areas (Floater et al. 2016; Raymond et al. 2017). Biesbroek et al. (2009) already outlined the potential to combine adaptation and mitigation efforts to create joint benefits in planning. Among others, Matthews (2012) addresses the key role of metropolitan areas in coping with climate change as a “transformative stressor” (see also Yiannakou & Salata, 2017). Parker and Simpson (2018) highlight the benefits of green infrastructure to enhance the quality of living in urban areas based on an extensive literature review.

Green areas, especially trees, provide cooling through evapotranspiration and shading effects keep surfaces cool (e.g., Akbari et al. 2001, Gill et al., 2007, Morabito et al., 2021). Semi-natural structures and connected urban green spaces, cannot only allow coping with climate change impacts but also provide a highly functional habitat network, when an optimal spatial configuration can be achieved (Venn et al., 2013). Honeck et al. (2020) elaborated a first multi-functional GI modelling approach for Geneva and its surrounding areas, through dynamic response to emerging and aggravating challenge.

To date, several studies exist on the effects of enhancement of strategic planning of nature-based solutions in urban-sub-urban planning context (Garmendia et al. 2016, Pauleit et al. 2017 or Mayrand and Clergeau 2018). However, the opportunities but also barriers for implementing novel and holistic concepts through a cross-sectoral integral planning approach are rarely investigated so far, especially for the context of urban-sub-urban cooperation in spatial planning.

Monteiro et al. (2020) outline important principles for the enhancement of green infrastructure with the main motivation to foster consideration of them in spatial planning. The analysis of about one hundred studies identified multifunctionality and multi-scale planning, among others, as key principles. Achieving multifunctionality in planning is necessarily dependent on multiple cross-sectoral perspectives to obtain knowledge on joint goals, enable practical implementation and management of the development/ measures but also to create awareness for hindering factors to overcome right from the beginning of the planning process. Multi-scale planning in terms of vertical cooperation and tiering is often discussed in the context of identifying planning alternatives as well as exploiting the mitigation hierarchy, but also in the light of achieving climate change adaptation and mitigation purposes. Complementary consideration of connectivity of UGI deserves consideration of efforts to minimise negative impacts of climate change along the mitigation hierarchy but also across planning boundaries (horizontal cooperation).

Monteiro et al. (2020) also confirm in their study that the transfer of these overarching goals, also reflecting the European Commission’s strategy (e.g. EC 2013), into spatial planning practice is very limited. Similarly to Lennon and Scott (2017), they summarise that the procedural consideration of cross-sectional planning objectives is rare.

Against this background, this study examines the state of the art of cooperation across sectors as well as barriers and opportunities for future integral planning in a large metropolitan area prone to severe impacts of climate change.

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4 METHODOLOGICAL APPROACH

The authors undertook a systematic review of the thematic and procedural entry points for cooperation across diverse sectoral planning units, thereby applying a multi-disciplinary approach as outlined in the following sub-sections.

4.1 Description of the case study area

The paper is based on a case study in the eastern part of Austria. The case study area includes three federal states - Vienna, Lower Austria and Burgenland - with around 3.9 million inhabitants in a total of 745 municipalities. The Planungsgemeinschaft Ost (Planning Association East, PGO), which was founded in 1978, is responsible for the coordination of spatially-relevant activities in the three federal states. The case study area is an area of the larger metropolitan area of Vienna, the so called Stadtregion+ (City region+), which includes Vienna with its 23 districts, 205 Lower Austrian and 63 Burgenland municipalities with a total of 2.8 m inhabitants. The urban region of Vienna is characterised by strong commuter links and many additional functional relationships between the core city and the surrounding area (PGO 2011).

The complex challenges of this case study area showcase the variety of options for integral planning and cooperation at various planning levels (federal, regional to local) and need for multi-disciplinary perspectives. A central challenge are the diverse federal laws on spatial planning and the planning monopoly at the municipal level, which is relevant to determine land use and construction permissions. Different conceptual planning instruments – which are not legally-binding (e.g. strategy concepts, sectoral concepts) – are used by federal states, regions or municipalities for their spatial development. The supervisory authorities for municipalities are the offices of the state government, which have to review and approve planning acts. In some federal states, additional regional planning levels exist, including conceptual or binding concepts, plans and programmes for supra-local and sectoral planning.

Regarding the climatic situation the eastern part of Austria is the region with the lowest rainfall in Austria (Reniu 2017). Dry periods are an actual challenge since they can cause problems to the water supply needed for the vegetation, and also to the drinking water supply. Climate change will exacerbate this situation in the future, although there will be no significant decrease in precipitation on an annual basis, but the forecasts predict a strong increase in evapotranspiration due to warming and in particularly occurrence of heat waves. The Eastern region and especially the lowlands are also among the warmest regions in Austria. Therefore, especially urban regions are confronted with an increasing urban heat island phenomenon (MA 22 2018). Up to now, topics such as population development, settlement development, mobility or nature conservation dominated the work of the urban region+. Climate change adaptation has only recently been considered as a novel challenge.

For the analysis of entry points for integral planning strategies in the Viennese larger metropolitan area the following instruments were analysed regarding their suitability for cross-regional and inter-sectoral cooperation:

- cross-sectoral strategies at state level that deal with climate change mitigation and adaptation,
- federal state development programmes,
- regional development concepts or programmes,
- local development concepts,
- legally non-binding concepts and master plans,
- land use plan, as well as
- construction development plans.

4.2 Analysis of international case studies regarding entry points for cross-regional and inter-sectoral cooperation

While literature dealing with urban-sub-urban challenges for climate proofing is still scarce (Haaren & Moss, 2011; Van Eerd et al., 2014), international pilot projects have already dedicated their efforts to urban-suburban contexts for about fifteen years. A desk research and analysis of a selected number of international case studies was conducted to compare the findings of the presented case study (Vienna and larger Viennese area involving parts of Burgenland and Lower Austria) with other territories. The case studies show how cross-sectoral cooperation in the coordination of climate change adaption between urban and sub-urban areas can be organised and supported by regional planning and other forms of cooperation across planning areas.

The following case studies were analysed, two of them are discussed in more detail in this article:

- Stuttgart and the Greater Stuttgart Region
- Zurich and the surrounding area
- Hannover and the Region Hannover
- Hamburg and the Hamburg Metropolitan Region
- Karlsruhe and the Karlsruhe area

International literature identifies barriers and opportunities for cooperation across sectors and planning regions (e.g. Ledda et. al. 2020; Wachsmuth 2014; Serrao-Neumann et. al. 2014). The following categories will be used as the basis for the analysis of the international case studies and the expert interviews:

- Communication and coordination of targets for climate proofing from multi-sectoral perspectives
- Data availability and knowledge of climate change impacts
- Procedural entry points for cross-sectoral cooperation to confront climate change
- Opportunities to increase co-benefits for climate change mitigation, public health and nature conservation

4.3 Expert interviews

Nineteen expert interviews were carried out with spatial planning units, forestry, geology and water management departments in three Federal states of Vienna, Lower Austria and Burgenland. Some of these experts were personally involved in large-scale development projects and planning cases in urban-suburban planning contexts such as e.g. the Viennese/ Lower Austrian development area in Rothneusiedl. The interview-guideline included several sections, out of which one focused specifically on cross-sectoral cooperation reflecting the thematic aspects listed in section 4.3.

5 REUSULTS

This section provides an overview of the core results from the three methodological steps, the analysis of the Austrian case study, the international case studies and parts of the expert interviews related to integral planning to face climate change.

5.1 Entry points for integral planning strategies in the Viennese larger metropolitan area

Similar to the international literature, the Austrian strategy for climate change adaptation points out the importance of cross-sectoral consideration of adaptation measures in order to avoid conflicts and create benefits for diverse ecosystem services (BMNK 2017). In this context, cooperation between spatial planning, agriculture, forestry, water management, tourism, energy, protection from natural hazards as well as urban and green spaces planning is acknowledged as a highly relevant matter.

All three federal states in the PGO region have cross-sectoral strategies at the state level that deal with climate change mitigation and adaptation considering different sectors (Lower Austria climate and energy programme (Amt der NÖ Landesregierung 2017), Burgenland climate and energy strategy (Amt der Burgenländischen Landesregierung 2019), Smart City framework strategy (Magistrat der Stadt Wien 2019) climate protection programme of the City of Vienna (Stadt Wien 2009)). With regard to climate change adaptation only lower Austria partly takes cross-sectoral synergies into consideration. What the strategy documents have in common is that they name spatial planning as a central "player" that is relevant both for reducing greenhouse gases and for fulfilling major adaptation needs.

The integrative function of spatial planning regarding adaption to climate change can be implemented at various planning levels and with various instruments (MA 22, 2015). Points of contact are provided by nominal spatial planning, informal and civil law instruments as well as sectoral policies with planning instruments, which are not subject to the rules of spatial planning laws such as water management plans, forest development plans or danger zone plans.

The federal state development programmes combine the legal requirements with the implementation instruments of spatial planning and are therefore a central point of contact for the implementation of adaptation measures to climate change. They specify the guiding principles, goals and strategies and are therefore also suitable for the strategic anchoring of adaptation to climate change. They serve to coordinate the development concept at different planning levels, planning areas or planning departments, i.e. between the state, the regions and the municipalities. They are mostly aligned across sectors, so they also serve to coordinate different planning departments and sectors. But that is where the similarities end. All three PGO countries rely on fundamentally different instruments: Burgenland and Lower Austria have regulatory planning and legally binding programmes. Burgenland has a legally binding regional development programme (LEP 2011, based on the ROG regional spatial planning plan (§ 2a), development programme (§7)), which consists of a model with goals and principles as well as an organisational plan. Lower Austria's spatial planning programme for the state (Section 3 (1)) is a basic document with a control and coordination function and contains the main features of spatial development as well as goals and principles. Vienna has an urban development plan and various specialist concepts with the corresponding targets. These are decided by the Vienna City Council and have a predominantly strategic character. Nevertheless, it is precisely this level that is relevant in order to anchor adaptation to climate change strategically across sectors and planning regions.

Another central planning level, which is basically created across municipalities and across sectors, is that of the regional development concepts or programmes. As highlighted previously, it is necessary to consider impacts in a cross-regional perspective and from a cross-sectoral point of view to confront effects of heat waves and heat exposure for example. Tackling this impact involves, for example, large free areas for the production and conduction of cold air or a network of green spaces. A supra-local coordination of the green spaces and the settlement boundaries is necessary here. Land use of the respective areas is decisive for both the production of cold air (e.g. type of agricultural or forestry uses) as well as for the cooling air duct (e.g. keeping it free from buildings). This can require inter-community exchange but also regional planning and even cross-regional approaches. In addition, there are questions related to water management or coordination with nature conservation in order to protect areas in the long term. For the city-region +, there is no common regional concept that acts across levels, planning areas and sectors and delimits and coordinates issues such as settlement boundaries and climatically relevant areas. Initial approaches to a joint regional strategy were discussed in 2019 at a meeting of the city-surrounding area management. During this meeting, the lack of coordination of the goals, principles, and measures for the city-region + were pointed out (SUM n.d.).

Consequently, measures to implement climate change adaptation are only carried out at the respective municipal planning level. In addition to the legally binding instruments of the zoning and development plan (in Lower Austria and Burgenland also local development concepts), non-binding concepts and master plans are decisive implementation levels which primarily exist for Vienna and suburban bordering areas in Lower Austria (see also Schlipf und Dickhaut 2018 for German metropolitan areas). In the case of local development concepts, the necessary spatial research on various sectoral topics and the strategic goals for community development derived from them provide a first point of contact for cross-sectoral coordination. It is also possible to locate the measures here. At the level of zoning planning, the phase before the specific zoning decision is particularly crucial for cross-sector coordination (see also Section 5.3). A crucial gap in an international comparison is the lack of solid information on expected impacts on natural conditions in the planning area such as water bodies, soil, or vegetation. In other countries explicit landscape planning instruments can provide essential knowledge on these aspects such as the landscape plan at the level of the land use plan or the green space plan at the level of the development plans, which exist for example in Germany (Federal Agency for Nature Conservation 2012). Additionally, they allow to control the implementation of green infrastructure effectively. Unfortunately, also the SEA, which could add information to assess interrelationships and cumulative effects of climate change and foster integral strategic approaches to reduce negative impacts and enhance positive co-benefits to planning processes, is rarely applied in Vienna and Burgenland. An application at a strategic planning level is hardly happening (see also 5.3).

Positive opportunities were observable when examining informal instruments in urban and sub-urban planning. Due to the freedom of the design processes of informal planning instruments such as master plans, they offer the possibility of promoting sectoral coordination and thus are creating appropriate framework conditions for instruments such as zoning or development planning. At the level of these master plans, there are initial experiences in the PGO space for adaptation to climate change, at least between Vienna and Lower Austria, such as the Rothneusiedl urban development area (see also Chapter 5.3) or the green belt around Vienna.

5.2 Enhancement of cooperation across planning boundaries – challenges and opportunities from international case studies

The following section presents the results of the international case study analysis. The examples of Stuttgart and the Greater Stuttgart Region as well as Zurich and its surrounding area illustrate, how regional planning can support climate proofing across planning levels, sectors and planning boundaries.

In Germany, several projects funded by the federal government have supported climate change adaptation in regional planning over the last ten years. Examples are the model projects "Spatial Development Strategies for Climate Change" (KlimaMORO I and II) or the research project "Managing climate change in the regions for the future" (KLIMZUG) (BMBF 2020; BMVBS 2013). As a consequence, a number of regions and regional planning associations in Germany develop common adaptation strategies and coordinate regional and municipal climate change adaptation activities (Zimmermann 2017). The “Greater Stuttgart Region” (Verband Region Stuttgart) – a regional planning authority in the form of a public law cooperation, consisting of the city of Stuttgart and it’s five surrounding districts – is one of the model regions of the KlimaMORO funding programmes, which were implemented between 2009 and 2013 (BMVBS 2013; Verband Region Stuttgart 2021a, b). The association used the programmes to bundle and further develop the climate change mitigation and adaptation activities that already existed in the region (BMVBS 2013).

In Zurich and its surrounding areas, urban-suburban coordination on climate change adaptation started to take place within the framework of the umbrella organisation “Regional Planning for Zurich and the Surrounding Area” (Planungsdachverbands Region Zürich und Umgebung – RZU). The RZU operates as a private-law association that unites the city of Zurich, six regional planning groups in the Zurich region and the canton of Zurich into an umbrella organisation and coordinates their spatial development (RZU 2019; RZU 2018). The city of Zurich is one example of many cities in Europe that are already strongly affected by the effects of climate change and have developed their own climate change adaptation measures at an early stage. based on a given need for action. The RZU has taken initial steps towards cross-regional and cross-level coordination of climate change adaptation in the Zurich area, building on the experience of the city of Zurich.

5.2.1 Communication and coordination between planning units across planning borders

To support intersectoral and cross-regional coordination of climate change adaptation within the involved regions, both examples established stakeholder networks. As part of the KlimaMORO projects, the Greater Stuttgart Region initiated an informal network of spatial planners and experts from municipalities and various planning departments (including agriculture and forestry, nature conservation, water and energy management) as well as stakeholders from science and politics (BMVBS 2014; Verband Region Stuttgart 2021a). The KlimaMORO projects “helped to establish functioning working structures between local, regional, and scientific actors within the region" (Verband Region Stuttgart 2014, p. 18). In 2019, the RZU launched a network project on climate change adaption and inwards development that brought together experts from spatial planning and climate change adaptation from the city of Zurich, from other cities and municipalities in the RZU region, as well as from cantonal administration entities (RZU 2021). In both cases, the planning associations functioned as initiators of the networking process and as leading coordinators of the discursive development of regional climate change adaptation strategies.

5.2.2 Data availability and knowledge of climate change impacts

The analysed examples found different solutions to coordinate existing data across regions and sectors and to use common, region-wide data as basis for planning decisions. In order to establish an institutionalised data exchange between planning departments and municipalities, the Greater Stuttgart Region set up a regional climate information system (Klimainformationssystem Stuttgart–KISS) as a web-database. It provides an overview of regionally available spatial, environmental and climate data, describes the data content and data properties and names sources, responsible institutions and contact persons (BMVBS 2013). In addition, the Greater Stuttgart Region has been providing uniform climate analyses for the entire region since 2008. The "regional climate atlas" serves as a regional and cross-sectoral basis for considerations in planning processes and further specific vulnerability analyses (BMVBS 2014; Verband Region Stuttgart 2008). Similarly, the canton of Zurich has been creating canton-wide climate analyses and simulations since 2018. The results are available as open government data and form the basis for planning decisions of municipalities and various planning departments (Kanton Zürich 2021).

5.2.3 Procedural entry points for cross-sectoral cooperation to confront climate change

From the case study analysis, the development of common regional strategic goals and concepts for climate change adaption can be identified as central entry point for cross-sectoral and cross-regional cooperation in planning processes. The inter-sectoral and interdisciplinary networks described in 5.2.1 were the main drivers in the discursive joint development of regional climate change adaptation strategies and goals. Another entry point is the coordination and use of common data as a basis for conducting the vulnerability analysis and deriving planning decisions (see 5.2.2). Indications of cross-sectoral cooperation can also be identified in the integration process of regional climate change adaptation strategies into the formal and informal planning instruments at the municipal level. The results of the KlimaMoro projects are incorporated into the regional and municipal planning processes in the Stuttgart region. The vulnerability analyses for flood protection resulting from the KlimaMORO projects as well as the measures derived from them, are, for example, planned to be integrated into the partial update of the regional plan. The results report emphasises the necessary coordination with water management planning in this context (BMVBS 2013). The climate change adaptation strategy of the city of Stuttgart builds on the regional climate and vulnerability analyses. The fact that the strategy proposes measures for different sectors and disciplines indicates a continuation of an intersectoral perspective (Landeshauptstadt Stuttgart 2012). The city of Zurich has been focusing on the topic of heat mitigation and adaptation since 2011 – years before the RZU started its regional network project on climate change adaptation. Links to climate change adaptation are already anchored in the draft of the communal structure plan (RZU 2021; Stadt Zürich 2019) as well as in the municipal land use plan (e.g. open space factor or obligations to implement green roofs in certain areas) (RZU2021; Stadt Zürich 2016). Whether and to what extent cross-sectoral and cross-regional cooperation took place in these integration processes cannot be deduced from the desk research. In 2020, the city published a detailed heat mitigation strategy, which is based on the climate analysis and simulations of the canton of Zurich. The document addresses the need for collaboration with various planning departments and calls for a cross-sectoral planning approach (Stadt Zürich 2020).

5.3 Entry points or cooperative integral climate proofing across urban, sub-urban and rural boundary areas

In the following, central entry points for climate proofing in a multidisciplinary cross-sectoral approach are discussed in more detail in the light of the interview results. Therefore, key citations are included in the text.

5.3.1 Communication and coordination between planning units across planning borders

Some interviewees from spatial planning mentioned the input of the other departments as a central element for taking climate change impacts into account. Several times during the interviews, this exchange was attributed particularly to the local level of spatial planning, before a decision on land use (changes)/ dedication to a certain land use happens, as the following quote shows. Additionally, there are points of view that show that a consideration at higher planning levels, especially with regard to planning of climate proofing measures, can be important. This includes the instruments of other specialist planning matters, such as for instance the forest development plan.

„The timeframe of zoning has become increasingly important in recent years. This is the time when measures can be examined most intensively. We send amendments regarding new zonings out to 16 assessment bodies (e.g. cultural heritage conservation, the energy department, the water management department, nature conservation etc.) – everyone is integrated. In this way, you can examine amendments and projects carefully in a focused manner taking all factors into account. The main focus, however, is on the assessing institutions in other departments. They need to focus on the topic and have to think about problems related to climate change." (I RP14)

Two interviewees emphasised the particular potential for interdisciplinary climate proofing approaches in case of extensive urban development projects:

„With new urban development areas, it is a lot easier than in the existing city. This is also supported by politicians and the municipal administration. However, there are also major challenges. You can already see very clearly that this topic is very interdisciplinary.“ (I FP01)

With regard to the communication of interdisciplinary teams, the potential for coordination but at the same time also the complexity of interdisciplinary, integrative cooperation was pointed out. Thus, some experts considered a superordinate, coordinating institution necessary as the following quote shows:

„For each federal state it is important that the expertise of the climatologists is integrated into the administration. The fact that there a competence centre exists is essential. It's not a trivial but a complex topic climate change, it's indeed very interdisciplinary. It would be far too complicated if this was only divided into several institutions – this needs to be carried out in a coordinated way.“ (I FP04)

5.3.2 Data availability and knowledge of climate change impacts

Some of the interviewed spatial planners perceived the integration of data as a basis for decision-making in the planning process as a fundamental advantage of interdisciplinary exchanges and coordination with departments such as geology, water management, forestry and nature conservation. In this context, some of the instruments of other departments were also highlighted – both established and new ones – such as the forest development plan or the rainwater plan as well as interdisciplinary cooperation in urban planning competitions:

„Similar to the drinking water plan, we have newly developed a rainwater plan. The municipality can develop a plan on how to deal with rainwater management in the best possible way in the future. It is not only about averting danger in the event of heavy rainfall, but it is also about the sustainable use and retention of the water resources. [...]The municipality now has more options in the construction and building plan. The municipality gets the technical basics via the rainwater plan. They serve as data bases for the future development but are not mandatory.“ (I FP11)

„We now need new instruments or an adaptation of the existing instruments. I could, of course, solve this with a competition, but it has to be set up differently. The competitors that submit their ideas would have to be much more interdisciplinary. You need someone for climate change related aspects, for rainwater management, etc. Also energy issues should also be included much earlier. [...] The interdisciplinary approach must already be visible in the submissions of the competitors.“ (I FP01)

Likewise, the interviewees addressed the issue of the legal security of planning decisions, e.g. in case of dedication to a certain land use or restrictions to some types of land use purposes (e.g. settlement boundaries) and emphasised the necessity for increased cooperation in this context.

5.3.3 Procedural entry points for cross-sectoral cooperation to confront climate change

Overall, the interviews underline that integral perspectives for the cooperative consideration of climate proofing in spatial planning are particularly beneficial with regard to the following four procedural steps:

- The consideration of targets to tackle climate change impacts along with other planning objectives
- The cross-sectoral collection and interpretation of data to assess likely effects of climate change for the specific scope and planning territory as well as for the adaptation capacity
- A foresighted consideration of planning alternatives reflecting diverse drivers of land use change and the likely development in the area
- The development of measures to minimize negative impacts of climate change and maximize co-benefits for other sectors as far as possible

The following two quotes illustrate entry points in the development of measures through cross-sectoral thematic input on how to cope with climate change impacts as well as for the legal „backbone“ (explanation) of dedication (land use) decisions based on data from water management and geology departments:

„There is also no more new zoning as construction land possible in case no slope water concept exists. Here, the legislature has sharpened and passed a new law a few days ago in the state parliament. We are now

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following the same way as Lower Austria in terms of suitability for building land. In the case of flooding, we have a very restrictive dedication. In HQ100 it is simply not allowed to build. With the slope water, it's a bit different but you now need a concept developed by the water management department“ (I RP13)

„We then always engaged for feedback with the detailed construction planning department and then looked at what statements could already be made and where else we had to leave some room for manoeuvre. For the leeway, we then had a catalogue of qualities. We formulated it together with the ARE [...] development company) and the architects and that was then also the basis for an urban development contract.“ (I FP01)

Experts confirmed the potential of the SEA as accompanying instrument to foster the integration of climate change at several procedural steps from a more multi-disciplinary perspective. However, according to the practitioners the application of the instrument does not meet its potential so far. The following citation provides an example that outlines the core problem, which is the delayed application of the SEA either regarding the planning level or the timing of its integration in the planning process:

“The SEA needs to be applied at the right scale, because otherwise you are too early or too late. Then it's just a pro forma process. A SEA for a zoning plan only is too late.” (I FP02/03)

5.3.4 Opportunities to increase co-benefits for climate change mitigation, public health and nature conservation

Interviewees considered the avoidance and/ or mitigation of conflicting goals as a special opportunity for integrative approaches. An example of a forward-looking strategy which emerged through cooperation is shown in the following quotations, in which conflicts of interest and resources regarding the production of renewable energies as well as the spatial goals of settlement development are addressed:

Smart forest owners are now considering whether they can do anything else on these areas. A company has come up with the proposal to build 150 ha of PV systems and wanted a new zoning category. We collaborated closely with the department of spatial planning. They developed the priority zones for solar power systems for the federal state and thank God, the forest was completely taken out of these concepts.“ (I SP10)

„Finally one has to weigh up and decide whether a fresh air corridor is more important than the advantages of densification for climate change mitigation.“ (I RP07)

The example above illustrates the exacerbated conflicting interests over resources such as space or water due to divergences between the goals of climate change mitigation and climate change adaptation. In some other interviews the potential of combining climate change mitigation and climate change adaptation was also highlighted as a strength of integral approaches. This referred, among other things, to the exchange of instruments of nature conservation and green space planning and integration of relevant information with spatial planning.

6 DISCUSSION AND OUTLOOK

The results of the analysis show that particularly in the urban-suburban context, an integral planning approach is decisive. Challenges related to resource scarcity and trade-offs between different adaptation needs, but also mitigation and adaptation targets are even more evident in metropolitan areas such as the Stadtregion+. To confront these impacts, a strategic development of the green and blue infrastructure – reflecting principles such as connectivity and multifunctionality is decisive, as pointed out by Monteiro et al. (2020) amongst others. Cross-sectoral perspectives on planning goals, susceptibility to climate change and opportunities for the development of climate proofing measures at diverse planning scales enable the identification of co-benefits and can contribute to the reduction of conflicts of interest. In order to realize these potentials, it is crucial to increase awareness of climate change problems among planners, strengthen communication structures, as well as data and knowledge exchange across institutions (Serrao-Neumann et al., 2014; Raymond et al., 2017). At the core, this requires an understanding of how different sectors are affected by climate change, which objectives they pursue in response to that and how these objectives interconnect (Serrao-Neumann et al., 2014; Wamsler & Johannessen, 2020). While spatial planning laws differ between the federal states, sector-specific law of disciplines such as forestry and water management are comparable as they derive from federal legislation. Nevertheless, data on climate change impacts still vary between the federal states; and so do indicators and standards on how to consider these effects in spatial planning practices.

While institutionalised cooperation partly happens e.g. for the consideration of heavy rainfall and its impacts at the local level with hydrology and geology departments, cooperation across planning borders is still scarce and typically only event-related. In this regard, research shows that institutional cooperation is largely dependent on motivated individuals to date, lacking formalized processes of cooperation and knowledge exchange (Steele et al., 2014; Widmer, 2018). The strengthening of formal cooperation processes largely relies on institutions reaching a common ground with regard to their climate adaptation goals (Arens, 2012).

The interviews with planners in Eastern Austria confirmed the vast potential evolving from the integration of multidisciplinary approaches for large-scale development projects for both urban extension or re-densification and brownfield development. According to the international case study analysis, funding and research programmes can be drivers of cross-regional and inter-sectoral cooperation. In this way, the challenges of the scarcity of monetary resources can be overcome, which is often cited as an obstacle to the development of cross-regional and regional adaptation strategies. The examples from Germany also show that an umbrella organisation is needed that creates a stakeholder network involving representatives from the various panning bodies, regions and municipalities as well as sectors and that coordinates the overall process. Interviews confirmed the advantage of a superordinate coordinating institution to foster and steer cross-sectoral cooperation in planning also in the Austrian case study. An institution such as the PGO could take on exactly this function for the Stadtregion+.

The interviews also confirmed that in addition to the concrete implementation of the measures, strategic planning and cross-sectoral coordination at a higher level is necessary. This requirement is also supported by the current draft for the Austrian Spatial Development Concept, which calls for an improvement and further development of vertical and horizontal governance. Especially the federal orientation of spatial planning and development in Austria requires vertical and horizontal cooperation that transcends sectors and territorial authorities (ÖROK 2020). Looking at efforts to minimize climate change impacts, this cross-scale approach and full exploitation of the whole hierarchy of climate proofing measures, starting with an integral examination of planning alternatives, becomes even more valid.

The lack of interdisciplinary instruments such as the SEA being applied at regional level and the tiering at local level was discussed by the planners in several interviews. As the analysis of the case study in Eastern Austria and the interviews show, it could be precisely the regional planning level that holds a large potential to coordinate adaptation to climate change but also to balance adaptation and mitigation goals across sectors more strategically. Theoretically, the instruments of regional planning are available in both Lower Austria and Burgenland in the meantime and would imply strong opportunities to consider e.g. adaptation to heat and drought in the future from a multidisciplinary perspective e.g. throughout the functional analysis of spatial structures and future land use.

So far, regional planning instruments have not been applied across federal state borders yet and/or have not integrated cross-border adaptation needs. The Stadtregion + could be the first Austrian regional concept for adaptation to climate change across federal states. At the moment, legal framing conditions differ significantly despite novel amendments in spatial planning legislation in Lower Austria and Burgenland, which set the frame for a more progressive climate change adaptation. An option to establish the implementation of climate proofing measures across planning borders for novel developments are primarily municipal development contracts “Städtebauliche Verträge” so far. Cross-border and cross-sectoral coordination is necessary to create the same framework conditions also with regard to data and standards applied as well as the opportunities to integrate climate proofing measures and monitor their implementation.

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Towards Climate Neutrality through Integrated Energy Planning – a Cross-Country Comparison and Case Study Analysis of Positive Energy District Concepts between Switzerland and Norway

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1 ABSTRACT

Reaching for the Global Sustainability Goals, cities play a prominent role as from a geographical view they are identified as the main area for global emissions. On the other hand, they play a prominent role in putting global goals into local policies and means and at the same time embedding them in local context with site specific demands and settings. The Positive Energy District (PED) Concept is currently evolving based on the Strategic Energy Transition (SET) plan of the European Union member states and contributions from different initiatives. A common understanding or definition is not yet in place. Creating districts in the built environment that produce more energy than they consume embedded in a holistic approach to reduce energy demand and produce renewable energy is seen as one means to reach climate neutrality. As the first PEDs are developing all over Europe, we have little knowledge on how the PED concept is implemented nationally and how first PED projects develop within the specific national contexts. We ask: What are the concepts and approaches towards PED developments in Switzerland and Norway? What learnings can we extract from these projects? What are the implementation strategies and how are functional issues addressed?

By looking at different recent developments of PEDs in Switzerland and Norway, we describe the characteristics of national approaches towards PEDs. By deepening the description of 2 respective case-studies in the two countries, we analyse how PED approaches are implemented within the specific context. We compare the PED concepts, local implementation and functional issues to analyse the approaches. Our research is based on literature and document analysis and qualitative interviews.

The results show that different implementation concepts require different measures. From the analysis of the results, the conclusions are that integrated energy planning is more important than ever. Understanding the different dimensions of sustainable development in combination with energy supply and consumption is important to plan and realise settlements that not only contribute significantly to reducing energy consumption and securing the location of energy infrastructure (generation, distribution, storage), but also in terms of long-term sustainable development and specifically climate neutrality.

Keywords: climate neutrality, integrated energy planning, certification, PED, positive energy districts

2 INTRODUCTION

Climate change challenges the ambitious goals that regulators have put in place by setting more and more aggressive energy-related building and community requirements based on the Sustainable Development Goals of the UN. The concept of Energy Master Planning (EMP) can help initiate a better planning and implementation process to fulfil these goals. In the EU, reaching for the greenhouse gas reduction goals of the Paris Agreement, stakeholders on all geographical and organisational levels from nations, regions, cities and communities are challenged. Following bottom-up approaches for energy planning on the neighbourhood level is a promising attempt to reduce energy demand, increase efficiency and lower the carbon footprint in a multi-stakeholder approach (David, Schoenborn, 2018). Reaching for the Global Sustainability Goals, cities and communities play a prominent role as they are geographically the main cause for emissions and on the other hand play a prominent role in putting global goals into local policies and means and at the same time embedding them in the local context with site specific demands and settings.

The Positive Energy District (PED) Concept is currently evolving based on the Strategic Energy Transition (SET) plan of the European Union member states. A common understanding or definition is not yet in place. Creating districts plants in the built environment that produce more energy than they consume embedded in a holistic approach to reduce energy demand and produce renewable energy is seen as one means to foster the clean energy transition in the EU and at the same time reach climate neutrality.

The basic principle of Positive Energy Districts (PEDs) is to create an area, capable of generating more energy than consumed on a yearly basis and being agile/flexible enough to respond to the variation of the energy market (SET Plan 2019). In a new initiative of the European Commission, Positive Energy Districts are envisioned as "are energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while securing the energy supply and a good life for all in line with social, economic and environmental sustainability." (JPI UE 2020).

3 PROBLEMS/APPROACHES TOWARDS PEDS ON DIFFERENT (GOVERNANCE) LEVELS

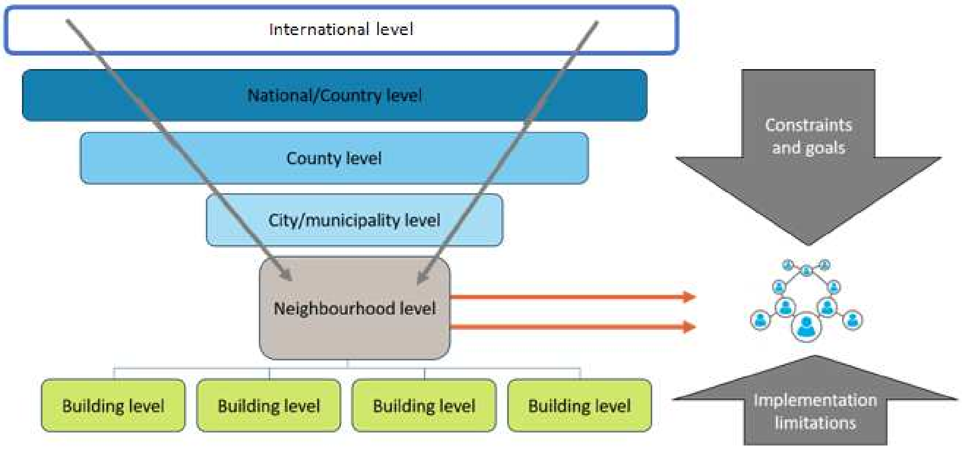

Fig. 1: Different levels of planning constraints in PEDs

3.1 Concept and approach

Significant additional energy savings, reduced emissions, and increased energy security can be realised by considering holistic solutions for the heating, cooling and power needs of energy communities, on district scale, comprising a group of buildings. As a result, considerable literature has become available, including both guidance and assessment tools aimed at EMP at the neighbourhood and district level as e.g. campuses (DOE 2013; Huang et al. 2015; Energy Plan 2019; BREEAM 2019; LEED 2019). But the existing guidance and tools do not seem to be fully solving the challenges. Energy planning consists in determining the optimal mix of energy sources to satisfy a given energy demand. The major difficulties of this approach lie in its multi scales aspect (temporal and geographical), but also in the necessity to consider the quantitative (economic, technical) but also qualitative (environmental impact, social criterion) criteria (Schiefelbein et al. 2017).

In order to be able to apply principles of a holistic approach to neighbourhoods and districts, often coined community energy planning in the literature, and to provide the necessary methods and instruments to master planners, decision makers, and stakeholders, it is essential to identify and frame the constraints that bound the options towards an optimised energy master planning solution (Sharp et al. 2020). Existing master planning guidance available indicates that identifying and establishing project goals is a critical first step (Jank, 2017). Sharp et al. (2020) compared EMP in several countries and analysed these constraints (Sharp et al. 20120). The results show that successful energy master planning is highly dependent on a thorough understanding of framing goals and constraints, both local and regional, and their associated limitations that will dictate the optimum master planning design. Haase and Baer (2020) pointed out that as more and more countries push to improve the efficiency, environmental impact, and the resilience of their buildings and neighbourhoods, the need for early and comprehensive energy master planning on neighbourhood and district level is critically important.

3.2 Implementation aspects of PEDs

The development of districts requires a distinct understanding of the actual situation as well as a vision of the future district to be able develop suitable pathways for the transition. In order to be able to do that, a district needs to be modelled in detail with several buildings. This allows a sufficiently detailed model so that the future district can actively manage their energy consumption and the energy flow between them and the wider energy system. The energy master planning process requires an analysis of different scenarios, which include new construction to different levels of energy efficiency, major renovation of all or some buildings comprising building stock under consideration with deep energy retrofit of these buildings, minor renovations with energy-related scope of work, or demolition of some old buildings. That is why we are doing a case study with two countries, and the respective "programmes" towards PED. What are the national approaches towards PEDs in Switzerland and Norways and how do they manifest in PED projects? What learnings can we extract from the early planning and implementation phase of these projects?

3.3 Functional issues of PEDs

In many cities, the necessary legal and strategic frameworks for the realisation of PED/PENs are not yet in place. Very often, there is also a lack of a planning culture in city administrations or the personnel resources available might be insufficient. In particular, the transformation of large (brownfield) areas to climate neutral city districts has a big potential for the development of PED/ but needs cooperation between administration, industry, and research. That is because a PED should not only aim to achieve an annual surplus of net energy. Rather, it should also support minimising the impact on the connected centralised energy networks by offering options for increasing onsite load-matching and self-consumption, technologies for short and long-term storage, and providing energy flexibility with smart control. PEDs can include all types of buildings and they are not isolated from the energy grid (JPI 2020). In the research community PED is a rising concept to shape cities into carbon neutral communities in the near future (Brozovsky et al. 2021). Reaching the goal of a PED requires firstly improving energy efficiency, secondly cascading local energy flows by making use of any surpluses, and thirdly using low-carbon energy production to cover the remaining energy consumption. Smart control and energy flexibility are needed to match demand with production locally as far as practical, and also to minimise the burdens and maximise the usefulness of PED on the grid at large. Additionally, the PED concept under development stretches the holistic integrated approach towards PEDs development to realise synergies between sectors and also to incorporate the realisation of aligning goals as e.g. integration of mobility, etc.

4 METHODOLOGY

This research adopts a qualitative-comparative case study method. Qualitative-comparative analysis is useful for highlighting similarities and differences between cases through the study of phenomena in various contexts (Hopkin, 2010). This approach enables a comparison of two national PED programmes in Norway and Switzerland, from which we draw insights on the approaches towards fostering of PED development in the respective national context.

5 CASE DESCRIPTIONS

5.1 Norway

5.1.1 Concept and approach

Norway is in a unique position regarding PED developments to investigate early stage implementation of PEDs. Not only is Norway's power system based on renewable energy with the electricity production based mainly on hydropower, but the initiative for PED development in Norway comes from the highest policy levels and influences research and innovation programmes for energy efficiency and urban development, positioning Norway as a European leader in a decarbonised electricity system. The PED development with the focus on local generation is an indirect consequence, since with the increasing decarbonisation of other energy demands, more generation and higher energy efficiency will be needed. Furthermore, in the Norwegian context, energy efficient solutions should become the preferred choice for consumers in the future (Royal Norwegian Ministry of Petroleum and Energy).

Already in 2008, the Norwegian Parliament decided that Norway should become “carbon neutral” by 2050 and recently Norway enhanced its nationally determined contribution under the Paris Agreement to reduce emissions by at least 50 per cent and towards 55 per cent compared to 1990 levels by 2030 (Norwegian Government) .

The Norwegian government has predominantly been focusing on reducing consumption in the building sector as a whole, with the state enterprise for energy efficiency, Enova, instituting a number of appliance and product labelling measures to influence household purchasing decisions. Enova also manages the Energy

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Fund, which is a government fund established to ensure a long-term, and stable source of finance for energy efficiency and the promotion of renewable energy.

There is no specific regulation for PEDs, so the policy framework consists of different laws and regulations, guiding principles, white papers and standards which influence the implementation of PEDs. As Norway is a three-tier unitary state, with a governance system that includes the national government, elected county councils at the regional level, and municipalities with elected councils at the local level, the policy framework is formed on these levels (Dannevig, 2016)   Prominent to name here is the adoption of EU directives with relevance to the EEA (including Norway): The Energy Performance of Buildings Directive (EPBD) and Energy Efficiency Directive (EED). Through these, which have yet to be completely transposed and adopted in Norway, progressively stricter efficiency requirements are being put into force. The Norwegian Building Authority has been tasked with implementing the EPBD and reaching its goals, including making all new buildings nearly zero-energy buildings by 2020 (Brekke, 2020) For the energy sector, the national energy laws (Act on the production, transformation, transfer, turnover, distribution and use of energy etc. (Royal Norwegian Ministry of Petroleum and Energy) require the development of energy and climate plans on the municipal level. The National Water and Energy Directorate (NVE) introduced the Plus customer arrangement to enable the rise of prosumers in Norway.

Even though Norway is not an EU member state, the country participates in the EU Emission Trading System. It is believed that Norway may play a more important role in reducing emissions abroad by exporting more renewable energy than it already does (Haase, Löfström, 2015) The development of PEDs in Norway will strengthen the position of Norway to export renewable energy and thereby help contribute to global greenhouse gas emission reduction goals.

Criteria	Key Performance Indicators
GHG emission	Total GHG emissions in tCO2eq/m2BRA/a; kgCO2eq/m2BAU/a; tCO2eq/capita, GHG emission reduction % reduction compared to the base case
Energy	Energy efficiency in buildings (Energy efficiency in buildings, Net energy need in kWh/m2BRA/a; Gross energy need in kWh/m2BRA) Energy carrier (Energy use in kWh/a; Energy generation in kWh/a; Delivered energy in kWh/a; Exported energy in kWh/a; Self-consumption in %; Self-generation in %; Colour coded carpet plot in kWh/a)
Power/Load	Power/load performance (Net load early profile in kW; Net load duration curve in kW; Peak load in kW; Peak export in kW; Utilisation factor in %); Power/load flexibility (Daily net load profile in kW)
Mobility	Mode of transport (% share); Access to public transportation (Meters; Frequency)
Economy	Life cycle cost (LCC) (NOK; NOK/m2BRA/a; NOK/m2BAU/a; NOK/capita)
Spatial qualities	Demographic needs and consultation plan (Qualitative); Delivery and proximity to amenities (Number of amenities, Meters (distance from buildings); Public space (Qualitative)
innovation	Under development

Table 1: Evaluation criteria of the ZEN demo sites (Wiik et al, 2019)

5.1.2 Implementation

Until now, there is no national programme towards PED development and initiatives are scattered around different initiatives, such as research projects that incorporate several real life demo sites, e.g. the H2020 founded +CxC project or the Research Centre on Zero Emission Neighbourhoods in Smart Cities (ZEN Centre) . As the ZEN Centre presents nine demo sites in Norway and with that a broad range of experiences, we build our paper on this project to study Norwegian PED approaches.

The Research Centre on Zero Emission Neighbourhoods in Smart Cities (ZEN Centre) will last eight years (2016-2024), with user partners from the private and public sector in Norway. NTNU is the host and leads the Centre together with SINTEF. The goal is to develop solutions for future buildings and neighbourhoods with no greenhouse gas emissions and thereby contribute to a low carbon society. The ZEN Centre has 11 public partners, including the Trondheim municipality, 21 industry partners and 2 research partners (NTNU and SINTEF). The partners of FME ZEN cover the entire value chain of the built environment development on neighbourhood scale in the framework of smart cities and include representatives from municipal and regional governments, property owners, developers, consultants and architects, ICT companies, contractors, energy companies, manufacturers of materials and products and governmental organisations.

The ZEN Centre will contribute to and manage a series of neighbourhood-scale demo sites, which will act as innovation hubs and a testing ground for the solutions developed in the ZEN Centre. They are geographically limited – primarily urban – areas in Norway in which the Centre's researchers, together with the user partners test new solutions for the construction, operation and use of neighbourhoods to reduce the greenhouse gas emissions on a neighbourhood scale towards zero.

Demo site	location	Type of area	Area size (m^2)	Project owner	further information
Ydalir	Elverum	Brownfield	430 000	Public	Residential area with a school and kindergarten
Furuset	Oslo	Mixed-use neighbourhood with local centre	870 000	Public	Retrofitting/upgrading and new construction: 1 700 – 2 300 dwellings and 2 000 – 3 400 workplaces (up to 160000 m^2)
ZVB	Bergen	Greenfield	378 000	Private	Residential area with 720 dwellings (92 000 m^2), a kindergarten and additional service functions
NTNU Campus	Trondheim	University Campus	339 031	Public	Retrofitting and new construction (ca. 136 000 m^2)
Sluppen, Trondheim	ZEN/ +CxC	Mixed use area, mainly commercial	275 000	Private/ Public	Multifunctional local centre with a mobility hub, residential area, offices, warehouses; incl. retrofitting and new construction
Evenstad Campus	Evenstad	University Campus	61 000	Public	Optimisation of energy system
New City – New Airport	Bodø	Former airport	3 400 000	Public	Multifunctional city quarter with residential and business areas; 2 800 dwellings in first construction stage
Fornebu	Bærum	Former airport	3 400 000	Public	Multifunctional city quarter, ca. 265 000 m^2 existing building stock with ca. 3 700 new dwellings
Mære	Steinkjer	Agricultural school	18 000	Public	Optimisation of energy system and control

Table 2: Demo sites for Zero emission neighbourhoods in Norway

5.2 Switzerland

In Switzerland, a certification scheme is in place which is based on the SIA (Swiss Society of Engineers and Architects) Energy Path of Efficiency and the certification scheme "European Energy Award" for municipalities, which labels settlement areas with sustainable use of resources and efforts aimed at climate protection. The 2000-Watt Site certificate was developed as part of the «EnergieSchweiz» programme, whereby the Swiss Federal Office of Energy (SFOE) promotes the implementation of the national energy policy on energy efficiency and renewable energies. Certificates for '2000-Watt Sites' are awarded to housing developments that use resources sustainably in the construction, operation and renovation of their buildings, and in the traffic they generate. The Swiss Federal Office of Energy (SFOE) and the 'Energiestadt' (energy city) association award this certificate in two stages, the first being for 'Sites under development'. The next stage is reached when construction has progressed to the point that at least half of the total living space is in use. The development is then considered a 'Site in operation' and can apply for a new '2,000-Watt Site' certificate.

Actual operating values are then measured to determine whether the Site fulfils the necessary criteria for certification. This certification was developed as part of the SwissEnergy programme, with which the SFOE promotes national energy policy implementation, specifically in the areas of energy efficiency and renewable energy. Through a sub-program called SwissEnergy for municipalities, the SFOE systematically supports projects on a communal level.

5.2.1 Concept and approach (2000-Watt-Society)

The 2000-Watt Society is a concept for a liveable future. It focuses on ensuring a high quality of life that meets the goals of sustainability. The concept incorporates the notion of the resources the earth provides, to use them sensibly and share them equally around the globe. In that sense, the 2000-Watt Society vision represents a sustainable and socially just society. The basis forms the calculation that for every person on earth, 2000 Watts of continuous power (primary energy) are available. This provides enough energy to ensure prosperity and a high quality of life. The CO2 emissions caused by this level of energy consumption must not exceed 1 tonne per person per year. Today, the primary energy consumption per capita worldwide is on average 2500 watts – with enormous country-specific differences.

At present, each Swiss inhabitant uses about 4700 watts. Thus, drastic reductions have to achieved. The goals of the 2000-Watt Society are scheduled to be met between the years 2050-2100. This is under revision since the Paris agreement is focusing on "climate neutrality" to be achieved already by 2050.

Basically, three strategies exist to meet the goals of the 2000-Watt Society:

- efficiency: use less energy for the same purpose
- consistency: use renewable instead of non-renewable energy resources; use of environmentally friendly technologies; reuse and recycle
- sufficiency: use less, for a better quality of life

Individuals, private companies and the public sector have to combine all these strategies in order to achieve the objectives of the 2000-Watt Society.

5.2.2 Implementation (2000-Watt-Sites)

A 2000-Watt Site is more than the sum of its houses. The «2000-Watt Site» certificate allows to evaluate large site developments in terms of building quality, density, mixed usage and mobility. The total energy consumption of a certified site is optimised to the targets of the 2000-Watt Society. The aim for low resource consumption is achieved by energy-optimised buildings in a well-functioning urban development context.

The development of districts requires a distinct understanding of the situation now as well as a vision of the future district to be able to develop suitable pathways for this transition. In order to be able to do that a district needs to be modelled that consists of several buildings, described in sufficient detail so that the future district can actively manage its energy consumption and the energy flow between them and the wider energy system. The energy master planning process requires an analysis of different scenarios, which include new construction to different levels of energy efficiency, major renovation of all or some buildings comprising building stock under consideration with Deep Energy Retrofit of these buildings, minor renovations with energy-related scope of work, or demolition of some old buildings. Such analysis requires building energy modelling.

A 2000-Watt-Site (200WS) is a new form of settlement. It has achieved a reputation for energy efficiency, renewable energies and climate friendliness and reflects the values of a responsible society. The core idea of the 2000-Watt Site is an ongoing evaluation process of a site’s sustainability in terms of energy in development, planning, implementation and operation. Certificates are issued for a limited time period and must be renewed periodically. They are awarded in two stages: As a «site under development» until at least half of the total living space is in use, and after that as a «site in operation».

The concept of a 2000WS takes an integrative view of the entire site rather than individual buildings. It opens up the perspective by depicting the whole living environment. The subject areas of the criteria for evaluation of 2000WS are shown in Table 3.

Subject area	Max. pts.
1. Management system	110
2. Communication, cooperation, participation	70
3. Site utilisation and urban planning	100
4. Supply and waste disposal	70
5. Buildings	90
6. Mobility	90
Site total	530

Table 3: Evaluation criteria of the 2000WS certification scheme

5.2.3 Functional issues

The recent focus was put on recertification of sites that are a couple of years old, as well as sites in transition. For sites in transition, a separate certificate was developed that is used to certify plans, implementation and operation of existing sites that want to transform themselves into 2000WS. This requires setting up a transformation plan and continuous certification (every 4 years) where it has to be shown that the GHG emission reduction is followed according to a reference path (ref.). This ensures a medium timeframe planning and implementation (as many district transformations can take 20 years and more). Here, the goal is derived from the Swiss path towards a zero carbon society (ref. SIA Absenkpfad, etc.).

While features such as comfort and energy efficiency are inherent in MINERGIE buildings, buildings certified according to MINERGIE-P-ECO also meet the requirements of a healthy and ecological construction method and require the disclosure of the built-in “grey energy”. Structurally, all the prerequisites for this have been created, but the building can only achieve optimum energy savings during operation. It depends on how much the apartments are heated, how the users ventilate them, whether they leave the lights on unnecessarily, how much hot water they need, and much more. In “Kalkbreite” e.g. the cooperative largely dispenses with regulations to reduce resource consumption and focuses primarily on self-management and awareness-raising. The resource consumption can be calculated with various instruments, e. g. with the ECO2 calculator from Novatlantis or the footprint calculator from WWF. In this way, users receive clues about consumption in the following areas: living, mobility, consumption and nutrition. Every consumption contains a proportion of "grey energy" that can only be influenced to a limited extent, but should nevertheless be included in consumer behaviour. Conscious shopping, avoiding unnecessary purchases and economical use of consumer devices can improve the consumption of “grey energy”.

Site	Location	Certification	Area size (m2)	Achieved	Further information
«Erlenmatt West»	Basel	2017 (re)	25 600	66%	http://erlenmatt-west.ch/
«Stöckacker Süd»	Bern	2020 (re)	1 750 000	74%	http://www.stoeckackersued.ch/
«Burgunder»	Bern-Bümpliz	2017 (op)	7 660	61%	https://www.npg-ag.ch/projekte/siedlung-burgunder/
«Im Lenz»	Lenzburg	2018 (re)	61 400	63%	https://www.imlenz.ch/de/home
«Freilager»	Zürich	2018 (re)	7 050 000	74%	https://freilager-zuerich.ch/
«Hunziker Areal»	Zürich	2017 (op)	41 000	75%	https://www.mehralswohnen.ch/
«Kalkbreite»	Zürich	2021 (re)	6 393	89%	https://www.kalkbreite.net/
«Sihlbogen»	Zürich	2017 (re)	2 100 000	64%	https://www.bgzurlinden.ch/home
«City West»	Chur	2020 (tr)	26 500	57%	https://www.citywest-chur.ch/
«AXA»	Winterthur	2019 (tr)	32 000	63%	https://www.rwpa.ch/axa-gebaeude-g
«Campus Sursee»	Oberkirch LU	2019 (tr)	142 065	67%	https://www.campus-sursee.ch/2000-watt-areal/
«UNIL Dorigny»	Lausanne	2019 (tr)	90 000 000	65%	https://www.unil.ch/index.html
«Campus Mythenquai»	Zürich	2019 (tr)	22 908	68%	https://www.swissre.com/about-us/our-global-presence/campus-mythenquai.html

(op) in operation
(re) in operation, re-certifiied
(tr) in transformation

Table 4: Analyzed 2000-Watt-Sites in Switzerland

Dimension	ZEN	2000 Watt Areal
A. Concept and approach		
Integrated approach	Value chain integration approach of the construction sector	Measurable contribution to resource conservation and climate protection
PED Definition	Development of own ZEN definition during lifetime of ZEN centre, including challenge to apply ZEN in demo sites as long as definition is not finalized	Own definition and certification criteria.
System boundaries	Static geographical system boundary	Static geographical system boundary
Guidelines and tools	Own definition of PED including KPIs as guiding principles for planning and design, Toolbox development of relevant tools	Own definition and certification criteria. A planning tool is available
Energy flexibility	Intra-district energy flexibility	Intra-district energy flexibility
B. Implementation (learnings from pilots)		
Integrative urban transformation process	Urban transformation process based on experimental approach and stakeholder involvement	The quality characteristics are useful for marketing and image-building.
PED competencies	Professional competencies	Professional competencies
Steering and process leadership	(Mainly) public steered demo sites	Private steered process. users enjoy a high standard of housing and living
Holistic process of developing and deploying PEDs	Planning and design phase focused	Planning and design phase focus, but additional new programme focusing on transformation of existing sites
Approach to open innovation and stakeholder interaction	Open innovation is driven by public sector as main project owner (8 of 9 projects are public owned)	Implementation of proven technology
C. Functionality		
Functional sub-divisions in district	Diverse functions, ranging from residential areas with social infrastructure, mixed-used neighbourhoods, university campus areas	Often mixed use, with residential, office, and other functions
Stakeholders involved on site	Diverse, dependant on the context (phase of development and function)	creates added value for all stakeholders – for investors, planners, users, law enforcement agencies and authorities:

Table 5: Summary of findings

Next to living, mobility is the largest consumer of energy in our society. The need for mobility is very individual and therefore an area of sustainability that is difficult to influence. The 2000WS take various measures to make it easier for users to use their mobility more consciously.

In order to approach the goal of the 2000 Watt society, it is essential that all users minimise their energy consumption for mobility. This includes, in particular, avoiding frequent air travel.

2000WS aim at reducing area use; e.g. in Kalkbreite, the average individual space consumption per person, including the share of shared space, is 33.5 m². This is significantly lower than the usual space consumption of 45 m² (41 m² in the city of Zurich) per capita in today's new buildings. Depending on the situation (large building depth of 16.5 m and complicated corner situations), the Kalkbreite has apartments that are too large, which makes it difficult to achieve this objective. This is compensated by the relatively large proportion of apartments with 5 or more individual rooms, in which the space consumption is lower than in apartments with 1 to 4 rooms. In addition to the residential and commercial spaces, the shared rooms help reduce individual space consumption.

6 RESULTS

In this chapter we introduce the two concepts for PED development in Norway and Switzerland and present our findings within the three dimensions Concept and approach, Implementation (Pilots) and Functionality. We present the findings for each dimension and in relation to the Norwegian and Swiss Case. Table 3 gives an overview of the results, which will be further developed in the text beneath.

6.1 Concept and approach

6.1.1 Norway

The centre develops a definition and KPIs to assess zero emission neighbourhoods during its lifetime, which is combining the concept of Positive Energy Districts with climate neutrality. According the current definition, a zero emission neighbourhood aims to reduce its direct and indirect greenhouse gas (GHG) emissions towards zero over its life time. With help of life cycle assessment in all phases of neighbourhood development- including planning, implementation, operation and demolition phase – the total number of emissions are accounted for [Wiik et al., 2019; Wiik et al., 2021]. These emissions are compensated through renewable energy production on site during the operation phase of the neighbourhood, and what makes the neighbourhood become positive in its annual energy balance.

The ZEN centre has developed KPIs within seven categories: GHG; energy, load, mobility, economy, spatial qualities and innovation, both to assess the status towards carbon neutrality and to help stakeholders to guide them to identify the right solutions.

6.1.2 Switzerland

The concept of a 2000-Watt Site takes an integrative view of the entire site rather than individual buildings. It opens up the perspective by depicting the whole living environment. The definition of 2000-Watt-Sites is based on a set of KPIs which are all measured and evaluated for the certificate. These are divided into six themes: management system; communication, cooperation, participation; site utilisation and urban planning; supply and waste disposal; buildings; and mobility. In each theme there are 3 – 4 KPIs that are evaluated and points given (see Table 1 for details).

Most 2000WS provide a Minergie-P-Eco-Bau standard for its buildings which uses approx. 30 kWh/m²/year. That is around five times less than an average house or ten times less than an unrenovated house built between 1960 and 1980. The heating is designed for a comfort temperature of 20 ° C in the living rooms and bedrooms and 21 ° C in the bathrooms with an outside temperature of - 8 ° C. It only needs a little added heat, which is generated by other means (different technical solutions are in use, ranging from district (waste) heating to ground source heat pump). Considerable amounts of electricity are produced from PV systems on the roof.

6.2 Implementation

6.2.1 Norway

The ZEN Centre will contribute to and manage a series of 9 neighbourhood-scale demo sites, which will act as innovation hubs and a testing ground for the solutions developed in the ZEN Centre, moreover the ZEN definition and KPIs are tested and adapted [Wiik et al. 2019]. Learnings identified so far from implementation are:

- Public sector/municipalities as driver for PED development
- Difficulties to put ambitions higher than existing laws
- Land development agencies and public procurement as tools.

6.2.2 Switzerland

So far, 39 2000WS are in operation, implementation and transition in Switzerland (Haase 2021). The implementation was done by various stakeholders.

Interesting is the fact that 2000WS require a single point of contact to be certified. In that sense, a development company or cooperative is formed that plays the official partner in the certification. They pay the fees and receive the certificate (not the site itself). This ensures that a stable ownership is created as a prerequite to form the goal of becoming a 2000WS. If this goal is not agreed upon, it is often not possible to achieve ambitious goals (proof?).

6.3 Functionality

6.3.1 Norway

In the ZEN research centre, a neighbourhood is defined as a group of interconnected buildings with associated infrastructure, located within a confined geographical area. However, the system boundary for analysis of energy facilities serving the neighbourhood is not necessarily the same as the geographical area. Infrastructure includes grids and technologies for exchange, generation and storage of electricity and heat. Infrastructure may also include grids and technologies for water, sewage, waste, mobility and ICT.

6.3.2 Switzerland

User behaviour is decisive for achieving the savings potential. In the event of carelessness such as incorrect ventilation, letting the premise cool down, etc., deviations of several 100% are possible. In summer as in winter, there is a risk that the apartments will overheat if the sun is shining and the sun protection is not used properly. The sun can heat the rooms very quickly and because of good insulation it is difficult to dissipate excess heat. Disciplined shading is therefore necessary in summer.

The residential and commercial buildings have comfort ventilation, which ensures a constant, low exchange of air with filtered outside air. Heat exchangers remove the heat from the exhaust air and thus preheat the supply air. This enables sleeping with the window closed, although all windows can still be opened. In summer as in winter there is a risk of overheating if the sun protection is not used correctly. Excess solar radiation can heat the rooms very quickly. Because of good insulation, it is difficult to dissipate excess heat. In summer, disciplined shading is therefore necessary during the day.

7 DISCUSSION

The differences between the two concepts, what is specific for each of them with respect to certification, social and functional differences is an important analysis.

7.1 Concepts and approaches

The 2000-Watt Site certificate creates added value for all stakeholders – for investors, planners, users, law enforcement agencies and authorities: users enjoy a high standard of housing and living. They can live with the assurance that they are contributing to resource conservation and climate protection. Investors and owners are interested in value-preserving sites offering a high quality of living and working. The quality characteristics are useful for marketing and image-building. Due to the high level of acceptance, cooperation with authorities is much easier. For local municipalities it helps them to bring their concerns to bear at an early stage. The certificate is a guarantee of successful commercial implementation of their energy and climate-policy goals. The certificate was designed as part of the federal programme EnergieSchweiz (SwissEnergy). The Swiss Federal Office of Energy (SFOE) is thus promoting the implementation of national energy policy in the areas of energy efficiency and renewable energy. With the SwissEnergy programme, the SFOE supports specific projects at municipal level.

7.2 Implementation

The ZEN demo sites are all part of a larger research initiative and thus a progressive academic environment. Previous research projects with ambitions goals have shown that on the technical side it is relatively easy to get new technology used, especially when their economic benefits are communicated. It is more complicated to ensure that social practice is implemented. This implies a societal acceptance of the goals and that individuals follow those goals.

In Switzerland, the discussions of the 2000-Watt Society have formed the basis for a large support of the ideas connected to it. Several companies have identified business models around it, such as the 2000WS certification scheme. This scheme forms the structure and the social character of the district. People creating 200WS or moving to them are convinced that what they are doing is good in the sense of "good for society and good for the planet" (quote from one interview). In some 2000WS there are groups of active inhabitants which promote a "sufficient" lifestyle, offer sharing options and promote an alternative way of living (relying less on fossil fuel, vegetarian food, etc.). Car sharing options are available in many sites, together with strict rules for owning cars (and restricted parking space). These are rules in place that inhabitants have to agree to before moving onsite. So there is a possibility for segregation implemented in the system. Further work is needed to identify further implications.

7.3 Functional issues

In a typical district, there will exist several heating, or cooling loops and many electrical subdivisions (distribution boards) on top of various end uses of energy. The different concepts are explained in more detail in Haase (2020).

The energy related operation processes are usually in the control of facility managers and technical staff of each building. Multi-owned districts often lack professional skilled workers. A multitude of performance indicators can be related to this structure. Some performance indicators are important in the design and commissioning of the systems, others are of use in the day-to-day running of the buildings. Energy can be considered to follow function because energy in the end is used to meet requirements defined by the activities that take place in a district. In each district, requirements are diversified by the type of activities/functions (residences, commercial (shops, retail), service (schools, restaurants, cafes, etc.), by the sizes of tenants' rental spaces, or by the type of spaces (public areas, offices, parking etc.). The different activities can be characterised by functional patterns for various groups; – opening hours for commercial buildings will differ from operational hours for technical services and lighting. Facility operation has to meet the requirements of staff in commercial and cultural or service buildings before they open to the public. In districts, many tasks are performed outside of opening hours which require maintaining health and safety for the workers. Examples are maintenance and cleaning, sanitation and supply infrastructures, mobility and transport.

8 CONCLUSION

Concepts and approaches

When we look at the system for implementation, it becomes obvious that with the 2000WS certification scheme developed and applied exclusively in Switzerland, the implementation of ambitious districts has become more explicit than in Norway, where certification is so far done by international certification systems, such as BREEAM..

Implementation

In terms of acceptance and information dissemination the 2000WS have gained some public interest. Many different stakeholder groups have engaged in implementing 2000WS. There are construction companies totally specialising solely in the construction of 2000WS .

Functionality

However, when it comes to the criteria that need to be fulfilled, it seems that 2000WS do not aim for a "net zero emission" balance. The goal is to reduce energy use to (constant?) 2000W power per person. With 8760h/a this corresponds to 17500 kWh/a. The amount of GHG emissions that this energy use corresponds to depends on the GHG emission factor of the energy used and varies for the different purposes. Grey energy is not automatically accounted for in these calculations (only indirectly through the use of certain standards (Minergie). However, the goals of the 2000WS are currently under revision in order to become completely compatible with the energy policy goals of Switzerland (Bundesrat). This means that stricter rules are needed but it remains to be seen if these comprise a rigorous accounting of GHG emissions throughout the lifetime and certain amount of requested renewable energy production on-site as it does in the ZEN/PED approach.

On the other hand, 2000WS have a system in place to account for energy use of mobility and it even explores potential to induce a behaviour change to use less transport systems (by offering car-sharing services and by not allowing to own a private car) and more fossil free transport systems. For example, parking area within the 2000WS are normally restricted and are exemptions rare.

Further research

What could be next research questions? National transition pathway towards PEDS. How many PEDs does a city need? How are the PEDs embedded in the city network? Where do they deliver energy to? How is the mobility connected to the city transport system? How are parking areas managed?

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🏆 *reviewed paper*

Types of Morphological Configurations of the City across the Globe – a Remote Sensing based Comparative Approach

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1 ABSTRACT

The spatial configuration of the built city is like DNA – it is unique to each city. And yet, it could be shown, that spatial configurations of cities are very similar in certain geographical regions on our globe and, in turn, very different from other regions. In this study, the classification scheme of local climate zones (LCZs) is applied to spatially map the morphological appearances of the cities across the globe. We empirically explore their spatial configurations using different city models and three alternative data representations. We use a single spatial unit model to compute a global land use mixture, a monocentric model to compute density diffusion, as well as to describe a concentric land use mixture at intra-urban scale. We then, for each data representation, cluster cities using k-means to extract typologies of urban morphology. While the results show 1) the geographical congruence of some types of urban morphology, they also show that there are also 2) strong intra-regional variabilities, and 3) multiple cross-regional types. These point to deeper premises than the geographical location of the respective city as main encoder for the city's DNA. Through the comparison of the results obtained for the three data representation, we discuss these various aspects.

Keywords: Urban morphological patterns, Local Climate Zones, Remote sensing, City models, Comparative urban research

2 INTRODUCTION

Cities, in their diversity, offer a large variation of physical faces. Far from representing the city as a single object spread across the globe (Park et al., 1925), urban geography quickly recognised urban structures that differ significantly from one city to another (Harris & Ullman, 1945). Despite this non-universality, one can still perceive shared patterns between specific cities, as if they were sharing family ties. Many have argued on those ties with typologies based on their social, economic or political functions (Braunfels, 1976; Harris & Ullman, 1945; Henderson, 1974). However, cross-sectional studies of the morphologies of cities tend to mitigate the explicative power of such typologies on city structure (Kostof, 1991). Instead, cultural factors seem way more explanatory in this sense (Ehlers, 1993; Gaubatz, 1998; Griffin & Ford, 1980; Hahn, 2014; Krapf-Askari, 1969; Lichtenberger, 1972). Taubenböck et al. (2020) showed that culture is a non-neglectable factor that is embedded in the physical face of cities. Nonetheless, culture in the ethnic sense as defined by Huntington (Huntington, 1998) or Kolb (Kolb, 1962) does not correlate perfectly with morphologic types of cities found in previous work. It seems logical, then, that we must redefine or at least supplement the typology presented so far. Therefore, in defining an improved morphologic city typology, we step away from the solely cultural frame, at least initially. In this sense, this paper attempts an alternative approach to the work presented in Taubenböck et al. (2020).

To extract typologies of cities from the large variety in which they exist, we apply here a purely physical approach, i.e. we focus on the built and natural elements of the urban landscape. We rely here on intra-urban morphological descriptions of their physicality through geometrical parameters, such as the built-up surface fraction, building height, or semantic classifications such as, in our case, Local Climate Zones. We consider these characterisations of the salient built-up types and their arrangement as a typology of the land use mixture.

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The recent developments of remote sensing as a field and the large availability of satellite data, such as the Sentinel constellation, enable in combination with image data analysis techniques in the domain of artificial intelligence the large-scale production of richly spatial data on land cover. In our case we rely on a Local Climate Zone (LCZ) (Stewart & Oke, 2012) classification across the globe. This frame proves to be suited for large scale studies of the urban morphology. If they are aggregated in a consistent manner, they can shed light on key elements to understand the geography of the city (Bechtel et al., 2015). In order to measure spatiality and distribution within cities, there exist different spatial models such as single spatial units, monocentric, polycentric or more sophisticated models in urban geography. We understand here the single spatial unit as the straightforward approach treating the city as a single object bounded to a specific extent. The monocentric model acknowledges an inhomogeneous distribution of the properties of a city based on the distance to its centre (Park et al., 1925). The polycentric model further acknowledges this inhomogeneous character to be organised around multiple nuclei (Adolphson, 2009; Harris & Ullman, 1945; Siedentop et al., 2003).

In this study, we rely on two spatial model approaches: the single spatial unit and a monocentric model. For the global analysis based on three data representations of the intra-urban morphology, we offer a qualitative comparison between the obtained quantitative results. To do so, we rely on a LCZ land-cover classification allowing to quantify morphological categories. We propose three ways of presenting the data based on 1) geographical units considered and 2) the semantics of the data used. With it, we identify, 3) different types of cities among our global sample of 110 urban areas. With these results we try to propose a multi-parameters quantitative description of morphological typologies of cities.

3 CONCEPT, DATA AND METHODOLOGY

3.1 Conceptual foundation

The conceptual foundation of this study is based on an unsupervised classification of cities based on similar spatial configurations. The selection of cities under investigation is a balanced sample of urban areas across the globe. In those cities, we gather data following the LCZ frame. Even though this frame was originally developed as a tool relating to the urban climate, the classification scheme relies on a morphological description of the built and natural urban landscape. This source of data provides rich information on the intra-urban morphology (Bechtel et al., 2015), which is our object of analysis. As for being consistent in terms of spatial units, we use the Morphological Urban Areas (MUAs) (Taubenböck et al., 2019), a delimitation of cities based on a data-driven approach instead of administrative units which are artificial spatial units and thus less appropriate for geographic comparisons. For each city we extract from the LCZ classification three representations of their spatial configuration. The three data representations are namely a ‘global model of land use mixture’, a ‘concentric model of built-up density’, and a ‘concentric model of land use mixture’. For each model, we apply an unsupervised classification approach. Thus, we aim to identify morphological city types that are similar in their spatial expression.

3.2 Data

3.2.1 Study site selection

We base our selection of the study sites on demographic statistics from the United Nations (UN, 2018). We limit our study to 110 cities. We ensure the balance of representativity between continents by the following conditions: first we compute the relative share of urban population by continent. Within each continent, we select a respective sample of cities whose cumulative population corresponds to the share of the continent. However, such a selection cannot be perfectly fitting each share. Thus, we allow a tolerance error of 3% and keep the set of cities that enable us to stay within this margin. Beyond, we primarily select cities with large populations and ensure that there is a certain spatial coverage within the continent.

3.2.2 LCZ frame

The LCZ frame was first developed in Oke & Canada, (2006) to study urban climate. The unique scheme proposes nonetheless valuable data on intra-urban morphology. Stewart and Oke (Stewart & Oke, 2012) defined 17 thematic LCZs split into built types (LCZs types 1-10) and non-built types (LCZs types A-G). These types are defined through standardised measurable morphological parameters such as ‘density’, 'building size', 'building -or tree height' and 'open spaces'. Therefore these "regions of uniform surface cover, structure, material, and human activity span hundreds of meters to several kilometres in horizontal scale" (Stewart & Oke, 2012). They depict a range of built and non-built urban types in a universal, culturally-neutral manner, suiting the purpose of our study. The LCZ frame allows to consider the morphological configuration of a city embedded in this spatialised description of land-use mixture.

3.2.3 LCZ classification

As a consistent source we rely on a classification of LCZs produced by (Qiu et al., 2019). This work uses a recurrent residual network on multi-seasonal Sentinel-2 multi-spectral optical imagery of 10 to 60m resolution. The Re-ResNet was trained on the LCZ42 dataset. This dataset was produced on 42 cities across the globe by 15 domain experts and an overall confidence of 85% was assessed (Zhu et al., 2019). The final product is a 100m resolution LCZ classification covering our sample of 110 cities.

3.2.4 Spatial Units

For an admissible, geographical comparison, it is essential to relate the objects of comparison (here cities) to comparable spatial units. Thus, we argue here not to rely on administrative boundaries as they vary greatly in their definition between regions of the world and therefore are questionable in their consistency. We therefore use the MUAs provided by Taubenböck et al. (2019), i.e. a data-driven, consistent delineation between urban and rural realms.

3.3 Methodology

3.3.1 Descriptions of the configuration of cities

The LCZ classifications offer for each city a spatialised description of its land-use mixture. To produce a systematic analysis of this mixture, we reduce the dimensionality of the data. Therefore, we propose three models of representation of the LCZ classification:

First, we propose a 'global land-use mixture model' to depict the general land use characteristics of cities. For this model, we compute the share of each of the 17 types of LCZs within the boundaries of the MUAs. As an additional feature, we take the size of the MUA into account. With it, this model contains an 18-dimensional feature space.

Second, we apply a 'concentric model of density'. With it, we examine the dispersion of the built-up density in relation to the defined urban centre. To do so, we derive the built-up density as a derivation of the LCZ thematic classes. We retrieve the share of built-up fraction and the roughness element (height) from the semantic types of the LCZ classes. By multiplication of the built-up fraction and the roughness element, we approximate the built-up volume as a proxy of 3-dimensional (3-d) built-up density. For the spatiality of the monocentric model, we define 100 rings of width proportional to the maximum radius of the MUAs. For each of the concentric rings, we compute the average 3-d built-up density. By considering the concentric rings of MUAs here, we then obtain a 101-dimentional feature space that describes the concentric evolution of 3-d built-up density.

Third and last, we apply again a 'concentric model of the land-use mixture' that allows conclusions about the morphological configuration of the mixed urban structure as a function of distance from the MUA centre. To do so, we compute, in the same manner as above 100 concentric rings covering the MUAs. Within each ring, the share of each of the 17 LCZ classes is computed. For the final feature space, the size of the MUA is additionally integrated. Overall, this approach results in a 1701-dimentional feature space.

3.3.2 Clustering of cities

We consider our 18-, 101- and 1701-dimentional feature spaces as the descriptors of the morphological configuration of the cities studied. Based on these three feature spaces, we investigate the possible similarities and dissimilarities between the spatial configurations of cities. By an unsupervised clustering method, namely the k-means (Hartigan & Wong, 1979), we aim at a statistical grouping of cities. In this approach, a specific number of clusters is not pre-defined. Therefore, we determine for each of the models the optimal number of separable clusters relying on the gap statistic method (Tibshirani et al., 2001).

3.3.3 Description of the typologies

For each of the models, we visually represent our clustering results on a map. The different clusters will be represented by different colours. It must be mentioned that the clustering is not consistent across the three models. Therefore, the colours representing the clusters are chosen arbitrarily. We chose to use the same set of colours between the three results to highlight the similarities between the three approaches, but we point out that the clusters found across the models are not the same.

Subsequently we describe the morphology of the three typologies obtained with both textual and visual support. Visually we propose for each typology a figure of three parts: 1) A comparison, between clusters, of the LCZ shares. This is composed of 17 sub-figures, one for each LCZ class. The LCZ is indicated by the title of the sub-figure and the colour of the frame. For the specific LCZ are plotted the distributions of the share (in %), in the shape of a boxplot, of each cluster, side by side. The clusters are indicated by the colour of the boxplot. 2) A concentric repartition of the shares of LCZ classes. Each of the nested pie charts represents the averaged results of the cities of one cluster. The colour of the cluster is indicated by the title of the nested pie chart and the colour circling it. The nested pie charts are made of 5 concentric zones. Each of the zone is accounting for a fifth of the extent of the averaged city of the cluster. The zone is then to be read as a pie chart, the share of each LCZ class is depicted by its proportion on the chart. 3) An averaged profile of the built-up volume in relation to the distance to the centre of each cluster, indicated by its colour.

We then draw upon these descriptions to compare the results obtained through the three different models.

4 RESULTS

4.1 Geographical distribution of the clusters

In general, we find that there are definitely, regardless of feature spaces, groups of cities that have similar morphological configurations. Some lie, as one possible influencing factor, within a cultural or geographic region. However, the various morphological compositions are complex and fuzzy within and across regions. Our results also show that the feature space has a decisive influence on the obtained results. The identified clusters vary and it can be seen that spatial statistics are prone to ambiguities. As an example, we refer to the European continent (Fig. 1): in the 18-dimensional and 1701-dimensional feature space, the unsupervised classification groups most of the European cities into one cluster. In the 101-dimensional feature space, however, this is not the case. More detailed descriptions can be found below.

4.2 Morphological descriptions of the clusters

4.2.1 Typology of the ‘global model of land use mixture’

In the global model of land use mixture, the red cluster is located mostly in North- and South-America and in East Asia. It is defined by a relatively high share of large low-rise buildings (LCZ-8) and dense trees (LCZ-A) as well as, comparatively to the other clusters, low share of low plants (LCZ-D). The presence of the large low-rise buildings is consistent through the city but the share of dense trees, as well as the rest of the non-built-up land, from almost none in the core, augment progressively toward the periphery. The cities are large with an average radius of 25.1km. We observe a rather dense profile on average with a decrease in bulges, probably indicating secondary local centres of density.

Cities of the orange cluster can be found on the western coastline of the Pacific and on the U.S. west coast. They are relatively average in terms of LCZ shares. Exceptions are a slightly higher presence of water (LCZ-G) and a high share of large low-rise buildings (LCZ-8). This presence is consistent through the five concentric zones and gains a slight increase in the outermost one. The share of the vegetation is at maximum in the fourth zone. This, with the multiple bulges of the volume profile points to multiple-nuclei metropolis, with 37.4km in average -being the largest among clusters.

The yellow cluster is located mostly in East Africa, East and Central Asia. It is characterised by its high shares of open low-rise buildings (LCZ-6), sparsely built-up areas (LCZ-9) and scattered trees (LCZ-B). These LCZ classes become more and more prevalent toward the outskirts of the cities. This defines a slowly decreasing profile of built-up volume for these relatively small cities (12.2km of radius in average).

Most of the cities of the green cluster are located in Northern Africa and Western Asia. The cluster is defined by a high share of bare soil or sand (LCZ-F) and the presence of only low vegetation types. Despite the large dominance of non-built land in the outskirts, the cities are of average size with 15.2km depicted by a profile rapidly decreasing and then stabilising almost on a plateau of low built-up volume.

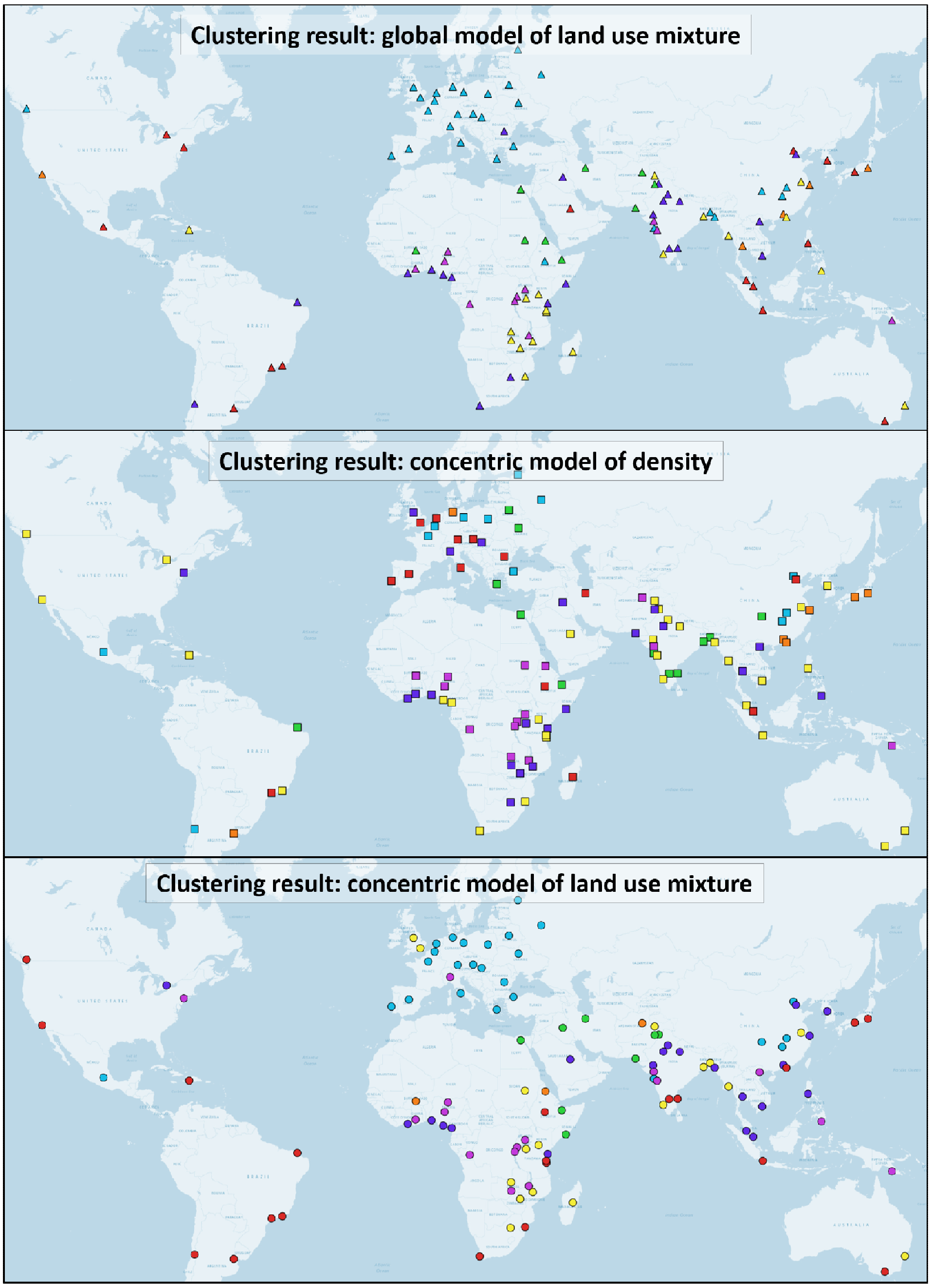

Figure 1:Maps of the results of the clustering for the global model of land use mixture (top); concentric model of density (middle); concentric model of land use mixture (bottom)

Most of the cities of the blue cluster are located in Europe. This cluster is characterised by the high share of open midrise structures (LCZ-5) as well as compact midrise (LCZ-2) and open high-rise buildings (LCZ-4). Concentrated in the core of the cities, these LCZ classes give way toward the periphery to more vegetation and large low-rise buildings (LCZ-8). The built-up volume decreases in a concave shape along the 13.7km of average radius.

The cities of the indigo cluster of this typology are mostly spread across the shores of sub-Saharan Africa, India, South America and South-East Asia. They have a comparatively higher share of lightweight low-rise buildings (LCZ-7), a quite large portion of large low-rise buildings (LCZ-8) and a fair amount of low plants (LCZ-D). The latter is predominantly present in the fifth concentric zone, where it accounts for almost half of the land. The built-up volume decreases in a slow concave manner for, on average, 14.9km. The details of the statistical analysis are illustrated in Fig. 2.

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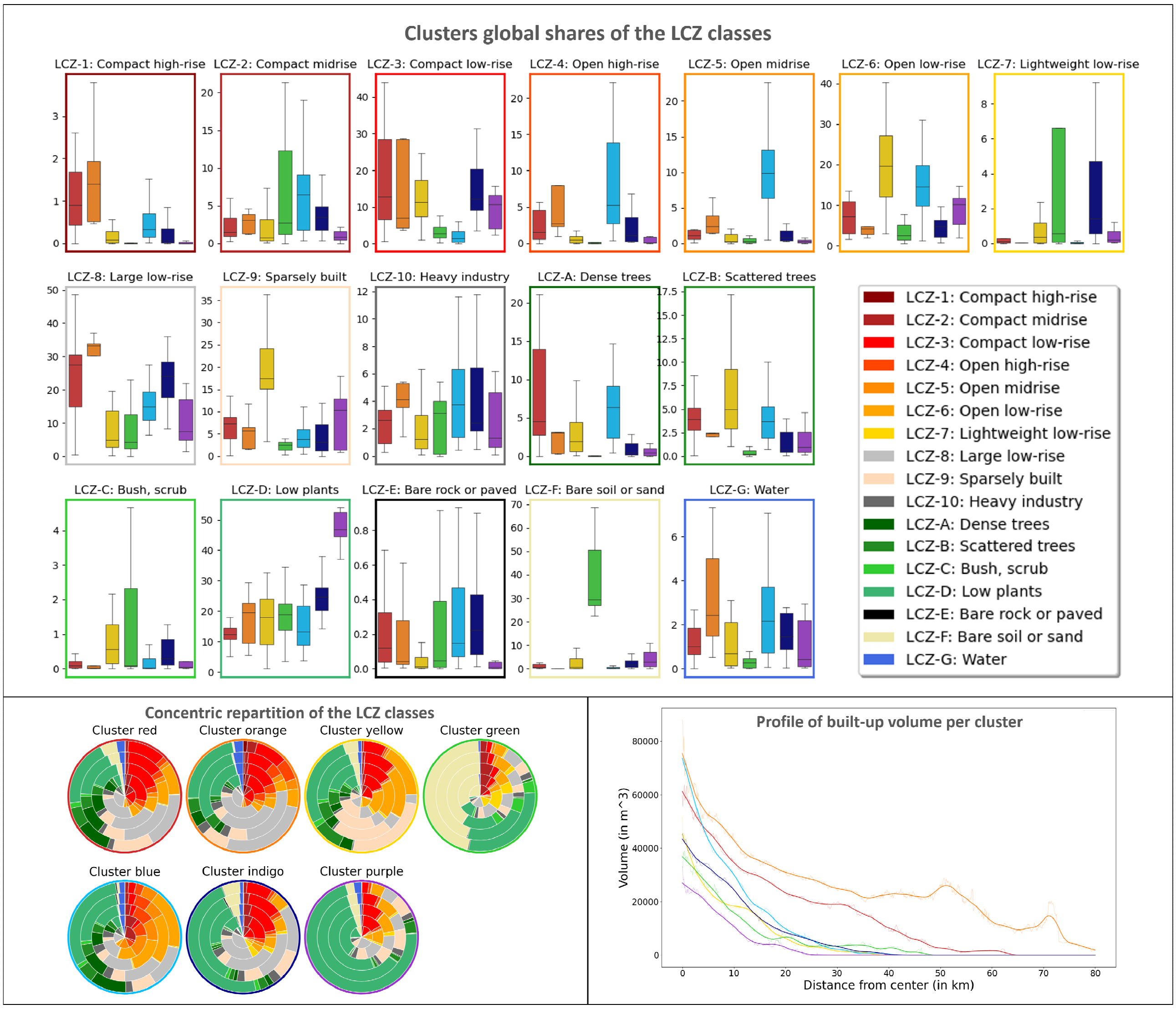

Figure 2: Morphological description of the clusters obtained for the global model of land use mixture

Last, the purple cluster is located mostly in inland sub-Saharan Africa and western India. This cluster is remarkable for its overall low share of built-up lands and the highest presence of low plants (LCZ-D) among the clusters. This class, already present in the inner part of the concentric zones, is almost covering three quarters of the fifth zone. This results in the lowest profile of built-up volume and the smallest cities (11.8km).

4.2.2 Typology of the concentric model of density

Cluster red is mostly located in Central and Southern Europe. It features mostly average shares in terms of LCZ shares with slightly high shares of compact midrise (LCZ-2), open midrise (LCZ-5) and scattered trees (LCZ-B). Overall it has a high share of built-up land, mainly in its core and presents a high built-up volume plummeting rapidly along its 16.6km of average radius.

The orange cluster consists of Eastern and Far-Eastern Asian harbour cities. Its cities are distinguishable by the higher presence of compact high-rise (LCZ-1), compact low-rise (LCZ-3), large low-rise buildings (LCZ-8), heavy industry (LCZ-10) and water (LCZ-G). The share of non-built-up land is low, except for the fourth of the five concentric zones, benefiting to a dense profile of built-up volume, decreasing with bulges. This seems to indicate large (28.4km) multi-nuclei metropolis.

The yellow cluster is scattered evenly across the globe, except for Europe. It is a quite average cluster in terms of LCZ shares. The spatial repartition of the LCZ classes, however, shows a large proportion of open low-rise (LCZ-6) and sparsely built structures (LCZ-9). Their share is increasing toward the peripherical zones. This low built-up volume with persistently built-up structures in the periphery produces a slowly decreasing profile running all along the average of 18.8km of those cities. The details of the statistical analysis are illustrated in Fig. 3.

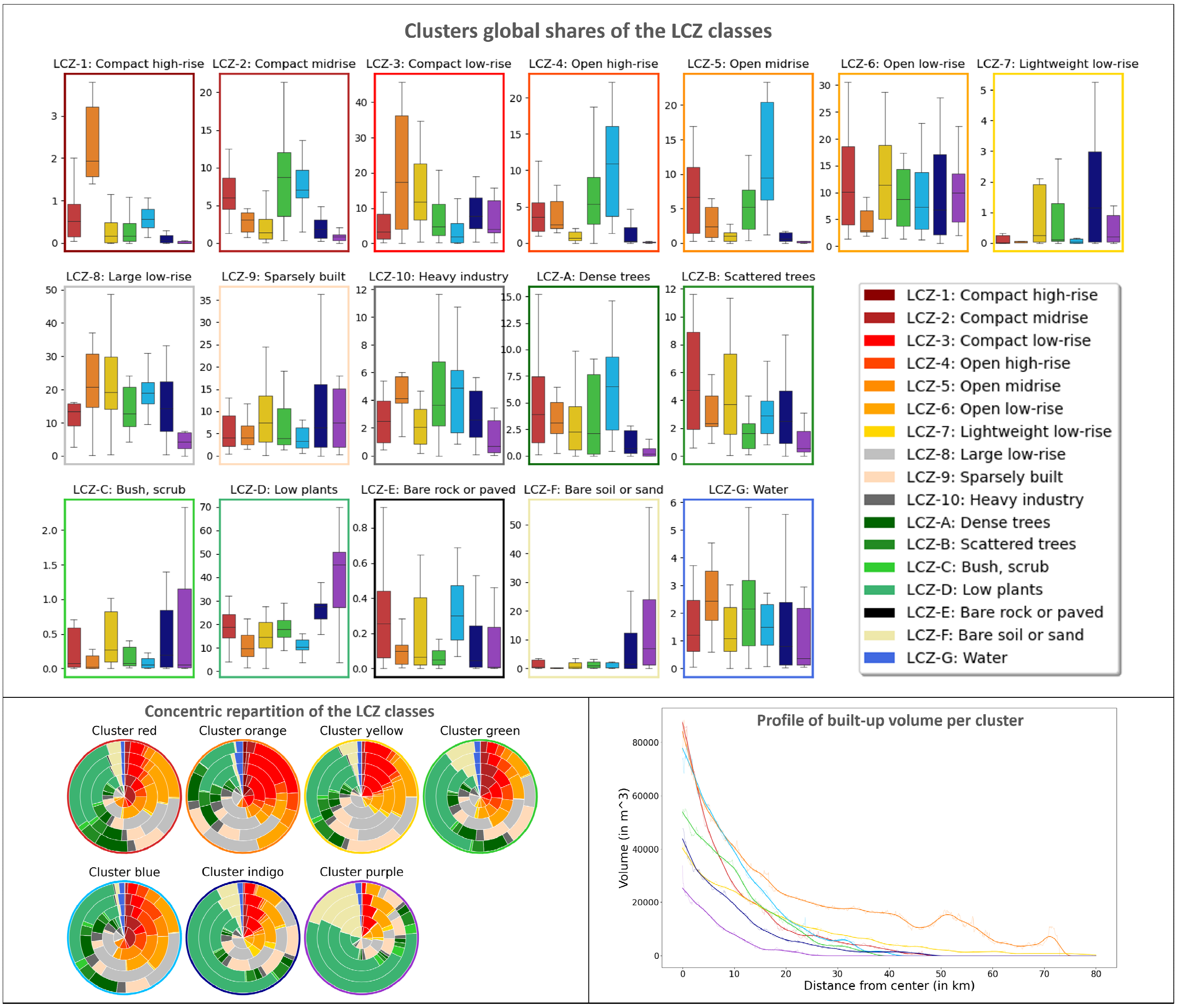

Figure 3:Morphological description of the clusters obtained for the concentric model of density

Cities of the green cluster can be found in the Indian region and in Eastern Europe. They show comparatively high proportions of compact midrise buildings (LCZ-2). Overall the group has a balanced share of the different types of built-up land. They feature a steady, almost linear decrease in its built-up volume. The cities are of average size (14.4km).

Cities of the blue cluster are mostly located in Central and Eastern Europe as well as in China. They are distinguishable by their comparatively large proportion of open high-rise (LCZ-4) and open midrise buildings (LCZ-5), as well as with heavy industries (LCZ-10) and dense trees (LCZ-A). They feature a core with a high share of the dense built-up classes, leaving progressively place to large low-rise buildings (LCZ-8). This is depicted by a high central built-up volume decreasing linearly with the distance to the centre. The cities of this cluster are on average of 17.2km of radius.

The indigo cluster is dispersed across Asia, as well as in both Eastern and Western Africa. Its signature is a comparative high share of lightweight low-rise buildings (LCZ-7) and an above average share of low plants (LCZ-D). The share of built-up lands is not high and their proportion is decreasing in favour of vegetation quickly with distance to the centre. This, in turn is reflected in the built-up profile with a cluster being among the less dense overall. The cities have an average size (15.8km).

Last, the purple cluster is mainly located in sub-Saharan Africa. It is noticeable by its low share of built-up land and the highest share, among all clusters, of low plants (LCZ-D) and bare soil or sand (LCZ-F). The two classes account already for almost half of the share in the core layers and become predominant in the outer areas. This is reflected by the extremely low built-up volume of its profile and its small average size (11.6km)

4.2.3 Typology of the concentric model of land use mixture

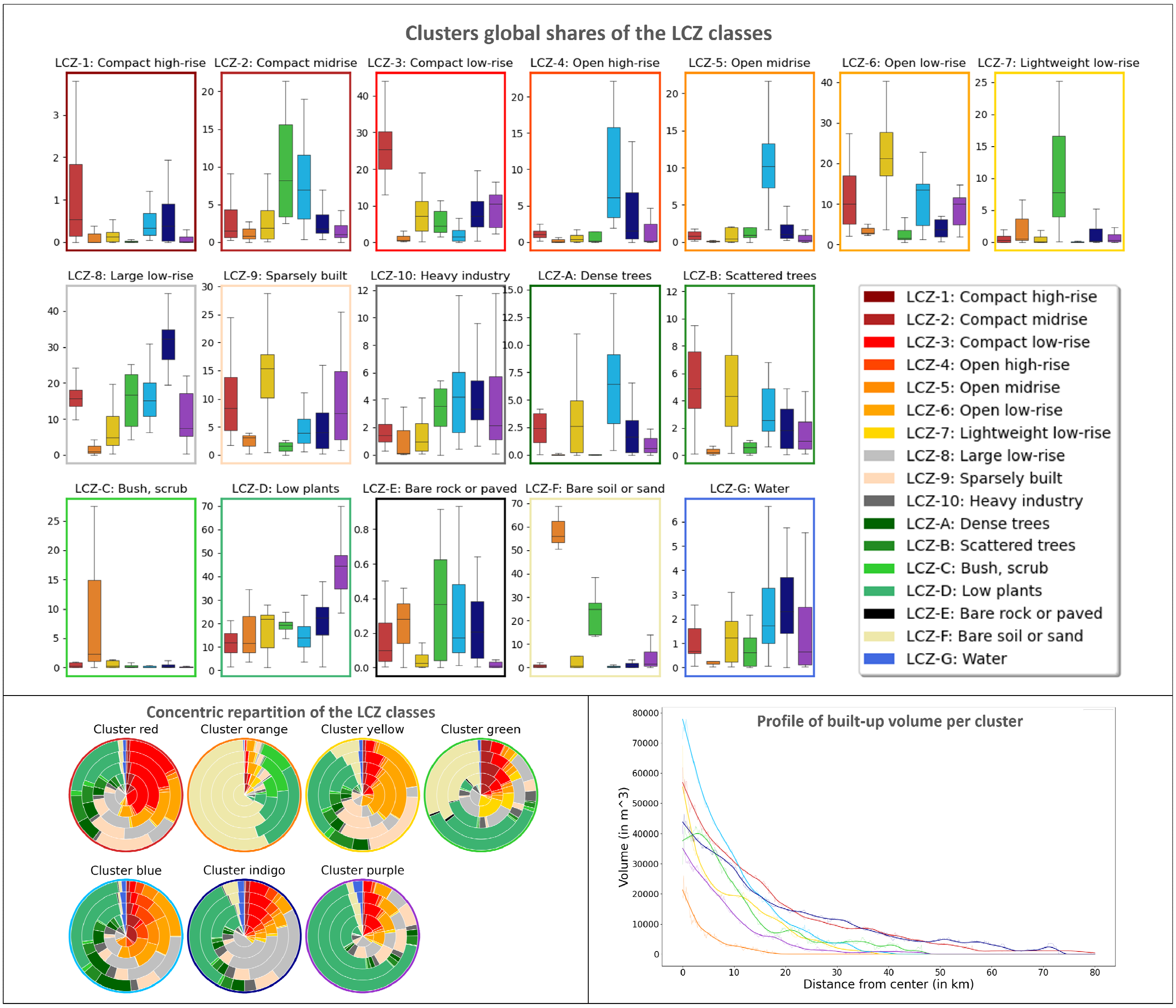

Figure 4: Morphological description of the clusters obtained for the concentric model of land use mixture

The red cluster is mainly located in North and South America, South India and Japan. It is defined by comparatively high shares of compact low-rise (LCZ-3) and scattered trees (LCZ-B) as well as, in lesser proportions, compact high-rise buildings ((LCZ-1). The dense LCZ classes in the core change into sparsely built-up areas (LCZ-9) in the periphery. This, together with a relatively large average size of 21.6km of radius, offers a slow decreasing profile of built-up volume with a long low-density tail.

The orange cluster is represented by three cities which have extremely low shares of built-up land. The cluster is mostly dominated by bare soil or sand (LCZ-F), low plants (LCZ-D) and noticeably bush, scrub (LCZ-C). The proportion of vegetation augments with distance to the centre comparatively to built-up shares. In turn, this results in small sized cities (10.9km) with low built-up volume.

The yellow cluster is mainly situated in Eastern Africa and Asia. This cluster is characterised by a comparatively large share of open low-rise (LCZ-6) and sparsely built buildings (LCZ-9). The core concentric zones are richer in dense built-up classes that change with distance to the centre to the two classes aforementioned. This give a sinuous decline of the built-up volume profile for these average sized cities (14.5km).

The green cluster is mostly located in the Middle East and Somalia. It presents a comparatively high share of compact midrise (LCZ-2) and lightweight low-rise buildings (LCZ-7) with a fair amount of bare soil or sand (LCZ-F). The two built-up classes are mostly packed in the core, increase slightly in the middle layers of the cities and leave place to non-built lands further out. This is reflected in a peculiar built-up volume profile, almost ridging up shortly outside the centre, then decreasing in sinusoidal decay. The cities of this cluster are of average size of 15.4km.

The blue cluster is shared between Europe (prevalent) and inland China. It is defined by comparatively large shares of open high-rise (LCZ-4), open midrise (LCZ-5), and a fairly important share of compact midrise buildings (LCZ-2). Its vegetation presents a higher fraction of dense trees (LCZ-A) than other clusters. The core is composed of compact built-up classes in higher proportions than other clusters. This gives place for almost exponentially higher vegetation shares towards the exteriors. With its average size of 14.9km, the profile of the built-up volume plummets from the highest volumes (in comparison to the other clusters) to a low one in a rapid concave descent.

The indigo cluster cities can be found across Asia and on the shores of Western Africa. It is characterised by its large share of large low-rise buildings (LCZ-8) and the significant presence of water (LCZ-G). The presence of low-rise buildings (LCZ-8) is prevalent across the concentric zones and the substitution of the built-up classes by the non-built-up ones does not affect it. Therefore, we observe for these large cities (21.6km on average) a slow, long-tail decay of the built-up volume profile.

Last, the purple cluster cities are mostly located in sub-Saharan Africa. It is characterised by a prevalence of low plants (LCZ-D) starting from the third concentric zone. The overall richness of non-built-up land is reflected by the low profile of built-up volume. The average size of cities in this cluster is of 13.0km of radius.

5 DISCUSSION

Cities, in their physical faces are diverse. To grasp this diversity, we rely on models of description. Through this study we show that depending on the applied model, the taxonomy of their diversity is not a fixed object; quite the contrary is true: very distinct typologies of cities evolve depending on the feature's spaces. As found in Taubenböck et al., (2020), there is a geographical consistency in the results, for a part that indicates a non-neglectable correlation between cultural regions and similar city types. Nonetheless, this relation varies between the typologies.

Here, it seems that we shed light on the structure of cities through mainly two prisms: By applying unsupervised clustering on three models, the outcomes are significantly consistent between the global model of land-use mixture and the concentric model of land-use mixture. The concentric model of density, however, leads to different categories and thus different geographical distributions. These different types of results when semantically different morphological parameters are used (LCZ in the first type of results and built-up volume in the second case) seems to hint to something else. The density-based approach leads to different types of clusters relying on the repartition of built-up volume across cities. LCZ brings types of buildings, or types of neighbourhood to the front. The latter is more consistent to geographical zones (cf. Fig.1). A hypothesis that relates to this finding is that specific regions of the world witnessed specific ways of development in cities, in the sense that they selected specific architectural support in the process of urban growth (Reference?). We assume that some clusters, which are spread across continents, could point to the fact that these cities also share the same architectural response to growth, at least in their types as defined by the scheme of the LCZs in (Stewart & Oke, 2012). When we study cities of the same clusters that are across different geographical regions, we observe similarities of historical trajectories of urban growth. The similarities are sometime in the nature of their past political governance (e.g.: colonial cities), sometimes on their mode of growth (e.g.: spontaneous or planned). The similarities seem sometimes to be of natures that have already been unveiled in previous works, e.g.: economic importance (Solow, 1973), social relevance (Braunfels, 1976; Kostof, 1991), cultural regions (Ehlers, 1993; Gaubatz, 1998; Griffin & Ford, 1980; Hahn, 2014; Krapf-Askari, 1969; Lichtenberger, 1972), among others.

Against this background, the importance of the ethnical settings in the morphology of the cities has to be nuanced. Further, we argue that rather than speaking of cultural types of cities when studying the similarities and diversities, we should talk about city types emerging from specific contexts of urbanistic culture.

6 CONCLUSION

In this study, we empirically sought to identify groups of cities that share similar morphological manifestations. Through unsupervised clustering of cities across the globe mapped by LCZs and related built-up densities, we pointed out that different models of representation of urban morphologies lead to different typologies of city clusters. This can be observed through their geographical distribution, their types of built-up structures, their spatial distributions and density profiles. An interpretation of the difference of typologies could be that the physical face of cities is influenced by a complex combination of social settings coined here as "urbanistic culture", i.e. how the development of the materiality of the city is typically steered by the multiple agents at stake. In this framework, the results of this study on extracontinental urban similarities could be revisited and further possibilities of influence could be analysed. However, this assumption would need to be proven before we could discuss it further.

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🏆 *reviewed paper*

Typologien räumlicher Auswirkungen der Digitalisierung

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1 EINFÜHRUNG

Im urbanen Zeitalter, in dem bereits die Hälfte der Weltbevölkerung in Städten lebt, aber auch vor dem Hintergrund der Klimakrise ist die Gestaltung der digitalen, räumlichen Transformation der Städte von besonderer Bedeutung. So stellt das Konzept der Smart City im Zuge der Digitalisierung einen Wendepunkt der Entwicklung und Weiterentwicklung, bzw. Transformation von Städten dar. Dies ist von besonderer Bedeutung, da sich die Digitalisierung mit immer kürzeren Innovationszyklen und ihren vielschichtigen Folgen rapide ausdehnt und weitreichende, teilweise unerwartete Veränderungen verursacht. Die stadtrelevanten Disziplinen[1] – wie Städtebau, Stadtplanung, Landschaftsarchitektur oder Raumplanung – sind mit neuen Schwierigkeiten konfrontiert, die räumlichen Auswirkungen auf unterschiedliche Raumkategorien zu erfassen und zu planen, obwohl die Folgen kaum abgesehen werden können.

Das Smart-City-Konzept, mit den entsprechenden technologischen Systemen der Informationsverarbeitung, wird zunehmend, global eingesetzt (Roland Berger 2019), um den aktuellen urbanen Herausforderungen, wie Klimakrise, urbane Hitzinseln, Abfallgewältigung, Versiegelung oder Zersiedelung um nur einige zu nennen, zu begegnen. Doch durch Individualisierung in der Netzwerkgesellschaft und durch die massive Ausweitung der Nutzung digitaler Informations- und Kommunikationstechnologien (IKTs) in allen Lebens- und Arbeitsbereichen entstehen vermehrt sichtbare Transformationsdynamiken in Folge der Digitalisierung, die sich im Raum abbilden und diesen wesentlich verändern. (Soike et al. 2019, Radulova-Stahmer 2019, Engelke et al. 2019) Globale IKT-Unternehmen bieten zunehmend digitale Lösungen für die Städte der Zukunft, ohne dabei stadt-räumliche Konsequenzen zu berücksichtigen. Dabei sind die räumlichen Auswirkungen digitaler Technologien schon heute zu beobachten. Es gilt die räumlichen Risiken zu vermeiden und gleichzeitig die Chancen der Digitalsierung für den Stadtraum zu nutzen.

Wenn verschiedene Technologien im Quartier eingesetzt werden, dann unterscheiden sich die Stadträume in ihrer Wahrnehmung, Flächenverteilung, Nutzung, Dimensionierung aber auch in ihrer physischen Gestalt von konventionellen Quartiersräume ohne den Einsatz digitaler Technologien. Es wird folgenden Fragen nachgegangen: Wie verändert Digitalisierung den physischen Stadtraum? Auf welche Art und Weise wirken Technologien auf den Stadtraum? Welche Muster der räumlichen Raumwirksamkeit von Technologien lassen sich erkennen und welche Typologien können gebildet werden?

Keywords: Smart City, typology, urbanism, digitisation, urban space

2 VORGEHEN

Die Typenbildung dient als Strategie, um die Datensätze der leitfadengestützten Expertinnen- und Experteninterviews typologisch zu untersuchen, um in der qualitativen Untersuchung von Einzelfällen, die isoliert und singulär für sich stehen, Verallgemeinerungen zu finden und diese weiter strukturgebend ordnen zu können.

Die Datensätze aus zwölf leitfadengestützten Expertinnen- und Experteninterviews der Bereiche Wissenschaft, Wirtschaft, Verwaltung und Praxis werden anhand einer qualitativen Datenauswertung mit MaxQDA strukturgebend geordnet, um daraus Typologien der räumlichen Auswirkungen im Bereich Mobilität und Umwelt abzuleiten. Die Typenbildung erfolgt methodisch nach Kuckartz (Kuckartz 2006).

Bei der methodischen Typenbildung handelt es sich um nomothetische Realtypen. Die hier gebildeten nomothetischen oder künstlichen Typen beruhen auf Merkmalen, die mit Hilfe eines Merkmalsraums gefasst werden. Dadurch werden die Typen durch mindestens zwei Merkmale beschrieben. Für die sogenannte künstliche Typologie ist es charakteristisch, dass unterschiedliche Elemente, welche einem Typ angehören, alle die gleichen Merkmale aufweisen müssen. Die Typenbildung wird anhand eines Quadranten mit dichotom ausgeprägten Merkmalen vorgenommen. (Kuckartz 2006)

[1] Die Bezeichnung der einzelnen Disziplinen variiert im deutschsprachigen Raum

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Mit der Typenbildung der Raumwirksamkeit wird zunächst untersucht, welche Technologien eine Raumwirksamkeit zeigen. Nach diesen Forschungsfragen richtet sich der Merkmalsraum, bzw. Quadrant.

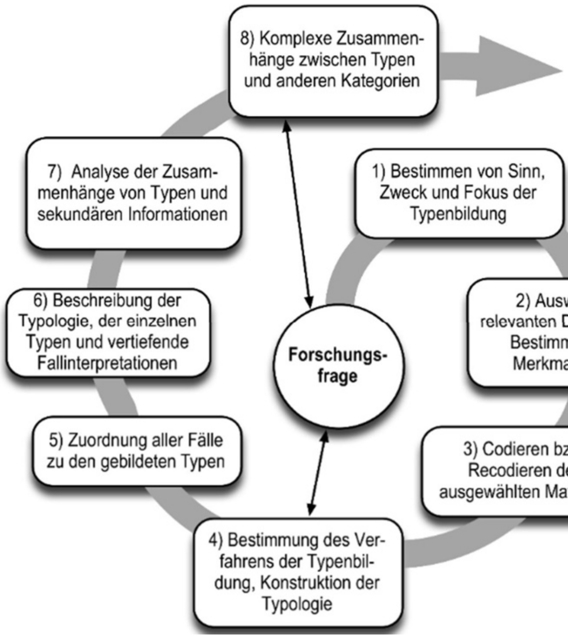

Abbildung 1 Ablauf der typenbildenden qualitativen Inhaltsanalyse. Quelle: Kuckartz, Udo; 2018; Qualitative Inhaltsanalyse. Methoden, Praxis, Computerunterstützung

Die Zuordnung von Technologien zu Typen ist probabilistisch. Das bedeutet, dass die Merkmale jedes Typs mit einer gewissen Wahrscheinlichkeit vorliegen, jedoch nicht mit Sicherheit vorliegen müssen. Als Gütekriterien dienen Reflexion, Dokumentation und methodische Kontrolle der Typenbildung.

ES wird die Raumwirksamkeit digitaler und analoger Technologien in einem Quadranten typisiert. Es entstehen die vier Typen: a) Digitale Technologie mit Raumwirksamkeit, b) Digitale Technologie ohne Raumwirksamkeit, c) Analoge Technologie mit Raumwirksamkeit und d) Analoge Technologie ohne Raumwirksamkeit.

3 RAUMWIRKSAMKEIT VON DIGITALEN UND ANALOGEN TECHNOLOGIEN

In beiden Teilbereichen, Mobilität und Umwelt, lassen sich sowohl quantitative als auch qualitative Veränderungen im Stadtraum durch Technologien nachweisen. Diese Raumwirksamkeiten können Quartiere jeweils positiv, aber auch negativ verändern. Sowohl digitale als auch analoge Technologien haben einen Einfluss auf Mobilität und Umwelt in der Stadt.

Definition und Abgrenzung Raumwirksamkeit von digitalen und analogen Technologien

Als raumwirksam wird eine Technologie verstanden, die eine temporäre oder dauerhafte für Menschen sichtbare, räumliche Veränderung jeglicher Art[2] im physischen Stadtraum (nicht in Innenräumen) verursacht. Dies gilt unabhängig davon, ob es in der Stadt oder im ländlichen Raum passiert. Beispielsweise können durch ein breites Carsharing-Angebot Menschen vom Eigentum eines PKWs absehen, sodass der Stellplatzbedarf in der Straße verringert wird und die freigewordenen Flächen anders genutzt werden können.

Eine Technologie ist nicht raumwirksam, wenn sie nach ihrer Installation die oben beschriebene Veränderung im Raum nicht aufzeigt und dadurch nicht sichtbar wirksam ist. Als Beispiel kann ein Elektrokabel dienen, das zwar eine physische Komponente hat und bei der Montage sichtbar ist, aber unterirdisch verlegt wird und damit nicht mehr im Stadtraum sichtbar ist. Dazu zählt auch eine Überwachungskamera, die zwar im Stadtraum sichtbar ist, aber keine räumliche Veränderung bewirkt.

[2] in der Struktur, in der Zugänglichkeit, in der Nutzungsform, oder -intensität, oder in der Wahrnehmung

3.1 Digitale Technologien - Raumwirksam[3]

Mobilität (Quantitativ)

Flächenbedarf erhöhen bzw. verringern

Technologien wie das automatisierte Fahren könnten sich auf negative Art und Weise räumlich auswirken, indem sie zusätzliche Flächen im öffentlichen Raum beanspruchen, statt den Flächenbedarf für motorisierte Mobilität zu reduzieren, erklärt Reicher (2020). Auch das E-Carsharing, wie beispielsweise in Hamburg mit einer großen free-floating Autoflotte, kann sich räumlich negativ auswirken und zu einer deutlichen Steigerung des MIV auf den Strecken unter fünf Kilometer führen, beschreibt Strüver (2019). In dichten innerstädtischen Bereichen kann es durch E-Mobilität zu einem erhöhten Mobilitätsaufkommen kommen, dies würde räumliche Probleme verstärken. Dadurch könnte der Flächenbedarf für den MIV und für den ruhenden Verkehr wachsen, so betont auch Hinterkörner die negative Auswirkung auf den Stadtraum. Auf der anderen Seite kann die E-Mobilität partiell positive räumliche Auswirkungen haben. Im ländlichen Raum kann mit E-Mobilität die erste und letzte Meile an Hochleistungs-ÖV-Strecken angeschlossen werden, erklärt Hinterkörner (2019). Auch automatisierte Busse können zur Erreichung der ersten und letzten Meile genutzt werden, beschreibt Grabner (2019). Das schafft ein alternatives Mobilitätsangebot zum MIV und kann dazu beitragen, Stellflächen zu reduzieren und sie für die qualitative Nutzung zurückzugewinnen, sagt er.

Nutzungsverdichtung[4]

Es bleibt schwierig, die räumlichen Auswirkungen des automatisierten Fahrens einzuschätzen, da es nicht isoliert betrachtet werden kann, erklärt Hinterkörner (2019). Das automatisierte Fahren wird mit Carsharing-Konzepten erweitert werden. Das könnte zu einer Effizienzsteigerung führen, weil mehr Fahrzeuge auf den gleichen Flächen, in Garagen oder im öffentlichen Raum, parken können, erklärt er. Auch Pernthaler (2019) ist der Meinung, dass das automatisierte Fahren den Stadtraum verändern kann, indem die Fahrzeuge nicht im öffentlichen Raum abgestellt, sondern über eine digitale App gerufen werden. Er beschreibt weiterhin, wie eine Nachbarschaftsapp dazu dienen soll, einen PKW-Stellplatz vielfach zu nutzen, indem er vermietet wird. So kann die Wohnungseigentümerin oder der Wohnungseigentümer über Nacht den Stellplatz nutzen und tagsüber an eine Arbeitnehmerin oder einen Arbeitnehmer vermieten. Dadurch entstehen eine Nutzungsverdichtung und Effizienzsteigerung in der Ausnutzung der Flächen. Weiter kann die Nachbarschaftsapp dazu verwendet werden, um Raumressourcen im Quartier, sowohl im Innenraum als auch im Außenraum zu bespielen, erläutert Pernthaler.

Mehrfachnutzung[5]

Die digital-basierten Sharing-Konzepte, wie E-Car-Sharing, E-Räder oder E-Skooter, jeweils mit der notwendigen Ladeinfrastruktur, reduzieren den MIV, aber intensivieren gleichzeitig die Nutzung des öffentlichen Raums in der Nachbarschaft (Pernthaler, 2019; Hoffer, 2020; Ranegger, 2019). Pernthaler (2019) erklärt weiter, dass mit dem Carsharing-Konzept acht PKWs durch nur ein Sharing-Fahrzeug ersetzt werden können, da die PKWs zu 97% der Zeit abgestellt bleiben und nur für kurze Zeit in Verwendung sind. Sharing-Konzepte in der Mobilität könnten folglich dazu führen, dass in Großstädten Eigentum von Fahrzeugen, wie Autos, Fahrräder oder Skooter, massiv zurückgeht und dadurch deutliche räumliche Raumressourcen, wie Parkplätze und Kellerräume entstehen, erklärt Knieling (2020). Die Fokussierung auf inter- und multimodale Mobilität, wie der multimodale Knoten TIM in Graz, der Carsharing und E-Lastenrad-Sharing beinhaltet, ist in einigen Ländern bei Smart City-Entwicklungen zu beobachten (Hoffer,

[3] Codedefinition: Dieser Code wird verwendet, wenn beschrieben wird, wie sich digital-gestützte Technologien in jeglicher Form auf den Raum auswirken und eine Veränderung hervorbringen. Diese Veränderung kann physisch räumlich sein, das heißt der Raum verändert sich in seiner Form, oder aber sie kann sozial sein, das heißt, der Raum verändert sich zwar nicht als euklidischer Raum die Nutzung im Raum erfährt jedoch eine Veränderung. – Ankerbeispiel: „Wenn es zum autonomen Fahren kommen würde und wenn es wirklich dazu führt, dass dann die Anzahl der einzelnen Autos sich verringert, dann könnte das tatsächlich auch für die Stadtplanung einen innovativen Schub bringen. Denn dann würden wir sehr viel Parkraum gewinnen, der aufgelöst werden könnte. Das ist aber eine Entwicklung, die wirklich noch lange in der Zukunft liegt.“ (Knieling, 2020, pos.20)

[4] Verdichtung derselben Nutzung auf der gleichen Fläche, z.B. mehr Autos auf der gleichen Fläche) und Effizienzsteigerung in der Nutzung der Raumressourcen

[5] Steigerung der Nutzungsintensität derselben Objekte, z.B. Straßenraum wird für Mobilität, oder für Bürgerinnen- und Bürgerfeste genutzt

2020; Grabner, 2019). Durch die gemeinschaftliche Nutzung des Mobilitätsangebotes kann die Anzahl der PKWs im öffentlichen Raum verringert werden, stellen beide fest. Intermodalität führt zu einer passgenauen und bedarfsgerechten, sowohl räumlich als auch zeitlich effizienten Fortbewegung, sagt Christiaanse (2020). Durch das stationsbasierte Bikesharing entstehen an den Stationen intermodale Schlüsselpunkte für einen Verkehrsmittelwechsel, erklärt er weiter.

Gleichzeitig kann die Technologie negative, räumliche Folgen haben. Technologie-basierte Verkehrsmaßnahmen, wie Gleichschaltung von Ampeln oder Pendlerinnen- und Pendler-Informationen, können den Verkehrsfluss in der Stadt verbessern, sagt Ranegger (2019). Auch Bruns-Berentelg und Gilliard (2020) führen die smarten Ampelsysteme auf, die wartende PKWs registrieren und die Schaltung bedarfsgerecht optimieren. Jedoch kann sich dies räumlich negativ auswirken, wenn die Technologie dazu beiträgt, Verkehrsstaus zu reduzieren und der MIV als Mobilitätsform begünstigt wird, sodass wiederum ein erhöhter Stellplatzbedarf nötig wird, erklären sie.

Mobilität (Qualitativ)

Wahrnehmung und Orientierung im Stadtraum

Durch die dauerhafte Nutzung von Navigationsapps auf mobilen Endgeräten – anstatt sich mithilfe von Stadtplänen, anhand von wesentlichen räumlichen Merkmalen und Identitätsträgern im Raum zu orientieren – verschlechtert sich die räumliche Orientierungsfähigkeit, sagt Nutz (2019). Das führt dazu, dass sich die Menschen auf die Navigation konzentrieren und dadurch den Stadtraum nicht bewusst wahrnehmen, sagt sie weiter. Strüver (2019) beschreibt, wie das Bikesharing in Hamburg niederschwellig mit einer Sharingapp funktioniert. Durch die kostenfreie Nutzung in der ersten halben Stunde würde eine kurzweilige Nutzung der Räder angeregt, sagt sie. Das führt zu einem halbstündigen Wechsel des Leihfahrrades bei längeren Distanzen. Dadurch werden einerseits die Räder gut organisiert an Stationen abgestellt und andererseits ändert das die Aufenthaltsdauer an den Stationen. Es reduziert insgesamt die Bewegungsgeschwindigkeit durch den Straßenraum und erhöht dadurch die Wahrnehmung der Stadt, beschriebt auch Ranegger (2019).

Soziale Sicherheit im Stadtraum (Begegnung, soziale Kontrolle)

In Mehrfamilienhäusern werden in den Treppenhäusern Info-Bildschirme mit den Fahrzeiten des öffentlichen Verkehrs angezeigt, beschreibt Grabner (2019). Dies kann dazu führen, dass sich Menschen weniger im öffentlichen Raum, beispielsweise an der Haltestelle, aufhalten und dadurch einerseits die persönlichen Begegnungen reduziert werden und andererseits die soziale Kontrolle im Stadtraum negativ beeinflusst wird. Verkehrsapps für mobile Endgeräte liefern ortsunabhängig Echtzeitinformationen über Abfahrtszeiten der öffentlichen Verkehrsmittel, sagt Strüver (2019). Das erhöht den Nutzungskomfort und bietet Alternativ-Verbindungen, wenn ein Anschluss nicht erreicht werden kann, beschreibt sie weiter. Allerdings führt diese digitale Technologie räumlich dazu, dass die Passagiere nur kurz an den Haltestellen warten. Wie bei den Info-Bildschirmen im Treppenhaus kann es dazu kommen, dass der Stadtraum an Lebendigkeit verliert und die Sicherheit im öffentlichen Raum verringert wird.

Umwelt (Quantitativ)

Klimasensible Stadt

Klimatologische Maßnahmen, wie intensive Begrünung und versickerungsoffene Oberflächen im öffentlichen Raum, können mithilfe von sensor-basiertem Wassermanagement in ihrer Wirkung verbessert werden, sagt Hoffer (2020). Auch Grabner (2019) beschreibt die sensor-gestützte Bewässerung der Grünflächen im Stadtraum. Durch sie kann die Austrocknung der Grünmasse an heißen Sommertagen vermieden werden und die Bewässerung kann bedarfsgerecht reguliert werden. Das trägt zu klimatischem Komfort im Stadtraum und zur Erhöhung der Aufenthaltsqualität für die Menschen bei. Ein sensor-basiertes Regenwasser-Monitoring misst die Versickerungsfähigkeit und ihre maximale Wasseraufnahmekapazität des Bodens, „um das Regenwassermanagement zu verbessern“, erkläret Christiaanse (2020, pos. 12). Begrünte Dächer sollen zur Regenwasseraufnahme beitragen und Sensoren erfassen den Wasserverlauf in Gebäuden, beschreibt er weiter.

Ferner können Sensoren dazu eingesetzt werden den Wasserstand im Kanal bei Sturmfluten zu registrieren, erklärt Grabner (2019). Dadurch können rechtzeitig Hochwassermaßnahmen aktiviert werden, um eine Überflutung der Straße vorzubeugen. Ranegger (2019) beschreibt Digital-basierte Tunnelbohr-Roboter. Letztere können mithilfe von Sensoren fossile Rohstoffe einsparen, indem weniger Erdmasse bewegt werden muss, um unterirdische Infrastrukturen zu verlegen oder zu reparieren, sagt er. Bei der Bohrung wird mit geolokalisierten Daten ein UIM (Urban Information Modelling) angelegt, sodass Reparaturen gezielt umgesetzt werden können, so Ranegger. Eine sichtbare räumliche Auswirkung ist, dass die Straße nur punktuell und nur kurzzeitig baustellenbedingt gesperrt werden muss, sagt er weiter.

Umwelt (Qualitativ)

Raumwahrnehmung

Smart Lighting kann über sensor-gestützte Lichtregulierung einer Lichtverschmutzung in der Stadt entgegenwirken. Es kann jedoch auch zu negativen Effekten im Stadtraum führen, erklärt Pernthaler (2019) indem das Sicherheitsempfinden der Menschen durch die eingeschränkte Einsehbarkeit des Stadtraum beeinträchtigt wird.

Ästhetische Gestaltung

Integrierte Fassadengestaltung mit PV-Anlagen, als Teil des architektonischen Konzeptes, wie bei der Listhalle in Graz, können den Stadtraum ästhetisch verändern, schildert Pernthaler (2019). PV-Anlagen auf Dächern und Fassaden dienen zur Stromgewinnung. Werden sie als Fassadenelement integriert, können sie ästhetisch raumwirksam werden, sagt auch Hoffer (2020). Durch E-Partizipation kann das Wissen der Bürgerinnen und Bürger in Planungsprozessen einfließen, erklärt Grabner (2019). Dies kann sich indirekt auf die Gestaltung des öffentlichen Raums auswirken und zu räumlichen Veränderungen führen, sagt er.

Reduktion von Ver- und Entsorgungsfahrten

Die Nutzung lokaler Ressourcen, wie Baustoffe für Baustellen, und eine digital-basierte, „smarte" Logistik können die CO2-Emissionen der Baustelle und sowohl Anzahl als auch Entfernung von Ver- und Entsorgungsfahrten reduzieren, argumentiert Ranegger (2019). Er beschreibt weiterhin, wie sensor-gestütztes Abfallmanagement die Anzahl der Entsorgungsfahrten reduzieren kann. Diese Sichtweise führt auch Nutz (2019) auf. Auch Knieling (2020) sagt, dass der Völlegrad der Container durch Sensoren erfasst wird und der Abtransport „bedarfsgerecht" erfolgen kann. Das reduziert die Zahl der Abfall-Schwerlasttransporte, es reduziert die Emissionen und verbessert die Luftqualität in der Stadt, sagt er weiter.

Barrierefreiheit im öffentlichen Raum (siehe 8.2.3)

Das sensor-gestützte Abfallmanagement, das Ranegger (2019) beschreibt, kann bei unterirdischen Mülltonnen die Barrierefreiheit im Straßenraum verbessern, indem nur die Einwurfsöffnung oberirdisch auf der Straße steht und der gesamte Inhalt des Abfall-Containers unterirdisch ist. Diesen Punkt schildern auch Bruns-Berentelg und Gilliard (2020) Zur Verbesserung der Barrierefreiheit im öffentlichen Raum kann das induktive Laden von E-Fahrzeugen beitragen, sagt Pernthaler (2019). Es befreit den Gehsteig von Ladesäulen und verbessert dadurch die Zugänglichkeit im öffentlichen Raum.

3.2 Digitale Technologie – nicht raumwirksam[6]

Ein Sharing-Konzept für Lastenräder in Mehrfamilienhäusern, welches über eine digitale App funktioniert, oder die kollektive Nutzung von Gemeinschaftsküchen oder Gemeinschaftsterrassen, die ebenso über eine App reserviert werden können, basieren zwar auf Digitalisierung, zeigen jedoch keine konkrete Veränderung im Stadtraum, erklärt Strüver (2019). Sensor-gestütztes Regenwassermanagement oder Steuerung von Bewässerungsanlagen mithilfe von Sensoren zeigen keine direkte räumliche Veränderung, sagt Grabner (2019). Wasserrohrturbinen können in Wasserleitungen der Stadt zur Energieerzeugung eingesetzt werden, beschreibt Hofstetter (2020). Diese Technologie ist in der Versorgungsinfrastruktur verbaut und nicht sichtbar und somit nicht raumwirksam. Hofstetter spricht des Weiteren den Einsatz von sogenannten „smarten" Mircogrids bei der Energieversorgung an, welche Teil der unterirdischen Infrastruktur sind und keine Raumwirkung haben. Auch Vlay (2020) schildert, wie die Fließbewegung der Donau zur Energieversorgung eines ganzen Quartiers eingesetzt wird. Die in Passivhäusern eingesetzten digitalen Technologien, welche im Architektur-Maßstab auf der Gebäudeebene oder auf der Wohnungsebene im Sinne

[6] Codedefinition: Dieser Code wird genutzt, wenn eine digitale Technologie keine im Stadtraum sichtbare Veränderung in der physischen Gestalt oder Nutzung des Raumes bewirkt. – Ankerbeispiel: „Sie haben sich zum Beispiel damit auseinandergesetzt, wie man aus der Wasserleitung, wo wir aus der Steiermark quasi unser Trinkwasser beziehen, wie man aus dem Wasserfluss Energie gewinnen kann. Durch kleine Minikraftwerke, die quasi in diesen Wasserrohren eingebaut sind." (Hofstetter, 2020, pos. 17)

von Smart-Home Verwendung finden, haben keine räumliche Wirksamkeit im Stadtraum, beschreiben Hofstetter (2020) und auch Hinterkörner (2019) Energieverbrauchs-Monitoring auf der Wohnungsebene kann zur Nutzungsveränderung der Bewohnerinnen und Bewohner dienen, sagt Hinterkörner (2019).

Bürgerinnen- und Bürgerwissen kann durch E-Partizipation in Veränderungsprozesse einfließen. Dank digitaler Apps können Informationen über Instandsetzungsbedarfe übermittelt werden, sagen Bruns-Berentelg und Gilliard (2020). Ein digitaler Messenger-Dienst, genannt „Seestadt.Bot", kann Echtzeitinformation über die Seestadt geben, beschriebt Hinterkörner (2019). Über das Internet oder über digitale Apps getätigte digitale Bestellungen für den Supermarkt, können den Komfort steigern und Zeit einsparen, erklärt Hinterkörner weiter. Reicher (2020) beschreibt, dass die Nutzung von digitalen Konferenz-Tools durch die Pandemie-Krise stark zugenommen hat. Diese Tools können zur Vermeidung von Mobilitätsbedarfen beitragen, erklärt sie. Somit sind sie ressourcenschonend, ohne dass sie den Stadtraum direkt verändern.

UIM, oder BIM-Systeme werden eingesetzt, um die Infrastruktur der Stadt zu planen und zu verwalten, sagen Bruns-Berentelg und Gilliard (2020). Dieses digitale Abbild der Stadt, das durch UIM erzeugt wird, kann zur Effizienzsteigerung in Planung oder Instandhaltung beitragen. Es ist nicht physisch räumlich sichtbar und schafft keine reale Veränderung im Stadtraum. Weiterhin können Urban Data Plattformen Daten einer Stadt bündeln, um durch Echtzeit-Daten ein Monitoring zu machen, sagen Bruns-Berentelg und Gilliard (2020). Digitale Technologien welche im öffentlichen Raum in Sicherheitssystemen eingesetzt werden, wie Kameras, Licht-, oder Geräuschpegel-Sensoren, sind als Objekte im Stadtraum zwar sichtbar, bewirken jedoch keine direkte räumliche Veränderung, sagt auch Knieling (2020).

3.3 Analoge Technologie – raumwirksam[7]

Mobilität

Reicher (2020) erklärt, wie stark der PKW den Stadtraum prägt und verändert. In der Covid-19-Pandeme wird deutlich welche Freiraumqualitäten entstehen, wenn der MIV und damit der ruhende Verkehr drastisch reduziert werden, beschreibt Reicher weiter. Sie erklärt, dass durch den technologischen Fortschritt die PKWs weniger emittieren, jedoch bleibt der Flächenbedarf unverändert, sodass keine räumliche Lösung zur Reduktion des Flächenbedarfs erzielt werden kann. Sie sagt, dass analoge Technologien wie das Auto „einen Einfluss auf die Programmierung von Nutzungen, auf die Dimensionierung von Bewegungsräumen, oder von Verkehrsräumen beispielsweise haben" (Reicher, 2020, pos. 42-43). E-Ladestation können sowohl auf der Architekturebene in der Sockelzone intergiert werden als auch im öffentlichen Raum geplant werden, erklärt Hinterkörner (2019). Unabhängig von ihrer Lage, ob auf privatem oder auf öffentlichem Grund, ist die Ladestation ein zusätzliches Element im Stadtraum und verändert diesen räumlich, aber auch akustisch. Carsharing Systeme mit E-Antrieb für Autos, Räder, oder Skooter schaffen ein Alternativangebot zum MIV. Sharing-Konzepte in der Mobilität tragen mit der entsprechenden Ladeinfrastruktur zur räumlichen Veränderung bei, erklärt Pernthaler (2019).

Strüver (2019) beschreibt die Verbindung des Bezahlsystems für den Park&Ride-Parkplatz mit dem Fahrschein des öffentlichen Nahverkehrs und des Bikesharing-Angebots. Diese kombinierte Zugänglichkeit ermöglicht eine veränderte Wahrnehmung und Nutzung des Stadtraums, sagt Strüver. Eine Zustellung der Online-Bestellung vom Supermarkt per E-Lastenrad kann zwar nicht die Nachbarschaftshilfe ersetzen, sagt Strüver, trägt jedoch zur Senkung der Emissionen im Quartier bei.

Umwelt

Reicher (2020) nennt auch „technologische Errungenschaften", wie Atomkraft, Energieerzeugung, Braunkohlegewinnung, die zu Problemen geführt haben. Zu Teilen haben diese Technologien zu kritischen, räumlichen Veränderungen, wie „Löcher mit Grundwasserabsenkung und riesigen Umweltschäden" geführt

[7] Codedefinition: Dieser Code wird verwendet, wenn eine analoge Technologie eine positive oder negative Auswirkung auf den Raum hat. Der Stadtraum wird dadurch in seiner räumlichen Gestalt oder Nutzung verändert. – Ankerbeispiel: „Ein anderes cleveres Konzept was meiner Meinung nach, dort den Raum wesentlich verändert ist das neue Müll-Konzept. Sie haben unterirdische Müll-Sammelanlagen mit sehr kleinen Einwurfsöffnungen. Allein, dass man diese riesigen Müllinseln, die man in anderen Städten sieht, dort nicht mehr sieht, weil sie unter der Erde verschwunden sind und auch nicht mehr riecht, das ist eine wesentliche Qualitätssteigerung." (Ranegger, 2019, pos. 15)

(Reicher, 2020, pos. 63). Andererseits kann mit Wasserstofftechnologie in kleinen dezentralen Kraftwerken durch Sonnen- und Windenergie Treibstoff für die Mobilität erzeugt werden. Vlay (2020) argumentiert, dass diese Kraftwerke zwar räumlich nichts verändern, aber indirekt sehr viel räumlich bewirken können. Vlay beschreibt weiter, dass manche Technologien, wie beispielsweise Windräder, die Stadt mit Energie beliefern können, jedoch entsteht diese Energie für das Quartier in der Landschaft, dort wo die Windräder aufgestellt sind. So kommt es zu einer räumlichen Veränderung, die jedoch eine geolokale Verschiebung aufweist, sagt er.

3.4 Analoge Technologie – nicht raumwirksam[8]

Technologische Lösungen, wie CO2-arme Zementproduktion, CO2-arme Produktion von Stahl oder Hochhäuser aus Holz, werden durch die Weiterentwicklung von Technologien ermöglicht, sagen Bruns-Berentelg und Gilliard, (2020). Eben diese Technologien sind wesentlich für eine resiliente Transformation der Stadt, sagen sie, obwohl sie nicht digital und in der Stadt nicht direkt räumlich wirksam sind. „Da spielen Technologien, traditionelle, moderne, zum Beispiel Elektrostahlöfen und vieles andere mehr, eine Kombinationsrolle bei der Produktion von Stadt.“, sagen Bruns-Berentelg und Gilliard (2020, pos. 36). Auch Nutz (2019) erwähnt Energieprojekte der Smart City Aspern Gesellschaft, zu denen Erdwärmespeicher gehören. Diese Technologie ist weder direkt digital, noch sichtbar. Energiekonsumierende und gleichzeitig -produzierende Gebäude benötigen lokale Transformatoren-Stationen, erklärt Hinterkörner (2019). Analoge Energiesysteme oder Wassertechnologien, so Knieling 2020), können die Effizienz in Quartieren erhöhen. Wenn die Infrastrukturen nicht offen liegen, sondern unterirdisch verlaufen oder in Gebäude intergiert sind, sind sie nicht raumwirksam. Die Art der Informationssysteme in Gebäuden, aber auch in der Stadt, verlagert sich von analogen Installationen, wie Kabel die „Fixierung in Gebäude“ verlegt sind, hin zu einer digitalen Infrastruktur, mit der kontaktlos und kabellos Informationen abgerufen werden können (Bruns-Berentelg & Gilliard, 2020; Christiaanse, 2020).

4 FAZIT

Es lässt sich feststellen, dass die Technologien im Bereich Mobilität im Vergleich zu den Technologien im Bereich Umwelt nahezu doppelt so häufig genannt werden. Das heißt durch Mobilität wird eine stärkere Veränderung des Stadtraums von den Expertinnen und Experten wahrgenommen. Dabei wird ein deutlicher Teil der räumlichen Veränderung im öffentlichen Raum durch den MIV verursacht. Wie Degros und Bendiks in ihrem Buch „Traffic Space is public space“ darstellen, ist heutzutage ein Großteil des öffentlichen Raums durch Verkehrsflächen und Stellflächen des MIV belegt (Bendiks and Degros 2019). Diese Gegebenheit eröffnet das Potential der räumlichen Transformation des Stadtraums durch alternative, IKT-gestützte Formen der Mobilität (Reicher 2020). Darüber hinaus sind nahezu alle technologie-basierten Umwelt-Veränderungen im Raum ausschließlich positiv, während die Technologien im Bereich der Mobilität oft sowohl positive als auch negative Auswirkungen auf den Stadtraum haben können.

Die quantitativen Auswertungsergebnisse der Typenbildung-Codierung zeigen, dass beide Typenbildungen, Raumwirksamkeit digitaler und analoger Technologien, sowie die Typenbildung direkte und indirekte Raumwirksamkeit, eine vergleichbare Nennungsdichte aufweisen, mit insgesamt 169 Codierung für die Raumwirksamkeit und 146 Codierungen für die Wirkungsart. Innerhalb der Typenbildung Raumwirksamkeit hat sich gezeigt, dass die meisten digitalen Technologien eine Raumwirksamkeit aufweisen (85 zu 19 Nennungen). Auch die analogen Technologien haben eine deutliche Raumwirksamkeit (50 zu 15 Nennungen).

Die in den Interviews genannten digitalen Technologien, die keine Raumwirksamkeit haben, sind ausschließlich quantitativ. Sie dienen dazu, die Effizienz der Stadt als System zu erhöhen oder den Nutzungskomfort der Menschen zu steigern. Zudem werden fast alle dieser digitalen Technologien ohne Raumwirksamkeit positiv bewertet. Ausnahme bilden die Urban Data Plattform und die Sicherheitssysteme, welche im Sinne des Datenschutzes kritisch gesehen werden. Auffällig ist weiterhin, dass sich nahezu alle digitalen Technologien ohne Raumwirksamkeit im Bereich Umwelt eingliedern und nur eine der genannten

[8] Codedefinition: Dieser Code wird verwendet, wenn analoge Technologien eingesetzt und genutzt werden, diese jedoch keine räumliche Wirkung oder Veränderung im Stadtraum verursachen. – Ankerbeispiel: „Was für das Quartier toll wäre, ist eine Art Lastenräder-Sharing. Wenn man das mitplant, dass jeder Block ein Lastenrad hat, so wie jeder Block eine Gemeinschaftsküche und eine Gemeinschaftsdachterrasse hat.“ (Strüver, 2019, pos. 43)

Technologien, das Sharing-Konzept für Lastenräder, im Bereich Mobilität. Bei der Raumwirksamkeit von analogen Technologien überwiegen hingegen die Technologien im Bereich der Mobilität. Eine zentrale Rolle spielt der MIV, unabhängig davon, ob er mit Verbrennungsmotor oder mit elektronischem Antrieb funktioniert. Im Bereich der Umwelt werden vermehrt analoge Technologien der Energieerzeugung geschildert, die sich alle zwar räumlich auswirken, jedoch nicht am Ort des Energieverbrauchs. Alle erwähnten analogen Technologien ohne Raumwirksamkeit beziehen sich auf Energie-Verarbeitung oder -Speicherung, Ressourcenverarbeitung und Daten-Infrastrukturen. Es wurden keine analogen Technologien im Bereich der Mobilität beschrieben.

Wirkungsdimensionen

Des Weiteren konnten drei Wirkungsdimensionen identifiziert werden. Die technologische Wirksamkeit auf den Raum lässt sich unterschieden in a) Veränderungen im menschlichen Verhalten, b) Veränderungen im physischen Stadtraum und c) Veränderungen im räumlichen System. Die räumliche Transformation wird ausgelöst durch die Änderung des Nutzungsverhaltens der Menschen im Raum. In Folge werden singuläre und punktuelle stadträumlichen planerischen und gestalterischen Anpassungen vorgenommen, um den neuen Bedürfnissen gerecht zu werden. Und letztlich werden die Raumsysteme entsprechend der neuen Bedarfe durch den technologischen Fortschritt verändert und adaptiert. Jede einzelne digitale Technologie kann jeweils zu einem bestimmten Zeitpunkt in ihrer technologischen Entwicklung und Ausbreitung der Nutzung sehr unterschiedliche Veränderungen auf unterschiedliche Ebenen erzeugen.

Veränderungen im menschlichen Verhalten

Technologien wie Verkehrs-Apps mit Echtzeitinformationen, Apps für multimodale Mobilität, Online-Konferenz-Tools, oder weit verbreitete Navigationsapps verändern das menschliche Verhalten, Bewegungsintensität, Aufenthalt und allgemein die Bewegungsmuster im Raum. Durch die Konsolidierung bestimmter Technologien kann die Veränderung der Bewegungsmuster im Raum langfristig, indirekt, in Folge in eine stadträumliche Adaptation an die Bewegungsbedürfnisse der Menschen angepasst werden. Die Veränderungen können auf alle drei systemischen Wirkungsbereiche erfolgen, im Maßstab des Quartiers, der Stadt, oder der Region.

Veränderungen im physischen Stadtraum

Einige digitale Technologien verändern unmittelbar den physischen Stadtraum. So kann durch ein IKT-gestütztes Parkraummanagement in Quartiers-, oder Sammelgaragen, oder durch eine intensive Nutzung von Carsharing-Angebote der Öffentliche Raum vom ruhenden Verkehr befreit werden. Solche Mobilitätskonzepte finden in neuen Quartiersentwicklungen häufig Anwendung. Durch multimodale Mobilitätslösungen und neue MaaS-Angebote wird zunehmend die Umkehrung der Mobilitätspyramide unterstützt, wodurch Nutzungsverschiebungen im Stadtraum folgen. Unmittelbare Veränderungen im Stadtraum sind im Zuge des Online-Handel-Booms durch die Covid-19-Krise sichtbar geworden. Einerseits hat dieser Aufschwung zu vermehrten Leerständen von Einzelhandelsflächen in Subzentren geführt und die Einzelhandelsvielfalt durch zahlreiche Insolvenzen – vor allem von Inhabergeführten Läden – stark eingeschränkt. Und andererseits hat es ebenso deutliche räumliche Auswirkungen in der Logistik gezeigt. So können digitale Technologien durch Disruption oder Krisenrahmenbedingungen kurzfristig weitreichende räumliche Folgen mit sich bringen. Die Veränderungen des physischen Raums betreffen vor allem die systemischen Wirkungsbereiche des Quartiers und der Stadt.

Veränderungen im räumlichen System

Digitale Technologien, vor allem aber ganze digitale Technologiesysteme, wie MaaS, IKT-gestützte erneuerbare Energiegewinnung, IKT-gestützte Nahrungsmittelproduktion oder automatisiertes Fahren verändern nicht nur den physischen Stadtraum lokal, sondern sie bewirken über unterschiedliche Raumkategorien hinweg, raum-gebundene Veränderungen ganzer räumlicher Systeme. Diese großmaßstäblich raumwirksamen, digitalen Technologien haben potentiell das größte Transformationsausmaß. Die können sowohl direkt, als auch indirekt, sowohl kurzfristig, als auch langfristig räumliche Veränderungen bewirken. Durch ihre hohe Komplexität sind die schwer konkret zu erfassen. Umso deutlicher wird ihre Bedeutung für die räumliche Transformation der Digitalisierung für die Zukunft. Die Veränderungen räumlicher Systeme betreffen überwiegend den regionalen systemischen Wirkungsbereich und dringen über die Stadt- bis auf die Quartiersebene hervor.

Die typenbildende Untersuchung der Daten aus den Expertinnen- und Experteninterviews haben aufgezeigt, dass Technologien im Stadtraum physische Veränderungen hervorbringen können und, dass diese Veränderungen nicht vordergründig direkt durch die Technologie ausgelöst werden, sondern überwiegend indirekt auf den Stadtraum wirken. Anhand der Typenbildung konnten in diesem Kapitel einerseits die Raumwirksamkeit digitaler und analoger Technologien aufgeschlüsselt werden und andererseits die Wirkungsart der Technologien in direkte und indirekte Wirkung auf den Raum unterschieden werden. Zudem konnten drei verschieden Wirkungsdimensionen, a) Veränderungen im menschlichen Verhalten, b) Veränderungen im physischen Stadtraum und c) Veränderungen im räumlichen System, identifiziert werden. So konnte aufgezeigt werden auf welche Art und Weise sich die Technologien im Raum auswirken.

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Upscaling “Building and Planning Culture” to a Regional Level in Römerland Carnuntum (Lower Austria)

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1 ABSTRACT

Under the term "Baukultur" (building culture), there have been a large number of success stories in Austria in the construction of new buildings or the renovation and transformation of existing buildings. But regional planning and design advisory boards such as the Neusiedler See World Heritage Association (Burgenland, Austria) or the "Rhätische Bahn" advisory board (Kanton Chur, Switzerland), institutionalized above single municipal initiatives (Verein Welterbe Neusiedler See (Hrsg.), 2011; Clemens, n.d.), are still rare. Basically, the term "building culture" (in German: “Baukultur”) is much more popular than "spatial planning" (in German: “Raumplanung”), but still misleading and incomplete. Building and planning projects are often preceded by a “common history” during many years of discussion and decision-making processes with different stakeholders, and various instruments involved on the local spatial planning level. Thus, a more comprehensive term, instead of “building culture” would therefore be "building and planning culture" (in German: “Bau- und Planungskultur”).

This paper describes how the use as well as the procedure of a Regional Planning and Design Advisory Board (REGB) is prototypically tested in a real-world laboratory, within the framework of a transdisciplinary research project (RLC 2040). The goal is future institutionalisation within the regional development association to aim for quality assurance in planning and building projects with regional relevance in the Römerland Carnuntum region. The participatory workshops including municipality representatives and interested citizens of the regional “future council” (an institutionalised civic platform) identified seven characteristics to classify the regional relevance of building and planning projects. It can be stated that basically every project is regionally relevant whose positive as well as negative impacts are clearly reaching beyond effects on a single municipality. Based on this fundamental finding, the paper discusses the construction and functioning of the catalogue of criteria used for project evaluations and the linkage of these criteria to the five fields of action (“Handlungsfelder”) developed for the vision of "RLC 2040". It also explains the possible uses of the catalogue of criteria beyond project evaluations and what added value the different types of the 30 municipalities from the “Römerland Carnuntum” region may gain by using this toolbox. The paper concludes with a summary of the advantages and disadvantages of the advisory board (REGB) draft.

Keywords: transdisciplinary planning, regional design, advisory boards, regional development, building and planning culture

2 MOTIVATION AND METHODOLOGY

The Römerland Carnuntum region is located in the metropolitan area between Vienna and Bratislava in Lower Austria and consists of 30 municipalities with 90,426 inhabitants (Statistik Austria, 2019a) in an area of approximately 613 km² (Bundesministerium für Digitalisierung und Wirtschaftsstandort, n.d.). It is one of the most dynamic growing regions in Austria with a population increase of about 17 % between 2002-2018 (Statistik Austria, 2019b). The region recognises building cultural guidelines as opportunity for integrative, sustainable and high-quality spatial development. This is why the region can be seen as a pioneer for planning and building culture throughout Austria. The ambitious goals of a quality planning and building culture in the region, which were developed in the predecessor project "LENA – Shaping our Living Space Sustainably Together" in 2018-2019, are to be implemented inter-municipally through the establishment of a Regional Planning and Design Advisory Board (REGB) for upscaling planning and building culture to a regional level.

Traditional instruments of spatial planning, structural policy and regional development increasingly show deficits regarding control and innovation in the face of complex and multidimensional challenges (Dentoni &

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Bitzer, 2015; Klein et al., 2001). Therefore, new forms of cooperation were initiated and have to be institutionalized in order to support “Sustainablity Transitions” (Schäpke, 2018).

The review of the basic principles and working methods of existing planning and design advisory boards is based on a secondary literature research, which is supplemented by guided interviews with experts who were entrusted with or involved in the development process of the analysed advisory boards. The methodological approach of the practical part is based on that of a real-world laboratory (Beecroft & Parodi, 2016) and consists of several components. It was conducted as systemic consensus building (Institut für Systemisches Konsensieren, n.d.) in a participatory process in which the essential questions were worked out with the interested population and municipality representatives of the region, regarding the planning requirements of an advisory board (content-related focal points including the spatial reference levels considered, organisational methods, financing and technical, administrative processing in the course of project accompaniment). The development of a catalogue of criteria with a rating tool and a procedure for the technical operation of an advisory board provided the basis for a test run with experts on a real project. A final scientific report will be produced on the institutionalisation of the regional advisory board (REGB) in the Römerland Carnuntum region as well as the transferability of this initiative to other regions.

3 INTRODUCTION TO THE AUSTRIAN “BUILDING AND PLANNING CULTURE”

The term “building culture” is still better known to the general public than the term “spatial planning”. On the regional scale, however, the term building and planning culture is much more appropriate, because it deals not always just with the design aspects of single buildings, but also with much larger and more integrative projects. The following section 3.1. first briefly describes the Austrian "Baukultur" history and the “LENA” project which led to a real-world laboratory that aims to establish a regional planning and design advisory board (REGB).

3.1 Austrian building culture – guidelines

In 2017, the building culture guidelines were adopted by the Council of Ministers, with which the federal government acknowledges its responsibility for Austrian building culture in its own sphere of influence. The aim is to promote building culture comprehensively. This is to be achieved by raising broad awareness in society, in particular among those with responsibility for this in politics, administration and business. An overall strategy at the federal level to anchor building and planning culture as an interdepartmental cross-sectional issue at the federal, provincial and municipal levels is to support these projects. The design of anthropogenic living space is always connected with the emergence or development of building and planning culture, which manifests itself physically as well as in terms of the design of buildings, public space, technical and social infrastructure buildings, industrial parks and village centres. The daily life of different user groups is shaped by the quality of building culture. This has a direct impact on the spatial behaviour of the population, which is determined by building and planning structures as well as the distribution of uses and is thus directly correlated with the quality of life to be found (Bundeskanzleramt, Abteilung II/4, n.d.).

How we design and change cities, towns and landscapes, in what processes and with what results, is what creates identity for the population. Successful building culture enhances the quality of life and upgrades business location. In this context, architectural and design aspects and the quality of internal and external development must be considered at the building and neighbourhood level in order to ensure optimal usability in accordance with the function (e.g. typical local development forms and architecture, local (public) transport connections, barrier-free access). At the local and supra-local planning level, the spatial-structural quality is important, which depends on the distribution of use of demanded functions in the area and has a significant effect on mobility behaviour. This influences the quality of life through noise and pollutant emissions as well as through required time expenditures. The desired sustainability goals of spatial planning cannot be solved at the administrative level of the municipality as it requires regionally coordinated spatial development. (Bundeskanzleramt, Abteilung II/4, n.d.) It can be concluded that building and planning culture goes beyond the architectural design of buildings and includes all elements of the built environment even outside protected zones and valuable sites, for example, the revitalisation of town centres and the high-quality design of streetscapes, squares and green spaces (Klingler, 2018).

3.2 Transfer of building and planning culture on the regional level of Römerland Carnuntum

In the project "LENA – Shaping our Living Space Sustainably Together" (2018-2019), the Römerland Carnuntum region has intensively dealt with its living space. The starting point was an extensive discussion process with local stakeholders, as well as external experts, on issues related to the processes of construction activities to maintain and promote the high quality of life. The results of the project are the Pactum Römerland Carnuntum and LENA's Toolbox in which principles and guidelines for future living space development were formulated. In the process, the federal guidelines for building culture have been transferred to the regional level for the first time. The Pactum is a commitment of all municipalities to common principles for a regional planning and building culture. LENA's Toolbox contains ways in which the principles can be implemented. One promising implementation option is the establishment of a Regional Planning and Design Advisory Board (REGBs), which was decided in the course of the "LENA" project (Dillinger et al., 2019).

The Römerland Carnuntum region is economically attractive and at the same time offers a high quality of life. In order to maintain these strengths in the future, the region has committed itself to a quality building and planning culture. In this context, buildings, streets and squares, traffic areas, village and town centres, as well as open spaces are part of the so-called built environment. Building culture arises wherever people are involved in shaping their living space, which has a significant influence on the quality of life in the region. The following four elements for a regional planning and building culture have been defined:

(A) Preserve and carefully develop settlement and landscape areas

(B) Observe and establish regionally typical construction and living

(C) Improve communication within the region and between all planning participants and stakeholders

(D) Promote attentiveness, awareness and knowledge of building culture issues (Dillinger et al., 2019).

These four elements were further differentiated and principles were derived from them. They are laid down in the Pactum Römerland Carnuntum, to which the signatory communities from the region commit themselves and formulate:

“We want to promote the quality of life for ourselves and our descendants by planning and carrying out all construction activities with care. Furthermore, we want to create better framework conditions for future-oriented construction and cooperate regionally” (Preisinger & Rupp, n.d.).

4 THE PROJECT “RLC 2040” AND REAL-WORLD LABORATORY “REGIONAL PLANNUNG AND DESIGN ADVISORY BOARD” (REGB)

The Project team of “RLC2040”[1] consists of 15 people from the University of Technology Vienna, the University of Life Sciences Vienna, the regional development agency Römerland-Carnuntum (30 municipalities) and the “Club of Rome Carnuntum”. RLC2040 has a transdisciplinary character, meaning to support the self-empowerment and self-organisation of the regional actors towards a “pervasive” transformation, instead of doing another research that ends with its financial support. Among the project methods are scenario processes (e.g. back-casting), visioneering, accompanying research (q method), serious games and two real laboratories. For several reasons, the preconditions in the Römerland Carnuntum region are outstanding among the Austrian regions:

- Decades of experience in inter-municipal and regional cooperation with lots of success stories;
- A well-trained and well-experienced staff of 20 people within the Regional Development Agency;
- A pretty active and socially diverse “crowd” from the civil society, willing to join and work in the numerous and various events and workshops.

After the first project year in spring 2020, our research was “struck” by the Corona pandemic which made it necessary to totally redesign all out events and workflows, but so far this was pretty successful and has even empowered some people to participate who might have stayed “invisible” in “non-digital” events. Within the visioneering scenario, we started with five thematic reports or ”fields of action”: (fellow) human beings, landscape & settlements, climate-energy-mobility, economy-agriculture-tourism and education-culture-

[1] See documentation (german only) at https://rlc2040.at/

innovation. Those five reports formed the initial input to aim, over several workshops, for a common vision which meanwhile led to several realistic projects that have started during the remaining project time (spring 2022) but will proceed far beyond that timeframe.

A speciality of RLC2040 are the two real laboratories. The first one is the REGB and the second one is called "future council 2.0." aiming to transform the current council body into something self-empowered, being active, transformative and creative also after the RLC2040 project is completed when the funded manpower of the research team will no longer be available.

The REGB aims to apply the LENA principles under "practical" conditions, together with surveys of the institutionalisation aspects from a perspective of a future "serial" use.

4.1 Finding a consensus on the "Regional relevance" of projects to be surveyed (or not) by the REGB

Together with municipality representatives and other interested people from the civil society from the "future council", it took four workshops before seven characteristics were consensually identified. These seven characteristics determine whether a project draft has or has not a "regional relevance". Herein, regional relevance does not only stand for importance clearly beyond the borders of a single municipality, but also to make sense that the REGB council should do an evaluation. If one or more of the following characteristics are true, this is the case:

- Development of large residential projects (both greenfield and local urban/central development projects)
- Large additional business areas (e.g., zoning and positioning of commercial units)
- Cross-municipality social infrastructure facilities (education, culture, health)
- Mobilisation of areas for potential energy plants that do not supply only one municipality
- Mobility supply
- Comprehensive transformation of an existing settlement (e.g., retroactive densification, revitalisation, reuse)
- Creation of regional strategies and concepts.

Although these seven criteria contain many fuzzy terms, the project team deliberately refrained from operationalising them in the first pre-selection stage. A more detailed evaluation will only take place in the second stage. Sections 4.2. and 4.3. show the "matrix" of the experts involved and the second, thorough evaluation step undertaken by using a MS Excel based toolbox that collects und summarises all the recommendations.

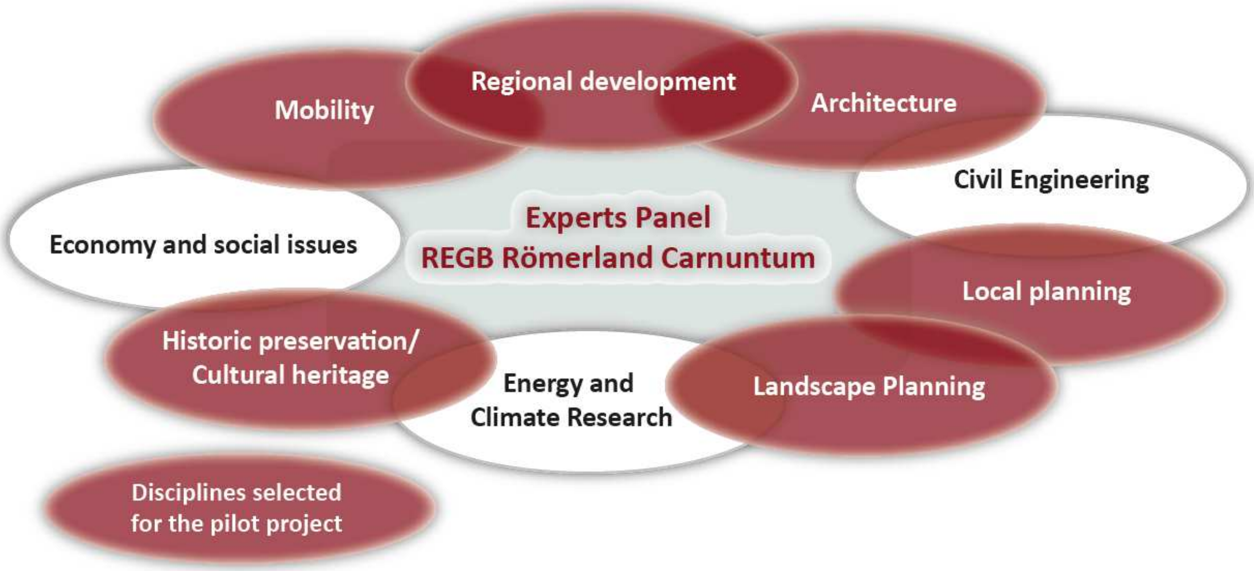

Fig. 1: Thematic clusters in the REGB "experts panel"

4.2 Constitution and workflow of the Regional Planning and Design Advisory Board

With regard to the constitution of the REGB experts are involved from the disciplines spatial planning, architecture, mobility, landscape planning, climate and energy research, civil engineering, monument preservation and cultural heritage, economy and social affairs. For a residential pilot project, experts of five relevant disciplines were selected to test the prototype (Fig. 1). It should be noted that a balanced and gender-appropriate constitution is required. The experts should bring along an relevant knowledge of the region, while excluding a possible bias. Regarding to a future seriality of the REGB Römerland Carnuntum the constitution can be selected accordingly, depending on the topic-specific task of planning.

The Regional Planning and Design Advisory Board (REGB) is available to all 30 municipalities of the Regional Development Association (REV) Römerland Carnuntum. The regional relevance of projects is assessed in advance. If a project is of regional relevance, the REGB advises the municipalities concerned and makes recommendations for their municipal implementation without competing existing procedures. Thus, the Advisory Board initially assesses projects, but also strategies and concepts. The research team from RLC2040 developed a draft catalogue of criteria for the test run, while the advisory board may develop further criteria in the future.

Fig. 2 shows in detail the elaborated work flow of project assessment, which have been tested in the first test-run. It was adapted respectively and refined via iterative feedback loops in coordination with the experts involved. Basically, a project in a municipality presents an occasion for assessment. Such a project is submitted by the municipality to the Regional Development Association, which assesses its eligibility for examination on the basis of criteria of regional relevance and the vision for the region. If a project is regionally relevant the expert committee assesses the project and submits an opinion, which may contain recommendations for quality improvement with regard to the catalogue of criteria created to promote sustainable spatial development.

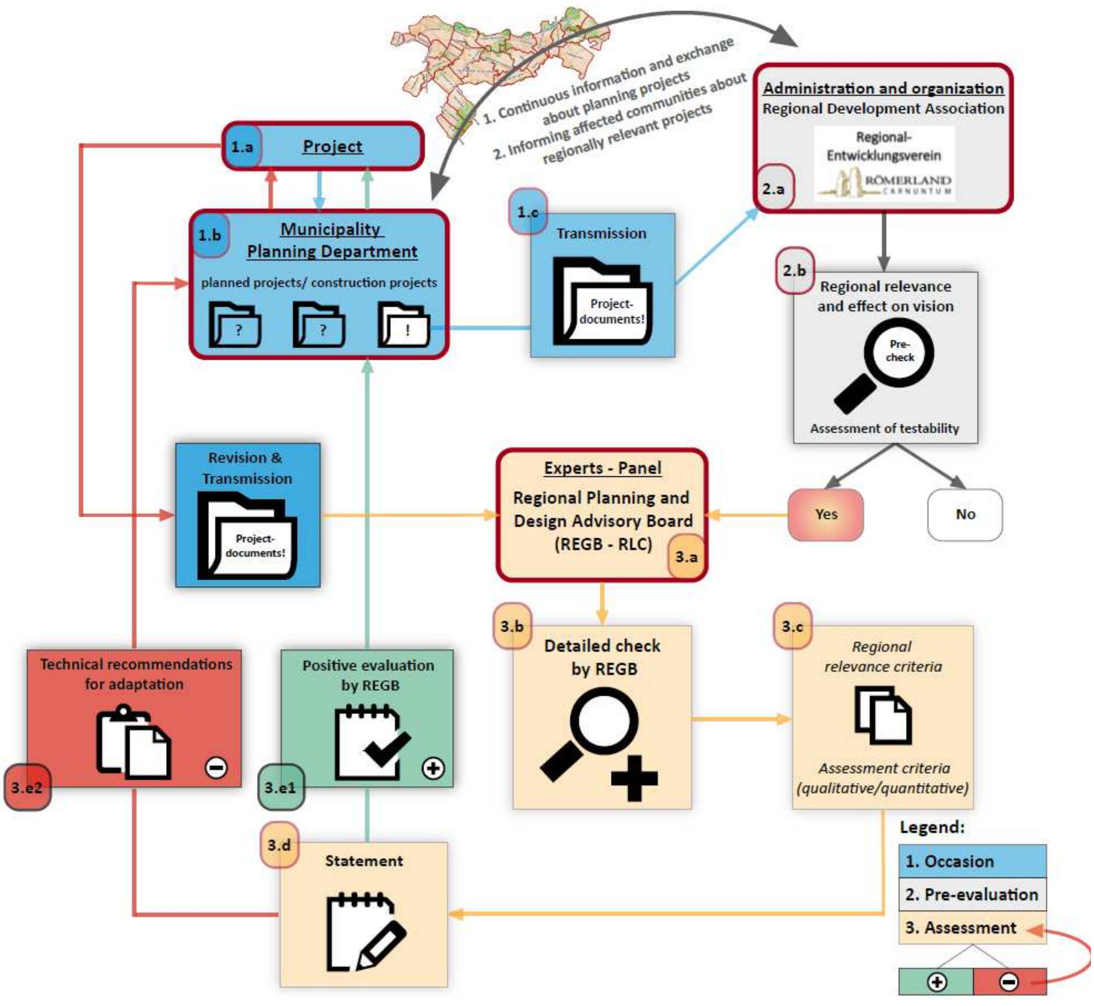

Fig. 2: Workflow of the advisory board (REGB)

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4.3 Catalogue of Criteria and evaluation tool

A toolbox was created with MS Excel to be able to collect the opinions of experts on a specific project in a standardised, comprehensible and simple way (Fig. 3). The following screenshot shows how this toolbox works and which settings are available. The complete list of 29 evaluation criteria from five fields of action is shown in the appendix.

	A	B	C	D	E	F	G
1					Weight: Criteria	1	Threshold value
2							49%
3					Weight: regional impact	1	
4							
5			Criteria value (Pulldown, yes-no-not clear)	Impact on the REGIONAL vision (Pulldown, not very important, important, very important)	Criteria Points (auto-generated)	Are recommendations necessary? (auto-generated)	Recommendations If "F" is "yes", please type some recommendations
6	C_index	Criteria for the field of action "People and Fellow Human Beings" Vision: https://rlc2040.at/handlungsfelder/handlungsfeld-1-mensch-mitmensch/					
7	MS_1	The planning project respects the daily needs of different population groups (children, youth, working people, retired people, ...).	no	very important	1	yes	text text text
8	MS_2	The project covers services for which there is a need at the communal level.	yes	very important	0	no	

Fig. 3: Screenshot from the REGB Toolbox (MS Excel)

Each of these criteria has an evaluation line and is evaluated twice: once in terms of local impact (column C) and once in terms of impact on the regional vision (column D). These two evaluations are used to generate a score using a VLOOKUP function, and this score is used to generate a "yes" or "no" answer to the question "Are recommendations necessary" via the threshold value (G2).

The screenshot shows the default setting: The weighting between local and regional importance is set to be the same (1:1), but this ratio can be changed in the F1 and F3 fields if it is suitable for the project situation. Likewise, the threshold can be changed between 0 and 99% to be able to simulate how this affects the amount of recommendations.

Each expert fills out an excel file, after which the individual files are merged and summarised and evaluated both in tabular and text form. This report can be passed on to local stakeholders. It contains all recommendations and all evaluations in a very comprehensible and transparent way.

5 CONCLUSIONS, DISCUSSION AND PERSPECTIVE

In the future, the Regional Planning and Design Advisory Board (REGB) could be available for all 30 municipalities of the Regional Development Association (REV) Römerland Carnuntum. The regional relevance of projects is assessed in advance by the REV. If a project is of regional relevance, the advisory board advises the municipalities and makes recommendations for their municipal implementation without competing existing procedures. The REGB initially assesses projects, but also strategies and concepts according to the criteria defined. At the moment, the advisory board is still in a test phase, but this paper has shown that both the evaluation criteria and the recommendations already work very well as a common toolbox. But there are still some steps to be taken and discussed to institutionalise it:

- After a unanimous decision of all mayors, the advisory board would need an ongoing, secured funding and an ongoing adaptation of the evaluation criteria during further practical applications;
- The regional non-binding nature of the recommendations would continue to exist in the future. This disadvantage may or may not be problematic, for example if the mayors voluntarily commit themselves to fully respect the recommendations of the advisory board.

Regardless of the specific test of the Römerland Carnuntum region, the evaluation tool offers the following options:

- It has a very high transferability for use and testing in many other regions. This would also have the advantage that after a few years an interesting collection of case studies could be created and collected. and this collection would be valuable for the exchange of experiences between the regions and the further improvement of the catalogue of criteria.
- The toolbox does not have to be used in its entirety; only parts of the criteria (even without text recommendations) can be used, for example to obtain a quick and simple overview of a project. which becomes also particularly easy when comparing several project variants for one location.

The authors are convinced that the advisory board REGB will be an exciting contribution to the future sustainable regional development of the Römerland Carnuntum region and are very much looking forward to the future improvements of the toolbox and also on feedbacks on the real-world laboratory.

6 APPENDIX

Criteria set of the "REGB" toolbox (29 criteria in 5 fields of activity).

C_index	Criteria for the field of action "People and Fellow Human Beings"
MS_1	The planning project respects the daily needs of different population groups (children, youth, working people, retired people, ...).
MS_2	The project covers services for which there is a need at the communal level.
MS_3	The project covers services where there is a need at the regional level.
MS_4	The project promotes population growth in the municipality.
MS_5	Does the project strengthen the regional identity?
C_index	Criteria for the field of action "Landscape and Settlement"
LS_1	The project promotes a transformation of existing buildings in the sense of inner central development (strengthening of local/regional centres; building densification).
LS_2	The design preserves the architectural heritage of the region, handles it with care and develops it further in a contemporary manner.
LS_3	The design preserves the architectural heritage of the municipality, handles it with care and develops it further in a contemporary way.
LS_4	The design includes high-quality qualitative and quantitative ideas on open and green spaces (private; semi-private; semi-public; public).
LS_5	The project embeds itself in the surrounding cultural landscape in terms of construction and landscape.
LS_6	The planning project preserves green and open spaces through a mindful and coordinated development of habitats.
LS_7	The planning project does not cause any landuse conflicts of use (no=it does!).
C_index	Criteria for the field of action "climate, energy and mobility"
KEM_1	Aspects of climate- and resource-friendly planning and construction exist in the design (consideration of a high overall energy efficiency of the project).
KEM_2	The planning project includes a concept for sustainable energy supply (heat demand for heating + warm water and options for local supply – share of renewable and/or decarbonised energy production).
KEM_3	A convincing, local mobility concept has been prepared with the design, including safety and layout of the pedestrian and bicycle connections.
KEM_4	Is there a good connection between the regional and the local mobility means (quality/frequency)?
KEM_5	Does the project promote environmentally friendly and health-conscious mobility and lifestyles?
KEM_6	Does the project respect microclimatic aspects such as the avoidance of heat islands and sufficient green space elements?
C_index	Criteria for the field of action "Education, Culture and Innovation"
BKI_1	The planning project was preceded by a municipal participation process.
BKI_2	The planning project has been preceded by a regional participation process.
BKI_3	The planning project includes flexibly usable community spaces (e.g. "discovery and experience spaces", but also for educational and cultural events)?
BKI_4	The project has a positive effect on an increased local culture of participation.
BKI_5	The project has a positive impact on an increased regional culture of participation.
C_index	Criteria for the field of action "Agriculture, Economy and Tourism"
LWT_1	Does the project generate additional jobs?
LWT_2	The planning project leads to a significant increase in municipal tax revenues.
LWT_3	The project promotes inter-municipal cooperation – costs and benefits are coordinated across municipalities, (land) resources are saved.
LWT_4	The project does not cause any/low additional land demand
LWT_5	The project promotes the supply of products from municipal agriculture
LWT_6	The project does not reduce fertile farmland soils (no=bad=it reduces soils; yes=good=no reduction!)

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reviewed paper

Urban Land Use and Food Supply: the Example of Vienna

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1 ABSTRACT

Since 2008 more than half of the world's population live in cities and in 2050 it will be more than two thirds. Urbanization increases not only the cities themselves, but also their responsibility to provide a 'Good Life for All' within planetary boundaries. Global agreements such as the Paris Climate Agreement, the UN Sustainable Development Goals or the Biodiversity Charter underpin and secure these aspirations. While 55% of the global population live in urban areas, it is estimated that 1-3% of world's land is urbanized. Hence, cities are characterised by land scarcity and urban land use conflicts crystallize around issues such as food production, housing, recreational areas or transport infrastructure. Nevertheless, soil and its biological productivity through photosynthesis is the prerequisite of every life on this planet and urban land use does not end at the city gates: food is just one example of how the city is connected to its hinterland, nation, and to the rest of the world. Their supply with agricultural products is feeding the city, but also connects it with both social and ecological impacts on people (e.g. farmers) and the environment at the place of production resp. processing. From this point of view, the responsibility of urban areas as consumption 'hotspots' does not end at their city borders.

Recently, a broader awareness of environmental impacts by consumed goods could be observed. An important contributor here is the communication and visualization of footprints, which are sustainability indicators that quantify resource use or ecological consequences of certain products. Some well-known examples are probably the ecological footprint, which measures the biologically productive area required, resource footprints for water and land or the carbon footprint, which illustrates the greenhouse gas emissions associated with the consumption of a product or lifestyle. Especially in the context of cities, contrasting consumption and production-based accountings has been proved to provide important insights for options to reduce ecological impacts of cities.

In the course of the IN-SOURCE project, we quantify urban land use intensities both inside and outside of city borders applying the concept of HANPP (Human Appropriation of Net Primary Production) as a further environmental footprint indicator. HANPP measures the depth of human interventions into the biological productivity of ecosystems. Net primary production (NPP) is the amount of biomass produced by the process of photosynthesis minus the plants' own energetic requirements in an ecosystem. Human appropriation of NPP occurs through two distinct processes: first, land cover/use change (e.g., from forest to cropland, HANPPluc) alters ecological patterns and processes, inclduing NPP, and second, via agricultural and forestry harvest, biomass is removed from ecosystems (HANPPharv). HANPP can be calculated for territorial units, e.g. cities or nations, and it also allows to relate the land use intensity of cities within their borders with impacts beyond. In this contribution, we focus on impacts associated with urban food supply in order to contextualize and explore these impacts within the urban food-water-energy nexus (FWE nexus).

In IN-SOURCE, we developed the HANPP Explorer as an interactive web application, which enables stakeholders and other practitioners to access insights from this research and interactively explore the topic. The HANPP Explorer intends to provide knowledge of the manifold dimensions of urban food, thereby gaining new perspectives on urban land use and opening up possible future developments for discussion.

Keywords: environmental footprint, Food-Water-Energy Nexus, sustainable food system, sustainable urban development, land use

2 INTRODUCTION

Fostering sustainability transitions needs interdisciplinary approaches which focus on relations between central resources and their use rather than on separated analysis as well as transdisciplinary research with the aim to co-create new knowledge and policy measures. A rising awareness of trade-offs between a sustainable use of resources such as food, water and energy as well as across disciplinary scales led to calls of a nexus approach from research and policy communities (Newell et al., 2019). As a result, the Food-Water-Energy Nexus (FWE nexus) is and has been discussed prominently by the United Nations (UN), Food and Agriculture Organization (FAO) and the European Union (EU).

Since 2008 more than half of the world's population live in cities and in 2050 it will be more than two thirds. Urbanization increases not only the cities themselves, but also their responsibility to provide a 'Good Life for All' within planetary boundaries. Global agreements such as the Paris Climate Agreement, the UN Sustainable Development Goals or the Biodiversity Charter underpin and secure these aspirations. While 55% of the global population live in urban areas, it is estimated that 1-3% of world's land is urbanized (Liu et al., 2014). Hence, cities are characterised by land scarcity and urban land use conflicts crystallize around issues such as food production, housing, recreational areas or transport infrastructure.

Growing food demand as well as growing demands on water and energy stemming from a growing population and rising living standards not only result in land use conflicts within a cities boundary. Additionally, these developments initiate a growing pressure on urban hinterland and on national and global resources. Therefore, cities as growing consumption 'hotspots' of resources appear to be decisive in a potentially successful approach to sustainability transitions. In this case study for Vienna, the FWE nexus approach is employed in the context of analysing options for urban sustainability transition. It serves as an entry point of analysing interdependencies, discussing synergies and reduction potentials as well as to foster the co-creation of new knowledge on transformative governance. By integrating an indicator framework for land use intensity (HANPP and Food-eHANPP), we connect urban land use with the necessity of urban resource supply for food in order to stress the accompanying impacts on local ecosystems in the near and far hinterland as one basic key aspect of urban resource use. In this paper, we start with a description of research aims of the underlying research project and more specifically, the characteristics of the case study for Vienna. We then introduce the integrative indicator framework 'Human Appropriation of Net Primary Production' (HANPP) followed by the presentation of the 'HANPP explorer', an interactive and comprehensive web application, which aim to not only show the results of the study, but also to offer an accessible tool to present the results to practitioners. Here, impacts of food supply for Vienna can be investigated and contextualized within urban land use intensity within city boundaries.

3 IN-SOURCE PROJECT AND THE CASE STUDY VIENNA

"Cities, undergoing rapid change throughout the globe, face common metabolic challenges to sustainably provide for energy, water and food supplies under healthy and economically productive conditions. Decision makers, such as governments, utilities, project developers and investors must be able to understand, quantify and visualize multiple interdependent impacts." (project website) The international SUGI project IN-SOURCE aims to model the impact of land use change and renewable energy transition on urban infrastructure with various tools.

Vienna represents a fast-growing city reaching almost 2 million inhabitants in 2021. This poses the major challenge for the urban planning of infrastructure and living space. The city has agreed upon a city development plan (STEP), a climate protection plan and a smart city initiative. In order to reach these goals, land-use change and energy-system change have to be analysed and transformed. The city of Vienna is known for its well-organized city administration in various fields (e.g. community housing, public transport, communal water, etc.). Not least because of the climate crisis, which transforms parts of the city into heat islands, different measures to cool down the city are currently discussed by the city administration. Using a FWE nexus approach in IN-SOURCE, we can ask how green areas, urban food demand and production and local energy and water demand relate to each other. Additionally, we are interested in the role the FWE nexus approach can play within a process to transform Vienna to a climate friendly smart city. The city administration has a strong planning and regulatory role concerning water and energy provision. In IN-SOURCE we aim to cooperate with representatives of the city administration in the endeavour to develop a shared understanding of problems and to co-create ideas and solutions.

The level of food production within Vienna is higher than in comparable cities as a result of a number of farms located within the cities borders. Additionally, initiatives promoting urban farming (e.g. vertical farming) are emerging and getting attention. Urban agriculture is not motivated (yet) by the heat island discourse but rather by the fact, that people aim for producing food (e.g. as in community gardens). Further questions arise around public and private food consumption where the structure of trade and retail services are implied and their availability could be subject to regulations or consumer decisions. Next to social assets, urban agriculture offers a series of co-benefits – such as cooling, less sealing of the soil, a better rainwater management – for the city, which can be analysed with the help of the FWE nexus. However, the agricultural production covers only a small percentage of the food consumption in the city as domestic biomass extraction in Vienna represents mere 2% of all biomass consumption for food, energy and material (Plank et al., subm). Thus, the lion's share of urban food supply grows on regional, national as well as remote areas. It therefore connects urban regions with land and biomass production in their regional and global hinterland embedded in a global supply network of international trade connections. Land use on these areas imply the human intervention into ecosystem processes, aiming at increasing the output of biomass products. We quantify the degree of these interventions using the HANPP framework ('human appropriation of net primary production'), a footprint indicator that measures land-use intensity, while considering spatial differences in productivity.

Moreover, one key aspect of the FWE nexus approach is the integration of transdisciplinary research. Building on several workshops conducted within the presented research project, we show how introducing the concept into discussion between city administration, civil society and scientists can help to start a process of joint problem framing and how analysing the FWE nexus links and visualization of results can be useful to develop future scenarios and policy measures for an urban sustainability transition.

4 ENVIRONMENTAL FOOTPRINT: HANPP AND EMBODIED HANPP

Recently, a broader awareness of the 'teleconnections' between producing and consuming regions (Seto 2016) and the ensuing environmental impacts by consumed goods can be observed. An important contributor here is the communication and visualization of footprints, which are sustainability indicators that quantify the resource use or ecological consequences of certain products respectively consumption patterns. Since the introduction of the ecological footprint in 1996, a large number of environmental footprint indicators emerged. The ecological footprint assesses the required biolgically productive global average area required to sustain a nation's consumption. Another popular example is the carbon footprint which quantifies the greenhouse gas emissions associated with the consumption of a product or lifestyle. These as well as other footprints covering resources such as water, land, nitrogen, phosphorus, material, biodiversity or energy are summarized and referred to as the 'footprint family' (Vanham et al., 2019). In the context of cities and their characteristic of resource supply from outside of their city boundaries, footprint indicators are from particular value due to their ability to capture the environmental impacts associated with urban resource consumption along the supply chain despite intricacies of congruent system boundaries. Moreover, if contrasted with production-based accountings, the consumption perspective has been proved to provide important insights for options to reduce ecological impacts of cities (Athanassiadis et al. 2018).

In the course of the IN-SOURCE project, we add a further environmental footprint built upon an established and acknowledged socio-ecological framework for material- and energy flow accountings (MEFA) (Haberl et al 2004, Haberl et al 2016). We quantify the impacts of human society on ecosystem productivity and further develop this framework to be able to quantify the extent of impacts associated with urban land use and food consumption. By doing that, we are able not only to contrast impacts occurring within and outside city boundaries in the same 'currency' but also to improve the comprehensibility of the framework as a basis of transferring a scientific concept into the applied realms of (city) practitioners. The quantification of environmental impacts by urban land use and food consumption follows the concept of Human Appropriation of Net Primary Production (HANPP). It measures the depth of human interventions into the biological productivity of ecosystems. Net primary production (NPP) is the amount of biomass produced by the process of photosynthesis minus the plants' own requirements in an ecosystem. Human appropriation of this energy occurs through two distinct processes: first, land cover/use change (e.g., from forest to cropland, HANPPluc) and second, product removal (e.g., agricultural harvest, HANPPharv) (see Fig. 1a).

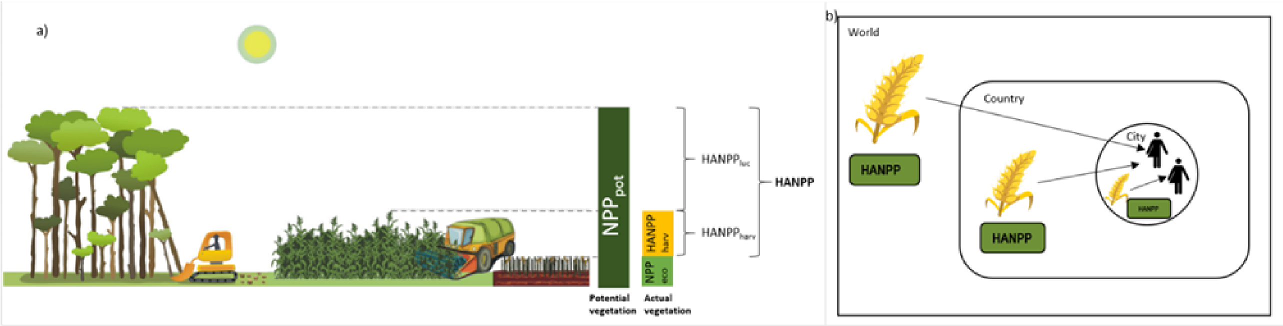

Fig. 1: Conceptualization of a) the Human Appropriation of Net Primary Production (HANPP) framework as a quantification of society's impact on the productivity of ecosystems (illustration by Plutzar, 2010, own adaption); b) the analysis of urban impacts on ecosystems associated with food consumption (=Food-eHANPP; own illustration).

Originating from the quantification of 'Human Impacts on Energy Flow through Natural Ecosystems and the Implications for Species Endangement' in 1990 (Wright, 1990), the concept has proved its applicability and ability to enable a better understanding of interactions between humans and nature and as a measure of human domination of the biosphere. For example, while Haberl et al. (2007) found a global HANPP value of 24% of the potential net primary productivity caused by humans, Krausmann et al. (2013) demonstrate the doubling of global HANPP in the course of the 20th century. Various national HANPP analysis (for example Kastner, 2009; Niedertscheider and Erb 2014) allow a better understanding of country-specific socio-economic pressures on terrestrial ecosystems. Against the background of increasing trade volumes since the 1960ies and resulting teleconnections (i.e. links between the place of production and consumption despite growing spatial disconnection), a land system analysis which assesses the impacts from a consumption perspective gained of growing importance, implemented by the quantification of the embodied HANPP (Erb et al. 2009). Akin to other footprint indicators, eHANPP allows to account for the HANPP resulting from the consumption of defined entities, here the city of Vienna (Haberl et al., 2014). Subsequently, for the application of the HANPP framework in the context of a transdisciplinary FWE nexus approach, we quantify urban land use (intensity) as the impacts of humans on ecosystem's productivity both inside and outside of city borders. For the latter, we focus on impacts associated with urban food supply (see Fig. 1b). The results are visualized in an interactive web-application with maps displaying the HANPP embodied in food differentiated by its origin ('HANPP Explorer').

5 HANPP EXPLORER: VISUALISATION AND INTERACTIVE LEARNING

The HANPP explorer is developed as an easy accessible online tool to transfer knowledge from the scientific community into practitioner's realm. In the following subsections, we first describe the approach of visualisation followed by data and method used for the application of the HANPP framework as well the conceptualization of the stakeholder workshops, which served as the basis of scenario development. Second, we show the results and information, which can be gained from the HANPP explorer differentiating between the land use impacts within (HANPP Vienna) and those occurring outside of city boundaries (Food-eHANPP Vienna) as well the insights and scenarios gained from the workshops.

5.1 Visualisation

HANPP Explorer is an interactive web application built within IN-SOURCE. The intention of creating this online tool was to present the HANPP framework within the context of the urban FWE concept in a straightforward and easy to understand way so that people who do not know the topic very well can easily assimilate this knowledge and use it in the future. The interface of the app is rather minimalistic with only necessary information displayed on the screen which makes it easy to navigate between the functions of the application. The navigation bar presents six sections: Home, About, Methods, Food-eHANPP, HANPP, and Scenarios (see Fig. 2). The Home tab welcomes to the explorer, second and third tabs are intended to familiarise the user with both the subject matter (the HANPP methodology) and the functionality of the application. While About is focused more on the purpose of the explorer with a short introduction to the topic and other sections, Methods dive into methodology of the analyses, description of the data and information on how to understand the results in further sections. After overall description, the focus lies separately on each topic, i.e. HANPP, Food-eHANPP, Scenarios. If a user is interested in the methods behind the results or wants to know more about the data, they are invited to use this section to find necessary information. The aim is to enrich text with illustrations, diagrams and maps. Additionally, in this section the user will find a video tutorial explaining the functionality of the application. The next three tabs (HANPP, Food-eHANPP, Scenarios) show the results of the topics respectively to their titles. HANPP and Food-eHANPP are interactive maps with the possibility to zoom in and out, rotate and click to show more information. Result values are represented by colours which are part of colour scale adapted to the range of input data. Next to the map, additional control widgets and graphs are placed (Fig. 2-4). These control widgets, like radio buttons, select boxes and sliders, are used to change parameters (e.g. different products) of the input data. Once the user selects the values, the updated information will immediately be shown on the map (Fig. 2-4). Another functionality is the possibility to display information depending on the specific area of the map (e.g. based on administrative or functional boundaries) by clicking on a chosen area (Fig. 4a). Next to each map an information 'I' button is placed. Once the user clicks on it, a short text shows up. The purpose of it is to give a quick overview of that page and how to change the parameters of the map.

HANPP Explorer is built with R programming language and the Shiny R package developed by R Studio, which allow to build an interactive web app (Gebetsroither-Geringer et al., 2018). The code in R is extended by CSS, HTML and JavaScript scripts which allows for a more unique and customised look and functionality of the application. Once the code is uploaded on a specific shiny server, the web application is available to public here: https://cities.ait.ac.at/uilab/udb/home/dev/HANPP_Explorer/.

5.2 Data and Methods

5.2.1 HANPP Vienna

Land use data sets are the basis of HANPP calculations. We use factual land use data ('Realnutzungs-kartierung') provided by the city administration, which is freely available online and is based on air photo interpretation complemented by factual data (OGD, 2020). We aggregate all 32 land-use and -cover categories into 6 land use classes: Cropland comprises of agricultural land used for crops like cereals or vegetables as well as intensively used grassland, while meadows are aggregated as grassland. We specify vineyards as separate land use class as they represent 90% of land with permanent crops and is from extraordinary cultural importance in the city of Vienna. Forestry activities are subsumed within the land use class 'forest'. We further distinguish between sealed settlement (i.e. transport infrastructure) and green settlements, the latter includes parks and other green areas. Additionally, water bodies are identified, but not further processed due to the focus of the HANPP framework on terrestrial ecosystems (see above). For each land use class, we quantify the entity of biomass flows on a given area in terms of net primary production (NPP) starting from the actual production (NPPact), the amounts of harvested biomass (HANPPharv) as well as the amounts of biomass, which would have been produced in the absence of human activities (HANPPluc) and are considered as human appropriation of ecosystem productivity due to land use changes. HANPP is the sum of HANPPharv and HANPPluc (see Fig. 1). The calculation of flows follows the method described in Krausmann et al. (2013) and is based on an extrapolation of available statistics and standardized factors. Agricultural harvest statistics serve as basis for the HANPP calculation on cropland (Statistik Austria, 2020). In vineyards, the main entry point stems from wine production data and has been converted into grape matter assuming a standard output of 69% according to reports from winegrower. Biomass extraction from forest areas is provided by the municipal department for forestry and urban agriculture (MA49) in the form of harvest statistics and reported in solid cubic meters. Similar to cropland, we extrapolate HANPPharv from harvest data using multipliers for wood density by differentiating both deciduous and coniferous species as well as wood fuel and industrial roundwood. We assume zero HANPPharv for sealed settlement, but estimate harvested biomass from parks, house gardens and roadside greenery for green settlement. Harvest data provided by the municipal department for Waste Management, Street Cleaning and Vehicle Fleet (MA48) include biomass flows from organic waste and other biomass not grown in within city boundaries. Therefore, we assume 5% of biomass recycled in Vienna to actually be grown in Vienna. The potential ecosystem productivity (NPPpot), which represents the biomass production in absence of human activities is based on vegetation modelling, here from LPJ-Guess (Smith et al., 2014). HANPPluc, the appropriation associated with land use change, is the difference between NPPpot and NPPact. All values are expressed on the basis of tonnes in dry matter as annual average for the years 2009-2011.

5.2.2 Food-eHANPP Vienna

The Food-eHANPP Vienna, which can also be interpreted as the HANPP footprint of food consumed in Vienna is based on a quantification of Viennese biomass metabolism (Kalt et al., 2021). The concept of the socio-economic metabolism is a systems approach to study society-nature interactions by linking socio-economic with biophysical processes. The reliance of social systems on the supply of biophysical resources and the determination of environmental pressures and impacts by their composition, magnitude and patterns are the key basic assumptions of this concept (Haberl et al., 2019). For the quantification of urban biomass metabolism, two research strands namely urban metabolism and material-flow accounting (MEFA) have been connected. The Viennese biomass metabolism provide data on Vienna's food supply, the embodied biomass as well as its origin (for further details on the methods see Kalt et al., 2021). The data comprise of 108 agricultural primary products aggregated into 8 main categories (cereals, oil crops, sugar crops, roots and tubers, pulses, fruits and nuts, vegetables and stimulants and spices) produced in 148 countries. Six livestock products are considered (milk, beef, pork, eggs, poultry and sheep and goat meat) and expressed in amounts of supplied product as well as in the amount of agricultural primary product required for their production (= embodied feed/biomass). We connect Vienna's biomass footprint for food with values of HANPP associated with the production of one unit of product for a given country. The so-called 'HANPP rucksack' is based on a crop-specific calculation of global HANPP for the year 2010. It is building upon the latest global spatially explicit dataset on agricultural production (Yu et al., 2020) and follows likewise the standard procedure to apply the HANPP framework (see above and Krausmann et al., 2013; Haberl et al., 2007). Methods and outcomes are explained in detail in Semenchuk et al. (subm.). As a result, we obtain the amount and location of HANPP related to food consumed in Vienna, which can be explored within the online toolbox.

5.2.3 Scenario development in stakeholder workshops

HANPP Explorer was developed as an interactive web application, which enables stakeholders, experts and students to learn from our research and interactively explore the topic. In order to achieve a goal of science communication and cooperation with stakeholders it is necessary to listen and organize exchange with stakeholders (Smetschka and Gaube, 2020). Based on the specificity of the case of Vienna we opted to invite stakeholders from city administration responsible for energy and water topics, from private and public food production and consumption bodies including civil society and NGOs to cooperate with scientists from the fields of FWE nexus. We invited a group of stakeholders to a series of workshops. Albeit, in the first workshop we learned that the systemic and complex concept of the FWE nexus is neither known or used by city administration. Stakeholders view the nexus as a promising but overly demanding approach. In the VisToolBox of IN-SOURCE we therefore offer tools addressing food, energy and water separately along with elements where systemic analysis is demonstrated.

In a first stakeholder workshop we explained the HANPP framework as an environmental indicator, discussing data availability and questions arising from stakeholders. In a second workshop we developed scenarios for food, energy and water separately. The HANPP Explorer, as part of the VisToolBox, intends to provide knowledge of the manifold dimensions of urban food, thereby gaining new perspectives on urban land use and opening up possible future developments for discussion.

5.3 Results

For an inter- and transdisciplinary approach of the urban FWE nexus, the 'HANPP Explorer' seeks to facilitate the understanding of urban impacts on terrestrial ecosystems which can be gained through the lens of the HANPP framework. It aims to easily explore the degree of human appropriation of ecosystem productivity associated with Vienna's land use activities – both within the city ('HANPP Vienna') as well as those in the local and global hinterland, which occurs by Vienna's food consumption (Food-eHANPP). As such, the 'HANPP explorer' not only supports a better understanding of the ecological consequences of urban land use and food supply, but also to make the HANPP framework more accessible outside of research communities.

5.3.1 HANPP Vienna

The tab 'HANPP Vienna' allows to explore the depth of intervention into natural ecosystem productivity as well as the differences among six different terrestrial land use classes in terms of HANPP per ha per year within Vienna. The lowest values of HANPP per ha per year can be found on forests and meadows (2.6 resp. 3.1 t dm/ha/yr and 18% resp. 22% of NPPpot), whereas green settlement and vineyards (5.2 resp. 6.3 t dm/ha/yr and 38% resp. 44% of NPPpot) show medium values. Highest values in terms of HANPP/ha/yr show cropland and sealed infrastructure (12.5 resp. 13.9 t dm/ha/yr and 92% resp. 100% of NPPpot). Altogether, the Human appropriation of Net Primary Production (HANPP) in Vienna amounts to 70% of potential net primary production (NPPpot). Fig. 2 shows a spatial presentation of described results for all land use classes within the HANPP Explorer.

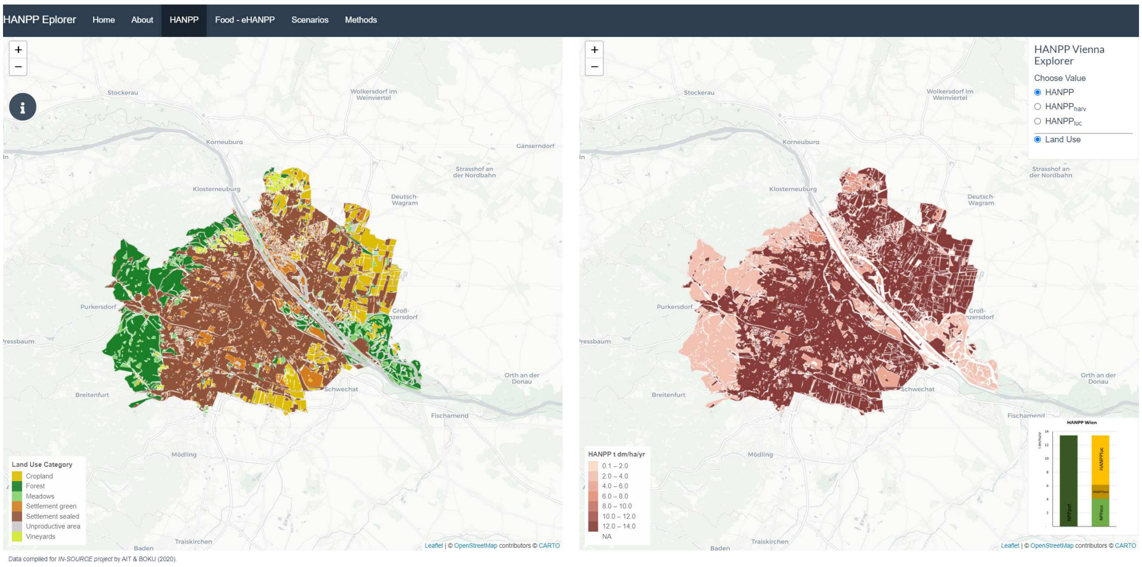

Fig. 2: Screenshots of 'HANPP Vienna' tab in 'HANPP Explorer'. left: shows the extend of 6 terrestrial land-use classes considered within the application of the HANPP framework. right: indicates the depth of intervention into natural ecosystem productivity in terms of HANPP per ha per year. Higher impacts are displayed in darker colours. (https://cities.ait.ac.at/uilab/udb/home/dev/HANPP_Explorer/ - accessed 06-17-2021

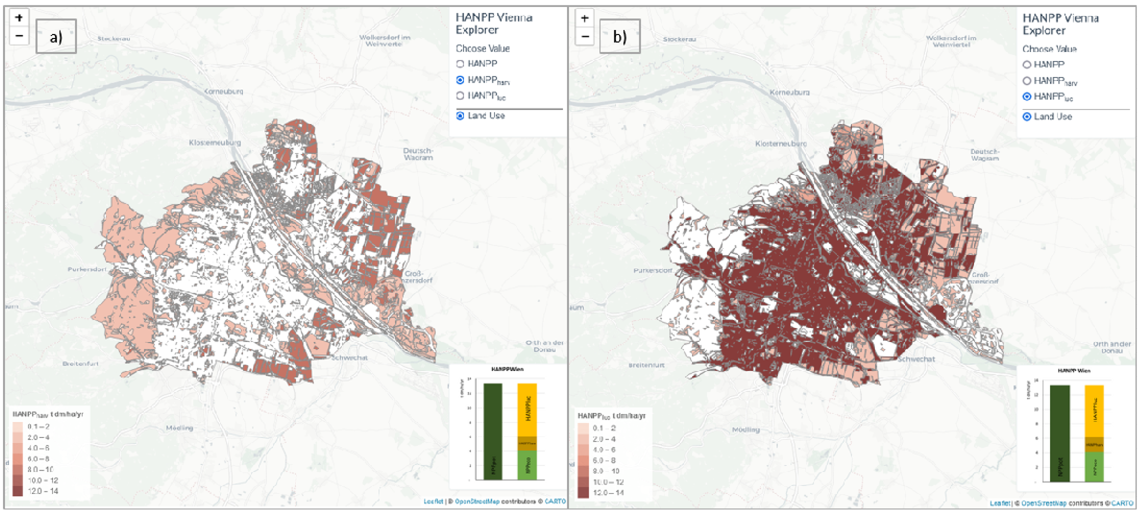

Fig. 3: Screenshot of 'HANPP Vienna' tab in 'HANPP Explorer' a) HANPPharv per ha per year; b) HANPPluc per ha per year for six land-use classes in Vienna. Higher impacts are displayed in darker colours. (https://cities.ait.ac.at/uilab/udb/home/dev/HANPP_Explorer/ - accessed 06-17-2021).

Further, the analysis along the HANPP framework allows for the differentiation of two different processes through which humans appropriate natural ecosystem productivity: while HANPPharv is characterised by biomass extraction mainly for harvest purposes, HANPPluc is induced by the change of land use/cover. This differentiation can be explored by explicit maps of HANPPharv per ha per year resp. HANPPluc per ha per year (see top right in Fig. 2 and Fig. 3). HANPPharv predominantly occurs on land use classes which are characterised by agricultural (cropland and vineyards) resp. forestry activities (forest) (see Fig. 3a). Agricultural areas in the Northeast as well as in the South of the city are coloured in rusty red as well as forest areas in the west (Wiener Wald). The average HANPPharv on cropland in Vienna is 9.4 t dm/ha/yr and in forests 2.6 t dm/ha/yr. Moreover, HANPPharv on green settlement is 3.8 t dm/ha/yr, where plants and trees are trimmed for regrowth or safety reasons. On the contrary, 90% of all HANPPluc occurring in Vienna is associated with sealed settlement (13.9 t dm/ha/yr), which is the largest land use class and characterise in particular central urban areas as can be seen in Fig. 3b).

5.3.2 Food-eHANPP Vienna

The tab 'Food-eHANPP' allows to explore the impacts of global agricultural activities on ecosystem productivity associated with Viennese food supply. It shows the relative distribution of HANPP from cropland and grassland on a country-resolution for the European Union and a regional-resolution for the rest of the world. Over all products, 51% of HANPP embodied in food products consumed in Vienna occurs in Austria, 25 % in other countries of the European Union and 24 % from non-EU-countries. In total, the supply of 0.3 t dm of food products per capita per year requires the production of 1.1 t dm biomass from cropland and grassland, which is associated with 3.0 t dm of HANPP. The difference between the final amounts of products available in Vienna and the biomass which is necessary to produce those is predominantly caused by the conversion efficiency of livestock. It represents the feed for animals for both to maintain their basic metabolism and to produce products such as meat, milk or eggs. Moreover, HANPP embodied in food products indicate further impacts on natural ecosystem productivity next to the harvest of products (=extraction), e.g. changes induced by land use change from the potential vegetation cover to cropland. By doing so, the analysis of Food-eHANPP reveals the disproportional impacts of imports from highly productive world regions such as Latin America and South East Asia.

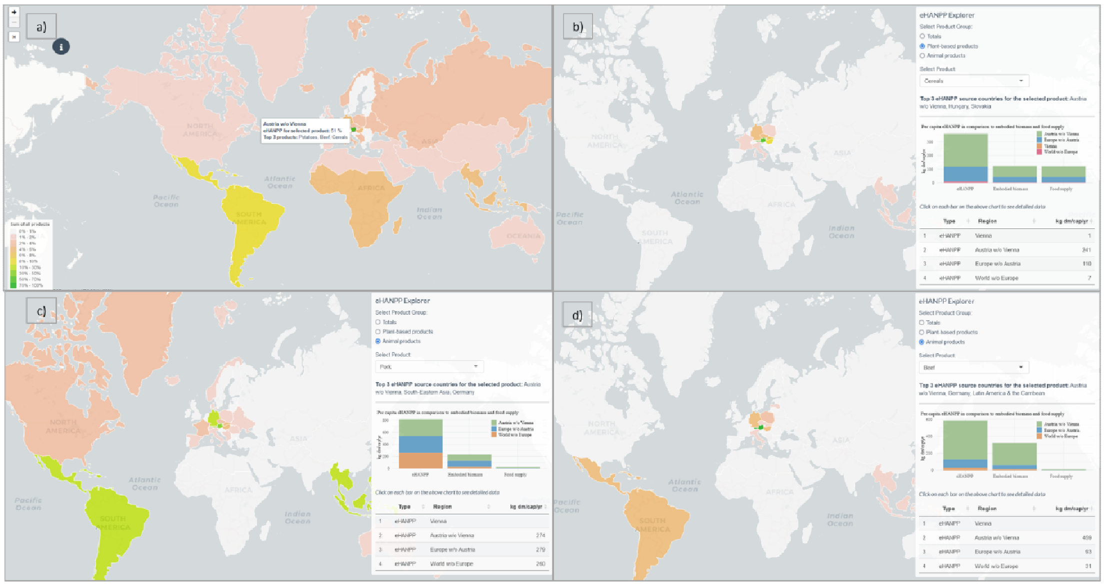

Fig 4: Screenshots of 'Food-eHANPP tab in 'HANPP Explorer' a) Total Food-eHANPP and relative origin; b) Embodied HANPP for cereals consumed in Vienna; c) eHANPP for pork c) eHANPP for beef.
(https://cities.ait.ac.at/uilab/udb/home/dev/HANPP_Explorer/ - accessed 06-17-2021).

Next to the sum of embodied HANPP associated with food supply in Vienna, the origin and the respective contribution of eight groups of plant and six animal products can be explored. For example, the supply of 122 kg dm cereals per capita is associated with 359 kg dm of HANPP of which 67% occurs in Austria and 30% in the rest of the European Union. As a comparison, the supply of 26 kg dm pork per capity per year is associated with 812 kg dm of HANPP. Here, only about 35% of embodied HANPP occurs in Austria, 33% in the rest of the European Union and 33% on Non-EU-regions of which Southeast Asia and Latin America are on top. In contrary, 70% of embodied HANPP in beef (10 kg dm supply per capita with an embodied HANPP of 583 kg dm) originates in Austria, demonstrating the importance of domestic grasslands in the feed supply of ruminants. Overall, the Food-eHANPP map within the HANPP explorer informs about the global ecological impacts of food products consumed in Vienna.

5.3.3 Scenarios

The last tab of the HANPP explorer will show first explorations on scenarios for changes in food production and consumption in Vienna. In IN-SOURCE we cooperated with a group of stakeholders from city administration and NGOs in order to co-create questions arising from a systemic view on the FWE nexus of the city. Scenario ideas elicited in stakeholder workshops range from urban agriculture to multi-purpose uses of roofs and facades of buildings for food production, energy production and lowering energy demands; from wastewater management in order to produce energy and greywater to changes in diets reducing food with high footprints and long-distance transportation.

The aim of the HANPP explorer in terms of scenarios is to inform on the potentials of urban agriculture on the one hand. On the other hand, the focus on food production and consumption of the HANPP footprint indicator can help analysing land-use conflicts in a growing city as well as the impact of diets on the city, but mostly on the urban hinterland and national and global ecosystems. We will provide calculations and explanations on these single issues and invite further questions from users.

6 DISCUSSION AND OUTLOOK

A FWE nexus approach offers an integrative systemic path for an analysis and evaluation of solutions in the context of urban sustainabilty transistions. Yet, to work with it often makes it necessary to focus on specific questions where data can be gathered and analysed. We approach this challenge on the basis of the application, analysis and presentation of the HANPP framework accompanied by stakeholder discussions.

The key questions derived from these stakeholder discussions - posed in a comprehensible language – aim to guide through the HANPP explorer:

- In comparison to other cities, Vienna has a lot of green areas and agriculture - can this contribute to nutrition?
- Vienna is growing fast – what does this mean in terms of conflicts / competition for land use?
- Nutrition has a big impact on ecosystems – (how) can we reduce the impact?

With the help of these questions, users can stroll in the HANPP explorer according to their own interest. The explorer serves three purposes, as it provides an easy introduction to 1) the FWE nexus approach offering links to other FWE tools as part of a bigger VisToolBox and 2) the environmental footprint of HANPP/eHANPP with interactive maps and explanatory texts and graphs. HANPP footprint shows the human appropriation of biomass, whereas eHANPP footprint shows the depth of interventions into ecosystems required for the food supply of the City of Vienna. Further, the HANPP explorer seeks to offer an opportunity for users to explore and learn on topics of sustainable urban development and sustainable resource use in contexts of food consumption. They can deepen their knowledge via in-depth explanations and literature links as well as learning on scenarios potentials and calculated results for example for dietary changes.

As cities can be considered as consumption hotspots, urban green areas and agriculture only can contribute little to urban food demands. Notwithstanding these results, urban food production can be promoted and enlarged in light of its many co-benefits, ranging from greening and cooling the city, providing better air quality and water management to social community aspects. Moreover, it is beneficial for both health and sustainability purposes, to rise knowledge and awareness of food production and its impacts.

Growing cities face conflicts on land use between the functions of living, working, transport and areas for recreation and experience of green environments (plants, good air quality, low noise, …). Though, they are mainly focused on urban land use within city boundaries, despite the prevailing teleconnections induced by food supply from the close and distant hinterland. The eHANPP footprint of food reveals that cities cannot focus merely on the environment within their boundaries but have to seriously consider their impacts, the depth and size of their footprint on the urban hinterland, on the national and global ecosystems. Our analysis revealed that, per capita, the total HANPP within city boundaries over all land use classes is 0.2 t dm/yr, whereas the eHANPP footprint for food supply in Vienna is 3.0 t dm/yr. Therefore, urban land use impacts outside city boundaries surpass those inside by a factor of 13. Discussing urban land use, in particular in the context of the FWE nexus, where sustainable urban resource supply under constrained land availability is explored, needs to adequately take this imbalance into consideration. Hence, the promotion and support of less resource intensive dietary habits such a diets low in animals products or vegetarian diets is inevitable in the urban context. Finally, we hope the HANPP explorer can be used for discussing FWE nexus questions with scientists, experts, administrators and planners in order to further systemic ideas on urban sustainability transitions.

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Urban Resilience Thinking. Dealing with Epistemic Uncertainty in Smart City Development

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1 ABSTRACT

The term resilience is used in various contexts where it is mostly considered within the boundaries of the system under consideration. Relevance of resilience thinking is emphasized in the UN Sustainable Development Goals– especially Sustainable Cities and Communities and Climate Action– and the UN Sendai Framework for Disaster Risk Reduction, which explicitly mentions resilience as a keypriority. Thus, resilience and system transformations must be considered together if sustainability developments should prevail in the long-term.

We propose Urban Resilience Thinkingas a design approach that sensitizes for transformational dynamics on different temporal scales from the short-term to thelong-term, for relations between physical resilience and socio-cultural issues of urban well-being, and for interdependencies between local urban resilience and global sustainability. Crucial to Urban Resilience Thinking is the consideration of potential multiple stable states in urban socio-technical systems, which poses questions with regard to dynamics of transformation between stable states, but also – more fundamentally – with regard to the criteria and values that define notions of systemic stability, risk and resilience.

In a world of changing boundary conditions (e.g. climate change) and fundamentally changing socio-technical urban systems, neither the frequency nor the consequences of various future risks can be reliably determined. This can be illustrated by the unpredictability of future urban supply risks, e.g. power supply, in smart cities with increasingly digitalized, automated and more interconnected services systems including critical services. Adding to such looming epistemic uncertainty we point to the phenomenon of creeping urban risks, such as risks associated with the built up of smart urban infrastructure, which are likely to shapefuture urban risk cultures through citizens' gradual accommodation to emergent risks. Eventually, and in spite of short-term reactions to immediate risks in smart cities, it is creeping urban risks that deserve more research attention.

Keywords: socio-technical systems, Smart City, resilience thinking, smart grid, urban risk cultures

2 URBAN RESILIENCE THINKING

For cities and urban development, the concept of resilience is presently gaining increasing importance as an approach to answer challenges of climate change and associated future urban risks and uncertainties on interrelated levels and subsystems of urban socio-technical organization. However, we should not take resilience as a simple and straight forward concept, but rather consider it in a critical and reflexive manner. The aim is not to implement resilience, but rather to use the concept as a thinking tool for sustainable urban planning and development.

2.1 From Single Equilibrium to Multiple Stable States

The origins of the concept of resilience are contested. It was already in use in psychology as early as the 1940s in reference to vulnerable individuals' and groups' capacities to deal withthe negative effects of adverse life events. Other disciplines such as physics, material sciences, and engineering have also been using the termsince the 1960s and 1970s, for example to characterize the endurance of materials in response to physical stress such as pressure or deformation. As Béné and Doyen (2018)note, around the 1960s ecologists then picked up the concept and started to use it to describe properties of ecosystem dynamics around equilibria, defining resilience, for example, as "a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist"(Holling 1973, p. 17).

Over the past two decades, the concept of 'resilience' has become increasingly important in systems thinking for studying transformative dynamics and the reactions to them within biological, environmental, technological, or social systems. In such disparate systemic considerations resilience approaches have been addressing a general problem of earlier single equilibrium approaches. According to the latter, systems develop around ahomeostaticstate, which gets exposed to negative and positive, destabilizing and re-stabilizingimpacts. According to such homeostatic understandings the functionality and durability, or the degradation and eventual collapse, of a system, or of a complex of interrelated and interdependent systems, is defined by the possibilities of regaining equlibrium after a destabilizing event has occurred.

By contrast, the concept of resilience, considers systems as defined bymultiple stable statesin which systemic dynamics may cause fluctuations between such states. Unbalancing of one stable state, therefore, not necessarily leads to collapse, but may cause systemic transformation into a different stable state. For ecosystems, for example, "this idea stemmed from observations that variability, disturbance and unpredictability are not exceptions that ecological dynamics strive to redress, but rather are the underlying rules for bio-physical dynamics" (Cote and Nightingale 2012, p. 476). With this shift,socio-political agendas and scientific approaches of how to deal with systemic forces of change diverge quite fundamentally: from the modernistic attempt to identify control functions that would allow to maintain, or return to, a single equilibrium state to resilience capacities emphasize adaptation capacities to the changing conditions of multiple stable states and to in-between transititional phases.

2.2 Towards Critical and Reflexive Urban Resilience Thinking

The term resilience has gained considerable influence on urban planning and design for smart cities(Carvalho 2015), it is present in public and media discourses, and it is excercisingmounting influence on institutional development and funding programs for scientific research, it is being applied to aspects of urban design, to legislation and administration, and it turns into an object even of moral and philosophical propositions. Resilience is thereby presently turning into what Michel Foucault (1980, p. 194) once termed an 'apparatus' (sometimes translated also as dispositif), i.e. a formation or network between the elements of discourses, practices, objects, laws etc. "that at a given historical moment has as its major function the response to an urgency." The notion of apparatus may help to develop a reflexive approach in resilience thinking that wards off potential pitfalls of ideological, normative and other biases.

With a view to its societal and political consequences, the concept of resilience has been criticized on at least three accounts. From a modernist stance it is criticized that the adaptive emphasis of the mode of governance that rises from the resilience apparatus de-politicizes adverse conditions by emphasizing the "naturalness of nature", thereby turning the ideological construction of nature into an "object and means of government" (Braun 2014, p. 60). What is more, from the viewpoint of social justice and equal opportunities it has been noted that resilience politics may cause an inappropriate deferrence of responsibility from the realm of politics to individual citizens. Whereas the social welfare state used to be accountable to provide for a population's well-being and access to basic services, resilience measures may focus ever strongly on fostering the capacities of individuals to operate under adverse conditions. And from a critique of neoliberal market practices it has been pointed to how resilience measures seem to develop in ever closer alliance with technology focused solutions for societal problems by succeeding to leverage "governmentally sanctioned infrastructure funding and legal mechanisms to ensure large-scale, low-risk private investments" (Adams 2014, p. 134).

However, clear advantages and critical potential of thinking with the concept of resilience lie in its recognition of presuming the existence of multiple stable system states and insisting therefore on change and transformation as rule rather than exception. Thisbuilds on a historically informed perspective of the longue durée. The continuity of citiesas forms of human settlement with specific functions for their larger reproducing systems with respective ecological, economical, political and cultural dimensions can be considered as evolving on the basis of a number of core characteristics over the past several hundred, or even several thousand years (Frank and Gills 1993). While such macro-historic approaches are debatable and come with their own pitfalls, they shed light on the value-laden and normative impregnation of any attempt at defining a given historical stable state as single, or 'natural'. The historical perspective and the multiple stable states approach, therefore, politicize the concept of resilience by urging questions such as "To whose benefit is this a stable state?", "How and why are alternatives available, or being foreclosed?" "What is to be gained and lost by whom, if forces of transformation are pushed or restrained?"

One need not go into the depths of milleniato bringto underscore that no single equilibrium exists in socio-technical systems. If history tells anything,notions of stability and transformation are a question of scales and temporalities. Cities, in partiuclar, may be conditioned for centuries by their geological settings and long-term physical infrastructure, within which other areas of social, political and cultural life change at medium rhythm, and yet other domains, such as technological innovation, enforce change at ever quickening pace. Approaching urban transformation through the lense of resilience thinking, therefore, gains additional bearing when considering the linkages and interactions between sectoral (environmental, technical, social, cultural etc.)subsystems in terms of social-ecological systems(Berkes and Folke 2002; Folke 2006), or socio-technical systems(Hughes 1990; Pfaffenberger 1988, 1992), and when considering the different temporalities involved in respective dynamics.

Urban resilience thinking, then, has to deal with the absence of definite knowledge about the direction of systemic change, and withan awareness of the impossibility to infer potential future stable system states from the system's history. This raises a set of hoary challenges of not only epistemic, but social and political nature, concerning the definition and representation of societal problems and the distribution of limited social resources to adress them. After all, calls for resilience and resilience measures pose the question: Stable states for whom, and consequently resilience for whom? And at what level? And what arethe objectives of resilience? A plethora of examples from urban contexts can show how what is resilient, or sustainable, in one sector, may have negative impact on sustainability and resilience of another sector, or level, or of the system as a whole.

3 RESILIENCE OF FUTURE URBAN ENERGY SUPPLIES

Uncertainties and risk of future urban energy supply systems that we address here through resilience thinking fall out of established categoriesof risk management. Uncertainties to which resilience thinking can be appliedare epistemic in the sense that scientists either have no single explanatory model or even several competing theories about their future manifestation(Snowden 2002).

3.1 The Temporalities of Epistemic Uncertainty

Expected lifecycles for technological innovation on the level of new urban infrastructure, such as smart distributed and renewable urban energy systems, face temporalities of almost inconsiderable scale whereunknown future boundary conditions of urban systemslead to epistemic uncertainties, because the future stable states of highly integrated socio-technical systems of urban technologies escape reasonable quantification or qualitiative description. In the case of smart distributed and renewable energy systems, quantitative and qualtitative epistemic uncertainties derive from a lack of knowledge about changing boundary conditions, like climate change, from ignorance aboutfuture use-patterns for yet to be invented power-consuming technologies and their dissimination, from the impossibility to forecast more abstract hazards produced by complex and integrated future socio-technical systems (Snowden 2002), or from uncertainty about ethics, values, or political struggles that will be associated with energy in the future.What is more, energy scenario based approximation is bound to decrease with expanding time spans, as is impressively demonstrated by millenial scenarios of future nuclear waste disposals (Ialenti 2020).Historically and conceptually informed in this way, resilience thinking needs to consider risk and vulnerability not as quantitative values, but as "collective constructs" (Douglas and Wildavsky 2010, p. 186). The notion of multiple stable states and the importance given to considering stability and transformation across different temporalities emphasizeshow urban risk and vulnerabilty, for example related to black outs of urban energy supply systems, actually depend on the perception and reception of society and therefore reflect cultural specificity and are susceptible to change(Kubicek et al. 2013; Mohun 2016).

3.2 Resilience Thinking and Systemic Considerations about Urban Risk Mitigation

Ottenburger et al. (2020) suggest that beyond technical and economic aspects, systemic risk perspectives need to contribute to smart grid planning and operation. Here, statistical probabilities of occurrence are complemented by considerations about socio-technical impacts of disrupted (critical) services on urban populations. Principles from resilience research, such as elasticity in the design and operation of technical systems as well as forms of non-digital urban self-coping capacities must be more strongly integrated into future risk mitigation considerations.And with regard to the adaptive capacities of urban societies,Kropp et al. (2021) suggest that socio-technical impacts ask for socio-technical answers in terms of urban social and cultural innovation.

Such innovative considerations clearly show the limitations of accustomed classification of urban risks into cateogries ofHigh Probability Low Impact (HPLI) and Low Probability High Impact (LPHI)which broadly rely on technical answers to events in both risk categories within the scope of sectoral containment of risk. In contrast to Reliability Engineering, which is mostly concerned with HPLI risks,Resilience Engineering is concerned with LPHI risks. The key thesis in our resilience thinking approach, therefore, is: if systems of urban critical infrastructures converge and become increasingly meshed, for example in urban smart grids, thus leading to a rising amount of potential cascades, the handling of smart urban risks, which can eventually produce high damages (high impact risks), must become an essential aspect in the development of resilient socio-technical systems.

4 CREEPING HIGH IMPACTRISKS IN LONG-TERM SYSTEMIC EVOLUTION

Creeping risks develop over longer time scales. They build up through a quite paradoxical social mechanism that involves, on the one hand, the gradual, and often unnoticed, accumulation of changes in urban everyday life, and, on the other hand, the gradual, and often unnoticed, accommodation to such changes. We will discuss the former with regard to the risk driving phenomenon of massification and the latter with regard to the risk driving phenomenon of accommodation.

4.1 "Massification"

In our terms, massification refers to supply risks resulting from an unrestrained multiplication ofmarket participants and consumers, and of interconnected technical objects, for example in smart homes, smart vehicles etc. Unrestricted multiplication of smart devices and use frequency is bound to translate into unforeseen feedback loops when reaching the limits of an expandable, but eventually finite physical environment of the technological infrastructure. It may therfore causea creeping deterioration in service performance and quality of life. Massification, therefore,unfolds from a sublime and initial stage with risks that are hard to assess or even address, to noticable and later impending drawbacks on the quality of services, on quality of urban life and eventually system disintegration whichmay leadeither to increasedmitigation efforts or, indeed, to risk cultures of accommodation.

One example to illustrate this dynamic in the context of urban smart grids is the largely unexperienced, but often favourably discussed concept ofdemand side management (DSM). Itaims at dealing with supply limits or physical system limits through price signal-oriented mechanisms, peak shaving, or nudging. However, besides opening the possibility for price manipulations (Li and Han 2011), DSM may prove incompatible with the paradigm of consumer rights and liberal markets. Or it may exploit social digital divides by economically prioritizing distribution in times of power scarcity, instead of maintaining fair power distribution (Ottenburger et al. 2020).

Going beyond such sectoral solutions, a systemic and resilient handling of future urban high impact risks should consider massification as an evolving socio-technical risk driving force. This need is illustrated by urban heat island phenomena due to climate change, which will likely cause extended use of existing and addition of new air conditioning units that may stretch urban renewable power demand beyond supply capacities (Radhi and Sharples 2013; Santamouris 2014). With urban heat rising over the coming decades, DSM solutions for grid stability may fail as the need to cool private homes and offices overrules price incentives. And even if the overall power demand can be satisfied in an economic sense, capacities of the urban distribution grid might physically fail to supply power, leading to local blackouts on the low or medium voltage level. This consideration of 'fairness' in power allocation brings urban resilience thinking full circle to the political, normative and value-laden baggage of notions as stable system states.

4.2 "'Accommodation"

Some risk mitigating technologies maycreate the paradoxical effect of producing new risks (Jablonowski 2007, p. 123; Büscher and Mascareño 2014, p. 71). Risk driving effects of massification thus cause a paradoxical space for future risk culture between, on the one side, the normative vision of smart urban technology as guarantor for efficiency, improvement and urban well-being (Raimi and Carrico 2016), and, on the other side, likely drawbacks, new risks and risk cultures of accommodation. The paradoxical situation "in which the condition of possibility is also the condition of impossibility" (Kessler and Daase 2008, p. 212) also seems to apply to the relation between risk mitigating smart technology and the risk driving dynamic of ensuing massification in urban smart grids.

From an urban planning perspective the paradox of, on the one hand, intended improvements and risk mitigation, and, on the other hand, improvements accompanied by drawbacks and new risks is usually treated in terms of the social acceptance and ethical acceptability of risks created by innovative technologies (Taebi 2017). Acceptance and acceptability approaches require a prospective awareness of future risks in question. However, future risks often cannot be foreseen, or awareness of potential risks does not become part of a wider public debate that would allow treating them socially and politically in terms of acceptability and acceptance. Instead, for risks that emerge paradoxically in parallel with expected improvements there is the evident danger of creeping accommodation to gradually routinized risks. Accommodation to risk proceeds along the standard pattern of organizational behavior where “past successes contribute to the persistence of a given path of action through focusing on the same strategies”, thus leading to a “path of convergence which diminishes awareness of important forces of divergence” (Cunha and Putnam 2019, p. 95). As emergent risks rarely show their fully-fledged potentials creeping accommodation, latency and suspended salience to new risks reign supreme. Indeed, accommodation to risk can be understood as a “process of learning and routinizing [that] is positioned on the level of individual experiences of risk-taking.” (Zinn 2020, p. 102) As Levitas (2000, p. 203) shows, monetary compensations for taking risks, for example through insurance, can lead to risk accommodation, but compensations for risk taking are also offered on more mundane and less institutionalized levels: many risks are accommodated into everyday behavior against rational consideration, for example for the sake of comfort and efficiency.

4.3 A historical analogy

The effects of massification and accommodation with regard to high impact economic and health risks become evident if we draw on a well-known analogy between the historical example of the advance of individual motorized mobility in the car-friendly city and the advance of smart grids in the computer-friendly city. In Germany, the intra and inter urban road system has increased massively over the past century. To take one example, the highway system today is about five times as long as it used to be in the 1960s, and even if we consider added highway width to compensate for the increase of registered passenger cars up to the present by factor ten, we must still acknowledge that through dynamics ofmassification in terms of use frequency the length of reported traffic jams has increased by a factor well over 50.000! This dynamic of massification in traffic, combined with rigorous expansion of road space into agricultural, natural and recreational spaces within and without cities, has turned into a drama of densification, intensification and system overload within a finite physical system. With hindsight one can say that while no one was able to foresee the risk of massification at the inception of the modern German road system, with progressive systemic evolution individual motorized mobility creepingly has turned into a non-negligible risk and today manifests as a high impact risk threatening the quality of life of many people who suffer from traffic stress, congestions, and waiting times, not to speak of environmental degradations, injuries and casualties caused by accidents or health issues due to air and noise pollution (Moore et al. 2003). Paradoxically, the forces of creeping accommodation still obscure this evident risk trajectory.

If we reason by analogy the above example creates a sombre prospect about potential effects of massification on smart urban grids, where an apparent necessity may involuntarily create considerable risks:In order to combat global climate change cities as major emitters of CO2 must seek transition to renewable energy sources, which will necessitate a new system of innumerable small and distributed (private) electricity producers that are coordinated by smart meters asnecessary system components for load balancing in urban smart grids under conditions of diverse, distributed and fluctuating power provision. However, their stabilizing effect on the level of infrastructure is compromised bynew security threats(Singh et al. 2020)they open the gate to risk driving effects of massification through innumerable market participants and consumers who put to use smart auxiliary appliances on secondary, tertiary and further levels of urban socio-technical systems.In more abstract terms, the historical analogy of the car-friendly city and the computer-friendly city demonstrates how massification in combination with accommodation leads to high impact risks as the system load surpasses certain physical and socio-cultural system capacities.

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5 CONCLUSION

By including the notion of multiple system states and the notion of dynamic and transformation accross different temporalities, extending from the longue durée of the evolution of urban socio-technical systems to the micro-seconds of urban smart grid management, urban resilience thinking draws attention to the normative and value-laden nature of any the conception of 'stable system states'.For dealing with future stable states of urban socio-technical systems it has therefore become evident that with regard to epistemic uncertaintyno authoritative quantitative estimates can be given on the probability, frequency, or impact of future urban energy supply risks. This, in turn, leads to the conclusion that decisions aboutthe allocation of present-day social resources to future problems are bound to be marked by the imprints of contemporary political contestations. The qualities of future risk cultures are quite impossible to foresee, but a larger societal debate on potential paradoxes, drawbacks and conditions of emergence for urban smart risks should not be barred by creeping accommodation to risk.

From the perspective of prospective resilience thinking the socio-technical framing of the conditions of emergence of the future requires not only social aspects to be integrated into technical systems, but also an increased attention to building a diversity of complementary and parallel non-technological and non-digital coping capacities, for example neighborhood energy storage systems (Ottenburger and Ufer 2019), or locally rooted systems of solidarity and mutual support (Ufer 2018). Building resilient structures in smart citiesthat can answer to urban transformations with multiple conceivable and presently unconeivable future stable states, therefore, should aim at enhancing socio-technical resilience and socio-cultural innovation.

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reviewed paper

Urban Rooftop Uses: Competition and Potentials from the Perspective of Farming and Aquaponics – a Berlin Case Study

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1 ABSTRACT

Accelerating urbanisation is profoundly changing our world, making it necessary to rethink - inter alia - the way cities distribute and provide food. Agriculture is an emerging urban use that can play an important role in these processes, supporting circular economy and resilience, but competes with other uses for limited space. One option to address this spatial problem in relation to urban food production is to exploit rooftops. For evaluation, we investigated the use, competition and potential of urban roofscapes, using the city of Berlin as an example. An overview of current roofscape uses in Berlin is given, plans and initiatives for further expansion are presented, rooftop potential studies are compared, and important boundary conditions of rooftop uses are discussed. Berlin's roofscape of 97.3 km² (excluding 4.5 km² underground garages) already has a wide range of roof uses, with green roofs (11.8 km²) and solar roofs (0.7 km²) being the most common ones. As on the ground, commercial urban farming competes for space in the roofscape. We highlight rooftop aquaponics as a possibility to save resources by coupling fish and crop production and producing animal protein with a low environmental footprint compared to other animal farming systems. Freestanding single-storey aquaponic systems in inner cities should be avoided and in Berlin, approximately 800 buildings of appropriate using type exist with more than 2000 m² roof area as a precondition to host commercial rooftop aquaponics. The selection of specific sites should consider the availability of urban resources and requirements of an urban situation for the roofscape under existing as well as future competitive conditions. Further research efforts are required to adapt building regulations and planning laws, determine circular city locations for rooftop aquaponics, and evaluate the potential of peri-urban versus urban rooftop food production.

Keywords: Urban Roofscape, Cityscape, Competition, Urban Agriculture, Aquaponic Farming, Aquaponics

2 INTRODUCTION

Nearly all future growth in the world's population will occur in urban areas so that by 2050, 68% of the global population will live in cities (UN, 2019). The projected global population growth will increase diet-related environmental pressure (FAO et al., 2020) and humanity's environmental challenges have grown in number and severity, thus now representing a planetary emergency (UNEP, 2021).

Urban agriculture is one solution to these problems and becoming more common in many cities, e.g. using the framework of the Milan Urban Food Policy Pact (MUFPP, 2015). Consumers seek healthy, local products; local food production can reduce carbon dioxide emissions by having minimal, short-distance-transportation from where food is produced to where it is consumed, and can also help consumers to become better educated about vegetable crops and their production cycles through programs at local farms (Walters & Stoelzle Midden, 2018). Urban agriculture has thus become of great interest in finding new answers for the challenges of how cities can master recent social, economic, and ecological challenges (Lohrberg, 2016). It can help to redirect straight chains of water, energy and matter into more circular flow patterns imitating natural ecosystems (Nehls et al., 2016). In addition, urban agriculture may contribute to the resilience of cities in pandemic situations (Baganz et al., 2020a; Lal, 2020). However, the limited space often results in conflicts of use and objectives for cities and municipalities, especially when climate-friendly measures are countered by high rents and land prices (Wagner et al., 2019). Being a special form of an optimised circular urban agriculture, aquaponic farming (Baganz et al., 2021a) will be briefly highlighted later on.

To avoid land consumption, the idea to produce food on a larger scale in and on buildings in urban areas emerged during the last years (Specht et al., 2013). High densities and scarce land reserves require new strategies for open space planning, in which the roofscape area represents a considerable potential for improving the quantity of open space available (MünchSB, 2012). There is great potential on roofs to accommodate additional functions spatially and structurally (Harada & Whitlow, 2020). Roof use is thus a comparatively easily accessible resource for agricultures related in the context of buildings, as roofs can be changed without affecting or altering the rest of the building use. Supermarkets, hotels, convention centres, hospitals, schools, apartment blocks, prisons, warehouses, and shopping malls may provide ideal settings for rooftop greenhouses (Caplow, 2009). Several examples of green roofs throughout the world are used to effectively produce a local and sustainable food source (Walters & Stoelzle Midden, 2018) and case studies are available, e.g. 'Brooklyn Grange Navy Yard Farm' (Harada et al., 2018).

These trends can also be observed in Berlin. The city is growing and that copes with a limited surface area, which means increased competition for space (SenSW, 2020). The Charter for Berlin's Urban Green Space also points out that the growing city leads to growing pressure of use on many areas, competing perspectives, and conflicts of interest and goals (SenUVK, 2020). An example of direct competition for land is the discussion about allotment gardens, which are either to become public parks[1] or – under the heading of 'garden cities instead of garden gnomes' - are to make way, at least in part, for housing construction.[2]

Berlin has a long agricultural tradition on its own and still has large contiguous agricultural areas. They are formative elements of Berlin's cultural landscape and climatic relief areas and are often still used intensively, with considerable potential for enhancing recreational use, climatic functions or habitats for plants and animals. These agricultural areas are to be ecologically upgraded with the aim of environmentally sound land management (SenUVK, 2020), inter alia using the "Berlin Ökokonto" (SenUVK, 2019a).

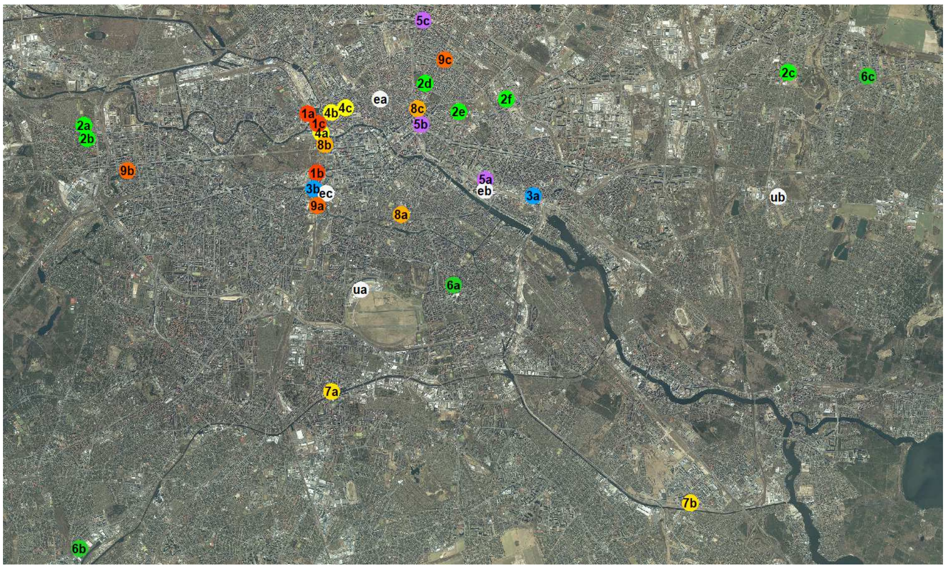

Fig. 1: Overview of the Berlin roofscape usage examples. Colours represent the different use categories of section 3. Codes relates to the sub-figure numbers. This and all following backgrounds: DOP by SenSW (2018).

The further development of Berlin is taking place under several conditions, one of which – population growth – has already been mentioned. A second is the decoupling of urban growth from the negative consequences of climate change by adaptation, a task addressed by the Urban Development Plan 'Climate' (SenStadtUm, 2016b). Thirdly, being a basic resource, land cannot be enlarged. In the climate protection concept 2016, the Federal Government of Germany strives for a circular land economy with a land consumption target of net zero by 2050 (BMUB, 2016). This is the frame for divergent claims on land and buildings utilisation and land competition for housing, industry, traffic, trade, commerce, ecosystem services (sponge town), nature conservation, compensation for interventions in the natural balance and landscape, and further ones. Therefore, it is proposed to switch to urban roof areas Specht et al. (2013); (Million et al., 2018), though there, similarly to on the ground, different uses compete with each other: extensive/intensive green roofs, biodiversity, rainwater retention, solar energy use, recreation, urban gardening and agriculture.

Aim

[1] https://www.zeit.de/zeit-magazin/leben/2019-01/kleingaerten-schrebergaerten-wohnungsmarkt/komplettansicht

[2] https://www.tagesspiegel.de/politik/wohnungsnot-in-berlin-weg-mit-den-kleingaerten-gartenstaedte-statt-gartenzwerge/23601056.html

To study the use, competition, and potentials of urban roofscape using the example of Berlin, also from the perspective of rooftop farming and aquaponics (food production coupling aquaculture with hydroponics), we pursue these goals: (1) to give an overview of current rooftop uses in Berlin, (2) to present plans and initiatives for further expansion of rooftop uses, (3) to show studies on the potential of rooftop urban farming, (4) especially using aquaponics as an example, and (5) to discuss some important boundary conditions of rooftop uses.

3 EXAMPLES OF ROOFSCAPE USES

This section gives an overview of current rooftop uses in Berlin through selected examples, whose locations can be seen in Fig. 1. The example set is not exhaustive but gives a good impression of the very different roof uses.

Core uses: The Official Real Estate Cadastre Information System of Berlin has recorded 535,400 buildings (ALKIS, 2020). The roofs of most of these buildings serve to protect the building from the weather or to provide lighting, shade or to accommodate building services (cf. Fig. 2).

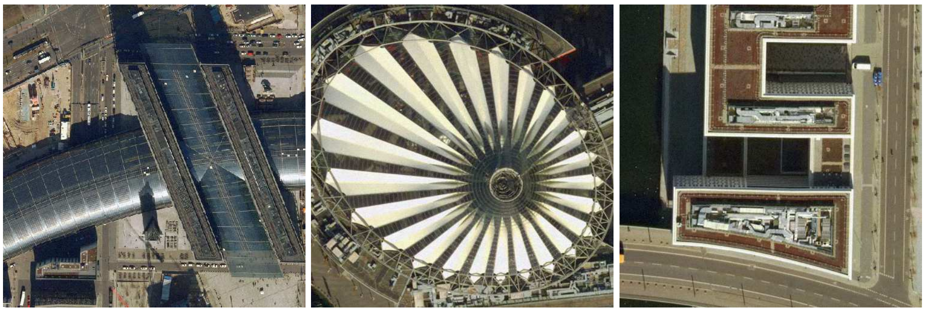

Fig. 2: Core uses: 1a) lighting, 1b) Shade, 1c) Technical equipment.

Greenery: Green roofs are multifunctional. They retain rainwater, mitigate the effects of heavy rain and extreme weather events, help to improve air quality, serve as recreational space for people, and generate new habitats for insects, birds and plants. Berlin has 400 ha of green roof area with a share of 85% in extensive (cf. Fig. 3/2a) and 15% in intensive (cf. Fig. 3/2b) green roofs.

		Green roof area		
Extensive	ha	339.7		84.9%
Intensive	ha	60.6		15.1%
Total	ha	400.3		100%
		Buildings with green roof	**Berlin**	
Buildings	num	18,368	604,865	3.0%
Building floor area	ha	1,185	10,330	11.5%
		Total green roof area	**Building floor area**	
Buildings with green roof	ha	400.3	1,185	33.8%
Berlin	ha	400.3	10,330	3.9%

Table 1 Berlin green roofs, Data from (Coenradie et al., 2016), including NOT-ALK buildings

The building floor area of buildings with green roofs accounts for 1,185 ha; this is a share of 11.5% of the total building floor area of Berlin. NB: The total count of buildings in Table 1 includes 73,000 NOT-ALK-Buildings.[3] At 34%, an average of one third of the area of a green roof is actually covered with vegetation (cf. Table 1). Another important function of green roofs is the support of biodiversity (cf. Fig. 3/2c), thus bringing back nature into the city (Knapp et al., 2019).

[3] Coenradie et al. (2016): "As part of the project Determination of building and vegetation heights in Berlin commissioned by SenStadtUm, approx. 73,000 buildings were recorded that were not available in the ALK of 2014. For this purpose, aerial photographs from September flights in 2009 and 2010 were evaluated. For the green roof mapping, a selection was made of the so-called NOT-ALK buildings, which were subsequently combined in gridded form with the ALKIS buildings in a new data set Buildings. With this building compilation, the analysis area to be evaluated was determined."

Fig. 3: Greenery: 2a) extensive and 2b) intensive green rooftop, 2c) biodiversity.

Public park: Roofs can be used for public parks, such as Vierhavenstrip in Rotterdam or New York's High Line Park at a former goods train track. The Berlin examples comprise buildings with rooftop parks open to the public without time restrictions and whose constructions are more than 100 years apart (cf. Fig. 4).

Fig. 4: Public park: 2d) Former water reservoir (1873), 2f) Former bunker (1941), 2e) Partly: Velodrome/indoor bath (1996).

Water: Stormwater retention (cf. Fig. 5/3a) is a challenge for Berlin and a study to mainstream rainwater harvesting in Berlin, which emphasises the split wastewater tariff introduced in Berlin in 2000 consisting of a fee per m² of sealed area for each property with the option of paying no fees or getting discounts for surfaces with no or low run-off (García Soler et al., 2018).

In an important location for the cityscape of Berlin, at the 'Stadtkrone' at Potsdamer Platz, a series of urban pools have been realised (ca. 1.2 ha), which are fed entirely by rainwater, collected from the roofs of the surrounding buildings (cf. Fig. 5/3b) and captured in underground cisterns; and used – besides the pools – for flushing toilets irrigating green areas.[4]

Fig. 5: Water: 3a) private housing, stormwater retention, 3b) rainwater harvest and pools.

Solar energy: By the end of 2016, around 6,280 photovoltaic systems (Fig. 6/4a) had been installed in Berlin, with a total installed capacity of about 86.2 MWp; the installed area is not specified. By the end of 2017, there were 7,900 solar thermal systems (Fig. 6/4b and Fig. 12) with a total installed collector area of about 71,000 m² and an average size per collector over the years of 11 m².[5] NB: For comparison, the large ground-mounted systems reach 20.9 MWp[6] for photovoltaic and ca. 0.7 MW[7] for solarthermics. Glass greenhouses

[4] https://www.urbangreenbluegrids.com/projects/potsdamer-platz-berlin-germany/

[5] https://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/d809_01.htm

[6] https://www.solarwende-berlin.de/grundlagenwissen-solarenergie/best-practice-in-berlin/2019-freiflaechen-solarkraftwerk-dallgow-doeberitz-saferay

[7] https://group.vattenfall.com/de/newsroom/pressemitteilungen/2018/berlins-groesste-solarthermie-anlage-ist-am-netz

also use sunlight (Fig. 6/4c); as far as we know, there is only one example of this in Berlin at the Institute of Biology at Humboldt University.

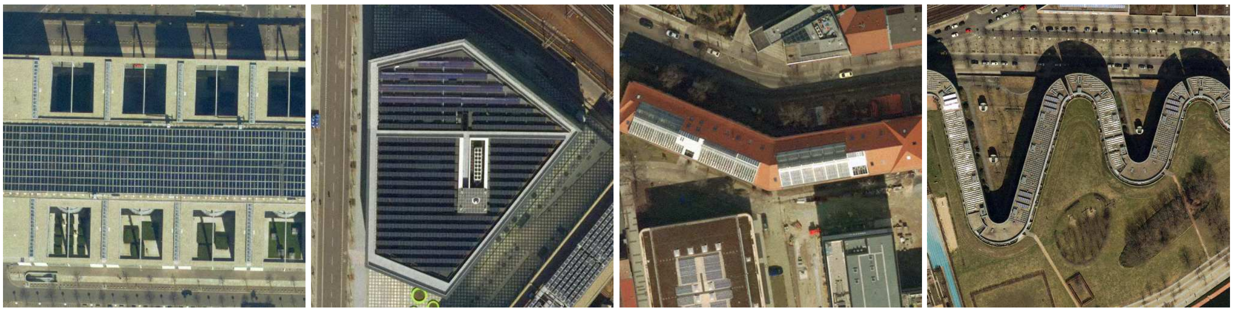

Fig. 6: Solar energy: 4a) semi-transparent photovoltaics, 4b) and 4d) photovoltaics and solarthermics, 4c) glass greenhouse.

Recreation covers a wide range of functions, and the examples show a small set only: a sports "field", a club, and a bar (Fig. 7).

Fig. 7: Recreation - 5a) sports “field”, 5b) club, 5c) bar.

Urban farming and urban gardening: Well-known rooftop examples are the Goerzwerk roof (cf. Fig. 8/6a)[8] [9]and the Horstwirtschaft at Klunkerkranich[10] (cf. Fig. 8/6b). Currently, gardening on Berlin’s roofscape plays a rather subordinate role.

Roofs are also used for beekeeping (SenUVK, 2019b), e.g. on the city hall’s rooftop[11], however, there is competition between wild bees and honey bees[12] [13] leading to a conflict of objectives with roof use for biodiversity.

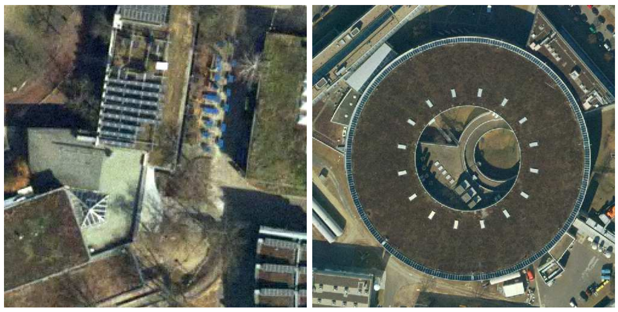

Fig. 8: Urban farming - 6a) urban gardening, 6b) urban gardening and bar. Fig. 9: Combined uses -7a) green/ photovoltaics, 7b) research centre, green roof and stormwater retention.

Combined uses: Functions can be combined on roofs, for example, greening and water storage. The Urban Development Plan “Climate” highlights the suitability of blue-green roofs (cf. Fig. 9/7b) in terms of adaptation to climate change; if the water is stored for a more extended time period, it can increase the

[8] https://www.berliner-woche.de/lichterfelde/c-wirtschaft/kartoffeln-und-exotisches-gemuese-vom-goerzwerk-dach_a221377

[9] https://www.naturopolis.nl/en.html

[10] http://klunkerkranich.org/locations/horstwirtschaft/

[11] https://berlin.deutschland-summt.de/rathaus-marzahn-hellersdorf.html

[12] https://www.tagesspiegel.de/berlin/kritik-an-bienenkaesten-auf-hochhaeusern-experte-wirft-berliner-imkern-tierquaelerei-vor/24304670.html

[13] https://www.tagesspiegel.de/wirtschaft/das-geschaeft-mit-den-bienen-honigbienenhaltung-hat-mit-naturschutz-ueberhaupt-nichts-zu-tun/24680722.html

evapotranspiration of the roof vegetation during dry periods and thus contribute to cooling the city (SenStadtUm, 2016b). The integration of green roof and solar photovoltaic systems (cf. Fig. 9/7a) is possible (Hui & Chan, 2011) and since green roofs are thermally cool, they potentially improve the efficiency of photovoltaic panels (Witmer & Brownson, 2011).

Etc.: The roofscape examples are compiled in this study to show the possibilities of various roof uses in Berlin. In addition, two further examples of a rather unusual roof usage in Berlin should be mentioned here: a swimming pool and a company trademark. Helipads on hospital rooftops are not shown.

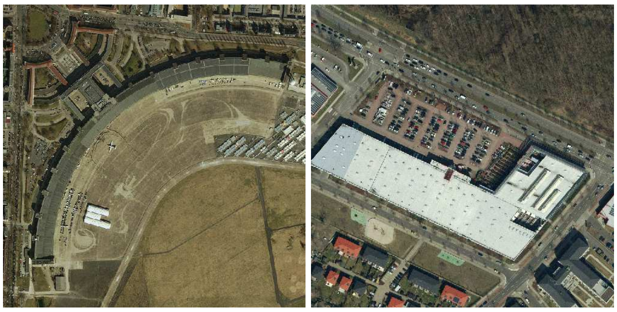

Fig. 10: Etc – ea) pool, eb) signet. Fig. 11: Unused/underused rooftops – ua) Tempelhof Airport Building, ub) Shopping centre

4 PLANS AND STUDIES

Unused/underused rooftops. Regarding the use of the roofscape, there are various plans by the Berlin Senate Administration and proposals that have been developed in research studies. These potentials refer to roof areas that are currently little or not used.

Green roofs offer – as nature-based solutions – approaches to increase the quality of urban settings, enhance local resilience and promote sustainable lifestyles, improving both the health and the well-being of Berlin's citizens. Therefore, a funding program was launched to create at least 1000 new green roofs to compensate for the increasing densification of the city and the associated negative environmental and climate impacts in the long term. NB: the programme 'GründachPLUS' (1) relates to a specific area, (2) requires precautions for statics as well as fall-protection of the respective green roofs, and (2) the green roof project must not lead to an increase in rental prices)[14]. In addition, the strategy for the protection and promotion of bees and other pollinators in Berlin was set out to benefit biodiversity roofs (SenUVK, 2019b). These activities go together with a general instrument for increasing the green share in the city, the biotope area factor, which can be used within legal regulations in Berlin in a landscape plan (Melzer & Herfort, 2020). There are also intensions to make green roofs mandatory on new buildings in the Berlin Building Code.[15] An office building with a roof park is also planned in Berlin[16], and of course, this use is incompatible with rooftop farming: where there is a park, there cannot be a farm. However, roof greenery is only a limited substitute for public greenery because of its limited accessibility, and it bears the risk of development towards inequality of public spaces (Loughran, 2014). To our knowledge, there is no survey of Berlin's total green roof potential. For the district of Friedrichshain-Kreuzberg, Belz (2010) has conducted a study and this methodical approach could be used to determine the potential for Berlin.

Fig. 12: Photovoltaics at Futurium, Berlin. © G.F.M. Baganz

[14] https://www.ibb.de/de/foerderprogramme/gruendachplus.html
[15] https://www.bz-berlin.de/landespolitik/neuer-rot-rot-gruener-bauplan-erschwert-das-bauen-in-berlin
[16] https://www.bauwens.de/projects/aera-berlin

Solar energy: In contrast to green spaces, a total potential for the use of solar energy was determined. The roof area of 10,660 ha (533,190 buildings) offers potential for photovoltaics and solar-thermal energy of 6,437 MW in a basic scenario (SenWEB, 2020). The Berlin Solar Act is intended to advance these plans concerning non-public buildings in the state of Berlin in order to increase the share of solar energy in electricity consumption to at least 25% as quickly as possible. For new buildings and for existing buildings in the case of significant roof conversions, the law stipulates that photovoltaic systems must cover at least 30% of the gross roof area of a building (SenJust, 2021).

19.5% of Berlin's total gross roof area belong to buildings under monument protection, which are excluded from this potential, as it is not possible to estimate the extent to which solar systems on monuments can be permitted in the future (SenWEB, 2020). The building sector, and thus also the listed buildings, plays an important role in achieving the Paris climate targets through CO2 savings and climate neutrality of all buildings by 2050. Conflicts between the requirements of climate protection, the protection of historical monuments, and roofscapes' visual appearance will increase. Albeit, solar systems can contribute to the contemporary use of architectural monuments, and new technological approaches to solar modules (shapes, foils, colour, appearance) offer great potential in the future.

Solarthermics is an alternative energy option in constructing new single-family homes, besides the use in other cases.

Roof extensions are a possibility for the use of existing roof surfaces. The certainly best-known Berlin example is the Bundestag dome (cf. Fig. 13/8b and Fig. 19). Berlin's Urban Development Plan for Housing responds to the development of Berlin's population: in 2016, 3,670,600 people with their main residence lived in Berlin; between 2011 and 2016, Berlin gained 243,500 inhabitants on balance, an increase of 7.1%. This creates a need for new construction of 194,000 flats, compared to a new construction potential of 199,000 flats, including roof extensions in existing buildings without specifying a number. However, this plan states that more than 10,000 dwellings were realised from 2011 to 2016 in single-family houses and through measures such as additions or loft conversions (SenSW, 2019). A study found that between 14,000-36,000 residential units could be realised at around 330 urban integrated locations of single-storey grocery stores at sites already developed and mostly located within or on the edge of existing residential areas; in some cases, with special location qualities, e.g. on the waterfront or opposite a park. (SenStadtUm, 2016a).

Fig. 13: Roof extensions - 8a) housing, solid wood construction, 8b) Bundestag dome, steel and glass, 8c) Metropolitan School, timber frame construction 8d) Hotel, prefabricated wooden boxes (under construction).

In a German-wide study on the roof extensions and conversion of non-residential buildings, the potential for housing construction was determined (Tichelmann et al., 2019) but without breaking down the data to individual federal states. Based on the data of this study, there are indications for a potential of between 150,000[17] and 180,000[18]) dwellings in Berlin, strengthening the internal development ('Innenentwicklung'). This pressure from housing displaces other uses, although roof extensions themselves have new roofs that can be exploited by uses without major statical requirements. To take advantage of adding storeys, Tichelmann et al. (2019) give 13 recommendations for adapting building regulations and planning laws, some of which also apply to urban farming.

Building inclusive roof conversions: In some cases, an entire building is converted and then it is sensible to consider extended roof use (cf. Fig. 14).

[17] https://www.sein.de/150-000-neue-wohnungen-fuer-berlin/

[18] https://www.tagesspiegel.de/berlin/nachverdichtung-180-000-neue-wohnungen-in-berlin-ohne-neues-bauland/24045550.html

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Fig. 14: Building conversions – 9a) former multi-storey car park (under construction), 9b) former courthouse, 9c) former hospital.

5 URBAN FARMING USE POTENTIAL

Specht et al. (2013) introduced the term “zero-acreage farming” (ZFarming) to describe all types of urban agriculture characterised by the non-use of farmland or open space, thereby differentiating building-related forms of urban agriculture from those in parks, gardens, or urban wastelands. Three main types of ZFarming are considered: rooftop gardens/farms, rooftop greenhouses, and indoor farms. The analysis of Specht et al. (2013) shows that ZFarming has multiple functions and produces a range of non-food and non-market goods that may positively impacts the urban setting. From our point of view, ‘zero-acreage’ is misleading because roofscape acreage is actually needed, and ZFarming prevents other uses there. Identifying the potential of ZFarming was the aim of project ZFarm. In 2013, the project determined an area of 831 hectares of potential space for commercial ZFarming, of which 479 hectares based on space layouts were suitable or highly suitable (ZFarm, 2013).

Based on the ZFarm results, among others, the project Roof-Water-Farm (RWF) has elicited a potential of 2.300 ha for rooftop greenhouses with a minimum roof size of 50 m². With a roughly assumed annual production volume of 25 kg/m² of vegetables and 13 kg/m² of fish, a production volume of up to 300,000 tonnes of vegetables and 10,000 tonnes of fish could be achieved (Million et al., 2018). With good aquaponic setups, significantly higher values for fileted fish and marketable tomatoes are attainable (Baganz et al., 2021b).

Research carried out by a team from the Humboldt University of Berlin reveals a potential area for rooftop farming of 888.7 ha with a minimum roof size of 1,000 m², including 998 roofs with 2,500 m² or more. The results indicate that vegetables grown on the available rooftop area could cover the annual need of Berlin’s inhabitants by more than 100%, even when cultivating the main vegetable species simultaneously (Altmann et al., 2018). All roof potential studies did not consider the statics of the chosen buildings or the legal feasibility of food production in the particular area.

These issues are to be included when building-integrated urban agriculture is considered in planned new residential quarters or at new locations (cf. Fig. 15). Here, for example, the building areas category "Urban Area" can be designated within the framework of the productive city.

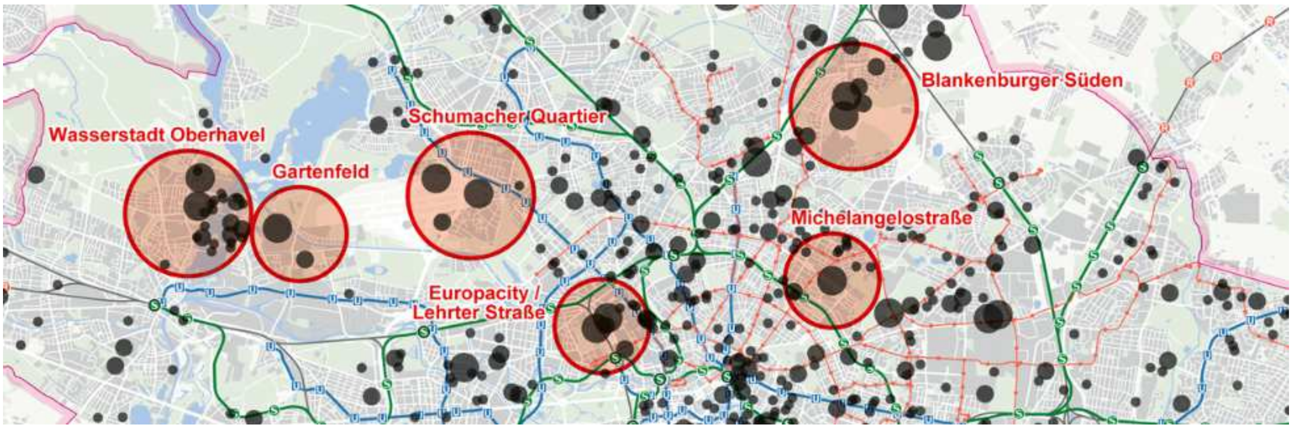

Fig. 15: Plan section: six new urban districts and other sites for new housing (SenSW, 2017).

Aquaponics serves as an example of rooftop urban agriculture in this study. Aquaponic systems save energy, water and nutrients by combining recirculating aquaculture systems (RAS) with hydroponic plant production; when wastewater from aquaculture is used to fertilise plants, it does not have to be discharged, thus reducing one of the key environmental problems associated with current aquaculture production and agricultural runoff (Kloas et al., 2015). We also highlight rooftop aquaponics for its ability to produce animal protein with a smaller environmental footprint compared to conventional animal farming (Joyce et al., 2019). This food production method has already been realised in a range of sites worldwide but its potential for urban food production, especially on rooftops, is far from being exploited. Rooftop Aquaponics – at least commercial ones – depend on rooftop greenhouses and studies have shown their advantages concerning buildings metabolism (Pons et al., 2015) as well as economics (Benis et al., 2018). A full-scale production site on the roof of a food market in the Abattoir neighbourhood in the Anderlecht district of Brussels opened in 2018. The Abattoir Farm is based on building-integrated aquaponics coupling aquaculture with a 2000 m² high-tech greenhouse and a 2000 m² productive outdoor garden (Beckers, 2019). Building-integrated aquaponic projects are also planned in Berlin, e.g. by the company "DachFarmBerlin".[19]

Fig. 16: Abattoir Farm, © BIGH-isopix, CC-BY 3.0, edited.

Urban aquaponics needs to balance higher production costs with competitive marketing and distribution advantages that urban locations offer (Proksch et al., 2019). Further system development and capacity building are essential preconditions for wider establishment in urban areas (Alsanius et al., 2017). Aquaponics is a special case of aquaponic farming (Baganz et al., 2021a): while aquaponics relies on hydroponics in greenhouses, aquaponic farming has a broader application range, e.g. open gardens which are a kind of green roof and easier to implement than greenhouses.

Within the project CITYFOOD (Proksch & Baganz, 2020), a medium-sized (< 2000 m² gross area) aquaponics was modelled, operating with an energy-saving plant production winter break and direct distribution of the filleted fish (9.2 t/a) and fresh tomatoes (39.9 t/a) which can be economically viable in urban and peri-urban areas (Baganz et al., 2020b). For the present study, we conducted a partial coverage scenario based on this model case and found that with 200 such aquaponic facilities, 25% of the tomato demand and 20% of the freshwater fish demand of Berlin could be covered. From the Berlin real estate cadastre, approximately 800 buildings > 2000 m² roof space and according to their function as a department store, shopping centre, factory, cold storage or commercial building were selected for the possible integration of aquaponics and only a quarter of them would be needed (cf. Fig. 17).

Fig. 17: Partial coverage scenario – roofs of selected building types with at least 2,000 m² in Berlin (detail).

To supply city's complete demand, including lettuce, 370 aquaponic facilities of a size of 6000 m² are required, with year-round production and the correspondingly higher energy demand (Baganz et al., 2021b).

[19] http://www.dachfarmberlin.com/#referenzen-section

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A Berlin specific life cycle assessment showed that these systems should be thermally coupled with buildings to compensate for the climatic disadvantages compared to production in the south European tomato growing regions (Körner et al., 2021).

Study, Plan, Cadastre	Year published	Rooftop Usage	Potential area [ha]	Roofs [number]	Residential units [number]	Condition	Source
Belz Master Thesis	2010	Greenery	218*	12203*		*) District Friedrichshain-Kreuzberg only	Belz, 2010
Z Farm	2013	Farming	831 479	7,302 3,122		flat roofs thereof highly suitable	Zfarm, 2013
Multifunctional commercial buildings	2016	Housing		330	14,000 up to 36,000	single-storey grocery stores	SenStadtUm, 2016
RW Farm	2018	Farming	2,300			rectangular >50 m² for rooftop greenhouses	Million et al., 2018
HU Berlin	2018	Farming	889	2,934 998		>=1,000 m² >= 2,500 m²	Altmann et al., 2018
Urban Development Plan for Housing	2019	Housing			not specified		SenSW, 2019
Keizers, Tichelmann	2019	Housing			150,000 up to 180,000	solid wood / timber frame	not explicit in: Tichelmann et al., 2019
Masterplan Solarcity	2020	Solar energy	10,660	533,190			SenWEB, 2020
Charter for Berlin's Urban Green	2020	Greenery	not specified				SenUVK, 2020
Cityfood	2021	Aquaponics		ca. 800		>= 2,000 m² selected buildung types	cf. section Aquaponics
Official Real Estate Cadastre	2020	All Uses	**9,732**	**536,004**		all buildings in Berlin excl. underground garages	ALKIS, 2020

Table 2: Berlin rooftop potential in studies, plans and the cadastre.

Building-integrated agriculture is a social, technical and design challenge for urban development. A practical guide for rooftop greenhouses assists here, especially for Germany (ZALF, 2013). The greenhouse section of aquaponics can further utilise agrivoltaics, mixed energy generation and crop production, enabled by semi-transparent organic solar cells made from eco-friendly solvent. (Wang et al., 2021). For facilities producing algae as food, the combined use with organic photovoltaics in agrivoltaics can increase performance, as the semi-transparent films filter the light and thus the photosynthesis efficiency of the algae is improved (Zorz et al., 2021).

6 OVERALL POTENTIAL, PRIORITIES AND SITE SUITABILITY

An overview of plans and studies on roof space potential concerning Berlin is given in Table 2. For comparison, we evaluated 2020 data from the Official Real Estate Cadastre Berlin to obtain Berlin's current roof area, using the buildings' floor area which is also the area of the roofs [20]). Underground garages, accounting for 451 ha or 4.4% of the overall floor area, were excluded. They may be located under other buildings, but even if they are not built over, they do not constitute rooftop usage in the real sense.

This overview shows that, for example, basically the entire available Berlin roof area is seen as potential for solar energy. The other studies too, explore the potential of roof use with a focus on a single roof use and thus refer either to greening, housing, or urban agriculture. If combinations are considered, they are not quantified (SenStadtUm, 2016b; SenSW, 2019), and the overall claim from the potential studies exceeds the total roof area of Berlin. However, these are minor concerns because the work done is of course excellent for getting an impression of the possibilities of roofs.

Whether a roof is used and for what purpose is up to the respective owner, but urban planning conditions can promote or inhibit this. One priority of the Berlin Senate is the climate change adaptation: 'Dealing with urban heat (hot days/tropical nights) and urban flooding (after heavy rain) is a core task of adaptation, as

[20] According to DIN 277:2005, with a range of ± 30 cm.

both extreme weather events will occur more frequently in Berlin due to climate change.' (SenStadtUm, 2016b). Blue-green roofs are an important element in the multi-disciplinary approach to mitigate its consequences. Another priority is using the sun as a regenerative source of energy (SenWEB, 2020). The roof potential does not seem to play a major role in residential construction (SenSW, 2019), and there are no plans at all for urban roof farming.

The discovery of suitable rooftops, e.g. for aquaponics, is linked to identifying a variety of urban parameters. From an urban fabric perspective, rooftop uses are usage types like others. They have characteristics – such as publicly accessible or not – which makes them more or less suitable depending on distinct locations. This applies e.g. for the impact of green roofs on the urban environment (Suszanowicz & Kolasa Więcek, 2019) to mitigate heat islands. The requirement of a site to the urban roofscape resulting from the site micro conditions must also be considered for other physical, spatial and social factors. Urban rooftop farming can be an entity within the circular city. To close circles, the proximity to input resources such as greywater is advantageous, as is the spatially adjacent use of its output streams.

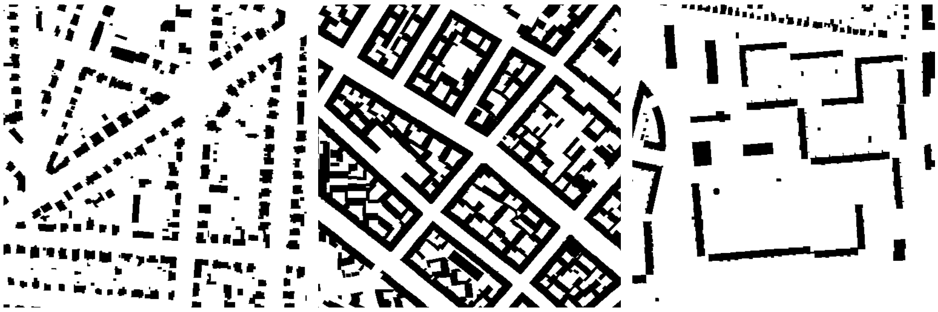

Fig. 18: Figure-ground diagrams of three Berlin morphologies, same scale a) single-family home area, b) dense blocks of the Wilhelminian period, c) large housing estate.

Baganz et al. (2020c) suggest establishing a site resource inventory (SRI) to enhance the information flow in the circular city. For example, roof areas of shopping centres looking for roof contractors could be entries in such an inventory. The urban structure also plays a role in finding a suitable location, as it determines the density, accessibility and environment of a site. A figure-ground diagram represents the density, complexity and coarseness of the space-forming building masses of an urban area. Examples of Berlin quarters as figure-ground diagrams depict some major morphological differences present in the city (cf. Fig. 18).

7 CONCLUDING REMARKS

Sustainable settlement development follows the principle of "inside before outside", thus exacerbating the net land take problem and reducing green spaces in densely populated inner cities. As carriers of ecosystem services, the remaining green spaces should not be treated as land reserves, and the roofscape offers alternative space.

We have shown that there is already a wide range of roof uses in Berlin. Several urban plans and research studies try to grasp the use-specific roofscape potential, which is currently far from being exploited. They often have a rather monothematic approach, and when combinations are mentioned, green/solar or green/water uses are most likely to be referenced. However, the overall claim from the potential studies exceeds the total roof area of Berlin. Up to now, many potential studies do not or only insufficiently consider important boundary conditions for roof use, such as statics, accessibility, proximity to required resources, as well as business, social and microclimate factors. Moreover, roofscape potential evaluation should consider existing and future competitive situations.

Rooftop farming, including rooftop aquaponics, is aimed at improving the urban food situation and relieving land pressure. That means single-story facilities, such as aquaponics, should be avoided in inner cities, even if serving public purposes, e.g. education. A study found that vegetables grown on suitable rooftop areas could cover the annual need for vegetables of Berlin's inhabitants by more than 100% Altmann et al. (2018). However, urban agriculture does not seem to be a high priority for rooftop use. In contrast to community and private rooftop gardens, commercial farming applications are scarce. For example, it is quite certain that aquaponic rooftop farming is not competitive (Wagner et al., 2019) compared to, e.g. residential use. Therefore, it is important to find business models allowing new companies or start-ups to invest in rooftop aquaponics, business models which may incorporate revenue from non-food sources such as climate

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adaption programs. Aquaponic rooftop farming needs to receive adapted building regulations and planning laws. European rural agriculture benefits from huge subsidies, sometimes misspent (Scown et al., 2020). Urban agriculture development would step up if it could participate in these transfers.

However, if other rooftop uses than farming are preferred, and single-storey farm buildings are to be avoided in the urban interior, then it is an option to locate urban farming in peri-urban areas. This, in turn, counteracts the goal of reduced net land take (SEP, 2016). To investigate this conflict, further research efforts are required to determine concrete locations for urban rooftop Farming. Other future research questions concern the setup of rooftop aquaponics, e.g., if they should include outdoor gardens or foil greenhouses; or if the aquaculture unit should be indoors in the basement of a building or better on its roof.

Fig. 19: The dome of the Bundestag, an icon of Berlin's cityscape. © G. F. M. Baganz

When discussing the scope and quality of roof uses, it is important to bear in mind that they have not only functional but also, and sometimes primarily, aesthetic aspects. Some roof uses are not visible from the ground, but others, such as extensions or aquaponics with rooftop greenhouses, have beside the physical a visual impact. The roofscape is an important constituent of the cityscape, which is impressively demonstrated by the multifaceted examples in this study.

8 MISCELLANEOUS

Author contributions: The contributions of the Authors are described by the CASRAI's CRediT taxonomy:

- Gösta F.M. Baganz: Conceptualisation, Methodology, Formal analysis, Visualisation, Writing – original draft, Funding acquisition
- Elias Baganz: Writing – review & editing
- Daniela Baganz: Writing – review & editing, Project administration, Funding acquisition
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🏆 *reviewed paper*

Urban Trees – Detection, Delineation, Quantification, and Characterisation based on VHR Remote Sensing

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1 ABSTRACT

Trees play a vital role in the urban ecosystem, providing benefits for society, ecology and economy. In particular in urban areas, trees mitigate the urban heat island effect, filter air pollution, regulate microclimate and hydrology, bond carbon dioxide, and provide spaces for recreation and leisure, among others. Despite these diverse positive effects, detailed information on the number, location, dimensions and other characteristics of urban trees remains scarce. For this reason, most cities in Germany currently aim to establish a tree information system for efficient and targeted management of their tree inventory. However, traditional terrestrial surveying is time-consuming and costly and therefore only suitable to a limited extent. In addition, the municipal tree cadastre usually only includes urban trees on public propertyand thus does not cover the complete stock. Against this background, remote sensing acquisitions with very-high spatial resolution (VHR) of less than one meter offer promising capabilities for area-wide detection, delineation, and characterization of urban trees.

In this study, we use VHR aerial imagery as well as a derived canopy height model (CHM) for detection and delineation of urban trees. Different methods for individual tree detection using local maximum (LM) filtering andLaplacian of Gaussian (LoG) blob detectionare compared and evaluated. For tree crown delineation, marker-controlled watershed segmentation (MCWS), clustering using Voronoi tessellation, and region growing are implemented as segmentationtechniques. The detection of individual trees and delieation of tree crowns are validated against about1,000 reference trees from visual interpretation via stereophotogrammetry.In addition, we relate our results to street tree location data of Munich, which was derived from mobile terrestrial laser scanning (TLS).The characterization of urban trees is realized based on the 3-dimensional shape of individual tree segments as well as auxillary data sets of land use and building density.

According to our analyses, there are 1.54 million trees in Munich.Compared to available reference trees, tree detection was evaluated with highest values of F-score, precision, and recall of 0.95, 0.99, and 0.94, respectively. Results of tree crown segmentation revealed an overall accuracy of 88.1 % compared to crowns of reference trees. Based on auxillary land use information, urban trees were categorized into street trees, (public) park trees, as well as trees in (private) residential gardens.In Munich, 9.1 % are characterized as street trees, 38.4 % are allocated in residential gardens and 33.1 % stand in public parks. The remaining 19.4 % oftree segments were found onother land use such as agricultural areas, parking lots, or along railroad tracks. According to these categories, the height and crown area of urban trees are analyzed and related to the distance to the city center. In a more general manner, this analysis was performed in relation to the building density in Munich. As expected, relatively few trees were found close to the city center and generally on areas with high building density. However, these areas are particularly associated with the greatest challenges in the context of sustainable and climate change-adapted urban development.In this study, we demonstrate that information derived from remote sensing contributes new spatial and quantitative knowledge on urban trees, providing the basis for sustainable management and informed decision-making in cities.

Keywords: characterization, very-high spatial resolution (VHR), urban trees, remote sensing, urban ecosystem

2 INTRODUCTION

Urban trees are highly relevant to the urban ecosystem and offer suitable capabilities to compensate for the negative consequences of urbanization and climate change(Pauleit, Zölch, Reischl, Rahman, & Rötzer, 2019). Particularly in urban areas, trees mitigate the urban heat island effect through evapotranspiration and shade, reduce surface water runoff, filter air pollution, and absorb carbon dioxide, among others(Rötzer, et al., 2020). In addition, trees provide city dwellers with space for recreation and leisure and have a positive effect on health in many ways(Taubenböck, et al., 2020).The great importance of urban green for people's well-being also became especially evident during the global COVID-19 pandemic (Grima, et al., 2020). Urban trees, also referred to as “Urban Forest” as a whole, include trees in parks, forests, on (private) residential areas, on squares and along streets, as well as greenbelt vegetation (Miller, Hauer, & Werner, 2015). Compared to forest trees, urban trees are exposed to diverse and mostly negative environmental influences at their growing sites which vary strongly within and across cities(Rötzer, et al., 2020). Thus, their structural development as well as associated ecosystem services are diverse and require consistent area-wide and up-to-date informationas a basis for efficient, targeted, as well as sustainable managementand informed decision-making in cities.

Traditional terrestrial surveying of urban trees is time-consuming and costly.For this reason, inventories of individual trees are scarce and often not publicly available (Kronenberg, Łaszkiewicz, & Sziło, 2021). This is also the case inthe city of Munich: no area-wide urban tree cadastre is available to date. In addition, municipal data bases target public spaces, whereas urban trees on private properties are omitted despite their equally important functions and ecosystem services. Remote sensing has proven suitable capabilities for area-wide assessment of land cover, also regarding vegetation and trees in cities(Tigges, Lakes, & Hostert, 2013; Taubenböck, et al., 2021). Especially acquisitions with very-high spatial resolution (VHR) of less than one meter offer promising capabilities for area-wide detection, delineation, and characterization of urban trees(Shojanoori & Shafri, 2016).Existing research on individual tree detection and crown delineation (ITCD) focuses on forest areas, whereas less than one tenth of all studies aim to capture treeswithin urban areas (Zhen, Quackenbush, & Zhang, 2016).Specific challenges for ITCD in urban areas are the complex and small-scale heterogeneous composition of land cover accompanied by diverse dimensions and structure of urban trees(Zhang, Zhou, & Qiu, 2015). The dominant source of remote sensing data for ITCD is a raster-based digital surface model (DSM) or canopy height model (CHM), which can be delineated from active LiDAR (light detection and ranging) acquisitions or passive stereophotogrammetry(Ke & Quackenbush, 2011).In general, leaf-on data is preffered over leaf-off data for ITCD, since detection and delineation of trees especially in urban areas requires masking of trees against other land coveras a preprocessing step (Zhang & Hu, 2012).Several methodological approaches have been proposed for tree detection, including local maximum (LM) filtering (e.g., (Pouliot, King, Bell, & Pitt, 2002), (Wang, Gong, & Biging, 2004)), scale-space functions (e.g., (Wagner, et al., 2018)), or template matching (e.g. (Vahidi, Klinkenberg, Johnson, Moskal, & Yan, 2018)), among others. Algorithms for tree crown delineation comprise valley following (e.g., (Gougeon, 1999)), region growing (e.g., (Pouliot, King, Bell, & Pitt, 2002), (Dalponte & Coomes, 2016)), or marker-controlled watershed segmentation(MCWS) (e.g., (Wang, Gong, & Biging, 2004), (Silva, et al., 2016)).Additional methods for tree crown segmentation are realized based on object-based image analysis (OBIA) (e.g., (Ardila, Bijker, Tolpekin, & Stein, 2012)) or recently emerging deep learning techniques (e.g., (Weinstein, et al., 2020)).

In this study, leaf-on VHR aerial imagery as well as its derived CHM are used as data basis for ITCD. We evaluate LM filtering and Laplacian of Gaussian (LoG) blob detection for individual tree detectionand compare MCWS, clustering using Voronoi tessellation (CL), and region growing (RG)for tree crown delineation. Validation is conducted based on 952 reference trees from visual stereo image interpretation as well asin relation to street tree location data of Munichderived from mobile terrestrial laser scanning (TLS). Finally, the 3-dimensional shape of individual tree segments as well as land use and building density are employed for characterization of urban trees in the city of Munich.

3 STUDY AREA & DATA

The study area is the city of Munich, which covers an administrative area of 310 km² (Figure 1). Recent analyses of the German Meteorological Service (DWD) revealedan increasing count of warm days, a decreaseing number of frost days and higher mean annual temperatures during the last decades. These observations are seenas a indicationsof climate change effects(Mühlbacher, Koßmann, Sedlmeier, & Winderlich, 2020). A recent study of Munich suggests that local heat stress can be reduced most efficiently by strategically planted trees (Zölch, Maderspacher, Wamsler, & Pauleit, 2016).

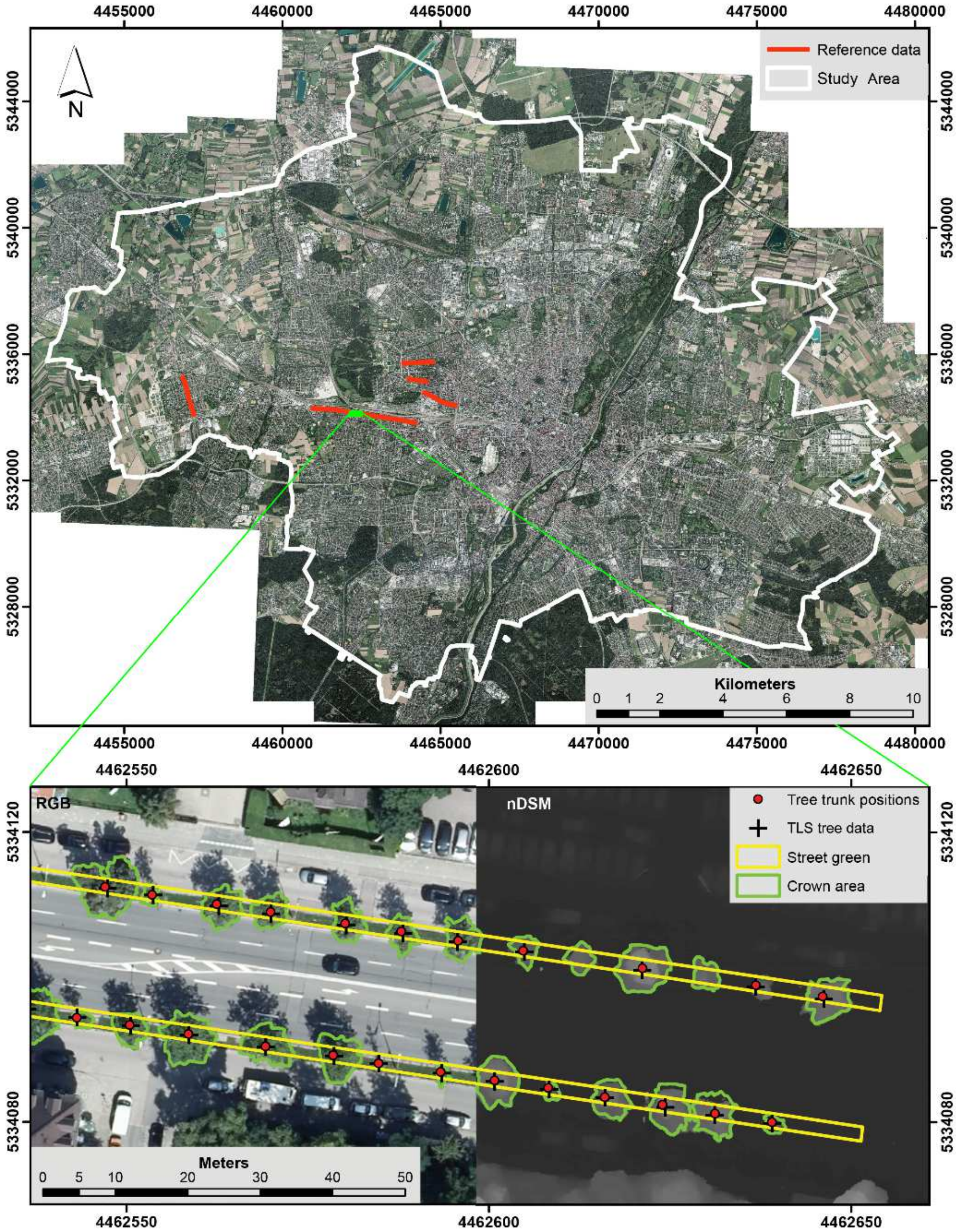

Figure 1: Study area corresponding to the administrative area of Munich, and detailed view of remote sensing as well as reference data. Aerial imagery is provided by Geobasisdaten© Landeshauptstadt München - Kommunalreferat -GeodatenService 2021.

VHR aerial acquisitions were recorded under leaf-on conditions in August 2017 as well as during the leaf-off period in February 2019 using the UltraCam Xp-1 with ground resolution of 10 cm (provided by Geobasisdaten © Landeshauptstadt München - Kommunalreferat -GeodatenService 2021). Multispectral imagery is available from these acquisitions as RGBI data, while a DSM as well as a DTM were generated by means of stereophotogrammetry. Based on leaf-on as well as leaf-off aerial acquisitions, tree trunk positions as well as tree crowns of 952 reference trees were collected via visual interpretation of stereo imagery. All aerial imagery is available in the geometry of true orthophotos, i.e. without parallax distortions of vertical objects.Additional comparative data on tree positions are available from the street tree location data of Munich, which comprises tree trunk positions of 57,800 street trees derived from mobile TLS acquisition in September 2020. However, the accuracy of this data is unknown. Auxillary data comprises a street green layer from the city of Munich which holds all roadside vegetated areas (with and without trees), a landuse dataset which distinguishes parks, residential areas and transportation infrastructure, as well as building density data, which is provided on a 100x100m² polygon grid.

4 METHODOLOGY

A CHM is generated by subtracting the DTM from the DSM of the leaf-on aerial acquisitions.Subsequently, non-tree pixels are masked by thresholding height in the CHM as well as the normalized difference vegetation index (NDVI).In order to compensate very small-scale variations due to single tree branches in the aerial imagery as well as in the CHM, a Gaussian filter was applied (Brandtberg & Walter, 1998).Tree detection is performed based on the filtered CHM using LM filtering and LoG blob detection. LM filtering is chosen due to its popularity and high level of development (Zhen, Quackenbush, & Zhang, 2016). In order to account for different sizes of tree crowns, a height dependent linear variable window function was employed as a modification of the traditional LM filtering technique (Popescu & Wynne, 2004). LoG blob detection belongs to the category of scale-space functions and compares kernel regions from the CHM to Gaussian blobs in order to detect indivudal trees (Kaartinen, et al., 2012).For tree crown delineation, three segmentation approaches MCWS, CL, and RG are compared. The MCWS algorithm is widely used for tree crown segmentation and uses markers (i.e. treetop positions) for gradual watershed delineation of the inverted CHM (Wang, Gong, & Biging, 2004). CL creates height-dependent circular buffers around each marker in the CHM, whereas at intersecting buffers a Voronoi-tessellation is carried out (Silva, et al., 2016). Finally, RG starts at marker positions and merges surrounding pixels of the CHM dependent on thresholds for crown segment growth and maximum crown diameter (Dalponte & Coomes, 2016).For application of ITCD for the entire city of Munich, a two-staged approach was realized. First, area-wide ITCD aiming to capture large and medium sized trees was performed based on masking parameters of CHM height > 2 m and NDVI > 0.4 for the entire city area. Second, small roadside trees were added by restricting the area for ITCD to the auxillary street green layer with simultaneous relaxation of the masking parameters to CHM height > 1.3 m and NDVI > 0.3.

Validation of results was carried out according to the two steps of ITCD, tree detection and tree crown delineation. For each reference tree trunk position, the closest markerswithin each reference crown were identified from LM filtering as well as LoG blob detection and subsequently counted as true positives. Additional markers within reference tree crowns were counted as false positives, and missed trees (i.e. reference crowns without markers) as false negatives. Precision, recall, and the F-score were calculated as measures of tree detection performance(Li, Guo, Jakubowski, & Kelly, 2012). Tree crown delineation was evaluated according to the intersection over union (IoU) as a spatial measure of common overlap of reference against predicted tree crowns.Dependent on theIoU of reference and predicted crown segments, tree crownsare categorized as matched, nearly matched, missed, merged, or split; for details on the definitions of this accuracy assessment scheme see(Jing, Hu, Noland, & Li, 2012). The categories ofmatched and nearly matched tree crowns are related to all reference crowns for calculation of overall accuracy (OA).

5 RESULTS

5.1 Accuracies of tree detection and delineation

Figure 2 illustrates results of ITCD for a small subset of the study area of the city of Munich.From a visual point of view, LoG blob detection found too few markers compared to LM filtering in case of street trees, whereas LM filtering identified too many individual trees in groups of trees with overlapping crowns (top row of Figure 2). Quantitative accuracy assessment regarding tree detection is presented in Table 1. The numbers confirm the visual impression that LoG blob detection results in very few false positives (i.e. no overestimation of trees), while LM filtering possesses fewer false negatives (i.e. missed trees). Consequently, highest accuracies of precision were retrieved for LoG blob detection, whereas recall and F-scorewere found superior in case of LM filtering. This applies to both, the area-wide as well as the street green restricted approach.The detected treetop positions are spatially offset compared to tree trunk positions, with mean distance of 0.94 m for the area-wide, and 0.78 m for the street green restricted approach.

The three segmentation methods for tree crown delineation presented in the bottom row of Figure 2 visually show very similar results. In general, RG results in the relatively smallest crown segments, while MCWS draws the most expansive tree crowns.By comparison of the second and third column of Figure 2, the dependency of all segmentation procedures on the previously detected markers represents the greatest difference and is methodologically inherent due to the two steps of ITCD.

	Tree detection method	Precision	Recall	F-score
Area-wide approach	LM filtering	0.936	0.866	0.899
	LoG blob detection	0.984	0.770	0.864
Restricted to street green	LM filtering	0.959	**0.939**	**0.949**
	LoG blob detection	**0.991**	0.832	0.905

Table 1: Tree detection performance.

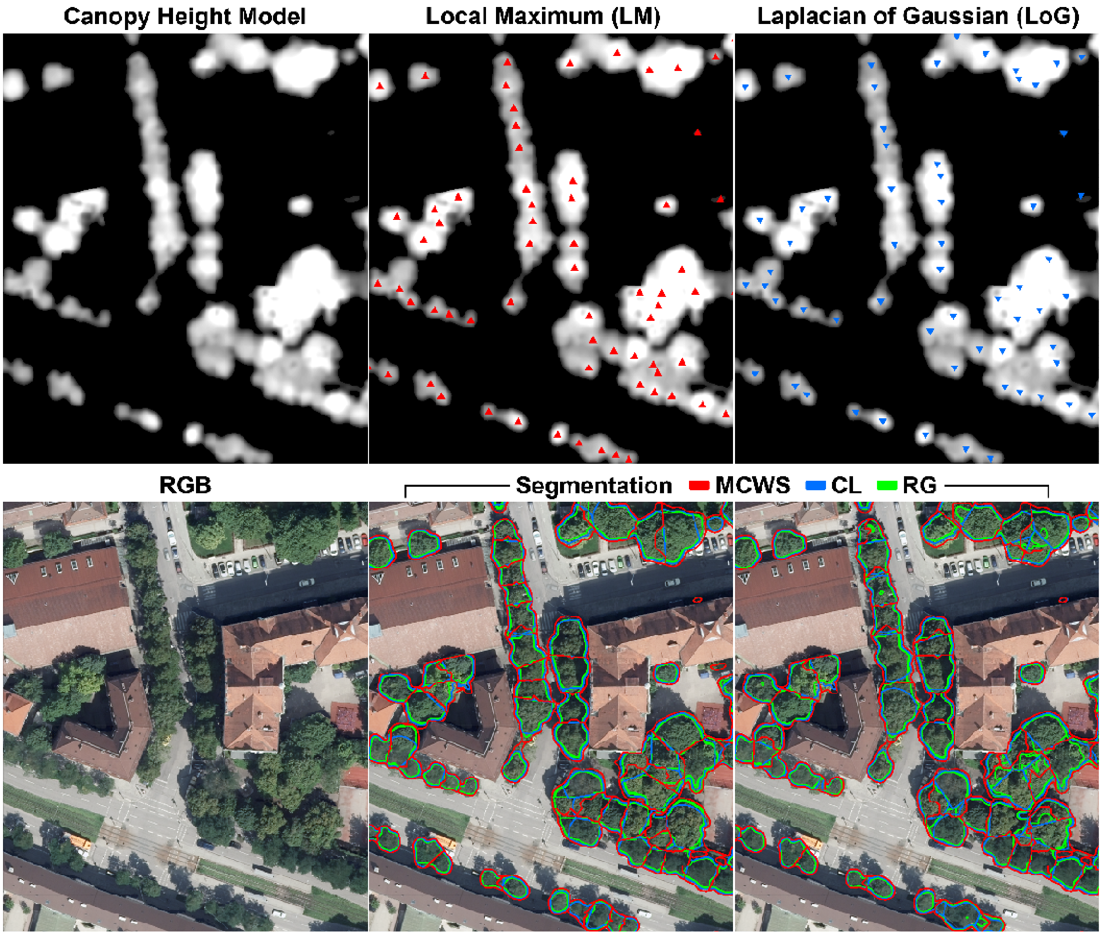

Figure 2: Results of tree detection (top row) and corresponding tree crown delineation (bottom row). Aerial imagery is provided by Geobasisdaten© Landeshauptstadt München - Kommunalreferat -GeodatenService 2021.

Figure 3 presents the relative distribution of categories from the IoU analysis of reference against predicted tree crowns for tree delineation performance assessment. In general and in accordance with tree detection, tree crown segmentation shows superior accuracy in case of the area restriction to the street green layer compared to the area-wide approach. In this regard, significantly less reference trees were missed (yellow category in Figure 3) compared to area-wide approach. The advantage of markers from LM filtering also becomes apparent with respect to all three segmentation methods. Comparing the three segmentation procedures, highest OA (i.e. share of matched and nearly matched crowns) of 76.6 and 88.1 % were retrieved by MCWS for the area-wide and the street green restricted approach, respectively.

An example of the relative comparison of the TLS data with ITCD based on the markers derived from LM filtering in combination with MCWS is depicted in Figure 4. 53,000 of the 57,800 tree positions from the TLS survey were located within delineated tree crowns which corresponds to an agreement of 91.7 %. On average, the distance of markers from the LM filtering to the tree positions from TLS is measured at 0.89 m.

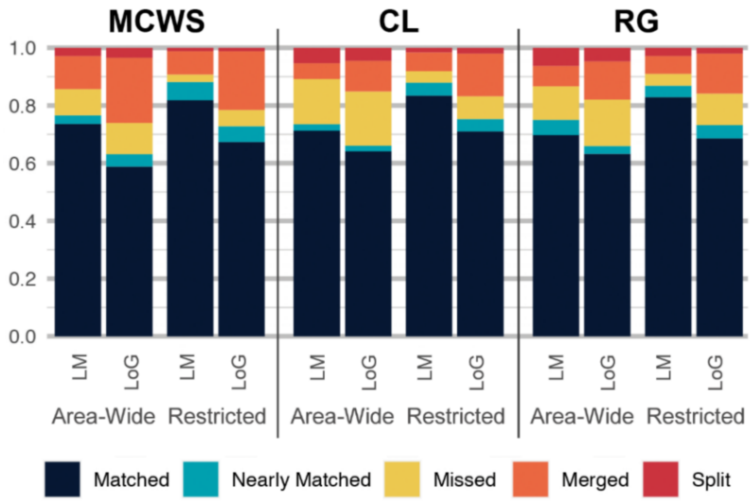

Figure 3: Categories of tree delineationperformance of three crown segmentation methods based on two tree detection results as well as different spatial units (area-wide approach vs. restricted to street green layer).

Figure 4: Visual comparison of markers from LM filtering and tree crowns based on MCWS with TLS tree positions.Aerial imagery is provided by Geobasisdaten© Landeshauptstadt München - Kommunalreferat -GeodatenService 2021.

5.2 Quantification and characterization of urban trees in Munich

According to our analyses, there are 1.54 million trees in Munich. This result was achieved based on the two-staged approach of area-wide analysis with subsequent refinement using the approach restricted to the street green layer. For ITCD for the entire city of Munich, LM filtering in combination with MCWS was used due to superior performance based on the accuracy assessment using 952 reference trees from visual interpretation.Figure 5 shows the spatial distribution of the urban forest of Munich in terms of the number of trees per hectare. The result is illustrated based on 100x100m² grid cells. As expected, lowest numbers of trees were found in the city center as well as in areas of high built-up density. In addition, few trees are located over agricultural areas. Highest numbers of trees are displayed in green to blue colors and can be attributed to parks and forests at the outskirts of the city.

On average, urban trees of Munich are 12.45 m high, with a mean crown height of 8.70 m and a mean crown area of 60.31 m². According to the land use data set, street trees (9.1 %), residential trees (38.4 %), park trees (33.1 %), and trees on other land use (19.4 %) were distinguished. The total area covered by tree crowns is 92.84 km², with 6.95 km² (7.49 %) street trees, 28.25 km² (30.4 %) trees in residential areas, 42.24 km² (45.5 %) in parks, and 15.40 km² (16.6 %) crown area of trees on other land use. Overall, park trees exhibit the largest as well as highest crowns with great variability of height levels in the urban forest of Munich. In contrast, trees on residential areas feature relatively small crowns with low height. Street trees are characterized by a clear concentration in the height level between 5 and 10 meters. The detailed statistical distributions of crown area as well as mean crown height are illustrated in Figure 6.

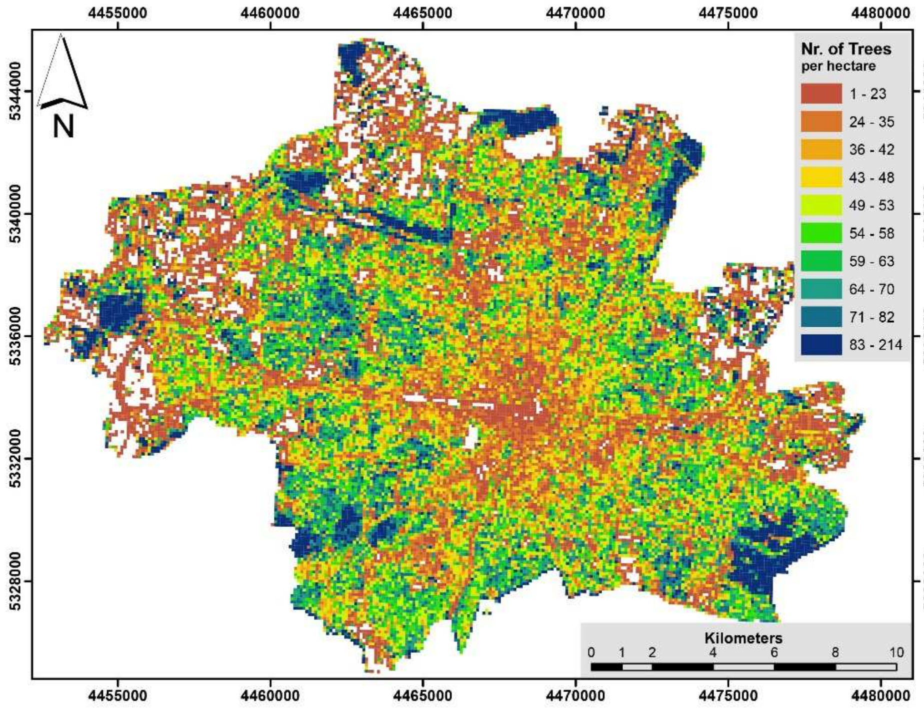

Figure 5: Number of trees per hectare in Munich.

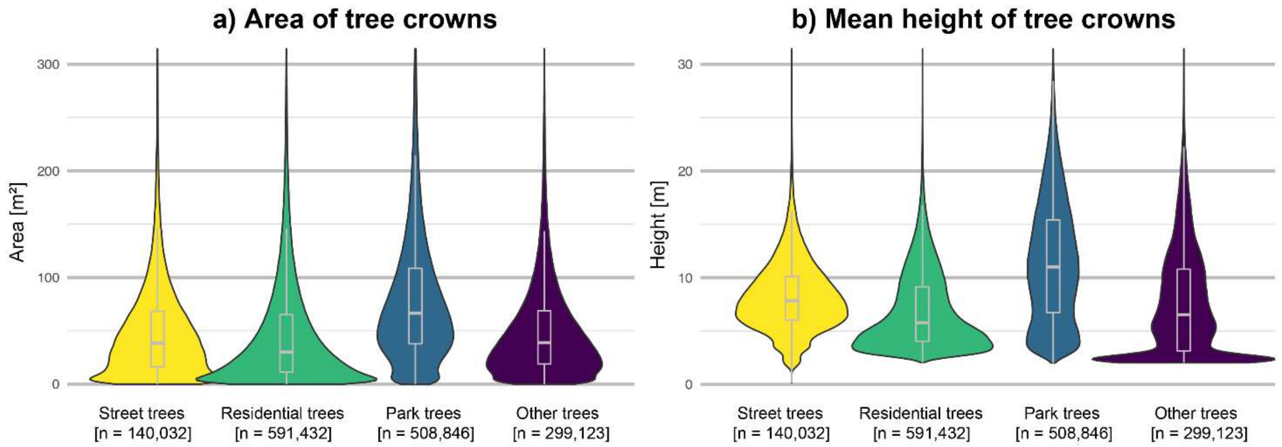

Figure 6: Crown area (a) and mean crown height (b) for urban trees on different land use in Munich.

Figure 7 presents the number as well as crown area of urban trees on different land use depending on the distance fromthe city center. Despite their small absolute number, street trees have ahigh share of up to 50% of all trees in the city center. Towards the outskirts of Munich, the number of park trees increases at the expense of residential as well as street trees. Nevertheless, the canopy area of park trees remains constant suggesting larger trees with increasing distance from the city center.In general, tree crown area is very low in the city center and increases to a constant share of about 25-30 % from a distance of about 3 kilometers. In this area in Munich, the dense inner-city block development transitions to less dense built-up structures.

This transition also becomes apparent in Figure 8a, which shows the dominant land cover of buildingsin the city center and its decreasing area proportions compared to tree crown area with increasing distance to the city center.Towards the outskirts of Munich, buildings account for area shares of only around 10-15 %, whereas trees occupy an areal share of about 25-30 %.The relationship between tree crown area and building density is also depicted in Figure 8b, which reveals tree crown coverage of around 25 % for building density up to 25 %, and decreasing crown coverage with increasing building area. In the class of the highest building densities (i.e. 75-100 %), trees play a negligible role with mean relative crown coverage of 1 %.

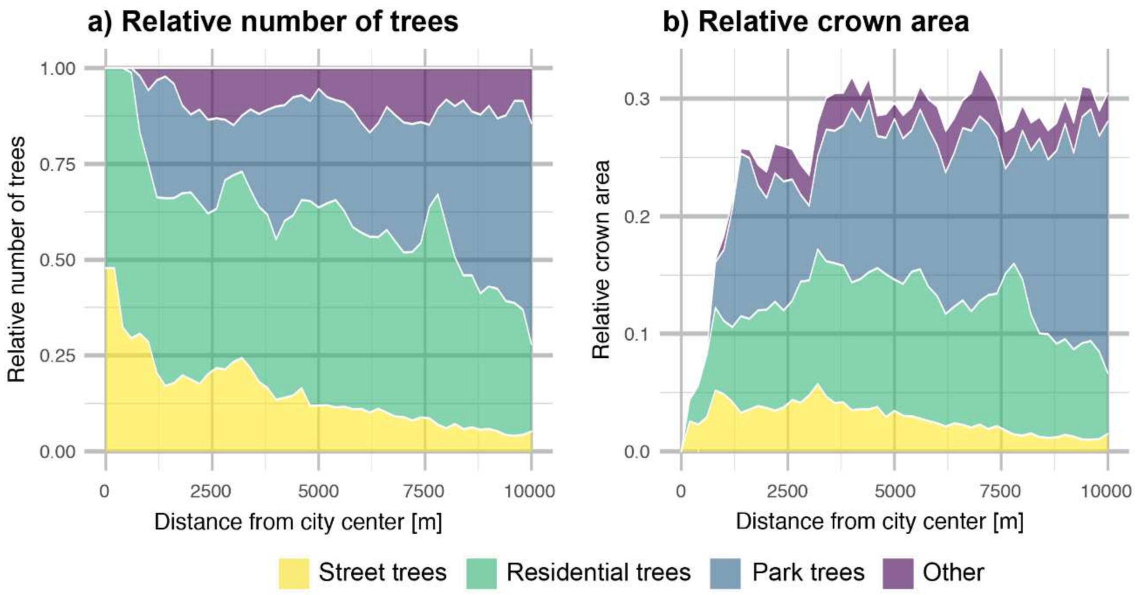

Figure 7: Relative number of trees (a) and relative crown area (b) of urban trees depending on distance from the city center.

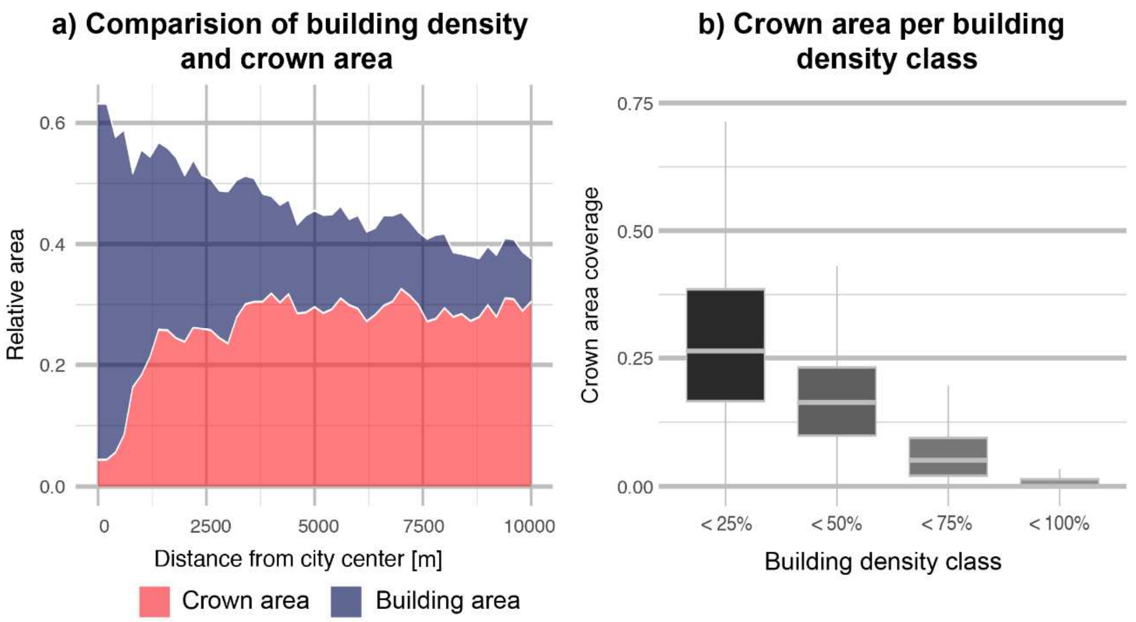

Figure 8: Comparison of building and crown area depending on distance from the city center (a) and statistics of crown area per building density class (b) of urban trees in Munich.

6 DISCUSSION

This study evaluates different methods for individual tree detection and crown delineation (ITCD) using remotely sensed and auxillary data in the urban forest of Munich. Compared to literature, this study conducts ITCD in an urban forest, whereas the majority of other studies developed and applied such methods for natural forests (Zhen, Quackenbush, & Zhang, 2016). As data basis, we rely on aerial imagery with very-high spatial resolution (VHR), which is collected regularly for many cities worldwide as well asfor German cities in particular.Considering the broad availability of aerial imagery and the high degree of automation of methods, ITCD can be transferred with little effort to other cities and study areas. In addition, the practical implementation usingthis source of remotely sensed data is facilitated together with the approach requiring only little additional information.

Tree detection based on the CHM from stereo aerial imagery performs well on different land use as well as in various tree densities across the study area of Munich. Regarding the implemented methods for tree detection, LM filtering performs better within rows of trees and detects more trees within groups. LM filtering also favors central points within large trees, whereas LoG blob detection tends to offset the marker.In case of tree crown delineation, the input markers possess larger influence on the result than the segmentation method (i.e., MCWS, CL, or RG) itself with the slightly highest overall accuracy in case of MCWS. However, the proposed two step implementation of tree detection and crown delineation allows to substitute individual processing components and to replace markers by available tree positions, for example from TLS surveying.Validation of the results showed good performance of ITCD compared to reference tree trunk positions as well as reference crown segments from visual stereo image interpretation. However, tree detection based on top view remote sensing captures treetop positions compared to tree trunk positions from the reference data and implies a spatial displacement dependent on vertical tree structure. Nevertheless, validation revealed good agreement with average spatial offset less than 1 m. In addition, the reference data set focuses on street trees as well as small groups of treesnearby infrastructure and biases validation at the expense of trees on other land use to a certain degree.

In this study, we found 1.54 million trees in Munich. To date, there are no reliable comparative statistics. Other unconfirmed estimates of the number of trees in Munich vary widely.Based on the good agreement of reference data as well as the street tree location data of Munich from mobile TLS data compared to the estimates from this study, high reliability and general suitability for practice can be assumed.The value of this approach is also reflected in the factthat municipal data bases target public spaces only and trees on private properties are omitted. The analysis in this study revealed one third of all urban trees on private residential areasin Munich, with limited possibilities for public management(Kronenberg, Łaszkiewicz, & Sziło, 2021) but equally important functions and ecosystem services. In contrast, the potential for tree management is high for street trees (Zölch, Maderspacher, Wamsler, & Pauleit, 2016), which were identified with highest share in the city center with high building density. However, these areas are particularly associated with the greatest challenges and highest vulnerability in the context of sustainable and climate change-adapted urban development.

7 CONCLUSION

This workdemonstratesthe good suitability of VHR remote sensing data for individual tree identification in the urban forest. Different methods for ITCD were implemented and evaluated and the most promising algorithms were subsequently applied to the entire city area of Munich. For tree detection, superior results were achieved by LM filtering compared to LoG blob detection with highest values of F-score, precision, and recall of 0.95, 0.99, and 0.94, respectively. Regarding tree crown delineation, the three segmentation methods showed less influence on the resulting tree crowns compared to the input tree positions.For area-wide detection and delineation of the urban forest of Munich, ITCD based on LM filtering as well as MCWS was applied. Refinement based on additional data of street green was conducted in order to add few remaining very small roadside trees. Overall, the two-staged approach showed good performance for the entire city of Munich, with 1.54 million individual trees detected, delineated, quantified, and characterized.

Due to the great importance of the positions of the individual trees (markers), future methodological work is suggested tofocus on this aspect. For example, (Zehner, 2021) proposed an aggregation approach in order to merge results from different procedures for tree detection. Also different sources of data should be considered and integrated for detection of tree positions. In particular side and street view data such as mobile TLS which was used for the street tree location data of Munich offers high potential in this regard. Such data could be utilized as source of tree trunk positions in combination with top view remote sensing data for detailed identification of street trees. Also other sources of VHR remote sensing data (e.g. satellite data with additional spectral channels) offer in-depth capabilities for characterization of the urban forest, like the assessment of tree vitality and detailed treespecies classification.

The results of this study can be utilized in a variety of different contexts. In addition to the management of urban trees and the completion of its municipal responsibilities(e.g., tree maintenance, traffic safety, etc.), municipalities can incorporate information on individualtreesinto urban planning or urban climate analysis. In addition, the city-wide establishment of suitable indicators regarding urban climate, social dimensions, or neighborhood effects becomes feasible. In a broader context, detailed data on urban trees enables area-wide estimation of ecosystem services and contributes to the assessment and acomplishment of sustainable urban development.

8 ACKNOWLEDGEMENTS

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Urbane Klimaresilienz hat viele Farben

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1 ABSTRACT

In der heutigen Zeit stellt sich immer wieder die Frage: „*Wie können unsere Städte klimaresilienter gestaltet werden*?“ Eine erst einmal einfache Antwort wäre: **BUNT**.

In Anlehnung an die **GRAUE** Infrastruktur (z. B. Verkehrsflächen) werden urbane Grün- und Wasserflächen auch als **GRÜNE** bzw. **BLAUE** Infrastruktur bezeichnet. Diese Flächen können wirtschaftliche, soziale, vor allem aber ökologische Leistungen ausüben (Reduktion der Lufttemperatur, Filterung von Luftschadstoffen, Erhöhung der Biodiversität etc.), die insbesondere in verdichteten Räumen von großer Bedeutung sind. Diese grün-blaue Stadtentwicklung mit einer Förderung des Stadtgrüns (Pflanzen) und Stadtblaus (Wasser) ist vielen bereits ein Begriff. Unbekannter oder weniger beachtet und gegenwärtig im urbanen Raum noch kaum aufzufinden ist die **BEIGE** Infrastruktur. Hinter der Farbe **BEIGE** versteckt sich das Holz. Doch gerade verbautes Holz liefert ein Rundumpaket zur Klimastabilisierung und -anpassung (u. a. reduziert die Holzbauweise Treibhausgasemissionen der Zement- und Stahlproduktion).

Urbane Räume erwärmen sich aufgrund des städtischen Wärmeinseleffektes stärker als das ländlich geprägte Umland. **GRÜN**, **BLAU** und **BEIGE** (Pflanzen, Wasser, Holz) können diesem Effekt entgegenwirken. Während die Ökosystemdienstleistungen der **GRÜNEN** Infrastruktur mittlerweile hinlänglich bekannt sind, steht die Betrachtung der **BLAUEN** Infrastruktur noch immer im Schatten ebendieser bzw. wird in vielen Untersuchungen - im Rahmen der Betrachtung innerurbaner Grünflächen - der Einfachheit halber in die **GRÜNE** Infrastruktur integriert.

Im Rahmen der Betrachtung der **BLAUEN** Infrastruktur ist vermutlich der Einfluss eines urbanen Gewässers auf die Umgebungstemperatur (in Abhängigkeit der Tageszeit) der am intensivsten untersuchte Effekt. Daraus resultierende Erkenntnisse nehmen für die angewandte Stadtklimatologie einen wichtigen Stellenwert ein, da die **BLAUE** Infrastruktur eine vergleichbare Wirkung aufweisen kann wie urbane Grünflächen.

Das Stadtblau kann aber auch eine tragende Rolle in der Stadtgestaltung und -entwicklung einnehmen. Hierzu zählen neben den temperaturregulierenden künstlichen und/ oder natürlichen Wasserflächen, die Vernetzung von Grünzügen durch Wasserachsen sowie Wasserspiele (Fontänen, Springbrunnen). Unter anderem üben offene urbane Wasserflächen am Tage teilweise einen größeren Abkühlungseffekt auf ihre Umgebung aus, im Vergleich z. B. zur Dach- und Fassadenbegrünung.

Ein ebenfalls positiver Effekt der **BLAUEN** Infrastruktur ist die Schaffung dezentraler Puffer- und Speicherräume (Rückhaltebecken, straßenbegleitende Tiefbeete, Versickerungsmulden, etc.) zum Rückhalt des Oberflächenabflusses bei Starkregenereignissen. Regengärten oder sog. Regendiebe sammeln, speichern und filtern Wasser und entsprechen dem Prinzip der „Schwammstadt“.

Die **BLAUE** Infrastruktur definiert sich aus einer Vielzahl kleiner und großer Wasserflächen, die u. a. auch einen positiven Nutzen für die menschliche Gesundheit besitzen. Fragen, die sich mit der Geographie der Gesundheit oder auch der psychologischen Wirkung der **BLAUEN** Infrastruktur beschäftigen, sind grundlegende Beispiele, die immer wieder das enorme Potenzial hervorheben, das natürliche bzw. naturnahe Wasserkörper auf die Gesundheit und das Wohlbefinden des Menschen besitzen.

Dieser Beitrag soll eine kurze Übersicht über die Potenziale einer **BUNTEN**, vor allem aber einer **BLAUEN** Infrastruktur im urbanen Raum geben, um noch einmal deutlich zu machen, dass eine planungsoriente, angewandte Stadtklimatologie weitaus mehr Möglichkeiten bietet einen Raum klimaresilient zu gestalten, als immer nur alleine auf die „grüne Karte“ zu setzen.

Keywords: grüne Infrastruktur, blaue Infrastruktur, graue Infrastruktur, Klimaanpassung, Klimaresilienz

2 EINLEITUNG

Die Folgen des Klimawandels sind längst allgegenwärtig und stellen u. a. urbane Räume vor stetig wachsende Herausforderungen. Starkniederschläge mit Sturzfluten, das Vertrocknen des Stadtgrüns und vermehrt auftretende Hitzewellen sind Klimawandelfolgen, die sich im Siedlungsraum zunehmend zeigen und Menschen sowie die Natur belasten. Neben dem Klimaschutz (Mitigation) kommt der Klimawandelanpassung (Adaption) eine immer größer werdende Bedeutung bei politischen Entscheidungen und im Verwaltungshandeln zu. Dieser Beitrag beschäftigt sich mit einigen Beispielen urbaner Adaptionund zeigt einige Anwendungsbeispiele, aber auch Stolpersteine für mehr urbane Klimaresilienz auf – aus Sicht der **BEIGEN**, **GRÜNEN** und schwerpunktmäßig vor allem **BLAUEN** Infrastruktur.

3 WIE ENTSTEHT NACHHALTIGE URBANE KLIMARESILIENZ?

Die Deutsche Anpassungsstrategie an den Klimawandel (DAS) bildet den politischen Rahmen zur Klimawandelanpassung. Das Ziel der DAS ist es, die Vulnerabilität von Gesellschaft, Wirtschaft und Umwelt zu verringern und die Anpassungsfähigkeit des Landes (Anpassungskapazität) zu erhalten oder sogar zu steigern.

Viele Bundesländer, darunter auch Rheinland-Pfalz, sind jedoch noch weit entfernt von einer flächendeckenden Integration des Themas „Klimawandelanpassung“ hinein in die kommunale Verwaltungsarbeit. Grundsätzlich sollte schon heute der Adaption sowohl auf Landesebene als auch kommunal ein größerer Stellenwert beigemessen werden. Selbstverständlich gibt es bereits Kommunen, die mit guten Beispielen voran gehen, z. B. durch Gesamtstrategien zur Anpassung an den Klimawandel, Konzepten zur Bewältigung von Starkregenereignissen, der Erstellung von Hitzeaktionsplänen oder Aktivitäten zur Förderung des Stadtgrüns. Allerdings sind diese noch immer auf einem zahlenmäßig geringen Niveau.

Eine klimaresiliente Stadt muss **BUNT** sein, um sich dem Klimawandel anzupassen. Die grün-blaue bzw. grüne Stadtentwicklung mit einer Förderung des Stadtgrüns (Pflanzen) und Stadtblaus (Wasser) ist vielen bereits geläufig. In Anlehnung an die **GRAUE** Infrastruktur (z. B. Verkehrsflächen) werden urbane Grün- und Wasserflächen auch als **GRÜNE** bzw. **BLAUE** Infrastruktur bezeichnet. Unbekannter oder weniger beachtet und gegenwärtig im urbanen Raum noch kaum aufzufinden ist die **BEIGE** Infrastruktur.

3.1 BEIGE Infrastruktur

Aber was verbirgt sich hinter der Farbe **BEIGE**? Es ist ein Baumaterial mit langer Vergangenheit, das aber nach und nach aus dem Stadtbild verschwunden ist – das Holz. Gegenwärtig wird Holz nur in einem äußerst geringen Umfang für den Häuserbau verwendet. Dabei stellt verbautes Holz quasi ein Rundumpaket zur Klimastabilisierung und Klimaanpassung dar und die aktuelle Entwicklung zeigt, dass Holz auch groß kann, wie der Bau des bisher größten Holzhochhauses in Norwegen (Mjøstårnet, 85,4 Meter) oder auch das in Planung befindliche „Roots“ in der Hamburger Hafencity zeigen.

Die CO_2-Emissionen aus der Zement- und Stahlproduktion haben einen großen Anteil an der Gesamtimmission klimarelevanter Treibhausgase. Durch den gezielten Einsatz und die Förderung der Holzbauweise könnte dieser Ausstoß vermieden oder zumindest deutlich verringert werden. Zudem stellen Holzgebäude eine Kohlenstoffsenke dar, da im Holz das von den Bäumen zuvor aus der Luft aufgenommene und in den Stämmen eingelagerte CO_2 gespeichert wird. Unter anderem Churkina et al. (2020) konnten zeigen, dass z. B. ein fünfgeschossiges Wohngebäude aus Brettschichtholz bis zu 180 kg C m^{-2} speichert. Dieser Betrag ist rund drei Mal höher als in der oberirdischen Biomasse natürlicher Wälder mit hoher Kohlenstoffdichte.

Auch in der Kreislaufwirtschaft erwächst dem Holz mittlerweile eine bedeutendere Rolle. Holz kann nach seiner eigentlichen Nutzung als Baumaterial wiederverwendet oder verbrannt werden, liefert so noch einmal klimaneutral Energie. Die Wiederverwertbarkeit nach der Erstnutzung steigert somit die Kreislaufeffizienz. Gleichzeitig kann die regionale Wertschöpfung gestärkt werden, u. a. durch die Verwendung von Holz aus kommunalen Liegenschaften. Es entsteht in vielerlei Hinsicht ein doppelter Nutzen zur Klimastabilisierung (Kotremba, 2021).

Zudem weist Holz thermoregulierende Eigenschaften auf und wirkt sich positiv auf den Brand- und Schallschutz aus.

Für Hans Joachim Schellnhuber, emeritierter Direktor des Potsdam-Institut für Klimafolgenforschung, […] *„bieten uns Bäume eine Technologie von beispielloser Perfektion. Sie entziehen unserer Atmosphäre CO_2 und wandeln es in Sauerstoff zum Atmen und in Kohlenstoff im Baumstamm um, den wir nutzen können. Ich kann mir keine sicherere Art der Kohlenstoffspeicherung vorstellen. Die Menschheit hat Holz für viele*

Jahrhunderte für Bauwerke genutzt, doch jetzt geht es angesichts der Herausforderung der Klimastabilisierung um eine völlig neue Größenordnung. Wenn wir das Holz zu modernen Baumaterialien verarbeiten und die Ernte und das Bauen klug managen, können wir Menschen uns ein sicheres Zuhause auf der Erde bauen" (Kotremba, 2021).

3.2 GRÜNE Infrastruktur

Siedlungsräume erwärmen sich aufgrund der thermisch-physikalischenv Eigenschaften der eingesetzten künstlichen Baumaterialien und der Bebauungsdichte stärker als ländlich geprägte Standorte. Was entsteht ist das mittlerweile sehr gut erforschte urbane Wärmearchipel, das Temperaturdifferenzen von 5 bis 10 K gegenüber dem Umland aufweisen kann. **GRÜNE** Infrastruktur kann diesbezüglich eine Milderung der urbanen Überwärmung erzeugen. Pflanzen wirken aufgrund ihrer Verdunstungsleistung wie eine „natürliche Klimaanlage“. Dach- und Fassadenbegrünungen können eine Reduktion der Umgebungstemperaturen um bis zu 15 K bewirken. Vor allem das Fassadengrün mindert das Erwärmungspotenzial im Straßenraum und fördert gleichzeitig eine Verbesserung des Stadtbildes. Zudem sorgt großkroniges, straßenbegleitendes und schattenspendendes Grün (Bäume) für eine Verringerung der Asphalttemperaturen um bis zu 20 K. Dies ist v. a. für den Effekt der lokalen Erwärmung von Bedeutung, da der Straßenbelag aufgrund seiner thermisch-physikalischen Eigenschaften als Wärmespeicher fungiert, der seine Wärme bis weit in die Nacht hinein an die Umgebung abgibt. Bis zu 160 m^2 Fläche kann ein großkroniger, vollständig belaubter Baum im Sommer mit seinem Schattenwurf kühlen. Zugleich besteht die Möglichkeit überden Festsetzungskatalog in § 9 des Baugesetzbuches viele „Angebote“ der **GRÜNEN** Infrastruktur im Bebauungsplan direkt festzusetzen.

Um den positiven Effekt des urbanen Grüns für das lokale Klima vollends nutzen zu können, bedarf es jedoch seiner Vitalität, denn nur dann ist die **GRÜNE** Infrastruktur in der Lage seine Ökosystemdienstleistungen auszuspielen. Daher ist es wichtig auf urbanes Grün respektive Baumarten zurückzugreifen, die sowohl hitzeangepasst als auch trockenstresstolerant sind, zudem keine Schaderregerempfindlichkeit aufweisen und keine Allergien auslösen (Henninger, 2015). Ebenso müssen sie Frost standhalten und mit weiteren urbanen Einflüssen wie dem Salzeintrag, der Bodenverdichtung und dem Platzmangel zurechtkommen. Das Projekt „*Stadtgrün 2021: Neue Bäume braucht das Land!*“ der Bayerischen Landesanstalt für Weinbau und Gartenbau in Veitshöchheim geht dieser Frage an drei urbanen Standorten in Bayern nach – bisher mit den folgenden urbanen Zukunftsbäumen: Ulme (*Ulmus lobel*, *Ulmus rebona*), Linde (*Tilia x euchlora, Tiliatomentosa*), Zerreiche (*Quercus cerris*), Gleditschie (*Gleditsiatriacanthus*), Purpur-Esche (*Fraxinus angustifolia 'Raywood*), Zürgelbaum (*Celtis occidentalis*) und Ahorn (*Acer campestre, Acer opalus*). Schon heute leiden die Stadtbäume unter Trockenheit und Hitze, zeigen Trockenstresssymptome oder sterben ab. Der Pflege und Bewässerung (z. B. durch eine ressourcenschonende Tröpfchenbewässerung) kommt eine immer größere Bedeutung zu, was wiederum eng verknüpft ist mit der **BLAUEN** Infrastruktur.

3.3 BLAUE Infrastruktur

Auch die **BLAUE** Infrastruktur nimmt eine zunehmend wichtige Rolle im Rahmen einer nachhaltigen Stadtgestaltung und -entwicklung ein. Zu den Themen der **BLAUEN** Infrastruktur zählen u. a. die Vernetzung von Grünzügen durch Wasserachsen und temperaturregulierende künstliche/ natürliche Wasserflächen, aber auch Wasserspiele (Fontänen, Springbrunnen). Offene urbane Wasserflächen üben im Vergleich zu Dach- und Fassadenbegrünungen oder Grünflächen während der Tagstunden teilweise einen größeren Abkühlungseffekt auf ihre Umgebung aus.

Das Forschungsfeld der **BLAUEN** Infrastruktur ist im Zusammenhang mit einer ökologischen bzw. lokalklimatologischen Betrachtung urbaner Räume ein eher junges. Gerade bei der Betrachtung der Frage „*Was ist eigentlich eine blaue Infrastruktur?*“ ergibt sich gegenwärtig keine eindeutige und einheitliche Definition. Grundsätzlich kann jedoch festgehalten werden, dass die **BLAUE** Infrastruktur urbane Gewässerflächen beschreibt, die zur lokalklimatischen Entlastung beitragen können (u. a. als urbane Ausgleichsräume). Hierunter sind sowohl Fließ- (Flüsse) als auch Stillgewässer (Teiche, Seen) zu verstehen, aber auch Überflutungsbereiche (Henninger & Weber, 2020).

Die **GRÜNE** Infrastruktur definiert sich aus einer Vielzahl kleiner und großer Grünflächen, die einen positiven Nutzen für den Menschen und die Natur besitzen. In vielen Fällen werden künstliche oder auch natürliche Gewässer innerhalb urbaner Grünflächen in das allgemeine Verständnis von solchen innerstädtischen Grünflächen hinzugezählt. Vor allem die englischsprachige Literatur setzt die **BLAUE** Infrastruktur oftmals mit der **GRÜNEN** gleich. Beide sind aus deren Sicht fester Bestandteil von Naturschutzgebieten, landwirtschaftlich genutzten Flächen, Waldlandschaften, urbanen Parkflächen, Landschaftsgärten, Kolonien von Schrebergärten, Friedhöfen, Brach- und Freiflächen, Feuchtgebieten, aber auch Gewässern inklusive deren Ufersaum und werden unter dem Begriff der **GRÜNEN** Infrastruktur subsummiert. Korrekt wäre in der eigentlichen Darstellung des Sachverhaltes aber sicherlich der Begriff der **GRÜN-BLAUEN** Infrastruktur (Henninger & Weber, 2020). Dieser enge Zusammenhang beider Flächen soll auch in keinster Weise in Frage gestellt werden. Jedoch wird an dieser Stelle der Fokus stärker auf das Stadtblau gelegt.

Die Schlüsselfunktionen, die einer **BLAUEN** Infrastruktur zugesprochen werden können, sind der Verbrauch/ die Nutzung von Wasser als Trink- bzw. Brauchwasser, die Wasseraufbereitung, die Speicherung von Wasser, die Infiltration in den Boden und somit die natürliche Grundlage zur Grundwasserneubildung, der Einfluss auf das lokale Klima aufgrund der Evapotranspiration und natürlich als Lebengrundlage vieler Pflanzen und Tiere als fester Bestandteil des urbanen Ökosystems. Vielfach werden die Leistungen und der Nutzen, den der Mensch und seine Umgebung von den Gewässern beziehen, ganz allgemein auch unter dem Begriff des Wassermanagements zusammengefasst.

Grundsätzlich können bei der Betrachtung der **BLAUEN** Infrastruktur drei größere Themenkomplexe

- Lokalklima,
- Gesundheit und
- Ökosystemdienstleistungen

unterschieden werden, die zwar mehr oder minder stark in ihrer Wirkung miteinander verzahnt sind, allerdings zum besseren Verständnis in der Folge getrennt voneinander betrachtet werden:

3.3.1 BLAUE Infrastruktur und Lokalklima

Vergleichbar mit dem positiven Nutzen „grüner Flächen“ bieten aus lokalklimatischer Sicht offene Wasserflächen ein für den urbanen Raum nicht zu unterschätzendes Potenzial. Auf Grundlage der dem Wasser eigenen thermisch-physikalischen Eigenschaften ist die Geschwindigkeit, mit der es sich am Tage erwärmt, verglichen mit der von natürlichen und v. a. künstlichen Bodenoberflächen sehr langsam. Dementsprechend sind Wasserflächen an Sommertagen deutlich kühler als ihre direkte Umgebung. Hinzu kommt die über Wasserflächen sehr viel höhere Verdunstungsrate im Vergleich zu versiegelten Oberflächen. Die Folge ist ein gesteigerter Verdunstungsprozess, der der Luft Energie entzieht, die letztendlich der bodennahen Luftschicht nicht mehr zur Erwärmung zur Verfügung steht (Henninger & Weber, 2020).

Bei der Betrachtung wie urbane Flächennutzungen Einfluss auf das Lokalklima nehmen können, wird neben den unterschiedlich stark bebauten und versiegelten Flächen in nahezu allen Beispielen die positive Wirkung des urbanen Grüns auf die nähere Umgebung hingewiesen, und wie diese aus lokalklimatischer Sicht die bodennahen atmosphärischen Verhältnisse zu modifizieren vermag. Diese Flächen der **GRÜNEN** Infrastruktur (innerstädtische Grün- und/ oder Parkflächen, Dach- und Fassadenbegrünung etc.) sind oft zitierte Beispiele, wenn es darum geht eine positive Bilanz innerhalb des urbanen Raumes zu ziehen. Deren nachhaltig positive Wirkung sowohl aus allgemein stadtökologischer als auch speziell stadtklimatischer Sicht ist natürlich unbestritten. Allerdings muss einer weiteren innerstädtischen Flächennutzung der „blauen Flächen“ Rechnung getragen werden, die ebenso die lokalklimatischen Verhältnisse modifizieren kann (Völker et al., 2013; Löhmus&Balbus, 2014; Haase 2015; Völker &Kistemann, 2015).

Inwieweit sich eine Wasserfläche lokalklimatisch (z. B. temperaturreduzierend) auf die umliegenden Bereiche auszuwirken vermag, hängt ganz entscheidend von der Eindringtiefe in die Bebauungsstruktur ab. Sind Gewässer an ihren Rändern offen ist der positve Effekt deutlich nachweisbar. Wird es jedoch durch z. B. Dämme oder Wände zum Stadtkörper hin abgetrennt, ist deren Wirkungstark unterbunden. Hindernisse von 5 m bis 10 m Höhe sorgen bereits für eine beträchtliche Verringerung des Temperatureffekts in benachbarten Straßen. Auch der Straßenverlauf bzw. die -breite, die Kfz-Dichte sowie die Art der ufersäumenden Bebauung behindern die lokalklimatische Wirkung des Gewässers. So ist beispielsweise die von einem Fluss ausgehende Zunahme der Luftfeuchtigkeit in einem dicht bebauten Stadtteil um rund zwei Drittel geringer als in einer aufgelockert bebauten Fläche (Hupfer & Kuttler, 2006).

Das urbane Gewässer bzw. dessen temperaturreduzierender Effekt ist demnach sicherlich aus Sicht der **BLAUEN** Infrastruktur und an dieser Stelle vor allem für den stadtklimatischen Aspekt die am häufigsten untersuchte Wirkung, die das Wasser auf die lokalklimatischen Verhältnisse des angrenzenden Raumes ausübt. Allem voran galt und gilt es die Veränderung der Umgebungstemperatur in Abhängigkeit zur Tageszeit zu untersuchen, da diese Erkenntnisse und die daraus resultierenden Schlussfolgerungen, vor allem aus Sicht einer angewandten, planungsorientierten Stadtklimatologie, eine vergleichbare Wirkung zu der von urbanen Grünflächen aufweisen und somit einen wichtigen Stellenwert einnehmen können (Henninger & Weber, 2020).

Gerade im Hinblick auf die Herausforderungen des Klimawandels, denen der urbane Raum gegenübersteht, ist es wichtig die unterschiedlichen lokalklimatischen Wirkungen der verschiedenen urbanen Flächennutzungen zu untersuchen/analysieren, um deren spezifische Charakteristika zu kennen. Wiederum offenbart sich in vielen Fällen das Problem, dass es eine entsprechend große Anzahl an Untersuchungen zu urbanen Frei- und Grünflächen gibt, nur wenige allerdings explizit auf die innerhalb solcher Nutzungen platzierten Wasserflächen eingehen. Daher ist es noch immer schwer eine allgemeine klimatologisch-orientierte Klassifikation der unterschiedlichen Wasserflächen vorzunehmen (Henninger & Weber, 2020).

3.3.2 BLAUE Infrastruktur und Gesundheit

Die gesundheitliche Wirkung urbaner Grünflächen ist hinlänglich bekannt und untersucht. Daher soll im Rahmen der positiven Wirkung der **BLAUEN** Infrastruktur auf die Gesundheit dieser Themenkomplex etwas genauer betrachtet werden. Dennoch gilt es zu berücksichtigen, dass sich bei einer genauen Wirkungsbeschreibung urbaner Gewässer auf den menschlichen Organismus der Einfluss „grüner Flächen“ nicht komplett ausschließen lässt, da diese das Gewässer meist umgeben.

Gegenwärtig existiert eine Reihe von Veröffentlichungen, die sich mit den Auswirkungen von urbanen, suburbanen und ruralen Wasserflächen befassen. Die Untersuchungsansätze hierzu sind vielfältig und reichen von qualitativen (Interviews etc.) bis hin zu quantitativen Methoden (GIS-Analysen, klimatologische Messungen etc.). Vor allem in Arbeiten, die sich mit der Gesundheit oder auch der psychologischen Wirkung von Natur- und Kulturlandschaften beschäftigen, finden sich grundlegende Beispiele, welche immer wieder das enorme Potenzial hervorheben, das solche natürlichen bzw. naturnahen Flächen auf die Gesundheit und das Wohlbefinden des Menschen haben. Jedoch zeigt sich auch hier immer wieder das Problem, dass keine flächenscharfe Einteilung bzw. Trennung vorgenommen wurde. Bei der Bewertung von urbanen Gewässern ist vielfach davon auszugehen, dass bei der Reflexion der Ergebnisse diese in nahezu allen Fällen sehr stark verflochten sind mit der Denomination „urbane Freiflächen“, worunter nicht nur das urbane Gewässer, sondern auch das urbane Grün zu verstehen ist (Völker &Kistemann, 2015). Dennoch zeigt sich vor allem in den letzten Jahren, dass der Bedarf und das Interesse an einer genaueren Betrachtung, mit dem Fokus auf der **BLAUEN** Infrastrukturleistung, beständig wächst. Die stetig steigende Zahl an Forschungsergebnissen in Bezug auf die gesundheitliche Wirkung von Gewässern spiegelt sich sehr gut in einer Reihe von fachwissenschaftlichen Publikationen unter anderem aus Großbritannien wider (z. B. Barton & Pretty, 2010). In zehn großangelegten Studien wurden der Zusammenhang und das Potenzial urbaner Wasserflächen auf das psychologische, physiologische und soziale Wohlbefinden der urbanen Bevölkerung untersucht. Eine wichtige Erkenntnis der britischen Studie war die signifikant positive Wirkung auf die Menschen, die von solchen urbanen Gewässern ausgeht. In Großbritannien hat diese Erkenntnis dazu geführt, dass im Arbeitsfeld der Grünflächenplanung bzw. auch der Stadtplanung mittlerweile sensibler mit dem Thema umgegangen und ein deutlicheres Augenmerk auf die Planung von urbanen Wasserflächen gelegt wird. Dies bedeutet nicht, dass zugunsten der **BLAUEN** Infrastruktur die **GRÜNE** Infrastruktur zurückgedrängt wird. Jedoch ist gegenwärtig ein Umdenken zu erkennen, was sich darin äußert, dass sich die Verantwortlichen intensiver mit der Frage der Nutzung und Gestaltung einer innerstädtischen Freifläche in Bezug auf eine **GRÜN-BLAUE** Infrastruktur beschäftigen.

Nordh et al. (2011) konnten in einer Studie im Großraum von Oslo zeigen, dass die Bevölkerung vor allem bei kleinen und mittleren urbanen Grünflächen eher auf Anpflanzungen von Bäumen und/ oder Blumenbeeten zugunsten einer Wasserfläche verzichten würden. Urbane Gewässer sind vor allem aus der Sicht der Stadtbevölkerung ein unverzichtbarer Standort der Erholung (Rose &Aspinall, 2012; White et al., 2013).In den Niederlanden werden urbane Wasserflächen von großen Teilen der Bevölkerung im Vergleich zu Grün- und Freiflächen als durchweg positiver empfunden (White et al., 2010). Und auch Studien aus semiariden Gebieten konnten aufzeigen, dass die urbane **BLAUE** Infrastruktur einen signifikant positiven Einfluss auf die Bewohnerinnen und Bewohner nimmt, die in nächster Nähe zu ebensolcher wohnen und leben (Yabes et al. 1997). Vor allem dieses Ergebnis ist aber sicherlich nicht alleine nur auf die psychologische Wirkung der **BLAUEN** Infrastruktur zurückzuführen, sondern in einem solchen Resultat spiegelt sich eine weitere Wirkung urbaner Gewässer wider und dies ist die bereits erwähnte positive Einflussnahme auf das lokale Klima.

Unter anderem wird der urbane Raum von vielen Menschen zunehmend als durchaus gesundheitlich belastend angesehen. Nicht zuletzt aufgrund einer Vielzahl negativer Einflüsse (Lärm, Luftqualität etc.) fehlt es vielfach an adäquaten Erholungsräumen und so ist das Verlangen nach einer entsprechenden Ausstattung urbaner Rückzugsräume enorm. Hierbei spielt die **BLAUE** Infrastruktur in den Augen vieler eine ganz entscheidende Rolle (Bolund&Hunhammer, 1999). Wasser, vor allem langsam bewegtes oder fließendes, wird als beruhigend empfunden, und dient somit dem Abbau von in der Stadt entstehendem Stress. So zeigten u. a. DeCoensel et al. (2011), dass wichtige Elemente der **BLAUEN** Infrastruktur, wie zum Beispiel künstlich angelegte Bachläufe und Fontänen, vermutlich durch das Plätschern des Wassers als beruhigend empfunden werden, da sie den benachbarten urbanen Lärm (z. B. Straßenlärm) größtenteils überdecken.

Interessanterweise wird der Rückzugsraum des urbanen Gewässers aus der Sicht der Erholung von vielen Menschen als anthropogen gemachter Kulturraum und weniger als naturnahe Landschaft wahrgenommen. Dies bedeutet im Verständnis vieler, dass urbane Gewässer zur eigenen Regeneration genutzt werden, jedoch nicht als Lebensraum, u. a. für Tiere zur Verfügung stehen dürfen. Dies konnten Bolund und Hunhammer (1999) an diversen Beispielen zeigen, wonach Frösche als ruhestörender Faktor in urbanen Stillgewässern aus diesem Bereich entfernt werden mussten oder auch originär an Gewässern beheimatete Insekten (v. a. Fliegen und Mücken) als negativ aufgefasste Erscheinung aus der Idealvorstellung eines solchen Raumes zu entfernen sind.

3.3.3 Ökosystemdienstleistung der BLAUEN Infrastruktur

Die **BLAUE** Infrastruktur stellt eine wichtige Komponente als integrativer Bestandteil des Ökosystemkomplexes Stadt dar, die auf die biotischen und abiotischen Faktoren der anderen Teilsysteme des Ökosystems Stadt Einfluss nimmt. Aus den dargestellten Wirkungen auf das menschliche Wohlbefinden und auf das lokale Klima ergeben sich ökologische Dienstleistungen, die sowohl als regulierende (ökologische) Dienstleistungen (*regulatingservices*) als auch als sozio(kulturelle) Dienstleistungen (*supportingservices*) angesehen werden können (Henninger & Weber, 2020).

Hervorgerufen durch den Klimawandel weisen mittlerweile nahezu alle größeren urbanen Siedlungsräume drei hydrologische Problemfelder auf (Henninger, 2011):

- Hochwasserproblem (Zunahme des Oberflächenabflusses)
- Kontaminationsproblem (Verschlechterung der Regen- und Grundwasserqualität)
- Vorratsproblem (Abnahme der Grundwasserneubildung)

Ökosystemdienstleistungen, sowohl von der **GRÜNEN** als auch von der **BLAUEN** Infrastruktur, definieren Vorteile, welche die Bevölkerung aus ihren „Leistungen“ beziehen kann. Vielfach beschränkt sich deren Nutzen jedoch auf die sozio(kulturellen) Dienstleistungen. Die entsprechenden natürlichen/ naturnahen Räume werden auf vielfältige Weise in Anspruch genommen, denn sie bieten Möglichkeiten zur Gesunderhaltung und Erholung, zur geistigen Bereicherung und Erbauung sowie zum ästhetischen Genuss (Grunewald & Bastian, 2013). Die eigentlichen Potenziale, definiert über die regulierenden ökologischen Dienstleistungen, die allgemein gesprochen die Grundvoraussetzung der Existenz menschlichen Lebens sind (z. B. die temperaturregulierende Wirkung u. a. durch die **BLAUE** Infrastruktur; Grunewald & Bastian, 2013), werden nur in einem geringen Maßen ausgenutzt und finden kaum Berücksichtigung in der Stadtplanung sowie den politischen Entscheidungsebenen, aufgrund von meist unzureichendem Fachwissen oder fehlenden, themenspezifischen Erhebungen ihrer Berücksichtigung.

Ökosystemdienstleistungen weisen eine ganze Palette von Vorteilen auf, die letztendlich auch durch gezielten, planungsorientierten Einsatz der urbanen Bevölkerung zu Gute kommen können. Solche Beispiele sind das Straßenbegleitgrün, Grün- und Parkflächen, Teiche und Seen, urbane Waldflächen, Feuchtgebiete sowie Fließgewässer. All diese natürlichen bzw. naturnahen Dienstleistungen generieren auf unterschiedlichste Weise positive Modifikationen für ihre Umgebung, die sich letztendlich auf die Qualität des urbanen Lebens auswirken und daher gegenwärtig und vor allem für zukünftige Planvorhaben stärker in die Stadtplanung bzw. Landschaftsplanung Einzug erhalten sollten. Einige dieser Dienstleistungen sind neben der lokalklimatischen Regulierungsfunktion die Verbesserung der Luftqualität durch Filterung der Luft, Lärmreduktion und Verbesserung des urbanen Wassermanagements.

Sicherlich ist die **BLAUE** Infrastruktur nur ein Bestandteil des gesamten ökologischen Komplexes, jedoch sollte klar sein, dass die gesamte Bandbreite an naturnahen und natürlichen Dienstleistungen, v. a. im urbanen Raum, nur funktionieren kann, wenn alle Teilsysteme in eine entsprechende Planung und potenzielle Umsetzung einbezogen werden. Mittlerweile gibt es eine Vielzahl von Beispielen, die den Ökosystemdienstleistungen Rechnung tragen. Bezogen auf die **BLAUE** Infrastruktur beschränkt sich dies zumeist auf Feucht- bzw. Auengebiete, also Räume, die charakterisiert sind durch Grünflächen mit einem hohen Durchfeuchtungsgrad.Ein Beispiel hierfür ist der „New York Green Infrastructure Plan“, der seit einigen Jahren an unterschiedlichen Standorten in New York City umgesetzt wird. Der Fokus hierbei liegt auf dem Umgang mit Hochwasserereignissen/-katastrophen, die nicht zuletzt durch Starkniederschlagsereignisse hervorgerufen werden. Dieser Herausforderung soll durch eine gezielte Zwischenspeicherung der Niederschläge begegnet werden, u. a. durch gezielte Begrünung von Dächern, aber auch durch Rückversiegelung entlang von Straßenzügen und an den Uferbereichen des Hudson und East River. Hier wird ein gezieltes Wassermanagement eingesetzt, das auch durch die Regenrückhaltung mittels kleinerer urbaner Stillgewässer unterstützt wird (Haase, 2015; Henninger & Weber, 2020).

Eine weitere positive Eigenschaft der **BLAUEN** Infrastruktur, v. a. im Rahmen einer planungsorientierten Betrachtung des Themas, ist die Bereitstellung von dezentralen Puffer- und Speicherräumen, wie Rückhaltebecken, straßenbegleitenden Tiefbeeten oder Versickerungsmulden zum Rückhalt des Oberflächenwassers bei Starkregenereignissen, die nicht zuletzt auch zu einer optischen Aufwertung des Stadtbildes beitragen können.

Regengärten stellen bepflanzte Vertiefungen im Gelände dar, in die Regenwasser von den Dächern und Oberflächen durch entsprechende Absenkungen eingebracht, gesammelt, gespeichert und gefiltert wird. Wasserdurchlässige Deckschichten nehmen Oberflächenwasser auf und erhöhen die Reaktionszeit während Starkregenereignissen. Rasengittersteine im Eingangs- oder Zufahrtsbereich ermöglichen ein Versickern vor Ort. Sogenannte Regendiebe leiten das Niederschlagswasser aus den Abflussrohren direkt in den Garten. Hiermit wird dem Prinzip der „Schwammstadt“ Rechnung getragen – nahezu das gesamte Niederschlagsaufkommen wird aufgefangen, gespeichert, wiederverwertet und fließt nicht oberflächlich ab bzw. wird in die Kanalisation abgeleitet (Kotremba, 2021).Auf Grundlage des § 9 Abs. 1 Nr. 20 BauGB kann diese Entwicklung unterstützt bzw. festgesetzt werden, sodass z. B. Stellplätze mit wasserdurchlässigen Belägen (z. B. Rasengittersteinen) auszustatten sind. Ebenso kann festgesetzt werden, dass unbebaute Grundstücksflächen gärtnerisch anzulegen sind, was wiederum die Entstehung von Kies-/Schottergärten verhindert.

Bezogen auf die Ökosystemdienstleistung, vor allem im Bereich der **BLAUEN** Infrastruktur, sind es wie bereits angesprochen die Feuchtgebiete und die dort beheimatete Flora und Fauna, die in zahlreichen Studien untersucht werden. Bezogen auf den monetären Gewinn, der aus den Dienstleistungen eines Feuchtgebietes pro Hektar erzielt werden kann, liegt ebendiese Fläche auf Platz eins (Costanza et al., 1997). Die **BLAUE** Infrastruktur dieser Flächennutzung dient oftmals der Abwasserbehandlung bzw. -aufbereitung. Entscheidend für diese Flächen ist, dass Tiere und vor allem Pflanzen das Potenzial besitzen Stoffe aus dem verunreinigten Wasser aufzunehmen und zu verwerten. Ebenso wird hier der Abflussbeiwert signifikant verringert, was letztlich zu einer erhöhten Ablagerung von Partikeln hinein in den Boden führt. Bereits Ende der 1990er Jahre hat sich gezeigt, dass solche Flächen in der Lage sind, große Anteile von Stickstoff und Phosphor aus verunreinigten Abwässern herauszufiltern und aufzunehmen, was wiederum eine Verbesserung der Biodiversität dieser Flächen zur Folge hatte. Vor allem aber wurden die Kosten für die Abwasseraufbereitung immens reduziert.

4 FAZIT UND AUSBLICK

Eine zentrale Herausforderung für Kommunen ist die Finanzierung von Anpassungsmaßnahmen an den Klimawandel. Mittlerweile gibt es bereits Lösungsansätze wie Crowdfunding, Sponsoring oder Fördermittel, um Adaptionsmaßnahmen finanziell gezielt zu unterstützen. Hierfür müssen die vielfältigen

Ökosystemdienstleistungen der **BUNTEN** urbanen Infrastruktur in Werte überführt werden – Lebenszykluskostenrechnungen legen die Vorteile von langfristig angelegten Investitionen offen. Wird eine solche Kostenkalkulation adäquat berücksichtigt, so wird eine aktuell noch in die falsche Richtung weisende Entwicklung (u. a. ein begrenztes Budget, Unterhaltungskosten und Flächenkonkurrenz), hin zur Klimaanpassung mit ihren vielfältigen Synergieeffekten (bspw. für die Gesundheit, die Biodiversität oder auch für soziale Aspekte) gelenkt. Dafür sind allerdings der politische Wille und die Überführung in Verwaltungshandeln essentiell. Klimawandelmanagerinnen und Klimawandelmanager sollten in allen Kommunen zum „Verwaltungsinventar" zählen, individuelle Leitbilder/ Leitstrategien müssen den Weg hin zu mehr Klimafreundlichkeit und Nachhaltigkeit vorgeben. Leitstrategien können entwickelt, in Beschlussfassungen integriert und von den Kommunen in Planungsinstrumente überführt werden. Flächennutzungs- und Bebauungspläne sind hierfür die entscheidenden Werkzeuge zur Umsetzung der Klimawandelanpassung(Kotremba, 2021).

Die Adaption an den Klimawandel ist neben dem Klimaschutz die größte Herausforderung des 21. Jahrhunderts und sollte in allen Planungen oberste Priorität erhalten. Eine Anpassung muss jetzt erfolgen, denn Städte sind auf Dekaden ausgelegt. Die gegenwärtige Klimaentwicklung bedarf daher einer frühzeitigen, proaktiven Anpassung an potenzielle Klimawandelfolgen. Berücksichtigen wir heute und in naher Zukunft keine Anpassungen in kommunalen Planungen, werden wir dies zu einem späteren Zeitpunkt tun müssen – mit wesentlich höheren Kosten.

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Urbanism to Riverine Planning Strategy for Climate Resilient Cosmic Sacred City in India-Varanasi

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1 ABSTRACT

The history of no other city is more fascinating than 4000-year history of Varanasi, which is inherent resilience in adopting itself to an ever-changing urban environment, independent of other religions and the whims and fancies of Indian culture. City is developed between two rivers i.e., Varana and Assi (Varanasi). City develops along the concave bank of river Ganges. Varanasi traces its origin to Anandvana; the forest of bliss where Lord Shiva sits in a yogic posture with his eyes closed listening intently to his wife Parvati playing the veena. He creates the cosmos contained in 'Kashi' with his yogic power and her music. He strikes his trident to hold the city and form three hills Omkareshvara, Vishveshvara, and Kedareshvara and place it beyond the ravages of time. He catches the sacred Ganga in his locks as she pours down from heaven (Kailash Glacier). The city originated with the creation of Manikarnika Kund (pool). Lord Shiva and Godess Parvati made Vishnu to handover "Kashi" (Kaash). "Who so ever should have died in Kashi shall reach salvation" - myth in Vedas. The name Mani Karnika refers to the jewel of Lord Shiva's earring. The earring was studded with a pearl "MUKTA"- so the sacred place "tirtha" should confer "MUKTI"- salvation. There are hundreds of lingas in the city, however supported by Shiva's trident are greatly revered formed radial arterial road pattern of city space. The Ganga is conceived as the Kundalini power rising through the lotus chakras in Lord Shiva's spine as form of finger shape water channels pour in Ganga. The west bank is visualized as the spine of the primordial 'Purusha'- man-creation of world and (Assi and Varana) Rivers are water channels intermingling with liquid power of Ganga. The city was developed in the square and circle combination. The square includes mostly temples and circle act as the circumam bulatory path around the temples. Further the expansion of the outside the square towards the panchkroshi route. The five sacred territories are further explained as the symbol of "gross elements". This is comparable to Shiva's dance symbolishing cosmic cycle creation and destruction as the basis of existence - sky, earth, air, water, and fire which creating pilgrimage circuits in the form of garlands consisting of different number of shrines in chain.

Aryan group marched and cleared dense forests, established settlements along the Ganga plains between 1500 B.C to 800 B.C established textile industry, agriculture, brick architecture, crafts and merchantile. In second stage of development during 500 B.C habitant settled along rivers as being mode of transportation of goods for trade. In third stage during 4th Century people settled on the western margin of the ridge that lined the Ganga and also along the streams that lay inland. Most of the ponds and lakes were converted into jalatirthas associated with both Puranic and other deities. In fourth stage from 8th century to 10th century A.D. Pratiharas and Gandavals settled towards west and south-west. Construction of 350 temples confirmed the growth of Vanaras as religious nucleus of North India. City expanded upto Lolarka Kund in the south. The inscriptions of this period mention seven ghats along Ganga. 6 Km. stretch is fascinating with 86 'ghats' – platforms of 12 Km. with wide along the river Ganges performs rituals, cremation, washing, fishing, simply resting etc. Further Chines invasion, conquerers Mughal architectural plethora shows the habitation in Varanasi. Maratha's rule rebuilded the shrines. In 19th century Britishers replaced Maidagin Tank by a company garden in cantonment area. Machodari tank was drained into the Ganga through underground channel and the site was turned into the park. Close by a new market was developed. Bisheshwarganj was established in 1830, today's greatest grain market. Railways, bridges, improved sewage, and drainage system modified urban fabric of Varanasi. City was improved as social, educational, political power centre. Areas adjacent to the ghat and the old city exhibit dense development due to its proximity to ghats and their longevity of existence which has become the cultural fabric of the city. Maze of buildings and narrow streets along the length of ghats, temples, shrines, dormitory for pilgrims, shops, restaurants, and hotels crowed the cramped spaces of the city. Streets just wide for two people to walk. Impact on cultural integrity of old city is due to increased population from 1.2 million to 6 million within 175 Sq. Km area premises in festive seasons. The growth of peripheral areas is likely to be more in comparison to other parts of the city. Most planned development increased in pakka houses which rapid encroachment of vacant spaces, ill-drained areas. Gadaulia drain, Machodari tank disappeared and replaced by parks as a result. River Assi become sewage drain. The city has grown in the north and north-west direction towords Sarnath.

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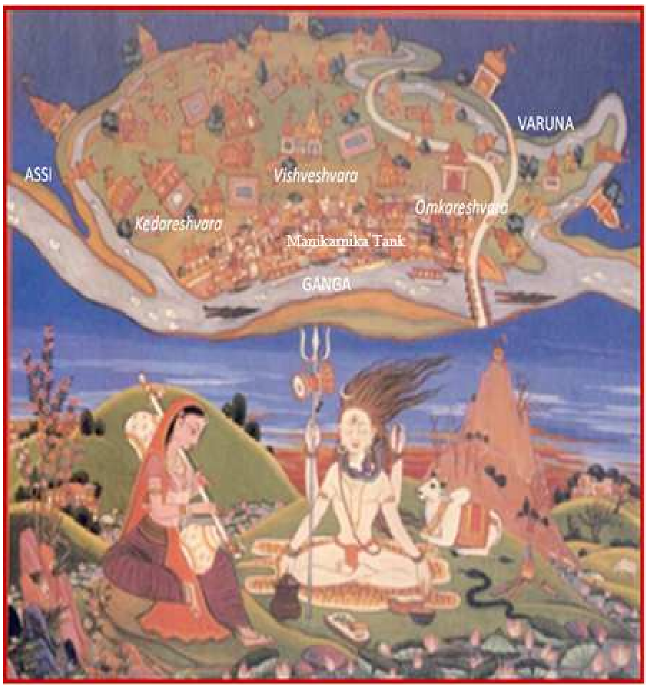
But with all malice the land of Varanasi is considered to be 'blessed land' because it was quite above normal flood level. In the flood plain site between the Ganges River, Ring Road, and Banaras Hindu University, a riverism planning strategy is using a combination of soil from cut and fill operations and dredged river silt to build the 'fingers'. The low-ground areas between the fingers will become capable of draining water to the river during monsoons while serving as ground for urban agriculture during the rest of the year. Infrastructure and transportation is also being proposed along the spine of the fingers, which will enable people formerly living on the low-grounds to have better connections with the city and its infrastructure, and live with resilience, harmony and improved economic opportunity. Restoration of Ghats, schools and temples surrounding kunds will coordinate tree nurseries. Varuna will be a site of community based nurseries to mitigate urban flood and regain its bliss of anadvan. Turning River Assis into a cleaning biotope. Self sustain water management through four water origin clouds (rains), nallahs (flows), kunds (holdings) and aquifers (deep holdings) will be made through productive terracing, trash catchment for reslient sacred cityscape.

Keywords: productive terracing, climate resilient, fingers, cosmic, riverism planning



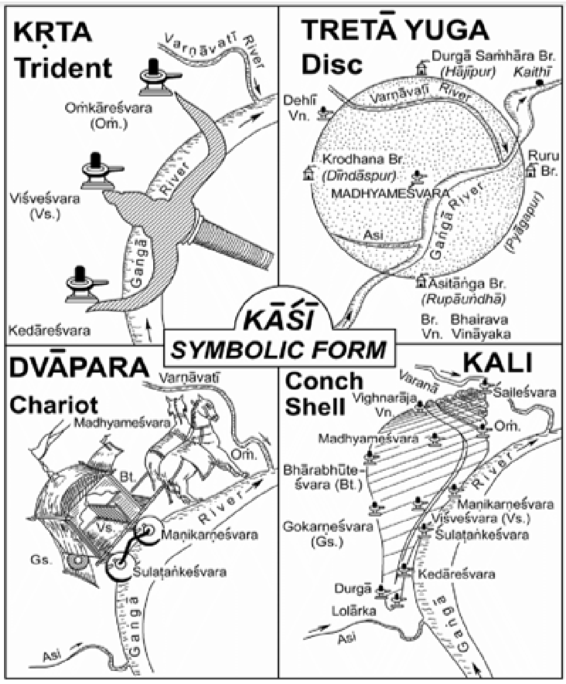


Fig. 1 (left): Origin of Varanasi. Fig. 2 (right): Symbolic form of Varanasi.

2 CITY SCAPE OF COSMIC CITY

Varanasi is developed between two rivers Varana and Assi in the state of Uttar Pradesh. The "sacred city" of India is recognized as the "most ancient continuously living city of the world". The city is unique in the architectural, artistic and religious expressions of traditional Indian culture and is, even today a living example of this culture. As fast as continuity of cultural tradition is concerned city surpasses all civilization centers. The city is placed at concave slope of longest river in India Ganges. "Myths explain the sacred geography of Varanasi and the embodied practices that give it meaning and value in ways history cannot" (Singh, 1993). Myths occur in absolute space and eternal time. Their enactments impart a powerful and timeless quality to the citytscape. Varanasi traces its origin to Anandvana, the forest of bliss where Lord Shiva sits in a yogic posture with his eyes closed listening intently to his wife goddess Parvati playing the instrument veena. He creates the cosmos contained in Kashi with his yogic power and her music. Kashi i.e. kash is symbolises eliptical shape of earth. He strikes his trident to hold the city and place it beyond the ravages of time. He catches the sacred Ganges in his locks as she pours down from heaven kailash (Glacier) because of sage Bhagirath's penance to revive the sixty thousand sons of King Sagara-ocean. Ganges purifies and sanctifies, washing away physical dirt and moral sins. In her phenomenal form, the Ganges invites rich visual, tactile, and haptic experiences in everyday, humdrum activities and performances that carry profound meanings. The tradition of ritual bathing at festivals, in the course of pilgrimage and in life cycle events, has continued through the centuries and carries great significance. Shiva, one among the trinity of Hindu pantheon is the controller of time and the destroyer of the universe; he is Varanasi's patron deity.

The west bank is visualized as the spine of the primordial purusha- man. The Ganga is conceived as the kundalini power rising through the lotus chakras in his spine and ‘Assi’ and ‘Varana’ Rivers are water channels intermingling with liquid power of Ganga. At the beginning of time, lord Brahma’s austerities resulted in a brilliant shaft of light erupting from the earth and piercing the skies and the numinous sound ‘OM’ signaling the creation of the world. Lord Vishnu dug a lotus pond and performed austerities there for thousands of years. Shiva and Parvati appeared and gave him a boon for living forever in Kashi. When they were bathing, Shiva’s crest jewel (mani) and Parvati’s earring (karnika) fell in the pond giving it the name Manikarnika. Close by is the mannikarnika ghat where the dying come to be cremated on the banks of the Ganga and have their ashes immersed in the river that flows through the three worlds-macrocosmos (heaven) into mesocosmos (earth) and further down into microcosmos (the temple, or body). In temples Shiva is worshipped in the form of a linga, the most famous one in Varanasi and its center, being jyotirlinga in ‘Vishwanath’ temple, the cosmic pillar of light that connects the city with heavenly and anotherworlds. There are hundreds of lingas in the city, however Omkareshvara, Vishveshvara, and Kedareshvara lingas in temples on the three hills supported by Shiva’s trident are greatly revered.

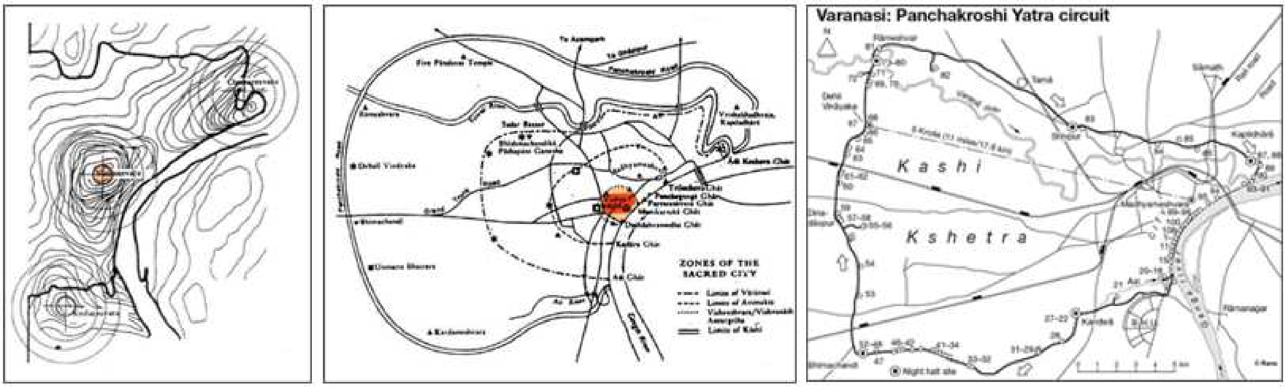


Fig 3: Three major temple in three hills placed in kashi- a sacret mandala-ring.

The meaning of Kashi as a sacred landscape rests as a mandala- ring, a cosmogram or symbol of universe, charged with positive energies. Kashi mandala is equated with the luminosity of Shiva’s fiery linga. On the banks of the holy river Ganga, it is the domicile of Lord Shiva who is known as Avimukteshvar, one who never forsakes the city. This is the center where all journeys begin and end. It is the point of origin and of continual renewal though the body’s engagement with the landscape in the circumambulatory journeys known as yatras. In obtaining darshan-visit in shrines and temples, bathing in the kunds, walking, performing rituals, chanting, among other activities, the sense of auspicious is enhanced. The holiness of the landscape lies in presenting wholeness through representation of the cosmos. Five circumambulatory circuits—Kashi,Varanasi, Avimukta, Antargriha, and Vishvanath—are traced in pilgrim yatras. They all begin and end with a bath at Manikarnika Ghat. The five sacred routes are also associated with the symbols of fivine body, transendental power and sheath (Singh, 1991, 9; Singh, 1993, 38). The five sacred above territories are explained as the symbol of “gross elements”. This is comparable to shiva’s dance symbolising cosmic cycle of creation and destruction as the basis of all existence. As per the five elements comprising of sky, earth, air, water, fire; creating pilgrimage circuits which developed in the form of garlands, consisting of different number of shrines in chain. These five layers of sacred territories in Varanasi are as under:

Macro cosmos elements	Mesocosmos sacred Route	Microcosmos Divine Body	Transcendental power	Sheath	Number of Shrines (Planets x Direction x Part of Body)
Sky	Caurashikroshi	Head	Consciousness	Mind	144 (9x8x2)
Earth	Panchakrosh	Legs	Action	Legs	108 (9x4x3)
Air	Nagar Pradakshina	Face	Cognition	Breath	72 (9x4x2)
Water	Avimukta	Blood	Wisdom	Intellect	72 (9x4x2)
Fire	Antargriha	Heart	Bliss	Bliss	72 (9x4x2)

Table 1: Cosmic Pilgrim Circuit in Varanasi. Source: Singh 1993

The patterns become base for further development of cosmic order. The pattern of traditional and royal cities in India mostly duplicates a celestial archetype, reflecting cosmomagical power. Varanasi five of the various pilgrimage circuits are well developed; taken as a sequence leading from outer to inner space, they reveal parallels between macro, meso and microcosmos and the related transcendental powers. Kashi mandala articulated in panchkroshi yatra is the largest, going beyond the city limits, while the Antargrihayatra is circumambulating only around the Vishvanath Temple complex. While the Kashi and Varanasi Yatras are loops, Avimukta circuit is a spiral reaching the center, Vishvanath Temple. The temple of Vishveshvara (Shiva as Lord, i.e. Ishvara, of the world, i.e. Vishva) is coneptualised as the pivot site on the cosmos.

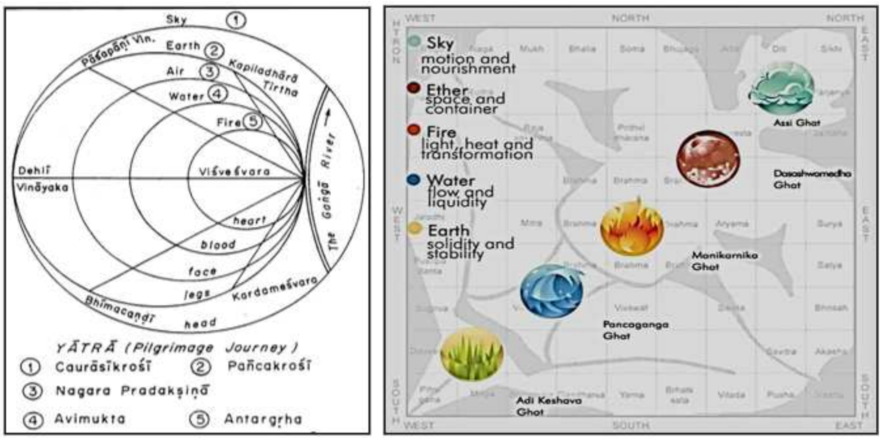


Fig. 4: Pilgrim circuit and symbols of nature's elements.

The land-water interface on the Ganga's banks is fashioned out of the need to access the rising and falling water levels in the monsoon and dry seasons. The cultural land-scape of this interface ghats (steps and landings) lined by temples and other public buildings, pavilions, kunds (tanks), streets and plazas is layered and kinetic, and responsive to the river's flow. The city was developed in the square and circle combination. The square includes mostly temples and the circle act as the circumambulatory path around the temples. Further the expansion of the city started outside the square towards the panchkrosi route.

3 GROWTH AND DEVELOPMENT IMPETUS

3.1 Spatial Growth

First water structure created by Gods is 'Kund' – manikarnika pond was the inception of Varanasi as myth states. Omkareshvara, Vishveshvara, and Kedareshvara lingas in temples on the three hills supported by Shiva's trident were extension of first stage of spatial growth of place. City develops along the concave bank but not along convex bank in spite of fact, that the concave bank is vulnerable to erosion. The concave bank can cave in and cause destruction and the convex bank prograde by continuous deposition preventing easy accessibility to water. On such a prominent natural levee of the concave (left) bank of a meander of the river Ganga, is situated Varanasi. On the concave bank, the water of the channel flows touching the lower part of the bank natural levee. On the other hand, the water along the convex bank recedes (away from the settlement after once it is established) along with the progradation of the bank due to continuous depositional process. This is exactly the reason why large habitations develop over the natural levees along the concave bank. Of course, it is a different matter, once after a large habitation develops along a concave bank, if the river channel shifts because of cutoff, the habitations end up on the side of convex banks. That means the early habitations like Varanasi developed along the concave banks with a clear understanding of river channel processes. The land of Varanasi is considered to be 'blessed land' because it was quite above normal flood levels. During floods, when everything else is submerged in flood waters, the natural levee with a relative relief of 5 to 7 meters above the lowest level in the flood basin, the surface on which Varanasi has developed, can remain high and dry. Many local natural depressions were deepened and lined with steps; these ponds served as water source for religious as well as domestic purposes. Gradually, with the space getting filled by urban elements, these inlets and outlets got truncated from these ponds. The entire concave bank as it can be seen nowadays from its top margin to its lowest possible water level is lined up by heavy and large stones creating beautiful stone stairs running along almost 12 Km of distance for 6.8 Km strech. (Raju, K., and Pandey, M. K. (n.d.). pp. 134 to 148).

Indias civilation was date back with Aryan invasion at sarswati river in northern part of India. Due to dried bed of the Sarasvati river Aryan group marched towards the eastclearing dense forests and establishing "tribal" settlements along the Ganga and Yamuna plains between 1500 BC and 800 B.C. By around 500 B.C.

and reached the bank of the Sadanira (Gandaki) river. They settled towards north region (Varana river) and expanded toward south (Assi river). They establishment of textile industry, agriculture, brick architecture, crafts merchantile. City had connections with distant places as Taxila and this route is presently known as Grand Trunk Road - National Highway – 2 or renamed 19. Remain of Aryan settlements in rajghat region is found in Kashi. (Singh, R. P. 2009). Burnt brick houses,ditches and drains near the house blocks indicated functioning sewerage system and outfall in ditches.

During third stage 4th to 6th Century B.C. (Gupta Period) the Varanasi stone pillari Inscription of Buddhagupta, (B.C. 478), found in Rajghat, promoted the establishment of religious monuments. The main road ran north-south, parallel to the Ganga river with buildings on either side, was regarded one of the main road passing through the heart of the city. The association of the Shivlingas and a ghats along water channel was given religious meaning and ritual. Was thickly populated, prospering, and combination of congested houses separated by narrow lanes, gardens and groves, and water pools with lotus flowers.

Fourth Stage at 8th to 10th Centuray A.D. people settled on the western margin of the ridge, ponds and lakes were converted into jalatirthas associated with both ancestral and other deities. Settlement spreads towards west and south west. Construction of 350 temples confirmed the growth of ‘Vanaras’ as religious nucleus of north India. City expanded upto Lolarka Kund in south. The inscriptions of this period mention seven ghats along the Ganga river.

Fifth Stage during Delhi Sultane and Mughal Period 14th to 17th century A. D. the notable structures in the city and its neighbourhood are the shrines and Idgah at Bakaria Kund, the Arhai Kangura mosque and the mosque at panchganga Ghat. 18th century-Gosains-holymen merchants organised as disciples around particular gurus i.e. religios teachers. Carvansarai- resthouse and dharamshalas-religious convention centres were built to shelter the visitors and travellers.

In sixtgh stage in year 1794 Varanasi came under British administration and with a limited jurisdiction known as the ‘Banaras State’, construction of several schools, hospitals, water pools and irrigation dams were under the Cantonment area. Establishment of the Banaras Hindu Universityin during 1914-16 in radial pattern makes city sprwal to expand along the riverfront southward and westward through the 20th century. Masonry bridges were built on the Ganga and the Varana river. Many ponds like Benia, Maidagin and Machhodari and Godaulia Nala (drain) were drained and replaced by parks or streets. Houses were demolished to widen the roads in the centre of the city Broad thorough fares were cut thorough the city where formerly there had been narrow lanes.19th to 20th century. Costruction of many eduactional institutions like Sanskrit College, Central Hindu College, Modern Hindu University, Christian Missionararies brought major change in the urban landscape. Opened a church at Sigra (1817) and another in the centre of the city at Gadaulia crossing. Hospital for women was also constructed.

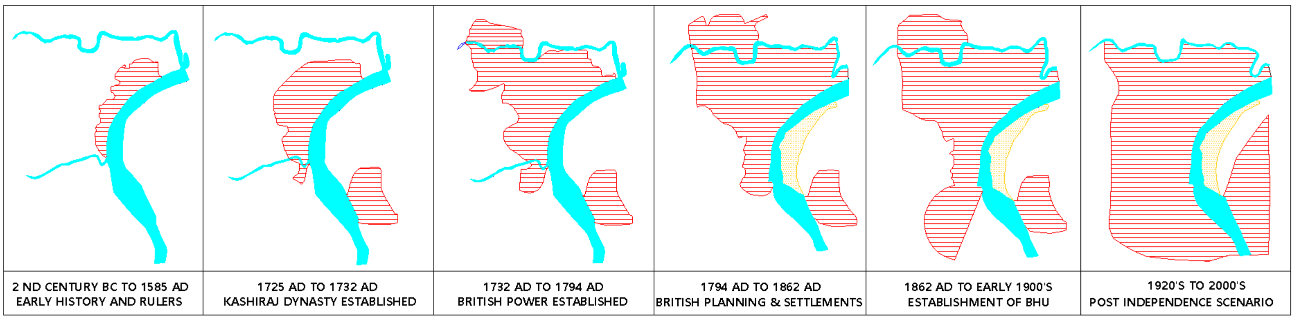


Fig 5: Origin and growth of City varnasi over period

The city of Varanasi has grown along the arc of Ganges with river Ganga as a focal point in one direction and growth of the city taking place in semi-circular direction. The growth pattern follows the origin of radial growth of three hills and fingers shape natural water channel falls in Ganges. The city has a radial development pattern with areas like Banaras Hindu University, Manduadih, Sheopur and Sarnath emerging as new growth centres in all directions. Over a period of time, with the inclusion of a large number of villages and urban settlements, the city development has resulted in irregularly shaped built up areas along peripheries of the central areas of the city. The coming up of the Diesel Locomotive works and residential colonies over an area of 250 Ha in the Southwest and the Soda Ash factory along the GT Road in the East mark the development around the rural city fringe. Dashashwamedha – luxa road was built running west from the river toward cantonment railway station (now Varanasi junction). The north-south artery called ‘chauk’ was replaced by business district. Slowly city came to its present shape.

In 1951 master plan was developed by Improvement Trust for the development of the city and form tourist destination for sake of increase in economy. Crunch of availability of infrastructure, good connectivity with surrounding areas, influx of population extends city limit. Complex urban character has undergone transformations over time, still retaining its original character. Areas adjacent to the ghat and the old city exhibit dense development due to its proximity to ghats and their longevity of existence which has become the cultural fabric of the city.

3.2 Population Growth

The population of Varanasi city grew from 1.09 Million in census year 2001 to 1.19 million in Census year 2011 at a growth rate of 10% of decade. In year 2020 it was estimated 4.24 million poulated city in master plan area. The population trend of this city was very much driven of its climatic condition. During the three early decades (1891 to 1921), the population of the city declined by 11.2% mainly due to several unfavourable factors like poor harvest, droughts, irregularities of weather, floods, epidemics and the post-war effects of the World War I. In fact, during 1901 to 1925, Varanasi was one of the most deadly cities in northern India recording high population and unsanitary conditions. Since 1921 the city has recorded constant growth of population, recording a growth of + 28.77 per cent in 1981 to 91. During 1821 to 31 the growth rate was 3.81 per cent, while it reached to 28.10 during 1931 to 41. The closing impacts of World War II had also encouraged city-ward march of population. The post-war developments, the influx of rural population for employment and immigration of refugee population were responsible for a very rapid growth during 1941 to 51, however the abrupt situation had changed in course of time, that is how during 1951-61 the growth rate had slightly declined. This tendency had continued till 1971 to 81. However, again during 1981 to 91 the growth rate became slightly higher, mainly due to impact of tendency of rural to urban migration in search of better livelihood and employment opportunities in the city. The city is also upgraded as metropolis in 1991 by recording population over a million. It is expected that the growth rate would further be increased in spite of measures to check it respectively. In comparison to other metropolises, its growth is slower mostly due to lack of services related to administrative- capital and diversified industrial developments.

The present area under Municipal Corporation of Varanasi (MCV) jurisdiction is 79 km² with a population of 1.2 million in 2001 nad followed by 1.4 million in year 2011 for area of 82.1 km². Owing to its rich tourism potential, the estimated daily flow of tourists and pilgrims to the city is 40,000 to 60, 000 during festive season. The population density of Varanasi is 146 persons per hectare in census year 2011. The population density in 2001 was 133 persons per hectare. The number of wards in the city has increased from 40 in 1991 to 90 in 2001.

Unit/Year	1931	1941	1951	1961	1971	1981	1991	2001	2011	2021*	2031*
Municipal area (MCV)	207,650	266,002	355,771	489,864	671,934	773,865	929,270	10,103,951	1,367,278	1,640,216	1,835,197
Urban area Addition							101,593	107798	205,558	344,502	511,962
VUA (Varanasi Urban area Agglomeration)							1,030,863	1,211,749	1,572,836	1,984,718	2,347,159
Decadal Growth , VUA%							29.48	17.55	29.80	26.19	18.29

Table 2: Population Griowth of Varanasi , 1971 to 2031. Source: Census of India, *Master Plan Estimation

3.3 Critical appraisal of development plans

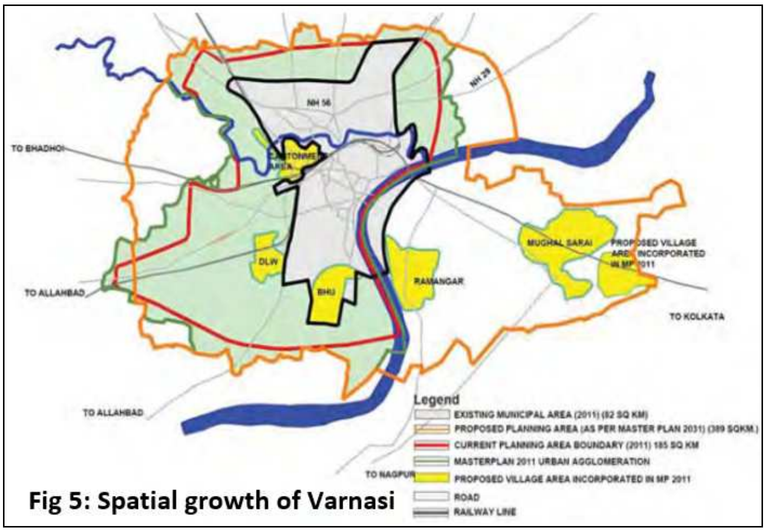


Fig 5: Spatial growth of Varnasi

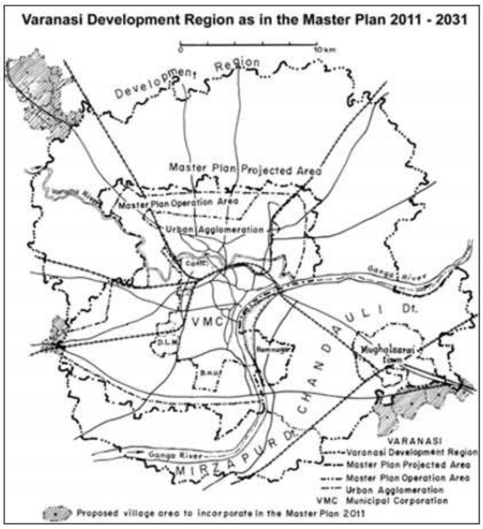


Fig. 5 (left): Spatial growth of Varanasi. Fig. 6 (right): Master plan region 2011–2031.

In 1982 the Varanasi Development Authority (VDA, formed in 1974) made five-tier areal units are of administration and planning strategy, taking Varanasi Development Region, VDR (as in Master Plan 2011). From lower to higher hierarchy they are: Varanasi City Municipal Corporation 84.55 Km2, Varanasi Urban Agglomeration, VUA 112.26 Km2, Varanasi Master Plan - Operative Area 144.94 Km2, Varanasi Master Plan - Projected Area 179.27 Km2, and the outer most Varanasi Development Region, VDR 477.34 Km2. Under the Master Plan 2011 the expanded area proposed for the Greater Varanasi is 179.27 Km2, however no way the land use categories fit to the standard norm of ecological balance. The most noticeable change during first mastrer plan 1991 to 2011 Second master plan is expansion of the area of the city (+112%). The major changes since 1991 as in the Master Plan 2011, introduced after 1988, indicate a catastrophic increase of land under government and semi-government uses (+390.50%), and public and community facilities

	Landuse Category	1988		MP (I) -1999		MP (II) -2011		MP (III)-2031		% Changes in Master plan area	
		Area Km^2	%	Area Km^2	%	Area Km^2	%	Area Km^2	% area	(I-II)	(I-II)
1	Residential	26.1564	46.2	54.5724	37.7	92.5461	51.6	98.8654	40	108.64	69.58
2	Mixed landuse							7.5983	3		
3	Commercial	1.7608	3.11	4.7510	3.28	6.1823	3.45	10.9954	4	169.82	30.13
4	Industrial	1.9531	3.45	9.8137	6.77	6.5619	3.66	5.1556	2	402.47	-33.14
5	Public and Community Facility	2.6105	4.61	4.5042	3.11	13.0907	7.30	23.3933	9	72.54	190.63
5	Recreation (Park & Open Ground)	0.5304	0.94	27.0576	18.7	9.4847	5.49	46.527	19	50.0136	64.95
6	Service and Utlities					1.0397	0.58	1.412	1		
7	Govt. and Semi Government	0.5669	1.00	2.9218	2.01	14.3315	7.99	5.0334	2	415.40	390.50
8	(Tourism area) & Heritage Zone					4.2373	2.37	0.924	0.14		
9	Transport and Communication	9.1430	16.1	13.0027	8.97	14.6035	8.15	34.425	14	42.21	12.31
10	Other (agriculture and open space)	13.9379	24.6	28.3206	19.5	16.8345	9.39	5.7105	2	103.19	-40.56
	Total Area	56.6590	100	144.9440	100	178.9122	100	246.4599	100	155.82	23.44

Table 3: land utilisation as per Master Plans of Varnasi (1991 to 2031). Source: Master Plans of Varanasi- 1991, 2011, and 2031

(+190.63%). The increasing pace of population results to increase area under residential uses up to 253.63% over 1988 (Table 3). This catastrophic change spoils the ecological system of the land use; the most crucial group is park and open ground that records decrease of over 60% in comparison to 1999. Similarly a great loss of agriculture and open land within the master plan area at the rate of above 40% is again a great warning. The existing urban setting and growth trends of Varanasi can be classified into three main categories. These areas are: (a) The Core or Old City consisting of the Ghat area including Chauk, Kotwali, Adampura, etc., (b) The Central City comprising of the area beyond the old city and bound by NH-2 or 19 now along the western and northern edge. and (c) Peripheral area comprising of the trans Varuna area.

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Core City: “The old city of Varanasi is a maze of buildings and narrow streets that run along the length of the bathing ghats, temples, shrines, dormitory for pilgrims, shops, restaurants and hotels crowd the cramped spaces of the city. Some of the important areas are chachori gali, chowk, Vishwanath gali, Haraka Sarai, Chatta Tale, Thatheri Bazaar etc. The streets of this city are just wide enough for two people to walk shoulder to shoulder. This increasing population is over burdening the carrying capacity of the urban environment and the river ecosystem and unplanned mass tourism could potentially have a hard impact on the cultural carrying capacity. Social hygiene and sanitation methods too are beginning to bend under the pressure of a growing resident population and a constant large floating population.

Central City: The areas adjacent to the city core are constantly under great development pressure due to close proximity to the core areas. This is because of availability of all services, cultural attractions and Varanasi is no exception to this. These areas have been categorized as “proximal areas” in developing the growth analysis.

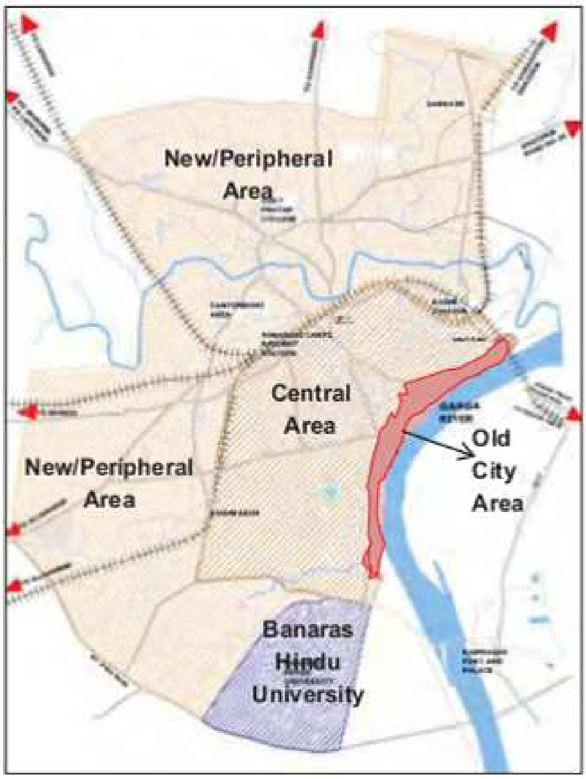

Fig. 7 (left): Classified areas in Varanasi. Fig. 8 (right): Heritage zone in Varanasi.

Peripheral areas: The peripheral areas encompassed by the municipal wards have more organized development pattern with infrastructure being relatively in better conditions. The State Housing Board, through the Varanasi Development Authority undertakes these developments. The demand for such development is increasing and with the participation of governmental and private development groups, the growth of peripheral areas is likely to be much higher in comparison to other parts of the city. The development in this zone is the most planned and organized in the whole city but there is a relative lack of recreational or green spaces in this zone. Major catalyst for urban growth will be development of new ring road to the north of the city. Combined with plans for a transport nagar in the western extremity of Varanasi and the connectivity across the Ganga to the eastern bank (to Ram Nagar and Mughal Sarai) the growth of urban areas and the population of Varanasi outside the municipal wards are likely to continue to accelerate.

Industrial Landscape: The small scale and household industrial was the backbone from Aryan invasion to till date all around Varnasi area. During post-independence period several large scale factories have been developed in and around the city. With the establishment of Diesel Locomotive Works (D.L.W.) during 1961 in the western part of the city, another industrial landscape has emerged. An Industrial Estate has been developed to the west of the city at Lohta where small-scale industries have sprung up. These incorporate manufacturing of chemicals, plastic goods, iron bars and metal equipments, etc. The city has recently developed a specialised industrial wing of bead and carpet manufacturing. Precisely, no industrial zone is identifiable. The city has grown haphazardly in a natural process. All industrial wastes are outfall through natural drain into river Ganges.

Heritage Scape: There are five heritage zone identified. UNESCO heritage site is also been identified. This city is very important especially for pilgrimage tourism where tourist enjoy morning boat ride, walk in narrow lanes (gali)

- Riverfront Ghats(stairways to the river bank), the crescent-shaped 6.8 Km bank of the Ganga river (Ganges), from the confluence of Asi drain in the south to the confluence of the Varana river in the north, where lies eighty-four. Among the 84 ghats Dashashvamedha Ghat is the most important place for with architectural grandeur for visitors.
- Durgakund-Sankatmochan Area, consisting of about twenty temples and shrines and the historical water pools of Durgakund, Kurukshetra and Lolark kundas.
- Kamachcha-Bhelupura Area, possessing some of the old monasteries, ancient shrines and Jain Tirthankara Parshvanath estblished here.
- Kabir Math (Lahartara) Area, having monasteries related to the life of Kabir.
- Sarnath, where the Buddha gave his first sermon in 532 BC, and Ashoka developed township in 2nd century BC.

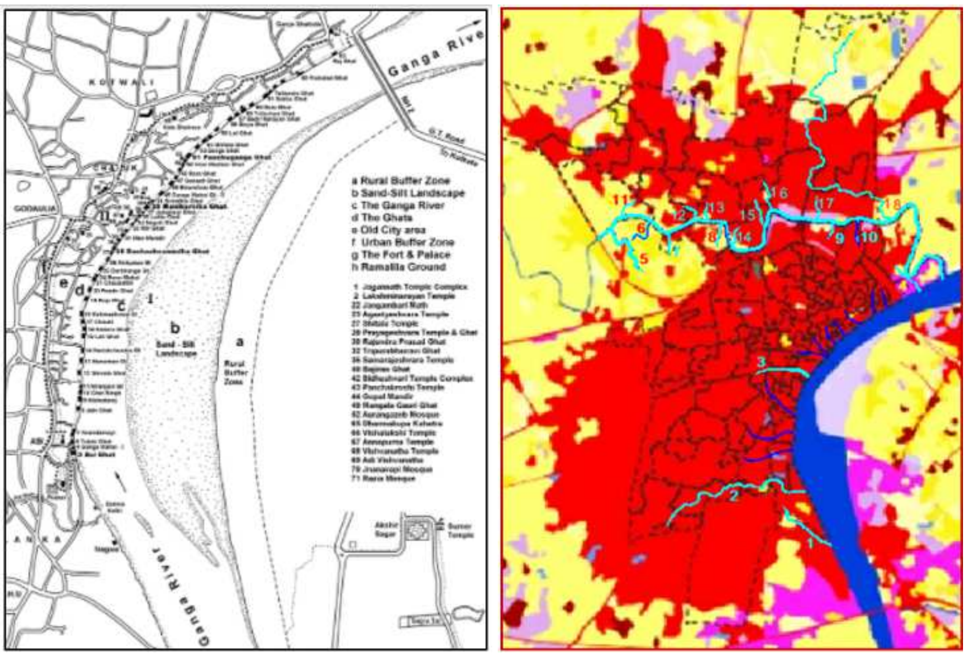

Fig. 9 (left): Varanasi riverfront heritage zone. Fig. 10 (right): Natural drainage channels in Varanasi.

	Name of Channel/Drain	Point of Discharge	Condition
1.	Nakki	Ganaga River	Dry
2.	Assi Drain	Ganaga River	Carrying Sewage
3.	Telia	Ganaga River	Intercepted at sewer Line
4.	Bhainsasur	Ganaga River	Intercepted in sewer Line
5.	Phuwaria	Varana River (Right bank)	Storm water drain
6.	Sadar Bazar	Varana River (Right bank)	Storm water drain
7.	Raja Bazar	Varana River (Right bank)	Storm water drain
8.	Teliabagh	Varana River (Right bank)	Storm water drain
9.	Nakhi Ghat	Varana River (Right bank)	Storm water drain
10.	Konia bypass	Varana River (Right bank)	Storm water drain
11.	Central Jail Nala	Varana River (Left bank)	Storm water drain
12.	Orderly Bazar	Varana River (Left bank)	Storm water drain
13.	Chamrautia	Varana River (Left bank)	Storm water drain
14.	Khajuri Colony	Varana River (Left bank)	Storm water drain
15.	Banaras Drain No.5	Varana River (Left bank)	Storm water drain
16.	Hukulgang	Varana River (Left bank)	Storm water drain
17.	Nai Basti	Varana River (Left bank)	Storm water drain
18.	Narokhar	Varana River (Left bank)	Storm water drain

Table 4: Natural Drainage Channel in Varanasi. Source: CDP, Varnasi

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Among the above five, of course the Riverfront City is underway of enlisting under 'mixed cultural landscape' in UNESCO Heritage List, ultimately there is an urgent need to re-vitalise the city with re-establishing the ecological ordering by promoting riverine planning. The impact of urban sprawl and neighbouring effect is constantly marked by the expansion and growth of two towns across the Ganga river, i.e. Ramnagar and Mughalsarai, lying only at 5 Km and 18 Km east of the main city, respectively, It is further estimated that both of these towns will be directly linked as a continuous urban space by 2031. This tendency will further intensify the demographic and economic pressure on the cityscpe of Varanasi.

The nallahs and rivers of the city are in a critical state due to the quantum of untreated sewage, Industrial waste and waste entering the rivers on a daily basis. Quality of water in Varanasi is found to be far below the ISI standards. It is estimated that out of the total pollution load runoff reaching the river stream, the load from point sources (urban wastewater and industrial effluent) is significantly high (94%), including 79% load from municipal sewage and 15% load from industries. The industries that are contributing to high pollution content are mostly dying industry, which is associated with making of Banarasi Saare and are located in old city area. The remaining 6% is observed to be contributed by non-point sources such as agricultural and forestry runoff, livestock, rural households, etc. There are total 18 drainage channel exist in varanasi City. They are all carying untreated sewage and industrial polltants. There are some big nallas in the city, which are very dangerous to human and animal lives. The city is presently divided into four sewerage districts. ntral City sewage district draining to Dinapur STP. This area includes the old city, about 1km in breadth and 5km along the Ganga River from Assi to Raj Ghat. Zone 2A is the sub-central district on the CIS-Varuna side west of the city centre and zone 2B is a slice of the Trans-Varuna district along the Varuna River up to the ridge line defined by the Jaunpur road. Trans-Varuna district northof the Jaunpur road. Wastewater in this. BHU/Assi district south of the City. At present this area is mainly the Banares Hindu University campus, which is fully sewered.area generally falls to the north east direction.

4 RIVERINE PLANNING STRATEGY

Like many cities in India and elsewhere, Varanasi is at the intersection of two water systems: One from glacier Himalayas, melting snow and another drawing water from rain. It also extends via an infrastructure of pipes and drains to fields, industries, homes, and entire cities that draw water from it and return waste to it. To make resilient citscape four major issues of concern are very prominant i.e. waters rising with climate change beyond the already 30 to 40 feet that they do each monsoons; increasing household and industrial waste in the Ganges basin; increasing volumes of silt coming off the Himalayas that buries the ghats and fills the some temples on the ghats under many feet of mud and debris each monsoon; the project already underway to inter-link India's rivers with siphons, dams, and canals promises to make the flow of the Ganges past Varanasi more unpredictable.

Second water system begins with the monsoons, a wind laden with rain that blows from June to September. It feeds tanks called kunds or pools. These tanks are connected in series by their overflows, called nallahs drains which were water potable points for neighbours. Today this system is disappear. Overwhelmed urban sprwal intercepts natural custodianship systems.

Water supply and drainage system that speaks the language of the river rather than the tanks, but also endangers the river (IIT Report). During Britisg period river hydraulics turned away from rain to rivers, constructing three sides to Varanasi: a) a "front" side on the river which is today the face of the city embellished with ghats populated by tourists and pilgrims; a middle city that Mark Twain on a visit describes as a "vast mass of building, compactly crusting a hill, and is cloven in all directions by an intricate confusion of cracks which stand for streets;" and a periphery of communities around abandoned tanks, many of them built over, made into ill-functioning parks, or lying derelict and polluted.

4.1 From Urbanization to River-ization

Varanasi is situated between two water commons: Varuna River in the north and Assi Drain in the south. The current "Varanasi 2031" Master plan proposed by the authorities is based on ring roads; it does not take into account the actual ground truths of the city's rich landscape such as natural water bodies, whether in the form of flows or holdings.

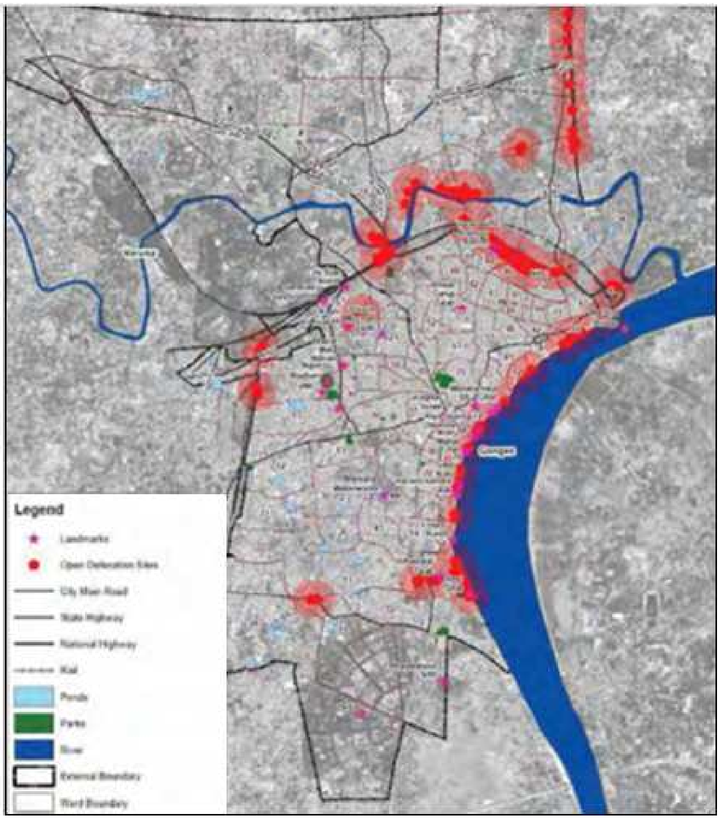

Fig. 11: Identification and location of intervention.

Rejuvinate Assi Nallah: ’If We Want a Clean Ganga, We Need to Start with the Nallahs’. At the origin point of the Assi drain, should decentralized and make biotic sewage treatment system. Since the landscape filtration system cannot treat all the wastewater, sequential platforms will provide initial wastewater treatment by removing the solids and reducing the smell. After this step, bio-filtration takes place to further clean the water. Runoff water is also treated through these folds in the landscape that act as bioswales.This treated wastewater and runoff water is channeled through the site into a larger water body that is designed alongs the open (maidan) spaces. Water from this water body filters into the existing kund (tank) and filters out to become the starting point of the Assi Nallah.These platforms of biotic sewage treatment infrastructure are expected to be owned and maintained by public health engineering department. At the confluence of the Assi and Ganga, this project celebrates this holy intersection by transforming an existing park into a delta of temporal productive landscape- for use by pilgrims and able to accommodate the flood waters of the monsoons.As Assi receives three billion liters of untreated waste everyday via nallahs which makes enormous untreated sewage pollutants to river Ganga.

4.2 Making room for river flood

The Varanasi Development Authority has prepared a 2031 Master Plan as meant to expand the city to accommodate the growing population. But looking Varanasi not means as fast growing urban centre but try to enhance its carrying capacity to adjust influx seasonal nomadics.So, rather than static and linear growth entity, public spaces should be flexible, adaptable and resilient to accommodate the intensifying seasonal flux of people, flora and fauna.

Open space- maidan are always welome density of users, and adaptability to different seasons. Talabs, parks and the edges of the Ganga River are common public spaces in Varanasi. They are identified as potential maidans which can be transformed into seasonal, adaptable and resilient spaces to absorb the intensifying flux.

Chakra Tal as a Maidan: Chakra Tal is currently an abandoned natural pond that once was an important social space for communities and a flourishing habitat for wildlife. The revitalization of the talabs (ponds) by introducing dams at the entrance of waterways into the talabs to act as silt traps during the monsoon. The residents will be encouraged to harvest this silt during rituals and then use the silt in community gardens along the talab. Service hubs and market stalls are proposed at the periphery to integrate the talab with the

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community and to turn it into a front yard rather than a backyard, the way it once used to be. Sewage treatment tanks are proposed to purify the water from the residential developments into the talab and to sustain the talab ecosystem.

Beniya Park as a Maidan: Beniya Park is currently occupied by as temporary shelter, flute makers use it as a shelter and production space, and residents around it use it as a playground. The park is currently enclosed and fenced separating it from the surrounding urban fabric with an unfinished abandoned structure that was supposed to be a fish market and is currently used as a toilet. Beniya Park can be transformed into a productive maidan, with the fences removed to create a direct and continuous access. Trees can define the park and prevent encroachment. This wetlands can be usefor migratory bird hub and in dry season for festive markets.

Dashashwamedh Ghat and the Sandbank as Maidans: Physical barriers along the Ghats prevent continuity of public spaces and soiled water outflow are currently contributing to the pollution of the Ganga River. An extension to the edge of the Ganga River is introduced by adding floating docks and gathering points that will ease the intense crowds and provide a continuity of public spaces along the Ghats. During the monsoon season, Ghat activities can be temporarily shifted inland to seasonal markets and ponds. The kit of parts highlights the temporary elements that correspond to the needs in different seasons.

4.3 Ganga Floodplain Urbanism

In the floodplain site between the Ganges River, the Ring Road, and Banaras Hindu University, ‘fingers of high ground’ may use for combination of soil from cut and fill operations and dredged river silt to build the fingers. This will be followed by an incremental building strategy on top of the fingers and the low-ground areas between the fingers will become capable of draining water to the river during monsoons while serving as ground for urban agriculture during the rest of the year. Infrastructure and transportation is also proposed along the spine of the fingers, which will enable people formerly living on the low-grounds to have better connections with the city and its infrastructure, and live with resilience, harmony and improved economic opportunity.

4.4 Varana River as an Entrance

Varuna should once again become the front of the city. Starting from the railway tracks, situated on a higher level, down to the Varuna River with this goal, series of holdings of water in the form of natural talabs (ponds) as well as kunds (tanks) where water flows through a filtration nallah (waterways) should reclame. The idea is to be able to filter and store water at different locations. At the Varuna, we propose to soften the river’s edge to create different ecological habitat areas as well as constructed wetlands that will help in bioremediation-wastewater treatment for the wastewater that is discharged by the buildings along the river. At the confluence point with Ganga Varuna should have designated delta designed to create a set of floodable islands that serve as the last layer of water-bioremediation as Varuna enters the Ganges. During dry season, these floodable islands can become destination points for boats and tourist flows, hosting various types of public spaces as well as a farmer’s market.

The Ganga river’s severe flooding is increasing proportionally to the depletion of forests. Forests hold wetness and regulate flows. Reversing deforestation will make living in the Gangetic plain more resilient as well as increase biodiversity and provide various services at a local level.The loss of the forest is a tragedy for those to recapituale of myth- Shiva’s Anandavan – forest of bliss. But it is possible to revive Anandavana. The forest will start to grow from alongwetlands toward the countryside aiming to ultimately achieve a single patch of forest cover in the future for the whole Gangetic Plain.

5 TAKE AWAY

Above envisage strategy planning will restore the origin form of Varanasi- a riverine ecological hub for clean spiritual destination, revitisation of god’s water structure Kunds, safe floodplain urbanism. Turning Rivers into a cleaning biotope, self sustain water management through four water origin clouds (rains), nallahs (flows), kunds (holdings) and aquifers (deep holdings) will be made through productive terracing, trash catchment for reslient sacred cityscape. In different ways, by different means, and at different times to restore the value of the Origin of place-Varana River as a spiritual spine, a cleansing biotope. Rejuvinating the glory of Assi makes recognition of nature value as drivers of self sustainable riverism planning in cityscape.. The residents of Varanasi will, then, benefit from a water oriented city where they will have access to clean water for drinking, irrigation and cattle rearing purposes in an ecological environment that can once again hosts a diverse species of animals and plants like it used to.

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Using Environmental Input-Output Analysis to Assess Energy, Water and CO_2 Emissions in Tokyo's Food System

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1 ABSTRACT

The sustainability of Tokyo relies on a big food supply chain to meet the huge demands of a population of 14 million people. The production of food consumes enormous amounts of water and energy along with producing the accompanying vast amount of CO_2 emissions. Excessive emissions create serious downward pressure on reaching the goal of being a carbon-neutral society by 2050. In order to relieve this pressure, it is required to first evaluate the CO_2 emissions quantitatively and then identify the main emitters exactly. Most of the previous studies focused on the emissions by industrial sectors, ignoring nexus effects across sectors. They also ignored the contribution of carbon emissions in the entire food supply chain, from supply industries to final consumption. This paper aims to develop a framework to visualize direct and indirect resource consumption and emissions in the food system, from food supply to food demand, and identity the key nodes and paths to achieve reduction targets using input-output tables at different scales. First, we define the elements in the food nexus system and establish the relationships among elements, in which the supply-side includes agriculture, animal husbandry, fisheries, and food manufacturing, while the demand-side includes food wholesale and retail, catering, and households. Then by using a monetary input-output table compiled from the statistics from the Tokyo Metropolitan Government, direct and indirect resource utilization and emissions are calculated to identify the sources of environmental stress through combining environmentally-extended input-output analysis and energy-water-CO_2 flow analysis. Finally, the reduction targets could be allocated to specific sectors and districts according to the results of emissions at different scales. The results show that the manufacturing and services sectors played the top roles of direct and indirect energy consumption and carbon emission, with manufacturing as the largest embodied energy consumer and CO_2 emitter, and services as the largest direct and embodied water user. These results indicate that the Tokyo Metropolitan Government could provide more measures on energy conservation and reduction in manufacturing and services. In addition, government should promote the wide use of zero emission vehicles to reduce emissions in transportation. It was found that the food system emits 10.73% of total CO_2 emissions and the embodied resource consumption and carbon emissions triggered by households is nearly a quarter of total embodied household consumption and emissions. Also, more than 80% of direct consumption and emissions comes from food demand. For embodied energy and CO_2 emissions, the main sectors with a strong correlation effect were manufacturing–services, manufacturing–transport/post, and services–transport/post, while manufacturing–services, telecommunication–services, and services–telecommunications were the major sectors for embodied water use. These sector pairs are the key paths for formulating energy conservation, water saving, and reduction measures. Our findings show that the food-energy-water (FEW) system is a significant contributor of CO_2 emissions in Tokyo. Thinking and acting on the FEW nexus across sectors could help the government to roll out its "Zero Emission Tokyo Strategy 2050" more effectively.

Keywords: Food systems, energy-water- CO2 emissions, environmental input-output analysis, Tokyo

2 INTRODUCTION

With increasing demand for food, energy and water (FEW), driven by population growth, urbanization, and economic development, the supplies of these three resources face significant challenges (Xiao et al., 2018), while the production and consumption of these resources is accompanied by production of a vast amount of CO_2 emissions. Excessive emissions contribute to the frequent occurrence of extreme climatic events and serious damages to the security of FEW services in cities. Traditional thinking analyzes food, energy, and water individually, and ignores the impact of emissions (Owen et al., 2018). In fact, these four factors are relevant. It is clear that water and energy are the crucial inputs along the whole food supply chain. The energy production process consumes a large amount of water, while a lot of energy consumption is embodied during the production and distribution of water (Xiao et al., 2018), and all these processes are accompanied by carbon emissions. The interrelationships and interdependence between them are important areas of study.

Nexus thinking is a sustained endeavor to understand the relationships between the four variables and applies an integrated management approach (Al-Saidi and Elagib, 2017; Sharmina et al., 2016).

Tokyo, Japan's capital and the largest metropolis in the world, with a high density of population and industries, is a good research case because it is an urban area with huge demand for food supply and the Tokyo Metropolitan Government has set the goal of net zero CO_2 emissions by 2050. Therefore, it is particularly important to have ways to to accurately evaluate resource consumption and emissions in the food supply chain. Input-output analysis is a valuable method for illustrating the supply and consumption processes of FEW resources in various economic systems (Zhang et al., 2014; Chen et al., 2017). In general, IOA can translate economic and environmental data in physical flows using value flows (Dong et al., 2014; Tang et al., 2018), and it can reflect the resource consumption and emissions that are embodied in the trade of goods (Zheng et al., 2020).

Input-output analysis is also an effective technique of evaluating supply and demand links between food, energy and water resources from a nexus viewpoint (Xiao et al., 2018). Owen et al. (2018) explore the relationship between products' energy, water, and food impacts by using input-output analysis in the UK, and finds that relieving environmental pressure cannot be achieved by reducing social welfare. Chen and Chen (2015) in a Beijing study find that the energy nexus impact is greater than water and a great majority sectors depend on manufacturing. Using a modified input-output analysis, Wang et al. (2017) find that manufacturing is the biggest supplier of embodied energy . Yang et al. (2018) find that Shanghai has similar and even greater environmental issues.

In this study, we first calculated direct and indirect resource consumption and emissions based on the input-output table (2011) of Tokyo at the sector level to identify the relationship between economic sectors and energy-water-CO_2 emissions. Then, we visualized direct and embodied resource utilization and carbon emissions, from food supply to food demand, and identity the key nodes which have high consumption and emissions based on an input-output table at the product level. Finally, the reduction targets were allocated to specific sectors and districts according to the results of emissions assessed at different scales.

3 DATA AND METHODS

3.1 EIO model construction and technical framework

The environmentally input-output mode can evaluate the relationship between environmental factors (energy, water, and CO_2) and socioeconomic activities by transforming a monetary input-output table to a physical input-output table, as shown in Equations: (1) and (2) (Zhang et al., 2014; Xu et al., 2021)

$$P + \varepsilon Z = \varepsilon X \tag{1}$$

$$\varepsilon = P[X - Z]^{-1} \tag{2}$$

where, $P = [p_i]_{1\times n}$, p_i is direct consumption and emissions in the ith sector; $Z = [z_{ij}]_{n\times n}$, z_{ij} is the I-O table currency flows matrix; X is a diagonal matrix consisting of each sector's overall economic output; $\varepsilon = [\varepsilon_i]_{1\times n}$, ε_i is the embodied resource intensity of the ith sector.

Fig.1 shows the data description and technical framework.

3.2 Direct consumption and emissions

For different types of energy, the direct energy consumption can be calculated in each sector. The types of energy in the Final Energy Consumption and Greenhouse Gas Emissions report in Tokyo mainly include electricity, city (natural) gas, liquified petroleum gas (LPG), and fuel oil. Therefore, CO_2 emissions were calculated based on four types of energy resources in this research. According to the Bureau of Waterworks, Tokyo Metropolitan Government, domestic water consumption consists of industrial consumption, urban activities consumption and daily life consumption. Sub-sectoral direct water use can be obtained from the total amount based on the economic output of the production and distribution of water (Xu et al., 2021). The direct consumption and emissions are formulated as follows:

$$e_i = E_{ele,i} \times \frac{T_{ele,i}}{\sum_{i=1}^{m} T_{ele,i}} + E_{gas,i} \times \frac{T_{gas,i}}{\sum_{i=1}^{m} T_{gas,i}} + E_{oil,i} \times \frac{T_{oil,i}}{\sum_{i=1}^{m} T_{oil,i}} \tag{3}$$

$$w_i = W_{water,i} \times \frac{T_{water,i}}{\sum_{i=1}^{m} T_{water,i}} \quad (4)$$

$$c_i = C_{ele,i} \times \frac{T_{ele,i}}{\sum_{i=1}^{m} T_{ele,i}} + C_{gas,i} \times \frac{T_{gas,i}}{\sum_{i=1}^{m} T_{gas,i}} + C_{oil,i} \times \frac{T_{oil,i}}{\sum_{i=1}^{m} T_{oil,i}} \quad (5)$$

where e_i, w_i, and c_i mean direct energy consumption (petajoules, or PJ), direct water use (m^3), and CO_2 emissions (t) of ith sector, respectively. $E_{ele,i}$, $E_{gas,i}$ and $E_{oil,i}$ represent the total electricity consumption of industry (PJ), total city gas consumption of industry (PJ) and total oil consumption of industry (PJ), respectively. $T_{ele,\ gas,\ oil,\ water,\ i}$ means the intermediate use (million yen) of sector m (production and distribution of electricity, gas, oil and water) in sector i. $W_{water,i}$ is the total water consumption of industry in Tokyo. $C_{ele,i}$, $C_{gas,i}$ and $C_{oil,i}$ represent the total emissions from electricity of industry (t), total emissions from city gas use (t) and total industrial emissions from oil use (t), respectively.

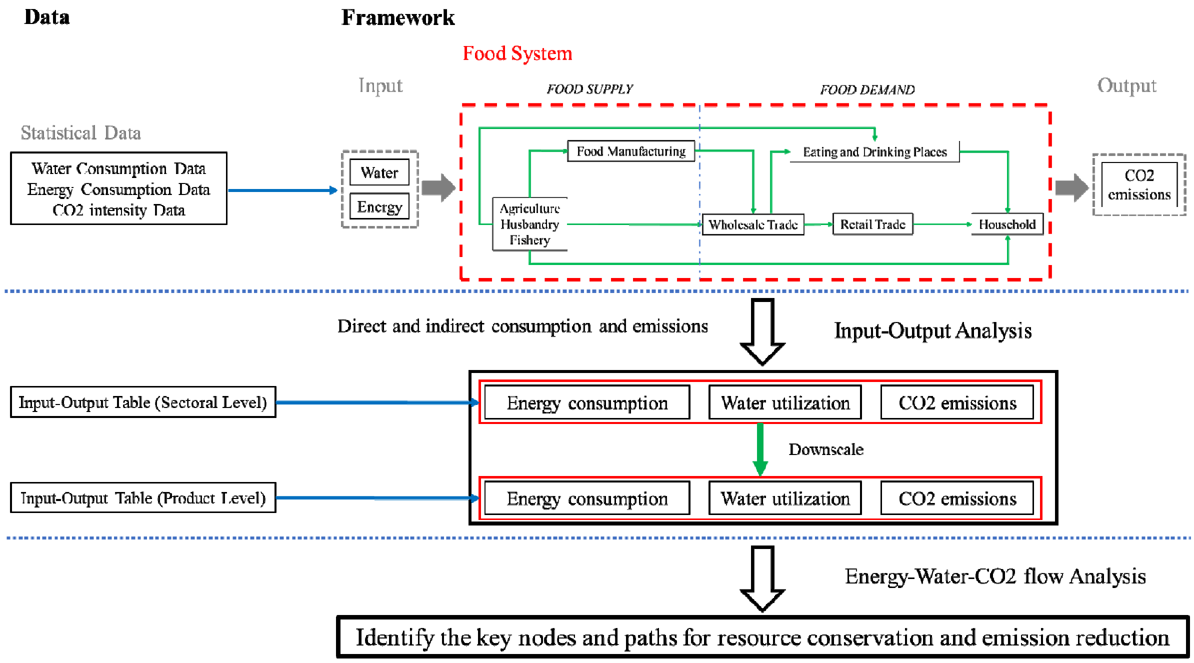

Fig. 1: Research framework

3.3 Indirect consumption and emissions

In addition to direct energy use and CO_2 emissions, sectoral production activities will create consumption and emission impacts as a result of sectoral linkages, which is referred to as indirect or embodied consumption and emissions. It represents the nexus impact of urban systems from a consumption perspective. The embodied consumption and emissions are triggered by urban final demand (Chen et al., 2016). Indirect consumption and emissions are calculated and analyzed based on the direct consumption and emission intensities as shown in Equations (7), (8), (9), and (10).

$$e_j^d = e_j / x_j \quad (7)$$

$$w_j^d = w_j / x_j \quad (8)$$

$$c_j^d = c_j / x_j \quad (9)$$

$$a_{ij} = z_{ij} / x_j \quad (10)$$

where e_{jd}, w_{jd} and c_{jd} are the direct consumption and emission intensity of energy, water, and CO_2 in sector *j*.

a_{ij} is the coefficients of direct consumption and x_j is the economic output of sector *j*.

Equations (11), (12), and (13) were used to determine the energy and water consumption as well as the CO_2 emission row vectors.

$$E_{em} = E_d(I - A)^{-1}Y \quad (11)$$

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$$W_{em} = W_d(I - A)^{-1}Y \quad (12)$$

$$C_{em} = C_d(I - A)^{-1}Y \quad (13)$$

where E_d, W_d and C_d are the row vectors of direct consumption and emissions intensities, respectively. A is the coefficients matrix of direct use. I is the identity matrix, and Y is the diagonal matrix transformed from the final demand.

3.4 Embodied flow analysis

By measuring the embodied flows between urban sectors, the efficiency and mechanism of the urban system can be quantified and analysed (Zhang, 2013). We can determine the vital sectors and pathways for resource conservation and emission reduction through analyzing embodied flows of energy, water, and CO_2 in the urban system (Li et al., 2017; Cai et al., 2019). Therefore, sectoral embodied flows of consumption and emissions must be considered (Fang and Chen, 2017). The embodied flows reflect the resource consumption and emissions embodied in goods trade. The embodied flows can be quantified based on the environmentally input-output mode through Equation (1)–(2) as follows (Tang et al., 2018; Xu et al., 2019; Wang et al., 2019):

$$F_{ij}^{ene} = \left[f_{ij}^{ene}\right] = \varepsilon^{ene} Z \quad (14)$$

$$F_{ij}^{wat} = \left[f_{ij}^{wat}\right] = \varepsilon^{wat} Z \quad (15)$$

$$F_{ij}^{CO2} = \left[f_{ij}^{CO2}\right] = \varepsilon^{CO2} Z \quad (16)$$

where f_{ij} is the embodied flows from sector *i* to sector *j*. ε is the diagonal matrix transformed from the row vector of embodied intensity.

3.5 Data sources

In this research, in order to assess resource consumption and CO_2 emissions at the sectoral level and product level (38-sector and 191-sector structures), Tokyo economic input-output table (2011) were available from Statistics of Tokyo. Energy use data including four types of fuel were gathered from the Bureau of Environment Tokyo Metropolitan Government. Information on the use of water in each sector has been acquired and analyzed from the Tokyo Metropolitan Government Waterworks Bureau. In addition, Tokyo's monetary input–output table (38-sector structure) is aggregated to a 11-sector table for assessing urban energy–water-CO_2 emissions, that are Agriculture (Agr), Mining (Min), Manufacture (Man), Construction (Con), Electricity, Gas and Water (EGW), Wholesale and Retail Trade (WR), Finance and Insurance (FI), Real Estate (RE), Transport and Post (TP), Telecommunications (Tel) and Service (Ser).

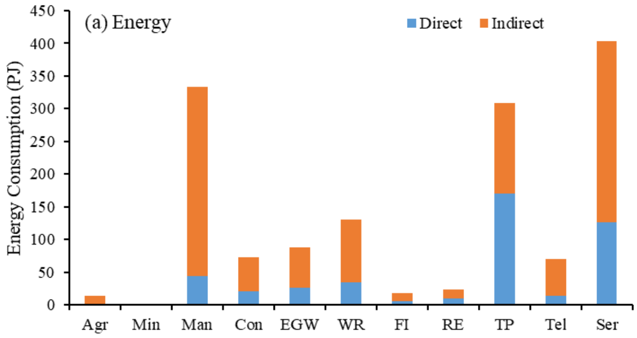
4 RESULTS

4.1 Sectoral energy and water consumption and CO_2 emissions in Tokyo

Fig. 2 shows sectoral energy consumption, water utilization, and CO_2 emissions in 2011. The total indirect consumption and emissions are higher than the direct consumption and emissions, where embodied energy consumption and carbon emissions are nearly two times the city's direct consumption and emissions. The reason for this phenomenon is that as the population grows there is a decrease in traditional production sectors, rapid tertiary industry development, and implementation of "Zero Emission Tokyo Strategy" policies, while the increase in citizen demand for goods resulted in an indirect consumption increase.

Fig. 2 (a) presents the direct and indirect energy consumption of each sector. The direct energy consumption of Tokyo in 2011 is 453.36 PJ. The biggest proportion of energy is consumed by the transport and post (TP) sector (36% of total energy consumption). Tokyo is a typical example of a railway-oriented city and 76% of total fuel consumption comes from transport. Services (Ser) is the second most energy-intense sector (27.6%), which includes education and scientific research, medical services, and various business services (accommodation business, eating and drinking services, and entertainment services, etc.). Manufacturing (Ma) consumed 9.7% of the energy, and the remaining sectors consumed another 26.7%. The total embodied energy consumption triggered by final demand is 1,008.37 PJ, in which the contributions of Manufacturing (Ma), Services (Ser) and Transport and Post (TP) are 28.67%, 27.34% and 13.69%, respectively. Compared with Fig. 2(c), the same trend was observed in energy consumption and carbon emissions. The biggest proportion of CO_2 emissions is Transport and Post (TP).

Fig. 2 (b) shows the sectoral direct/indirect water utilization of each sector. The direct water consumption of Tokyo is 4.029 billion m^3. About 2.38 billion m^3 of the water is consumed by Services (Ser) due to high demand in the food and beverage services and public bath services, accounting for 59% of the total water use, while 2.1% is used by Manufacturing (Ma). The total embodied water utilization triggered by final demand is 4.92 billion m^3, in which the contributions of Services (Ser), Wholesale and Retail Trade (WR), and Manufacturing (Ma) are 57.5%, 11.95% and 11.8%, respectively.



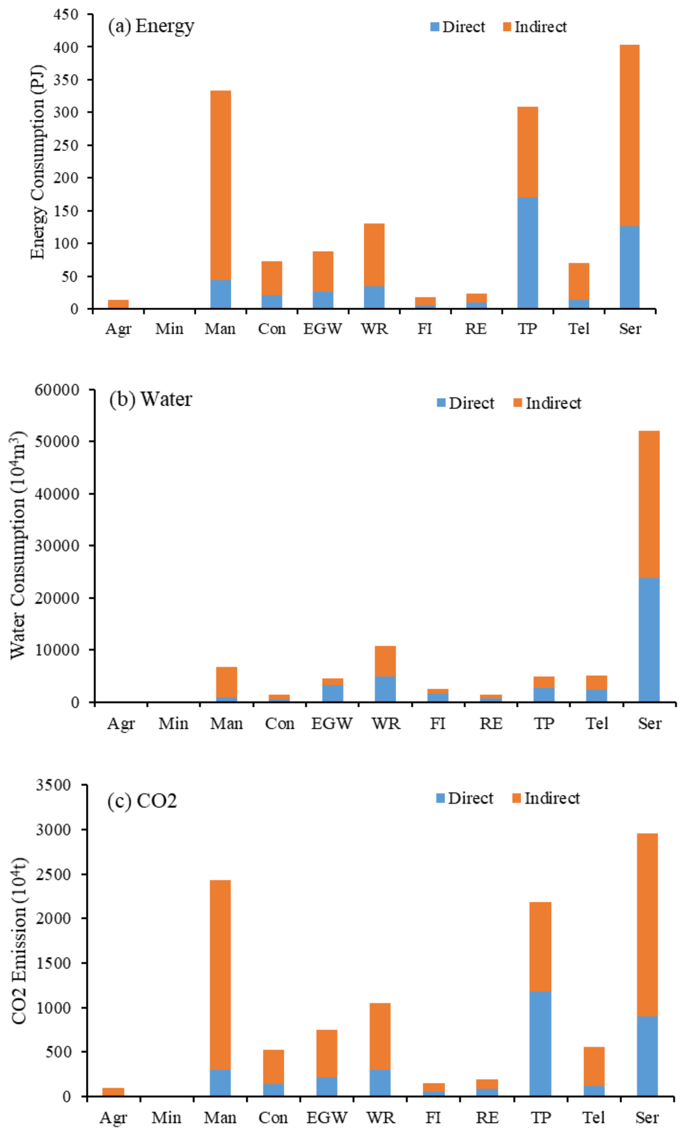


Fig. 2: Sectoral direct and indirect energy consumption, water resources utilization, CO_2 emissions in Tokyo

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4.2 Energy and water consumption and CO_2 emissions in the food system

Fig. 3 shows that the food system consumes 19.89% of direct water and 11.64% of direct energy and emits 10.73% of total CO_2 emissions. The embodied consumption and emissions triggered by households are 22.85% of embodied water, 28.57% of embodied energy, and 26.97% of embodied emissions, respectively. In the food system, more than 80% of direct consumption and emissions come from food demand.

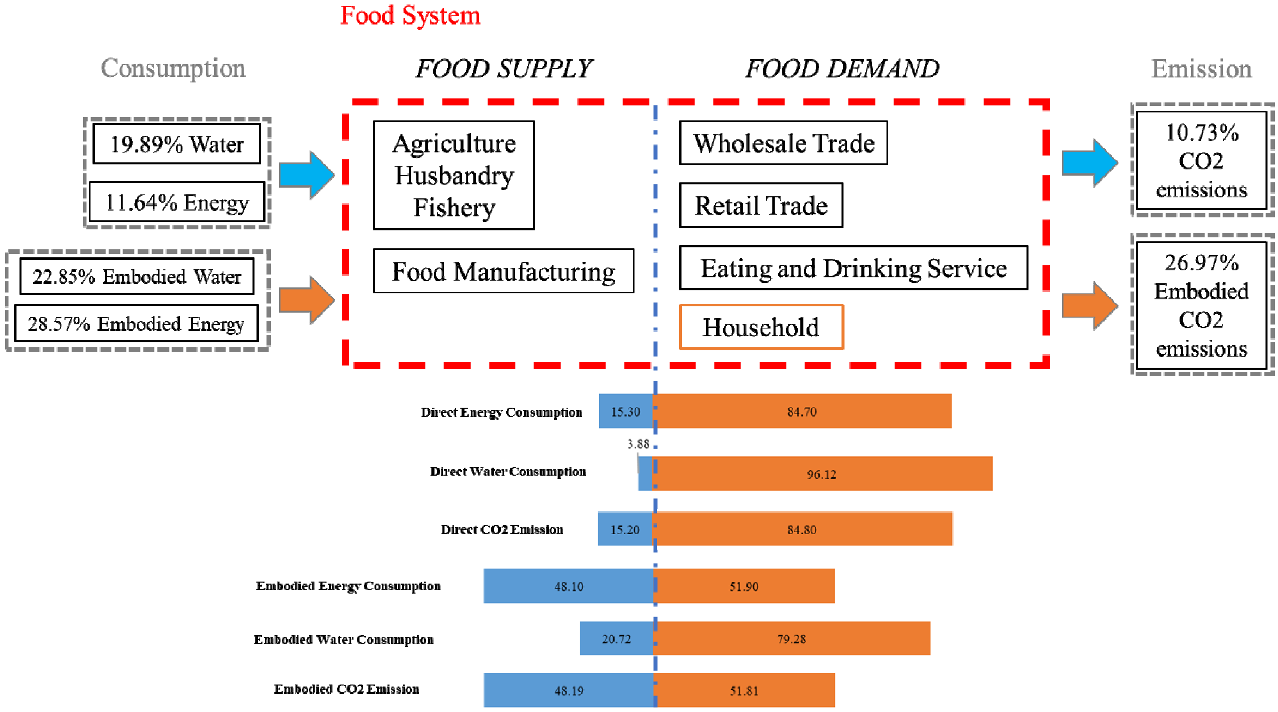


Fig. 3: Direct and embodied consumption and emissions in the food system

Fig. 4 shows direct consumption and emission in Agriculture (Agr) and Food Manufacturing (F Man). Marine fisheries are very developed, because they consume 71% of the energy in this sector. Agricultural services and non-edible foods consume 76% of the water, because seeds, flowers, and tobacco require much water to grow. Although there is little cultivated land in Tokyo, there are still professional farmers, mainly producing vegetables and fruits. Vegetable growing consumes 11% of water and energy, as shown in Fig. 4(a). Water and energy consumption are mainly concentrated in staple foods, condiments and other grocery products (frozen foods, fast foods, etc.), as shown in Fig. 4(b). Because the food supply in Tokyo mainly depends on imports, in order to feed 14 million people, it is necessary to refrigerate a large amount of vegetables, fruits and meat. As a result frozen foods and fast foods consume more than 36% of energy and water.

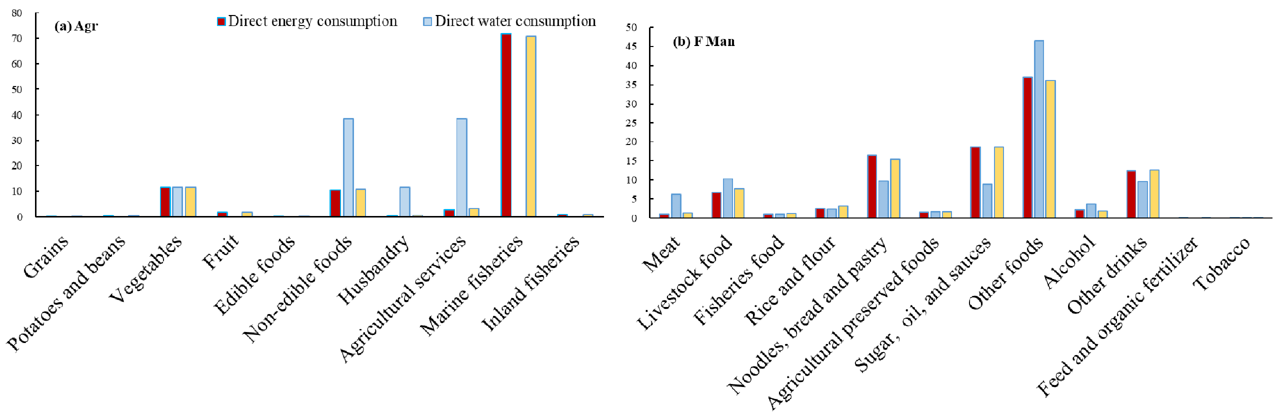
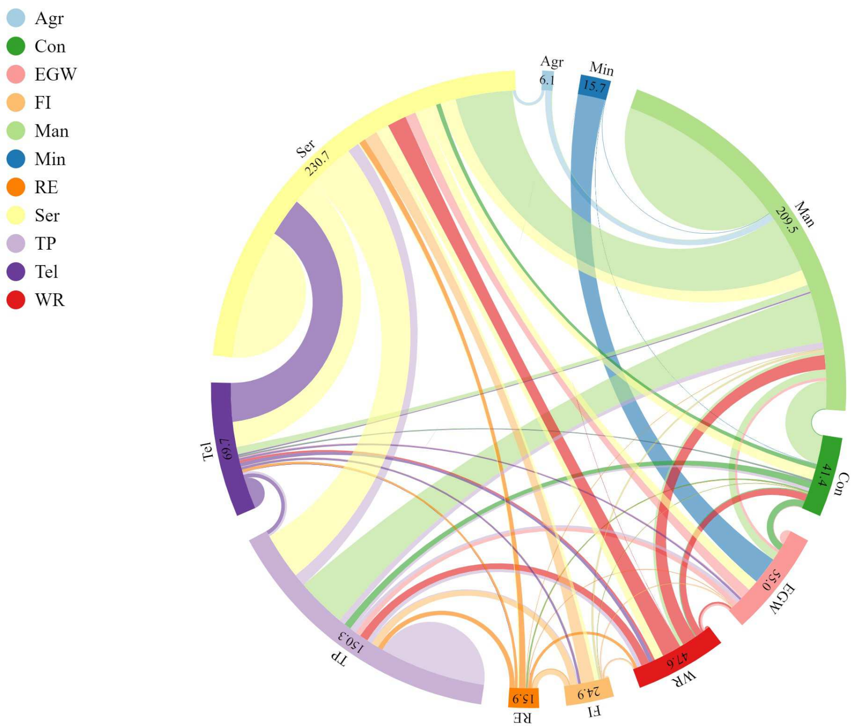


Fig. 4: Direct consumption and emissions in the food supply

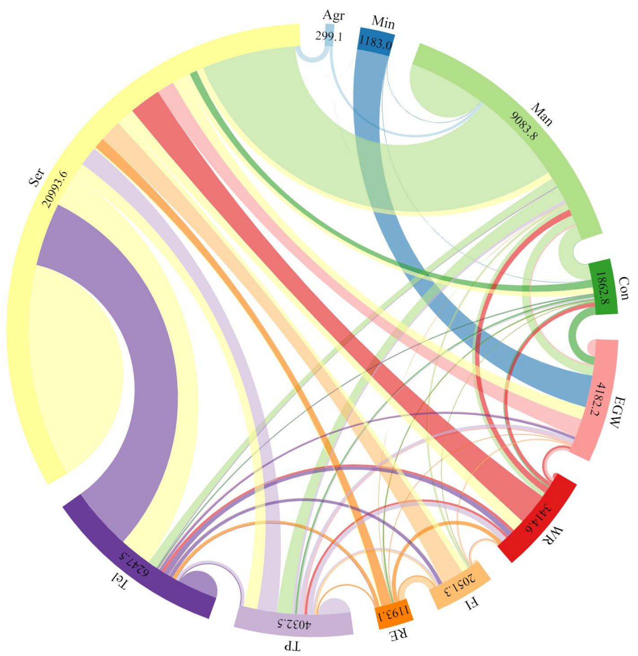
4.3 Embodied flows for energy-water-CO_2

In Fig. 5 (a) and (c), Man is the largest embodied energy and CO_2 supplier, with the amount of 133.9 PJ and 947.8 (104t), respectively. Man, Ser, and TP were always the top three suppliers of embodied energy and CO_2. The largest embodied energy and CO_2 consumer in 2011 was Ser, followed by TP and Man, because of huge demand or goods trade. In Fig. 5 (b), Ser and EGW were the biggest water users with the functions of public bath services and cooling water for power generation facilities, respectively. The description of the energy, water and CO_2 flow interactions between the various sectors in 2011 is shown in Fig. 5. The top three embodied energy and CO_2 supply-consumption flows pairs all existed in Man-Ser, Man-TP, and Ser-TP. Ser and TP were the biggest demanders of intermediate products from Man, in line with their sectoral features and raw materials demand. As the embodied CO_2 supplier, Ma has traditionally been the largest sector. The biggest supply-consumption flows pair is Man-Ser in embodied water.

(a) Embodied Energy



(b) Embodied Water



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(b) Embodied Water

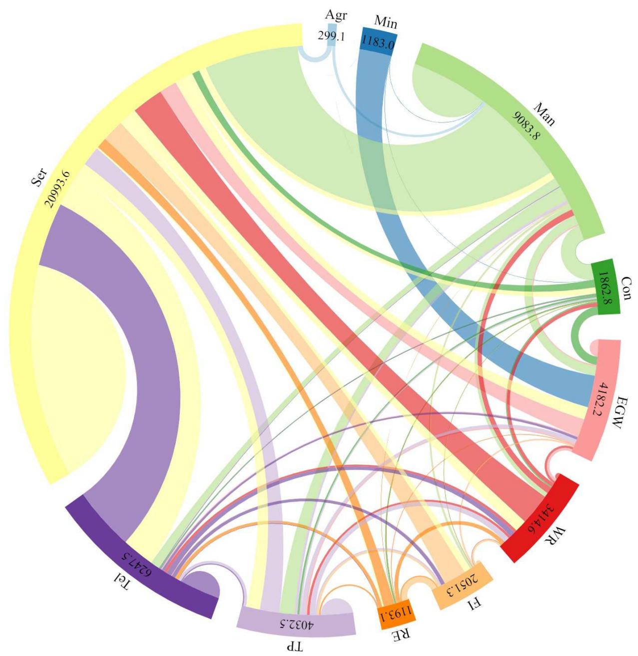

Fig. 5: Embodied energy, water, and CO2 flows between sectors in 2011. Note: The units for energy, water, and CO2 are PJ, 104 m3, and 104t, respectively.

5 DISCUSSION

From the research results, the energy consumption of Ser and Man had a great difference in 2011. Indirect consumption was more than two times direct consumption. A similar result was seen in the water utilization and emissions of the two sectors. Therefore, in the Ser and Man sectors, there should thus be greater consideration of energy and water conservation and carbon reduction methods. Although the energy consumption of Con is not high, indirect consumption is 2.6 times that of direct consumption. There are many wooden houses in Tokyo, and research has showed that the average wooden house life expectancy is only 40 years, lower than a steel-concrete structure apartment (51 years). Because of the short average life expectancy of building structures, much energy and water were consumed, leading to high emissions. A key objective to minimize consumption and emissions of the Con sector should thus be to improve the technology and technical standards of housing construction. The largest direct emissions come from TP. Relieving environmental stress in TP can be effectively accomplished by promoting a new innovation in the motor industry through various subsidy policies.

From the standpoint of resource trading between sectors, suppliers and consumers assume various duties to save energy and water, and reduce emissions. For instance, the biggest embodied energy and CO_2 consumers in Tokyo have been Ser, TP, and Man. Therefore, Ser, TP, and Man are the sectors with the most opportunity to undertake steps to save energy and to reduce emissions. Meanwhile, Ser, EGW, Tel, and Man are the biggest embodied water consumers and have higher opportunities and responsibilities than other sectors for water saving. For embodied energy and CO_2, the main suppliers-consumers were Man-Ser, Man-TP, and Ser-TP, while Man-Ser, Tel-Ser, and Ser-Tel were the major suppliers-consumers pairs for embodied water. The significant correlation impact between these sectors reveals the main path to formulate energy conservation, water-saving, and carbon reduction methods.

6 CONCLUSION

This study evaluated energy, water, and CO_2 flows through environmental input-output analysis using 2011 data at the sector and product level in Tokyo. in the urban system, services prove to be one of the industries in Tokyo, and direct and indirect process analyses show that services have the greatest energy consumption and carbon emissions. Indirect water use by services is higher than by other sectors, so there is great potential to conserve resources and reduce emissions from this sector, especially in the catering and public bath industries. Efforts targeting these services could help meet emission reduction targets, guided by strategic policies established in the Tokyo 2050 goal. In addition, direct and indirect energy consumption and CO_2 emissions from manufacturing showed a great variance. Most energy consumption and carbon emissions are indirect, as most manufactured products are needed by households, governments and for exports. Transportation dominated the list of direct energy consumption, suggesting that a focus on promoting zero emission vehicles (ZEVs) could help reach reduction goals. Manufacturing and services were the main embodied energy and CO_2 suppliers and embodied water consumers. These sectors are critical points for achieving the objective of conserving resources and reducing emissions. In the food system, more than 80% of direct consumption and emissions come from food demand, especially in the catering industry. More than 25% of embodied CO_2 emissions in the food system were triggered by households. In the food supply sector, non-edible foods dominated direct water consumption. This finding suggests that a focus on increasing the efficiency of irrigation water use will help conserve water resources. Our study also found that marine fisheries had the highest percentages of energy consumption and carbon emissions. The top three items for consumption and emissions in food manufacturing were staple foods (noodles, bread, and rice), condiments, and other grocery products (frozen foods, fast foods, etc.). One important conclusion is that people should strive to purchase locally grown, seasonal produce and eat a healthy balance of plant-based foods to relieve environmental stresses caused by food manufacturing

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Visioning of Next-Generation Wastewater Resource Recovery Facilities: Summary Findings of Student Work

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1 ABSTRACT

Components of traditional industrial infrastructure systems have unilateral input-output relationships—individual components transfer energy from natural resources and then dissipate the byproducts as waste into the natural environment. In what has been termed "Infrastructural Ecology", a multilateral approach reveals interdependencies and potential reciprocities between several urban systems viewed as part of a whole. To the extent that City authorities undertake improvements and upgrades to major facilities such as wastewater treatment processes and their campuses, an intersectoral approach, based on progressive trends for next-generation facilities incorporating practices for resilience, is timely. [1,2]

This paper provides a review of experimental findings from a sustainability graduate class that analyzed the cross-cutting issues and opportunities explored on the campuses of seven of the fourteen existing Wastewater Treatment Facilities in New York City. The students' findings and visions highlight the potential to break down municipal department silos and foster cross-sector collaboration to develop synergies that can decarbonize operations, metabolize portions of the City's waste stream, incentivize further resource recovery, and provide important co-benefits to improve the resilience, livelihoods, and quality of life in the adjacent communities.

Keywords: Infrastructure Planning, Sustainable Communities, Green Infrastructure, Food-Water-Energy Nexus, Wastewater Treatment

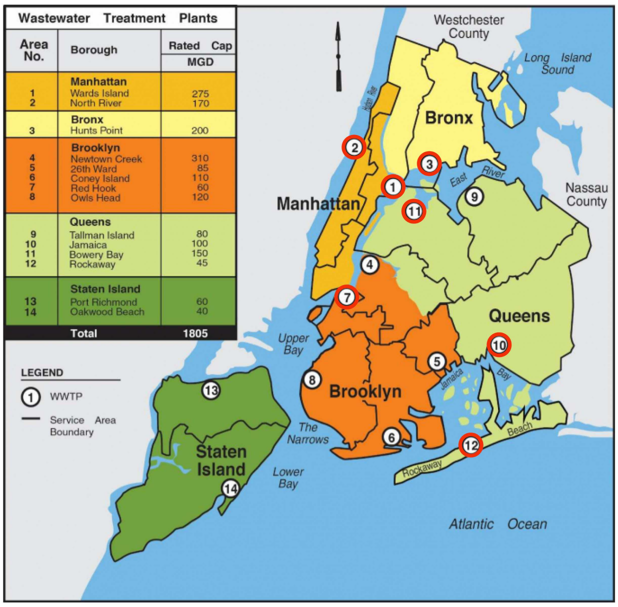

Fig. 1: NYC Wastewater Treatment Plants, selected sites with red circle.

2 STUDENT EXAMINATION OF WRRF SITES IN NYC

2.1 Introduction

New York City's fourteen Wastewater Treatment Plants, recently re-titled to be known as Wastewater Resource Recovery Facilities (WRRFs), are distributed throughout the five boroughs. Collectively they treat 1.3 billion gallons of wastewater daily (NYC Open Data). All fourteen plants are adjacent to bodies of water, including the Hudson and East Rivers, Jamaica and Bowery Bays, making the plants and nearby sewerage systems vulnerable to climatic threats like increased flooding, more frequent and intense storm surge, increased saltwater intrusion, and coastal erosion. In addition to their vulnerabilities, current facilities have been traditionally subject to design practice that turns these large facilities into fenced-off, impenetrable

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campuses, cutting off their neighboring communities' access to the waterfront, denying them valuable open space and connection with nature. Considered locally unwanted land uses (LULUs), these facilities can cause burdensome traffic, noise, odors, and may contribute to adverse public health. [3]

2.2 Student Examination of Seven WRRF Sites

Student teams were challenged to apply a set of principles and concepts to their assigned site using both analytical skills and creative intuition. Their final models were to reflect site assemblies that fostered potential new synergies between urban infrastructures - wastewater treatment, organic waste management, energy generation, and transportation. Students identified other nearby infrastructure facilities, commercial and municipal services to create potential loop-closing arrangements. Following an assessment of community needs/aspirations, potential new programmatic elements—appropriate public and community-oriented uses—were proposed for incorporation into the WRRF and/or adjacent underutilized sites, along with the addition of climate-resilient features to protect the enhanced campus and, possibly, nearby neighborhood areas.

3 COMPARATIVE ANALYSIS OF THE SITES

3.1 Methodology

We highlight commonalities and differences in the students' work across the selected seven sites as developed using public datasets and tools, GIS-based mapping of neighborhood assets and features, annotated GoogleEarth views, community surveys. Site strategies are identified and illustrated based on these these existing condition findings and site features.

3.2 Using the ENVISION Framework

The "Envision Framework," began as a guide to sustainability in infrastructure planning and construction, developed by the Institute for Sustainable Infrastructure (ISI) at Harvard University, In this treatment we adopt categories of the Envision Framework and group student findings into them. This is is intended to not only validate the work of the students against this sustainability guidance standard but also to further promote the use of Envision and its comparative metrics in other City agency capital investments. [4,5]

3.3 Site Strategies

Individual summaries are presented of what the student groups envisioned for each of the seven identified sites. Charts include flow-schematics for process inter-dependencies, developing following an Industrial Ecology model (Figure 2). Key concepts and proposed improvements of the student teams are identified in annotated Google Earth images and 3-D representations (Figure 3).

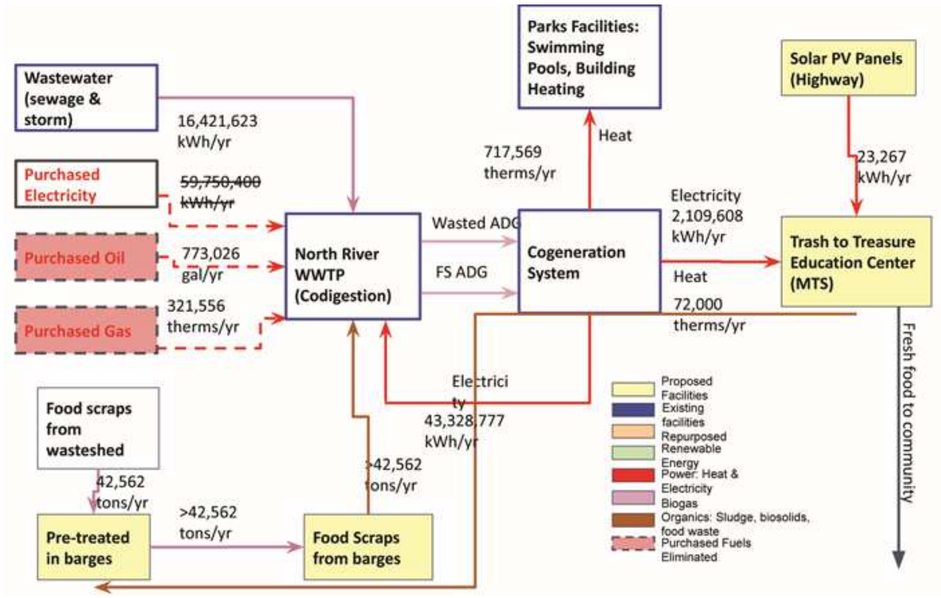

Fig. 2: North river water resource recovery facility, flow diagram. Source: student's work based on information provided by DEP.

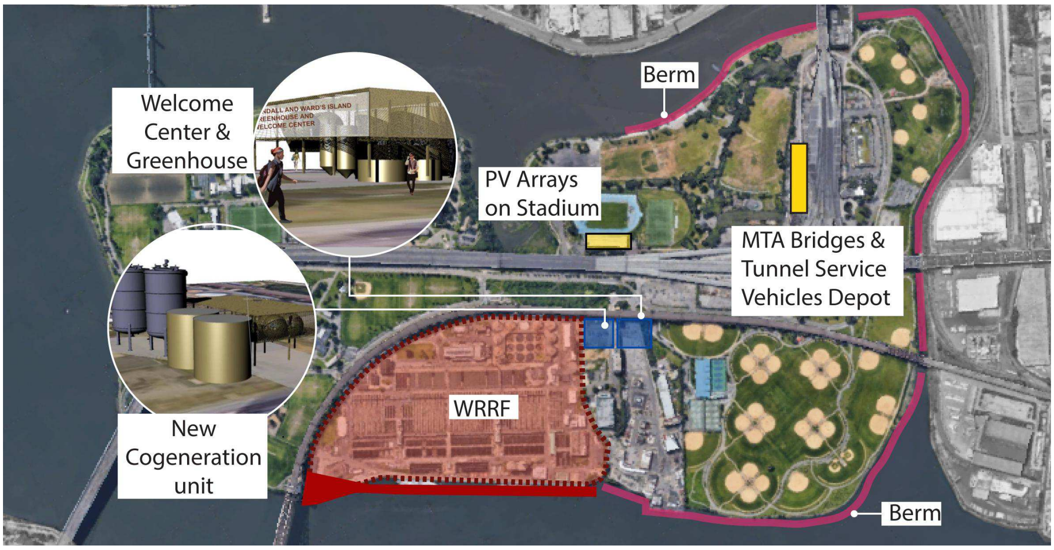

Fig. 3: Sample of student presentation of features as annotated GoogleEarth view

4 CONCLUSION

This exercise and summary report are an invitation to think and plan across the silos of City departments. This would allow for more extensive new connective waterfront greenways and open spaces, working with nature and with communities to improve overall quality of life. Such multilateral relationships described by the students' conceptual models for each of the seven WRRFs can serve to promote reciprocal exchanges of energy and matter on the path towards significant waste and GHG reductions, while also increasing the resiliency of each major component as well as the system as a whole. It is hoped that these principles and practices may eventually lend themselves to being widely adapted for a more "post-industrial" approach to infrastructure development not only by NYC DEP, but across all other city agencies.

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What makes a Participative Tool Elicit more Sample Views? Discussion with Supportive Means for Mutual Benefit

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1 ABSTRACT

Online discussion forums and survey applications are being used to elicit the opinions of people in online communities that could be used as the observation data for research and development. However, online collaboration-related problems such as low level of interest to participate and interaction among users arise due to the absence of mutual interests in the design of some of these tools. Many researchers have also found recruiting subjects for their studies through these tools very difficult, particularly in less developed countries like Afghanistan. Consequently, it is critical to find approachesthat incorporate someincentivemechanisms in order to stimulate participation in these forums, thereby serving the mutual benefits of researchers and their subjects/participants. Incentive mechanisms play a prominent role in stimulating users' intrinsic and extrinsic motivation to participate in online forums and enhance interactivity. However, the incentive mechanisms with appreciable prospects for stimulating the participation and interactivity of people in online forums remains poorly understood, and therefore has not been subjected to experimental comparative validation.

This paper highlights how financial motivation could serve as a supplemental incentive to virtual incentives in an online discussion forum. Towards that end, the authors conducted a comparative validation exercise/experiment with online communities in Afghanistanto assess how an efficient motivator could be utilisedtoincrease the overall participation of people with shared interests in online forums. In particular, online discussions was conducted, using a discussion forum with and without incentive, and an online survey was conducted using an online questionnaire without incentive. D-Agree was used as the online discussion instrument while SurveyMonkey associated with SVMK Inc. was used as the survey instrument for this study. The duration of data collection for each method was 17 days.We aimed to find outthe research methodological data collection and participative tools which ensure online communities' mutual benefit and stimulate quality participation and sharing of opinions. Based on the discussions and survey annotation files observation, and quantitative analysis of participants,we identified the participation and discussion performance metrics that describethe viability of the discussion forum with incentives as the most efficient method for increasing overall forum participation since it outperformedthe other two used in the experiment: discussion and survey forums without incentives. In addition, our quantitative analysis of participation from discussion and survey forums without incentives revealed that participation in online discussions without financial incentives, but with virtual incentives is higher than online survey forum without both incentives.

Keywords: discussion system, data collection, Online survey, Online discussion, online participation

2 INTRODUCTION

Following the proliferation of the Internet, online forums for various discussions, includingquestions and answers (Q & A) sessions are increasingly being used by researchers, policy makers and other stakeholders for data collection purposes (Haqbeen et al. 2021). Unlike conventional methods, this technique facilitates the collection of data across time and space in a cost-effective,rapid and efficient manner, although itmayalso require the use of some forms of motivators to encourage research subjects to provide meaningful responses (Hossain 2012; Ghosh and Kleinberg 2013; Jain et al. 2014; Ito et al. 2014). In particular, famous extrinsic motives as financial, social, technical and organisational perspectives have been introduced in order to stimulate people's intrinsic and extrinsic motivation to participate in online forums. Monetary rewards and other fringe benefits could be said to be constitutive offinancial motivation, while fulfilling the desire to learn and improve one's abilities, sharing knowledge and acquiring experience may be considered forms of social motivation (Hossain 2012). Virtual incentives such as ranking systems (Takahashi et al. 2016) and gamifications (Dai et al. 2016) are some examples of technical motivations used in online forums, while organisation ranking prospects and acknowledgment processes are considered as organisational motivations.

The existing research (Hossain 2012) emphasises that both intrinsic and extrinsic motives influence user's propensity for engaging in interactivity. Personal interests and hobbies are some examples of intrinsic motivation, while extrinsic motivation relates to the expected compensation associated with engaging in that interactivity or work. Financial motive is generally viewed as a core extrinsic motive because it increases someone's interest to innovate and collaborate. This study is guided by the following two questions.

Research question 1: What effects do the change from conventional online discussions with only virtual incentives to online discussions with financial incentive have on peoples' willingness to engage in interactivity in an online environment considering least developing countries?

Research question 2: Based on the authors' comparative experiments of the performance metrics of online discussion and survey forums, which is a better and more efficient data collection and observation data-assisted tool in less developed countries like Afghanistan?

The answers to the two questions above require a comparative validation exercise/experiment. This study aimed to verify the effects of incentive on the willingness to engage in online discussions and overall discussion performance.We conducted three social experiments on online forums, where online users were invited through an open convenience call to join and post their opinions on the forum. We first had an online discussion without financial rewards/inducements for a period of 17 daysand then, conducted another social experiment with incentives to ascertain if the online community users will participate higher or lower than the previous experiment where no incentive was attached. We then conducted the third social experiment using a survey forum without incentive to investigate the optimal use of a forum (discussion and questionnaire) as data collection for analysis and research. Our findings show that attaching incentives to online discussion increases online activity (participation and discussions) whileonline discussion without financial incentives was associated with lower participation and less discussions. However, online discussions without incentive activity outperformed online survey in terms of users' engagement and participation.

2.1 Problem identification

Online discussion and survey forums are widely used at individual and organisational levels to collect people's feedback on a variety of topics ranging from poverty, inequality, climate change to organisational policy development. The data gathered through such feedback are further analysed for academic or policy purposes depending on the interest of the researcher (Halim et al. 2018; Ito et al. 2020). In particular, the outbreak of the COVID-19 pandemic transformed researchers' approach to data gathering throughconventional means (through physical presence in the field), as many of them were compelled to embrace online data collection technique, using online forums (Haqbeen et al. 2020c; Haqbeen et al. 2020d). However, a major concern in leveraging online platforms for data collection purposes is how to foster users' engagement and enhance discussions outcomes (Brabham 2013). Moreover, data collection through online forums is often associated with lack of interest on the part of the targets/respondents, digression of discussions, and low survey participation and response rates (Tavanapour et al. 2019). Incorporating different incentive mechanisms into data collection endeavour through online forums have often been used to encourage users to participate and ensure that the discussions stay focused.However, identifying the incentive mechanisms with greater prospects of generating users' interests and facilitating robust meaningful discussions that both meet the mutual needs of the researcher and those of the research targets/subjects and sociocultural context of the research has received less empirical scrutiny.

This study sheds light on the following questions: (1) Are online discussions which incorporate incentive mechanisms more effective/beneficial for/to the researcher than online discussions which do not incorporate incentive mechanisms in terms of eliciting users' interests and generating robust discussions among them? (2) How beneficial/effective are online discussion forums compared to online survey forums? In view of the above-stated questions, an open-call idea was placed onsocial media to invite users of online communities to join discussion and survey forumsby the authors in collaboration with the Kabul Municipality.

3 BACKGROUND

In research communities,researchers often outsource the sampling for their studies to a company in order to reach targeted audienceson online platforms (e.g. survey and discussion forums). For example, they could buy targeted responses by running advertising campaigns to reach a targeted audience, and then build up these audiences (e.g. buying targeted responses on SurveyMonkey, buying Likes and boosting posts on

Facebook and Fiverr[1]). However, accumulating audiences through these platforms does not necessarily suggest mutual benefit or guarantee social good to the researchers and their subjects, as the business and the company whose account monies are paid into are often the beneficiary rather than those who accessed the posts.

Unlike using these services, where participants reached/invited gather to share their opinions and answer questions without receiving any incentives, online discussion platforms focus on promoting extrinsic motivation by utilising incentive mechanisms. In this context, technical motivators (e.g. virtual incentives, ranking and gamification) are introduced into online discussion to stimulate participation and discussion. The ranking system is a virtual rewarding point system for posting, replying, and liking within a discussion thread. As a result, users are better motivated to take part in discussions when observing other users' participation (e.g. Sun et al. 2011; Hadfi et al. 2021). However, incentive bias cannot be avoided because each participant may be influenced by different motivators in the process of engaging in discussions. In addition, some methodologies are relevant to categories of people's beliefs and motivations, and some are not. Moreover, some methodologies are biased in favour of the researcher's interests while others reduce the researcher's influence over the responses of participants. Additionally, some tools ensure mutual benefits to promote social good, while some others are just one-sided. Thus, researchers use different methodologies,which are appropriate for their study, geographical area, online communities and sociocultural context as data collection tools. As a result, it becomes increasingly necessary to study different methodological tools used for gathering sample views while conducting online surveys and discussions.

3.1 Online discussion forum

An online discussion forum (Malone et al. 2009; Klein 2011; Introne et al. 2011) is a discussion site on the internet where users can discuss specific topics by posting a series of messages while a facilitator moderates(Ito et al. 2014)and lead the discussion in order to arrive at innovative solution (Haqbeen et al. 2020e). The message posted on the discussion site could be used as the data for analysis just as interactions among the users could be used as the observation data (Haqbeen et al. 2020a). Online discussion forums are often established intentionally by a research team to study a topic of interest (Haqbeen et al. 2020b). Usually, participants are recruited through Internet communities (e.g., Facebook, Twitter) or in community settings. Typically, when participants visit the online site, they are assigned user identifications and passwords through which they could access the online forum site. Researchers usually post discussion topics and/or prompts so that the participants could initiate their discussion on the specific topics and/or prompts. In addition, researchers use social platforms data such as Facebook and Twitter for qualitative and quantitative research (Franz et al. 2019). These sources of data, their model and straightforward accessapplication programming interface (API) (Antonakaki et al. 2021) naturally allow researchers to unpack deep meaning within a selected group of people and probe for underlying values and assumptions (Yauch and Steudel 2016), as well as obtain more novel information, unlike using other methods such as online surveys (Yauch and Steudel 2016). However, because of the nature of these social platform data (e.g. Facebook), research method may require additional adaptations to appropriatelyreconcile textual interactions with the accuracy and usefulness of the subjects'responses(Atieno 2009). As a result, it become critical to manage discussion annotation and extraction by setting specific discussion, using discussion support system (Haqbeen et al. 2021).

3.2 Online survey forum

An online survey forum is a site on the internet that allows a one way or asynchronous method of insight collection for qualitative and quantitative research (Im and Chee 2006; Antonakaki et al. 2021). In particular, famous online survey forums such as SurveyMonkey (Halim et al. 2018), Google forms (Nurmahmudah and Nuryuniarti 2020), and SurveyGizmo (Halim et al. 2018) have been developed to support online survey service solutions.Unlike online discussion, surveys are simply not intended to facilitate two-way communication and engagement. Online surveys capture immediate responses and reactions to structured questions, but they do not promote the same level of discovery generated from a-two-way discussion. Thus, an online survey doesn't give us the same depth of insightsthat could be gotten from discussion forums (Yauch and Steudel 2016). However, there is no doubt that online surveys are an easy way of facilitating a

[1] https://www.fiverr.com

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one-way question and answer session with many people at the same time compared with in-person survey and interview (Sahab et al. 2016), but it does require you to have a good grasp of the intended audience and more importantly, the objectives of your survey.

4 METHODOLOGY

4.1 Study area

After careful consideration, a completely open online asynchronous environment was used as the study area for this study.The Afghan online community was informed through an open call for participation in collaboration with Kabul city, without assuming, of course, that all citizenshave access to internet services. Kabul, Afghanistan's capital city, considered the main and central hub for the country's 32 million people (NISA 2021) was chosen as the focus of the study. The city was chosen due to its accessibility to all Afghan online population and the authority's partnership to carry out the online experiment. Internet access rate in Afghanistan was estimated at 11.4% as of 2017 (World Bank 2017). The majority of residents in Kabul city lacks internet facilities, particularly using smartphones. Thus, only internet users (citizens) in online communities whose links were widely disseminated, and who consented to participating in the discussions and surveys took part in the experiments for this study.

4.2 Sampling method

This study was conducted in a large-scale online environment.Our general multimethodologies (Brewer and Hunter 1989; 2006) aimed at conducting experiments, using online discussion and survey forums.For the discussion forums, two settings were considered: (a) a discussion without financial incentive, and (b) another discussion with financial incentive. For the online discussions, D-Agree (Ito et al. 2020; Haqbeen et al. 2020e), an online discussion support platform was used to conduct the two discussion experiments. A total of 741 peoplevolunteered to participate in the online discussion without financial incentive while 1402 people featured in the online discussion with financial incentives. D-Agree, is a text-based online discussion platform, which is anchored on support and facilitation means developed by our team for hosting large-scale discussions or deliberations. We chose D-Agree because of its ease of useat any place and time, its facilitation support (Hadfi et al. 2021) and its ability to host large-scale discussion (Haqbeen et al. 2020a). More importantly, D-Agree was chosen because its incentive function could easily support the implementation of our experimental settings (discussion with and without incentives). For instance, it allows us to see the quality of opinions and their ranking. It alsogenerates post-discussion annotation files that allow usto easily undertake performance metric analysis.The user interface (UI) of D-Agree is shown in Fig. 1.

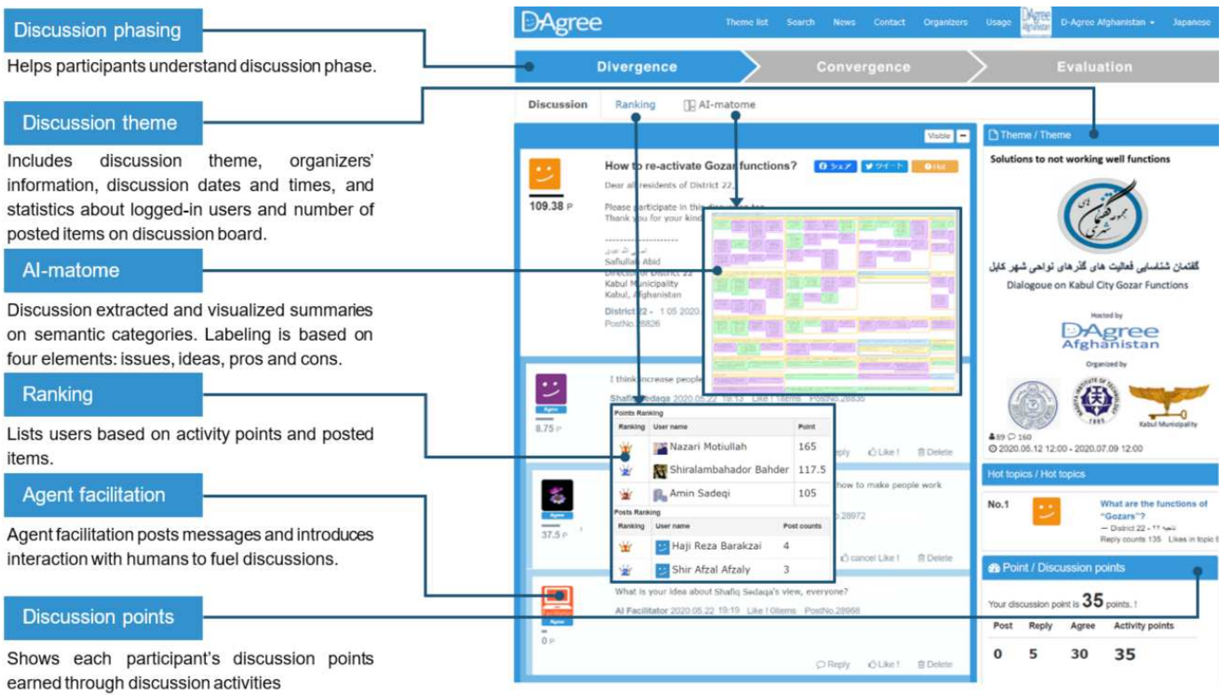

Fig. 1: A snapshot of user interface in D-Agree, adopted from Haqbeen et al. 2021, p. 16.

For the online questionnaire, SurveyMonkey, an online survey forum was used to conduct a question answering experiment. SurveyMonkey (Abd Halim et al. 2018), which was founded in 1999, is a cloud-based software developed by Momentive Inc. (Formerly SVMK Inc.). The software specialises in providing either free or licensed, customisable online surveys as well as a suite of premium back-end applications that include data analysis, sample selection bias elimination, and data visualisation tools. We used alicensed version of the software to design our questionnaire survey and sent the link to anybody who participated in the online discussions, using D-Agree. The registered users who participated and filled out the online survey were 140 (female = 38; 27.1% and male = 102; 72.9%). We choseSurveyMonkey because of its worldwide accessibility to anyonewho has access to internet connectivity (Abd Halim et al. 2018).

Since weused a convenience sampling technique (see Baltes and Ralph 2020) to collectsamples for ourthree research settings, online open-call (Brabham 2013) links were widely disseminated to allow anyone interested in the study to freely join the discussions and surveys (Haqbeen et al. 2021).

4.3 Study samples

The tool and samples of respondents who consented to participate in the three experiments are summarised in Fig. 2.

The experiment on discussions without incentive which took place between May 12 andMay 28 2020, (17-days) generated 874 opinions from 741 registered participants. The topics of discussion during this period focused on various topics,particularly neighbourhood and community planning. Residents from 22 urban districts discussed the same topics within the same time and based on each participant's engagement in online discussion, they were scored and ranked by the system in real-time.

On the other hand, the experiment on discussions with incentive, which took place between September 1 and 17, 2020 (17-days), a total of 4709 opinions were generated from 1402 registered participants. Similarly, the topics discussed revolved around solid waste management and community planning. Residents from 22 urban districts participated in these discussions within the same time. Participants were then scored and ranked by the system in real-time based on their engagements in online discussions. In addition, we linked the ranking system to monetary rewards offeredtomotivate participants to freely discuss among themselves. These rewards ranged from cash prizes of 30k, 20k to 15k Afs (≈ 385, 257 and 192 USD) as well as presentation of certificates to the top ten most active discussants.

For the third experiment,the online survey started on October 8 andended on October 24, 2020 (17-days). A questionnaire (includingone open-ended question and other closed-ended questions) were used as instruments for data collection. 140 participants (female = 38; 27.1% and male = 102; 72.9%) participated in the survey. The questionnaire consisted of 23 questions, which were divided into different sections, including: (i) personal and demographic information (n = 6) ;(ii) preferred activities in online discussions (n =6); (iii) preferred elements in online discussion forums (n = 10); and (iv) an open-ended question related to SWM. We included other questions in some sections (ii and iii) for the purpose of another research, but for this paper, we only considered the number of participants and response rate, particularly responses to the open-ended question.

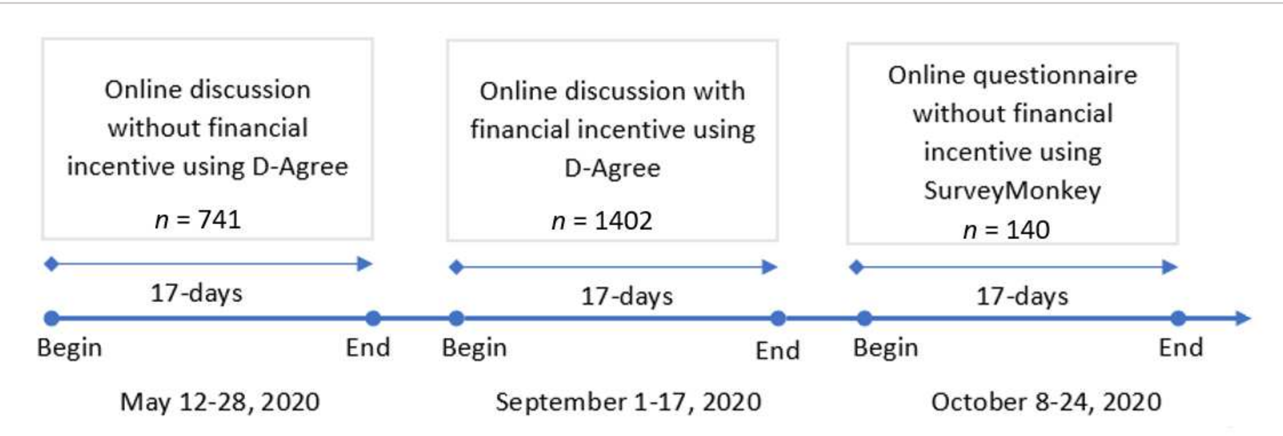

Fig. 2: Timeline of data collection using online discussion forum with two setting (with and without incentive), and online survey forum

We posted the three experiments on Facebook by boosting it through Facebook ads, prompts and open-call invitationto users (Brabham 2013). We did not include any financial incentives in therequest for participation for the first and the third experiments.The average time expected of a respondent to login and participate in online discussion was estimated at between estimated 10 and 150 minutes, while the average time projected for the completion ofthe online questionnaire was 3 to 5 minutes.

4.4 Data collection and analysis

To reiterate, this study seeks to achieve two objectives: (a) to determine the effect of incentives on participation and interactivity of respondents in online forums based on discussion annotation files and; (b) to ascertain the data collection and observation tool with better prospects (that is more effective) for increasing the mutual benefits of researchers and participants in online forum discussions.

The data collection lasted for six months,corresponding to the aforementioned three experiments of the research. To assess the effect of incentives on participation and interactivity of respondents, we analysed and compared the annotation files, using performance metrics likethe number of participants and posts or opinionsshared during the experiments.However, we did not analyse the qualitative data across two settings in this study, as it will be incorporated into another study.

To ascertainthe effectiveness of theconsidered data collection tool for empirical research studies in Afghanistan as a less developed country, we compared the numbers of participationsin each online experiment and the interest that each discussion generated from the people (respondents or participants).We used the discussion annotation datasets downloaded from D-Agree (Table 1), and the response data exported from SurveyMonkey.

Items	Description
Entry ID	Integer that identifies parent post
Title	Title of post
Body	Original posted opinion
Thread ID	Integer that identifies post as a thread
Parent ID	Integer that identifies a post and links it to a parent
Name	Author of post
User group	Integer that identifies a group
Labeling confidence	Node extraction result
Entry ID	Integer that links a child post to a parent post
Post time	Time of opinion's submission
Text	Extracted node contents
Node ID	Integer that identifies a node
Type	Type of label
Type confidence	Set of node extraction results
Point	Evaluated points from user activities

Table 1. Collected data for online discussion forum

4.5 Experimental setup

In the first online discussion, conversational agentsand discussion scoring system were activated as artificial facilitation and virtual incentive to stimulate data collection. Conversational agentsarechosen to facilitate discussions and stimulate participation (Haqbeen et al. 2020a). The ranking system was chosen to assign rewards aspoints for posts, as well as replies, and likes received by participants in a discussion thread. We thought these points might simplify the recognition of active discussions and potential ideas as well as improve one's abilities through knowledge gains. As a result, through these settings we might be able to stimulate extrinsic motives.For the second experiment, we added a financial (e.g. monetary reward) besides putting in place all the experimental set-ups for the online forum mentioned above. We defined this as online discussion with incentive which promote mutual benefits in this study. We decided to provide cash prizes to the top three active discussants and certificates to the top ten discussants. The active discussants were analysed based on their realtime generated discussion scoring, using a system ranking. For the third experiment, we conducted an online survey, using a questionnaire following the same strategy used for soliciting for participation in thetwo experiments mentioned above. However, we did not introduce any virtual or financial incentive as extrinsic motivators to stimulate participation here.

5 RESULTS

The results of the quantified data on the online discussion with and without incentives and online questionnaire survey are summarised in Table 2. The results of the quantified number of daily participation in online discussions are shown in Fig.3 while the comparisons of the associated number of posts in the two discussion forums (with and without incentives) are shown in Fig.4.

To address research question 1, the performance metrics (number of participation and posts) of participants in the online discussions with and without incentives were measured and compared in Section 5.1. Similarly, to address researchquestion 2, we compared the participation and survey completion rates in the online survey without incentives with participation rates in online discussion forum without financial incentives in Section 5.2.

Means	No. of participants	Average logins per day	No. of posts	Average posts per day
Online discussion forum without financial incentive	741	43.58	874	51.41
Online discussion forum with financial incentive	1402	82.47	4709	277
Online survey forum	140	8.24	-	-

Table 2. Characteristics of the respondents for online discussion forum without and with incentive, and online survey forum.

5.1 Comparison between number of participants and posts generated in online discussions

The quantified data in Figs. 3 and 4show the daily number of participation and participants' posts generated in online discussion with and without financial incentives. During the 17-day period, 741 and 1402 users created accounts and participated in the online discussion without and with financial incentives, respectively. We obtained 874 opinions from registered participants in the first experiment, which were submitted as initial posts on D-Agree, and received 4709 opinions from registered participants in the second experiment. We conducted t-test to statistically determine if there was a difference between the means of the number of participation rates and number of posts, being the performance metric used to assess theeffectiveness of the discussions in thetwo settings. The experimental results suggest that online discussions with financial incentive was more effective at engaging people in discussionsand citizens' participation (n =1402; avg logins per day = 82.47)than one without incentives (n =741; avg logins per day = 43.58).

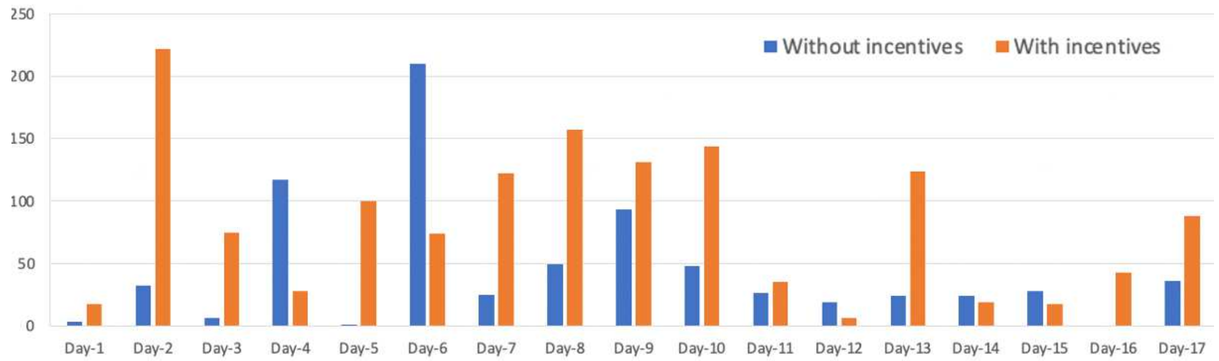

Fig. 3: Participants daily login on online discussion forum (with and without incentive)

Furthermore, the average daily opinions posted in online discussions with incentives was 277 (Fig. 4), which exceeded the average daily opinions for discussions without incentives (avg posts per day = 51.41). Thus, participants were clearly motivated to spend more time exchanging ideas and opinions in online discussions with incentives than one without incentives. This difference in means of participation and discussions could be attributedmainly to the financial inducementsthat accompanied the online forums with incentive.

The main purpose was to study the effects that the change from conventional online discussions with virtual incentives to online discussions with financial incentive have on people's interest in and interactivity in online environment in less developed countries. From analyses so far, we conclude that financial incentivesmotivate people to engage in online discussions. Therefore, financial incentives have a great potential toincrease participation in online discussions and the rate at which participants share or express their opinions or ideas when online crowdsourcing projectsare implemented.

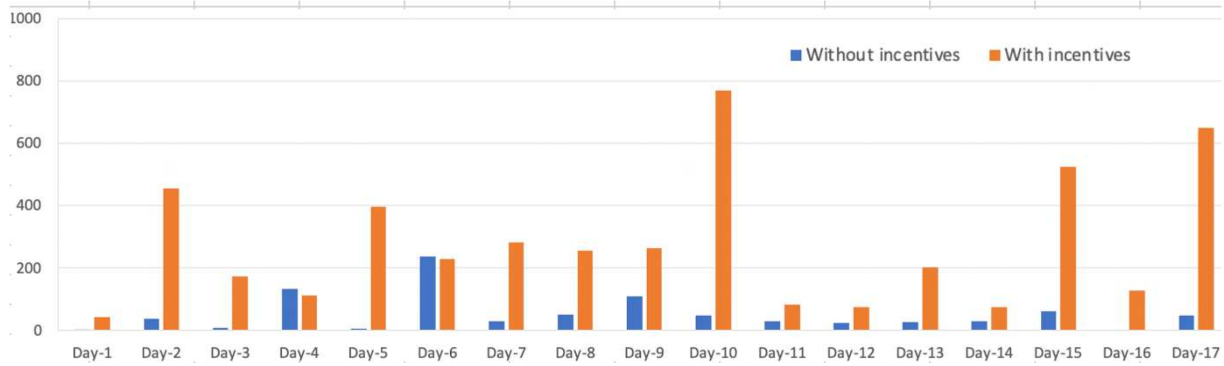

Fig. 4: Number of daily posts from participants in the online discussion forums (with and without incentives)

5.2 Comparison between the numbers of people/respondents who participated in online discussion and survey forums

We compared the rate of participation in online discussion and questionnaire without financial motivators.Therefore, we compared the first experiment (online discussion without incentive) with the third experiment (online survey without incentive) to ascertain the research methodological data collection and participative tool with better prospects to providemutual benefits for online communities and increase the quality of their participation and willingness to share their opinionsin online forums (Research question 2). Regardingparticipation in online discussion and online survey forums, we conducted a t-test analysis to examine if there was any significant difference in the means of the response and participation ratesbetween online discussion and survey forums. The result indicates that the average participation rates of citizens/respondents were higher in online discussion, using discussion forum (n =741; avg logins per day = 43.58) than the citizens/respondents' participation rates (n = 140; avg logins per day = 8.24) of questionnaire survey, using the online survey forum. This difference could be attributed to non-interactive (one-sided communication) attribute of online surveys, unlike online discussions, which are reputed for being interactive.

In addition, we considered the fourth section of the online survey forum, which contained open-ended question while looking at the responsiveness rate of participants. Accordingly, comparingthe responses from sections ito iii, with those of section iv, which containedan open-ended question, the participants responsiveness rate was found to be significantly lower in theopen-ended question (answered = 14; skipped = 126) than other three sections (avg= 139.55)

The results of participants' responses in the online questionnaire are summarised in Table 3.

6 DISCUSSION

The analyses and results of the discussion forum with financial incentive suggest that the rate of participation (number of logins and posts) is higher in online discussions accompanied by incentive compared to online discussions without incentive (Fig. 3). This finding reinforces the role of extrinsic and intrinsic motivators in online discussion with financial incentives, unlike participation in online discussions without financial incentives, which only provide virtual incentive. Indeed, online discussions with financial incentives provide mutual benefits for both the city and citizens/participants, while discussions without incentives might be perceived by citizens/participants as providing one-sided benefits to the city even though participation in them may be portrayed as a-two-sided communication and engagement.

With respect to participation in online discussion forums without financial incentive and online survey forum, the average participation rate of citizens/respondents per day was significantly higher in online discussions (avg = 43.58) than that of online survey (avg= 8.24). The reasons for this may be: (1) the greater interactivity of online discussions since people could read, react and reply to other participants' and experts' opinions; and (2) the attractivity of D-Agree atfacilitating discussions, providing incentivesby assigning virtual points and ranking participants based on their level of interactivity on discussion platforms. Thus, the participation rate was higher in a-two-sided communication (online discussion) than in a one-sided communication (survey questionnaire).

Section	Question number	Answered	Skipped
i. Demographic information (*n* =6)	Q1	140	0
	Q2	140	0
	Q3	140	0
	Q4	135	5
	Q5	139	1
	Q6	140	0
ii. Preferred activities in online discussion (*n* =6)	Q7	140	0
	Q8	140	0
	Q9	140	0
	Q10	140	0
	Q11	140	0
	Q12	138	2
iii. Preferred elements in online discussion forum (*n* =10)	Q13	140	0
	Q14	140	0
	Q15	138	2
	Q16	140	0
	Q17	140	0
	Q18	140	0
	Q19	140	0
	Q20	140	0
	Q21	140	0
	Q22	140	0
iv. Open-ended question (*n* =1)	Q23	14	126

Table 3. Characteristics of the respondents for online survey forum for this study (n = 140).

The experimental results show that online discussions were more effective at engaging people/respondents in discussions irrespective of whether or not incentives were attached to these discussions than online survey forums.Furthermore, the average daily opinions posted in online discussions exceeded the average rate of responsiveness to questions in online survey forums.

6.1 Study limitations and suggestions

Although online-discussion platforms could provide efficient mediafor collecting people's insights, in addition to being used as observation data for research and development purposes, the method may be replete with several limitations that need to be addressed in future works. For example, online surveysmay allow for the collection of specific answers, using closed-ended questions, but in online discussion, getting the discussion focused in order to get meaningful responses may be a challenge due to the openness (unstructured attribute) of the platform and people's tendency to veer off the discussion paths.To address this challenge, there is a need to keep the discussion questions concise and focused on a particular issue so that people/respondents/discussants could easily participate and share or express their ideas and opinions in line with theme of the discussion. In addition, simply defining a problem or topic as a high-priorityone may offer a more promising prospects for generatingappropriate and meaningful responses from the respondents/ participants (Haqbeen et al. 2021).

Moreover, we believe that selecting an appropriate online methodology that could be used to collect data in Afghanistan may pose many challenges that should be considered in the future. Low literacy rate (43 percent as of 2018) (see World Bank 2018), widespread poverty (the per capita GDP was UD$508.8 as of 2020) (see World Bank 2020), limited access to internet services (with a penetration rate of 11.4 percent as of 2017) (World Bank 2017)and low level of smartphones ownership are some of the major issues militating against most Afghan residents'participation in online data collection platforms. These constraints require a multiplicity of strategies, including mediation techniques, using telephonic sound recording audio interviews, and then transcribing the audio into texts. The challenges associated with low literacy rate may also be addressed through the use of telephonic conversation technique mentioned above. Most importantly, it would be useful to consider society-friendly experiments that also offer mutual benefits to both the research community and the online public community.

Note that, gathering people for large-scale social experiments is often a risky endeavour in an unsafe city like Kabul. For this reason, Kabul City authorities do not encourage massive concentration of people in urban districts due to security threats.Moreover, in our previous studies (seeSahab et al. 2015; Sahab et al. 2016), we conducted various surveys, using face-to-face questionnaire to collect dataacross only five districts of Kabul city. Due to budget, time, and particularly security issues, we were not able to extend the studies beyond these districts, using traditional techniques of data collection. Unfortunately, public apathy towards engagement in research activities was found to impair our data collection efforts during those surveys. Thus, considering Afghanistan'sinsecurity situation, online forums may provide an effective medium for data collection, with a view to generating observation data for research and development.

7 CONCLUSION

In this paper, we conducted three social experiments with different settings in order to explore the effectiveness of various methodsof collecting people's insights that could be used as observation data in research and development. In particular, we designed an online discussion with and without financial incentives,using an online discussion forum called D-Agree, and an online survey, usingSurveyMonkey as a software/instrument for developing and administering questionnaire in this study.

Results show that participation is higher in online discussions withprospects for financial incentives compared to discussionsthat incorporate only virtual incentives. This suggests thatfinancial incentive may better stimulate participation and facilitate greater interactivity, as measured by the number of posts and opinions sharedamong users/participants in online discussion forum. Furthermore, by comparing online discussion without financial incentives, using D-Agree with online questionnaires using SurveyMonkey, we found that the participation rate in online discussion without incentive was higher thanthat of online survey, suggesting that theD-Agree software is capable of stimulating both participation and solicitation of opinions. This might also be related to use of extrinsic and intrinsic motivations in online discussionscompared to the absence of incentives for participating in online surveys.

In all, our findings lead us to the conclusion that both financial and virtual incentives, as well as artificial facilitation approaches offer promising prospects for promoting the effectiveness of data collection in online empirical experiments. Indeed, incorporating mutual benefit rationalisation (by using various incentives, gamification and artificial facilitation) into data collection strategy through online forums may offer better prospect for attracting larger numbers of people to participate in research-based social experiments. Our next step is to examine whether methodological andcontext-specific peculiarities impacted citizens participation, using more controlled experimental setting. Finally, we plan to investigate further motivational approaches to stimulate discussions in online discussion forums, especially focusing on gender preferences in online discussion and survey forums.

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Wie können öffentliche E-Ladestationen sozial fair positioniert werden? Eine Analyse der Aktivitätsmuster und potenziellen Ladevorgänge von Frauen, Personen mit niedrigem Einkommen und Über-65-Jährigen

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1 ABSTRACT

Der Ausbau der Elektromobilität ist ein Weg hin zu einem umweltfreundlicheren Verkehrskonzept. Bei der Erweiterung der E-Ladeinfrastruktur sollte auf die Bedürfnisse von bereits benachteiligten Gruppen eingegangen werden, um Ungerechtigkeiten im zukünftigen Verkehrsmodell zu meiden. In dieser Arbeit wird das Ladeverhalten von Frauen, Personen mit geringem Einkomen und über-65-Jährigen als mögliche benachteiligte Gruppen untersucht. Grundlage dafür ist die Fragestellung, wo ein Laden innerhalb des Aktivitätenverlaufes und den damit verbundenen Aufenthaltsdauern möglich ist. Bei der Geschlechterbetrachtung zeigten sich deutliche Unterschiede in der Weglänge und dem Wegzweck. Auf Basis einer Kurzbefragung wurden zusätzlich die Stellplatzverfügbarkeit an Wohnort und Arbeitsplatz sowie die Bereitschaft zur Verlängerung des Aufenthalts an einem Ort, um Laden zu können, erhoben. Darauf aufbauend wurden zwei synthetische Ladeszenarien definiert, die sich durch verbesserte Fahrzeugtechnik und E-Ladeinfrastruktur unterscheiden um einerseits die Unterschiede für die benachteiligten Gruppen darstellen zu können, und andererseits die Robustheit der Aussagen auch für zukünftige Entwicklungen zu überprüfen. Das Aktivitätsmuster nach Geschlecht und Einkommen wird analysiert, um den idealen Ladevorgang räumlich, wie auch zeitlich in die jeweiligen Aktivitätsmuster einordnen zu können. Es zeigt sich, dass das Laden am privaten Stellplatz am Wohnort den Ladebarf am besten abdecken würde. Hier sind jedoch die betrachteten Gruppen benachteiligt und erhöhen so die Nachfrage an öffentlicher Ladeinfrastruktur in der Nähe von Einkaufsmöglichkeiten und Freizeitstandorten.

Keywords: E-Mobilität, Gendergerechtigkeit, Ladestationen, Aktivitätsmuster, Ladeverhalten

2 EINLEITUNG

Die Elektrifizierung des motorisierten Individualverkehrs spielt eine wesentliche Rolle für die Dekarbonisierung im Verkehrssektor. Energieunternehmen und Stadtplanung stehen aktuell vor der strategischen Aufgabe, die Verteilung und Ausstattung von E-Ladestationen im öffentlichen Raum zu gestalten. Diese Planung hat weitreichende Folgen, denn einerseits schafft sie die Voraussetzung für den raschen Markteintritt von Elektromobilität. Andererseits führt gebaute Infrastruktur zu Pfadabhängigkeiten für die kommenden Jahrzehnte.

Frauen und Männer weisen ein klar unterschiedliches Mobilitätsverhalten auf, da Frauen mehr und kürzere Wege als Männer zurücklegen. Männer verfügen häufiger über PKWs und unternehmen weniger Wege für Versorgungszwecke. Folglich haben Frauen andere Ansprüche und Bedürfnisse an das Mobilitätsangebot als Männer. Die genderrelevante Ausrichtung von E-Ladeinfrastruktur ist zentral, um nicht Benachteiligungen auf lange Zeit zu zementieren. Ladestationen müssen nicht nur technischen und wirtschaftlichen Anforderungen genügen, sondern müssen auch einen fairen Zugang für alle ermöglichen, indem alle Nutzer/innen die Ladephasen in ihre alltäglichen Aktivitätsmuster integrieren können. Wenn die Ladeinfrastruktur für alle Bevölkerungsgruppen zugänglich sein soll, sind Bedürfnisse von vulnerablen Personengruppen zu berücksichtigen. In diesem Projekt werden daher die Auswertungen sowie die darauf basierenden Szenarien für die drei ausgewählten Gruppen Frauen, Einkommensschwache und ältere Personen differenziert betrachtet.

In dieser Arbeit werden vorläufige Ergebnisse zur Einbindung der Aktivitätsmuster in die Ladenachfrage dargestellt. Ladevorgänge sind räumlich (Stromanschluss) und zeitlich gebunden (ausreichendes Zeitfenster für den Ladevorgang). Aktivitätsmuster werden danach analysiert, an welchen Typen von Aufenthaltsorten (z.B. Arbeitsplatz, Supermarkt) passende Zeitfenster auftreten. Aufenthaltsorte und Zeitfenster werden

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differenziert nach Gender, Einkommen und Alter ermittelt. Ergänzend wird dargestellt, wie hoch die Bereitschaft zur Anpassung von Aktivitätsmustern ist, wenn bestimmte Aufenthaltszeiten auch für das Laden des eigenen Elektrofahrzeuges genutzt werden können.

Diese Arbeit ist Teil des Forschungsprojekts FEMCharge. In diesem Projekt werden Entscheidungskriterien für eine gendergerechte Positionierung und Ausstattung von E-Ladestationen für Elektroautos erarbeitet, welche die jeweiligen Anforderungen von Verkehrs- und Elektrizitätsnetz, öffentlichem Raum, Wirtschaftlichkeit, Aktivitätsmustern und sozialer Segregation aufeinander abstimmen und optimieren. FEMcharge wird gefördert in der 6. Ausschreibung FEMtech Forschungsprojekte (FFG Projektnr. 873011).

3 DATEN

Die Analyse der Aktivitätsmuster basiert auf einer Sekundäranalyse der Mobilitätserhebung Österreich unterwegs 2013/14 sowie auf einer Kurzbefragung, die in FEMCharge durchgeführt wurde. Die Mobilitätserhebung „Österreich unterwegs 2013/2014“ bestätigt den Einfluss des Geschlechts auf das Mobilitätsverhalten. So legen Frauen mehr Wege zu Fuß und deutlich weniger Wege mit motorisiertem Individualverkehr zurück. Die Diskrepanzen im Vergleich zu Männern lassen sich durch unterschiedliche Verfügbarkeit der Verkehrsmittel, sowie durch berufliche und private Verpflichtungen und daraus folgend aus unterschiedlichen Wegeketten erklären.

Um aussagekräftigere Informationen über die soziale Situation treffen zu können, sowie die Tätigkeit Einkaufen stärker klassifizieren und grundsätzliche Fragestellungen zu Ladeverhalten ableiten zu können (z.B. Ausweitung des Aufenthaltes), wurde ergänzend eine Kurzbefragung in Graz durchgeführt. Eine Stichprobe von 92 Passanten/innen, die mit dem PKW unterwegs waren, wurde mittels standardisierten face-to-face Interviews befragt. Die Auswahl erfolgte im Umfeld von Points-of-Interest für Einkauf, Gastronomie, Freizeit und Versorgungsrichtungen. Dabei wurde an ausgewählten öffentlichen Aufenthaltsorten in 2-3 Grazer Stadtquartieren Daten zu vor-/nachgelagerten Aktivitäten, soziodemografischen Merkmale, Ladebereitschaft, Verhaltensadaptierungen, Einstellung zur Elektromobilität etc. erhoben.

4 SZENARIEN

Aktivitätsmuster von Verkehrsteilnehmer/innen sind ein wichtiges Merkmal zur Bestimmung des Potenzials von Orten für Ladevorgänge. Alltagsroutinen zu bestimmten Aufenthaltsorten und zu bestimmten Tageszeiten fließen hier ein. Insbesondere Frauen weisen komplexe Wegeketten und eine straffe Zeitplanung auf. Je kürzer, räumlich enger begrenzt und variabel Aufenthalte an öffentlichen Orten sind, desto stärker sind die potenziellen Zeitfenster für Ladevorgänge eingeschränkt. Es kann zu sozialer Benachteiligung kommen und bestehende Benachteiligungen können verschärft werden, wenn die Positionierung öffentlicher Ladeinfrastruktur nur unzureichend die spezifischen Aktivitätsmuster von Frauen, Personen mit niedrigem Einkommen und älteren Personen einbezieht.

Auf Basis der bestehenden Verkehrsnachfrage (Kfz-Wege, Alltagsverkehr, Werktagswoche, Grundlage Österreich unterwegs 2013/14) wurde ein synthetisches Ladeverhalten anhand der Aufenthaltsdauern und einer Priorisierung nach Verkehrszwecken berechnet. Bei der Verkehrsnachfrage wurde angenommen, dass alle Bewohner/innen der Großstädte, die derzeit werktags mit dem PKW unterwegs sind, diese Wege mit einem privaten Elektrofahrzeug durchführen. Personen, die lange Wegstrecken zurücklegen müssen (> 100 km), werden gesondert betrachtet, weil hier die Wahrscheinlichkeit höher liegt, dass diese verstärkt externe E-Ladeparks (z.B. Schnellladestationen im hochrangigen Straßennetz entlang ihrer Fahrstrecken) nutzen. Aufenthaltsdauern wurden in Wohnen, Arbeiten, Einkaufen (≤ 60 min), Einkaufen (> 60 min), Freizeit sowie Bringen/Holen (inkl. privater Besuch) klassifiziert. Die Szenarien beziehen sich auf die km-Verkehrsleistung der Werktage einer Woche als primäre Eingangsgröße für die Abschätzung der Ladenachfrage; der zusätzliche Ladeenergiebedarf für die km-Verkehrsleistung an Wochenendtagen muss gesondert (z.B. Freitag/Samstag, oder Samstag/Sonntag) abgedeckt werden.

Aus der Literatur, aber auch aus der im Zuge des Projektes durchgeführten Befragung wird abgeleitet, dass verfügbare Stellplätze am Wohnort (Privatstellplätze) und Stellplätze am Arbeitsort generell für das E-Laden bevorzugt werden. Diese Stellplatzverfügbarkeit wurde auf Basis des „Österreich unterwegs 2013/14“ Datensatzes ermittelt. Auf Grund der rechtlichen Wohnsituationen (Zustimmung aller Eigentümer/innen in Mehrparteienhäusern, etc.) und der Bereitschaft der Arbeitgeber ist eine 100 % Verfügbarkeit von

Lademöglichkeiten an diesen Stellplätzen nicht realistisch. Daher wurde dieser Anteil auf Basis von Wohnungsdaten der Statistik Austria (EU SILC 2018) abgeleitet.

Es wurden zwei synthetische Ladeszenarien definiert und berechnet. Als Systemgrenze wurden die Großstädte (> 100.000 Einwohner/innen in Österreich, ohne Wien) herangezogen. In beiden Szenarien wurde bewusst auf eine Veränderung der Verkehrsleistung auf Grund globaler Faktoren (Bevölkerungszahlen, Wirtschaftsentwicklung, COVID-19 etc.) verzichtet, um die Priorisierung der Aufenthaltsorte (Verkehrszwecke) und Aufenthaltsdauern explizit und fokusiert auf die vulurablen Gruppen evaluieren zu können.

Szenario Bestand+: Bestehendes Kfz-Verkehrsaufkommen einer Werktagswoche (100 %), erweiterte Aufenthaltsdauern (auf Basis der Kurzbefragung)

Szenario Zukunft+: Bestehendes Kfz-Verkehrsaufkommen einer Werktagswoche (100 %), erweiterte Aufenthaltsdauern und verbesserte Fahrzeugtechnik und E-Ladeinfrastruktur

Für die zukünftige Fahrzeugtechnik (Batteriekapazität) und E-Ladeinfrastruktur (Ladeleistungen) wurden Durchschnittskennwerte definiert (Tabelle 1). Bei Batteriekapazitäten und Ladeleistungen wird eine 100%ige Durchdringung des Fahrzeugbestands und des Ladestationennetzwerks angenommen.

	Szenario Bestand+	Szenario Zukunft+
Mittlere Batteriekapazität	55 kWh	75 kWh
Nutzungsbandbreite der Batteriekapazität	90 %	90 %
Energieverbrauch	17.5 kWh	17.5 kWh
Ladeleistungen (langsam)		
• Wohnen (Wallbox)	11 kW	11 kW
• Arbeiten	11 kW	22 kW
• Einkaufen (> 60 min, Einkaufszentrum etc.)	11/22 kW	22 kW
• Freizeit	11 kW	22 kW
• Bringen/Holen (inkl. privater Besuch)	11 kW	22 kW
Ladeleistungen (Schnelllade-Einrichtungen)		
• Einkaufen (< 60 min)	50 kWh	150 kWh
• Elektro-Ladestation/park, extern	150 kWh	150 – 350 kWh
Parkplatzanteil mit E-Ladeinfrastruktur		
• Private Stellplätze	62%	84%
• Firmenstellplatz	41%	56%

Tabelle 1: Eingangskennwerte für die Fahrzeug- und E-Ladeinfrastruktur je Szenario

Das Zukunftsszenario beschreibt die Auswirkungen zukünftiger Entwicklungen auf die Ladenachfrage (Erhöhung der Batteriekapazitäten der Fahrzeuge, Steigerung der Ladeleistung der E-Ladeinfrastruktur bzw. der E-Ladetechnik im Fahrzeug). Der Fokus dieses Szenarios lag primär darin, einen Robustheitscheck durchzuführen, ob die über das Bestandsszenario abgeleiteten Aussagen auch bei einer technologischen Weiterentwicklung zukünftig weiterhin zutreffend sind.

5 ERGEBNISSE DER BEFRAGUNG

Ein Teil der Ergebnisse, die direkt in die Szenarienentwicklung eingehen, werden in den folgenden Graphiken exemplarisch dargestellt. Für die Szenarienentwicklung ist die Stellplatzverfügbarkeit im Haushalt aber auch am Arbeitsplatz ein wichtiger Input. Bei der Implementierung von privaten Ladeeinrichtungen sind derzeit bei vielen der Befragten noch organisatorische und rechtliche Fragestellungen nicht geklärt (z.B. erlaubt der Arbeitgeber das Laden von Privatautos am Firmenstandplatz), daher wurde für die Szenarien eine Teilverfügbarkeit abhängig von dem zeitlichen Szenarienhorizont sowie der Anteile der Wohnungseigentums- und Wohnungsmietverhältnisse in Österreich angesetzt. In den folgenden Graphiken sind die Stellplatzverfügbarkeit am Wohnort (Privatstellplatz) und am Arbeitsplatz (Firmenstellplatz) mit einem räumlichen Bezug des engeren Untersuchungsgebietes dargestellt. Das Ergebnis (siehe Abbildung 1) unterstreicht die Tendenz, dass Bewohner in den Kerngebieten (Stellplatzverfügbarkeit ca. 31 %, Graz Innenbezirke) seltener einen privaten Stellplatz zur Verfügung haben, als Bewohner in den äußeren Bereichen (Grazer Außenbezirke mit einer Stellplatzverfügbarkeit von ca. 95 % sowie die Umlandgemeinden von Graz bei ca. 100 % der Befragten). Bei der Stellplatzverfügbarkeit am Arbeitsplatz zeigt sich ein umgekehrtes Bild, Bewohner im Kerngebiet haben mit ca. 77 % eine höhere

Stellplatzverfügbarkeit am Arbeitsplatz, als Bewohner in den Außenbezirken (ca. 71 %) und in den Umlandgemeinden (ca. 67 %).

Abbildung 1: Stellplatzverfügbarkeit am Wohnort (n = 41 Antworten) und am Arbeitsplatz (n = 53 Antworten)

Bei der Fragestellung zur Bereitschaft, die Aktivitätsdauer für den Ladevorgang des Elektroautos zu verlängern, zeigte sich, dass diese bei Frauen deutlich geringer als bei Männern ist (siehe Abbildung 2). Diese ist bei der Verlängerung der Aufenthaltsdauer um 30 Minuten bei Frauen um 6 %, bei 60 bis 90 Minuten um 11 % bis 12 % niedriger als bei Männern. Grundsätzlich wäre weniger als die Hälfte der Befragten prinzipiell bereit, die Aufenthaltsdauer für das Laden zu verlängern. Diese Werte wurden in einer generaliserten Form abhängig von den Aktivitäten in die Szenarien Bestand+ und Zukunft+ Berechnungen implementiert.

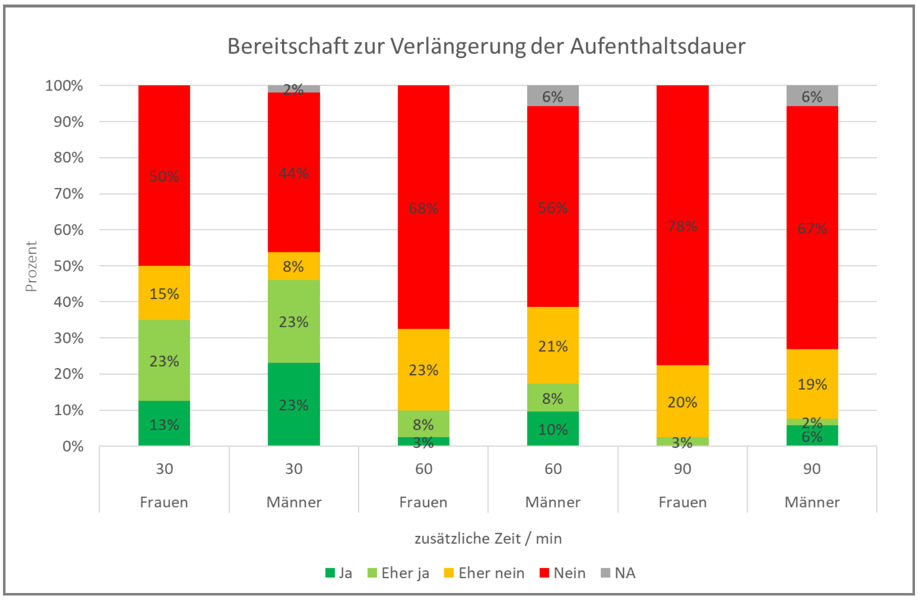

Abbildung 2: Bereitschaft zur Verlängerung der Aufenthaltsdauer für das Laden des E-Autos nach Geschlecht (n = 92 befragte Personen)

6 ERGEBNISSE DER SZENARIEN

Für die Wochenweglänge wurde für die einzelnen Personen der Ladeenergiebedarf der Woche (Mo-Fr) ermittelt und die Anzahl der potentiellen Ladevorgänge (bzw. potentiellen Ladetage) für eine Volldurchdringung errechnet, wenn die durchschnittliche Batteriekapazität zu 90% genutzt wird. Daraus errechnet sich eine hypothetische Ladehäufigkeit pro Werktagswoche. Diese Werte gehen als minimale bzw. angestrebte Ladehäufigkeit in die Szenarienbetrachtung ein. Betrachtet man die zukünftige Entwicklung des

Szenarios Zukunft+ in Relation zum Szenario Bestand+ zeigt sich, dass die urbanen potentiellen Ladevorgänge (bzw. potentiellen Ladetage) bedingt durch die erhöhten Batteriekapazitäten (siehe auch Tabelle 1) abnehmen werden. Der Anteil von jenen Personen, die dann theoretisch mit einer einzigen Vollladung in einer Werktagswoche auskommen, steigt bei den gewählten Rahmenbedingungen von 86% auf 91% (siehe Abbildung 3).

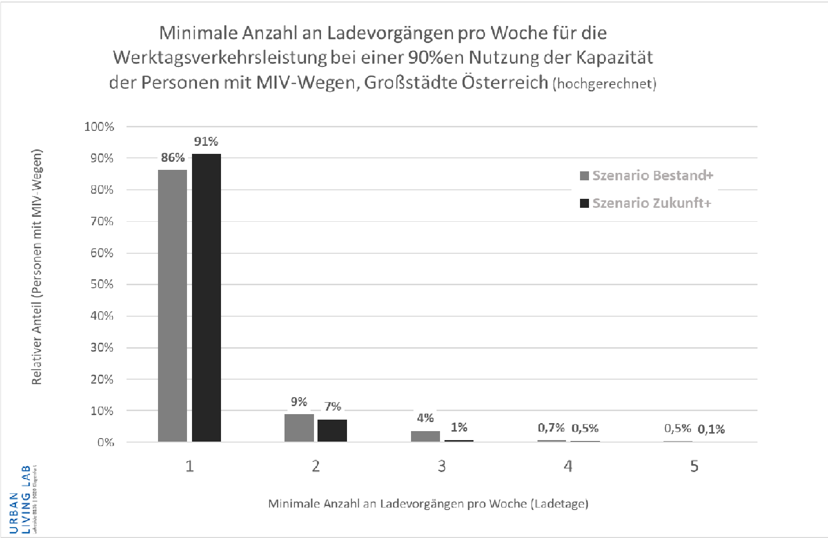

Abbildung 3: Minimale Anzahl an potentiellen Ladevorgängen bei den Szenarien Bestand+ und Zukunft+ in den österreichischen Großstädten (n=311043, hochgerechnet), Szenario Bestand+

Die Betrachtung der potentiellen Ladevorgänge in Hinblick auf die ausgewählten vulnerablen Gruppen zeigt, dass ca. 90% der Frauen im Szenario Bestand+ theoretisch mit einer Vollladung (90%) pro Werktagswoche auskommen (siehe Abbildung 4). Bei den Männern ist dieser Anteil geringer und liegt bei ca. 86%. Dieses Ungleichgewicht zieht sich auch bei den höheren potentiellen Ladevorgangszahlen (>1) weiter.

Bei den einkommensschwachen Bevölkerungsgruppen (unteres Quartil der österreichischen Einkommensverteilung) liegt das Verhältnis bei ca. 84% zu ca. 87% der Normal-Einkommensgruppe (siehe Abbildung 5). Bei den vulnerablen Altersgruppen der über 65jährigen (siehe Abbildung 6) zeigt sich, dass bei ca. 88% eine Vollladung (90%) pro Werktagswoche reichen würde. Bei der jüngeren Altersgruppe (kleiner 65 Jahre) liegt dieser Anteil bei ca. 86%.

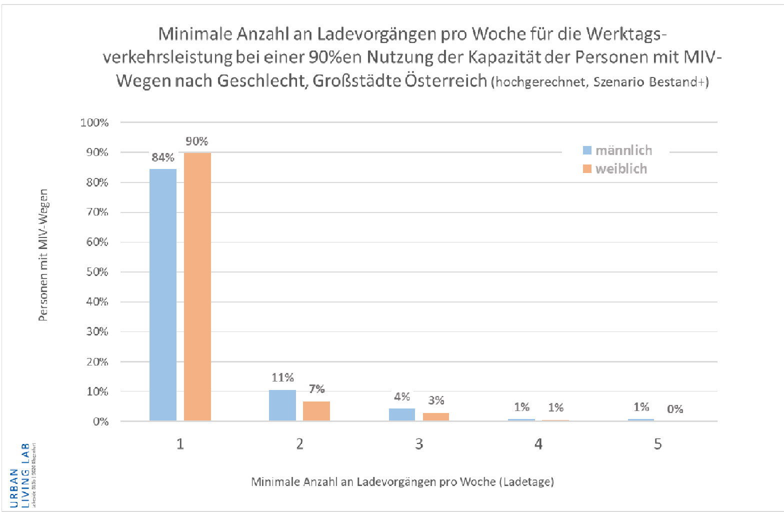

Abbildung 4: Minimale Anzahl an potentiellen Ladevorgängen unterteilt nach Geschlecht in den österreichischen Großstädten (n=311043, hochgerechnet), Szenario Bestand+

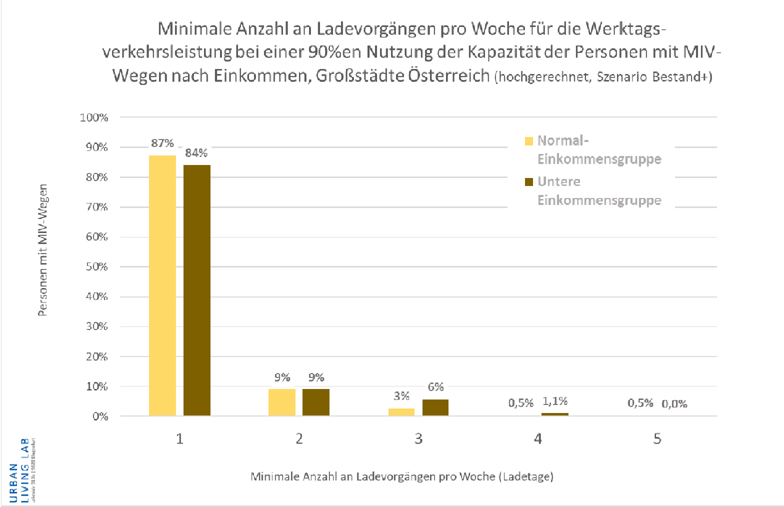

Abbildung 5: Minimale Anzahl an potentiellen Ladevorgängen unterteilt nach Einkommensgruppen in den österreichischen Großstädten (n=311043, hochgerechnet), Szenario Bestand+

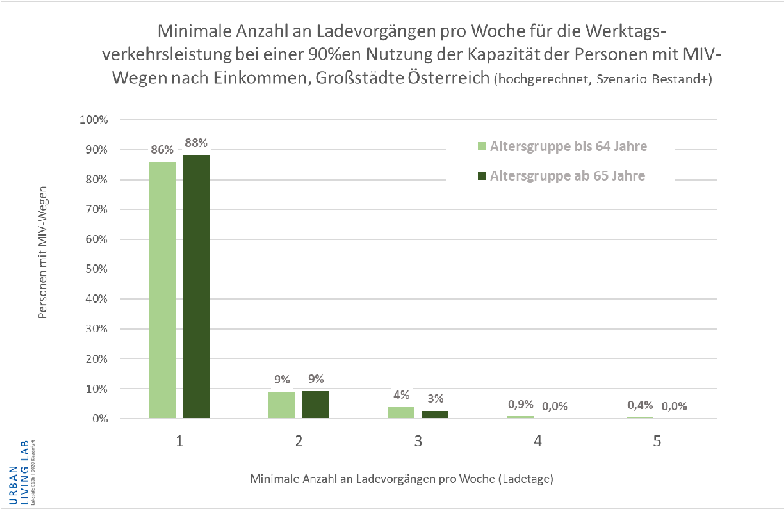

Abbildung 6: Minimale Anzahl an potentiellen Ladevorgängen unterteilt nach Altersgruppen in den österreichischen Großstädten (n=311043, hochgerechnet), Szenario Bestand+

Bei den Szenarien wurde untersucht, wie die Ladenachfrage im Tagesablauf im Zuge der Aufenthaltszeiten der täglichen Aktivitäten (Wohnen, Arbeiten, Einkaufen etc.) abgedeckt werden kann.

Dabei wird bei den Szenarienbetrachtungen die während den Aktivitäten zeitlich mögliche Ladeenergiemenge für die einzelnen Nutzer/innen kumulativ ermittelt und dargestellt. Bei der Klasse „nicht im Tagesablauf abgedeckte Ladenachfrage" korrelieren die ausgewiesenen Prozentwerte im Groben mit der Anzahl der Nutzer/innen, die in den Folgetagen nachladen müssen, weil sie keine angemessene Lademöglichkeit bzw. Ladefenster vorfinden. Grundsätzlich zeigen die Ergebnisse in den folgenden Abbildungen, dass der Ladeenergiebedarf der Elektroautos im Szenario Bestand+ zu 48 bis 50 % primär am Wohnort (private Stellplätzen inkl. Wallboxen) und im Szenario Zukunft+ zu 65 bis 67 % am ersten Tag der Ladekette abgedeckt wird. In Summe kann im Szenario Bestand+ 12 bis 14 % der notwendigen Ladeenergie nicht im Zuge der Aufenthaltsdauern bei den Aktivitäten nachgeladen werden, d.h. diese Ladenachfrage muss an den Folgetagen nachgeladen werden. Beim Szenario Zukunft+ nimmt dieser Anteil deutlich auf 6 bis 7 % ab, weil durch die erhöhten Ladeleistungen der Ladeinfrastruktur die Aufenthaltsdauern deutlich effizienter genutzt werden können. Die Aufenthaltsdauer an Einkaufsorten (> 60 min, Einkaufszentren, Innenstädte) und Freizeiteinrichtungen kann 7 % (Männer) bis 10 % (Frauen) der Ladeenergienachfrage im Szenario Bestand+ bedienen. Dies reduziert sich in Zukunft auf 4 % (Männer) und 6 bis 7 % (Frauen).

Der nichturbane Ladeenergiebedarf (lange Wege) wurde gesondert betrachtet (siehe Abbildungen 6 bis 9, grüne Rahmen). Dieser wird zum Teil über die Wallboxen der Stellplätze am Wohn- bzw. Arbeitsort und zum Teil an E-Ladeparks mit Schnellladestationen entlang der Routen abgedeckt.

Bei der vulnerablen Altersgruppe der über 64jährigen zeigt sich (siehe Abbildungen 11 und 12), dass bei diesen erwartungsgemäß das Potential des Ladens am Arbeitsplatz (Szenario Bestand+) mit ca. 1 % deutlich geringer ausfällt, als bei der Vergleichsaltersgruppe der Personen unter 65 Jahre (ca.8 %). Interessant ist, dass dies nur bedingt durch ein verstärktes Laden am Wohnort (52 %) kompensiert werden kann. Daraus kann abgeleitet werden, dass für die vulnerable Altersgruppe der über 64jährigen dem Laden an öffentlichen und semi-öffentlichen Ladestellen eine höhere Bedeutung zufällt. Auffallend dabei ist jedoch, dass diese Nachfrage zu einem hohen Prozentsatz (ca. 14 %) nicht ausreichend mit dem bestehenden Aktivitätsmuster abgedeckt werden kann. Bei der vulnerablen Altersgruppe sind die Ladeanteile beim Einkaufen oder bei Freizeitbetrieben mit ca. 6 bis 7 % in Relation zu der jüngeren Altersgruppe (<65 Jahre, mit ca. 10 bis 12 %) deutlich geringer. Diese Problematik der vulnerablen Altersgruppe kann intern durch stärkere Verhaltensanpassungen wie z.B. eine längere Aufenthaltsdauer bei Einkaufs- und Freizeiteinrichtungen, eine zukunftsorientierte Wohnort- bzw. Wohnausstattungswahl oder extern durch zusätzliche öffentlichen und semi-öffentlichen Schnellladestationen im urbanen Raum kompensiert werden.

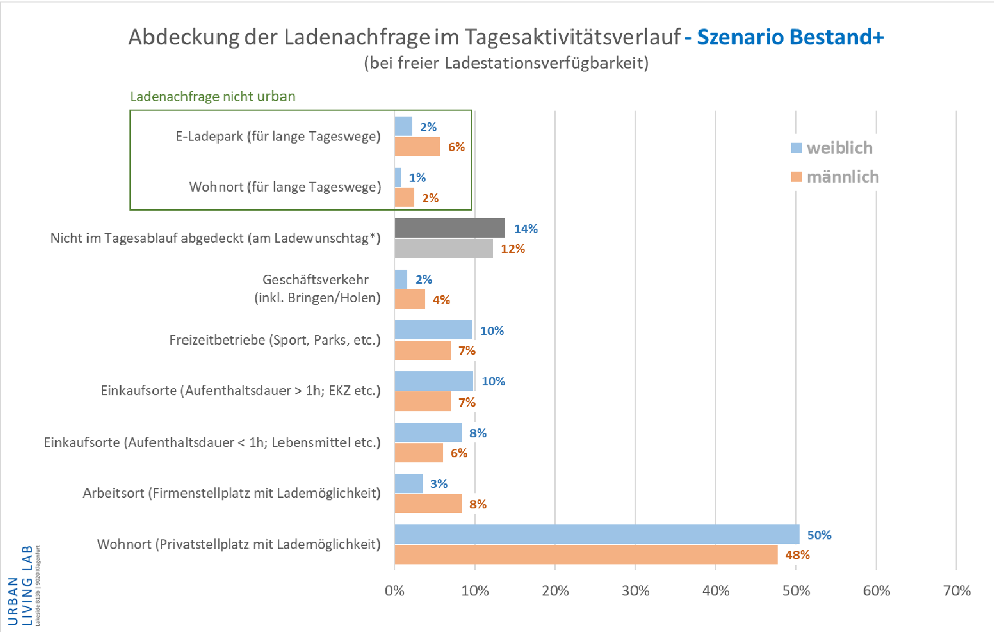

Abbildung 7: Abdeckung des Ladeenergiebedarfs im Tagesaktivitätenverlauf des Szenarios Bestand+ nach Geschlecht

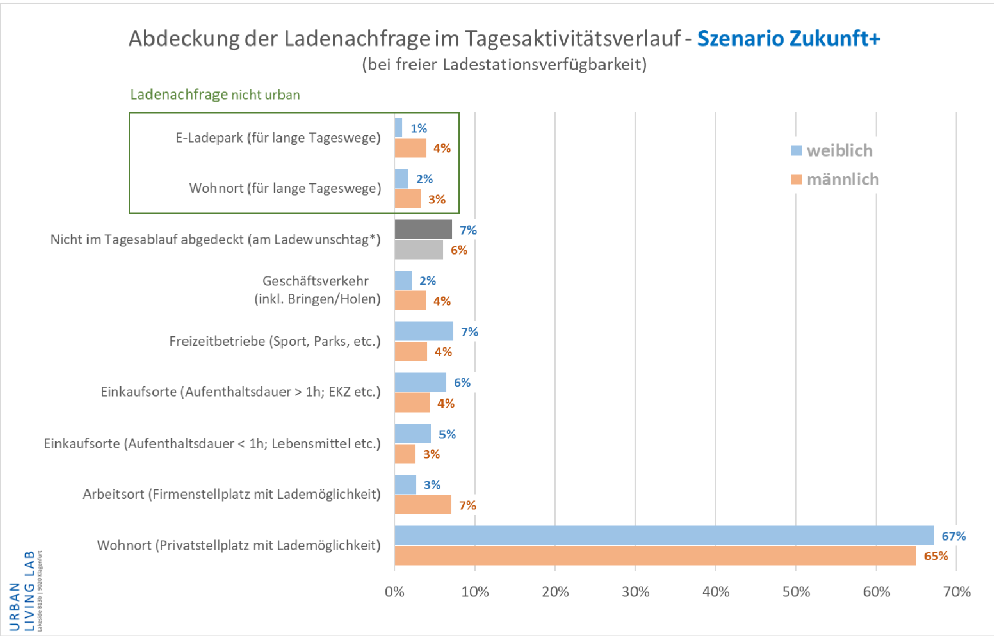

Abbildung 8: Abdeckung des Ladeenergiebedarfs im Tagesaktivitätenverlauf des Szenarios Zukunft+ nach Geschlecht

Betrachtet man explizit die Unterschiede zwischen Frauen und Männern (Abbildungen 7 und 8) zeigt sich, dass bei Frauen Ladestationen am Wohnort (+2 %) wichtiger sind, als an den Arbeitsorten (-5 %). Die

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Einkaufsorte (+2 bis 3 %) und Freizeitorte (+3 %) weisen bei Frauen eine höhere Wichtigkeit auf. Generell können Frauen ihren Ladeenergiebedarf schlechter in ihr Aktivitätenmuster integrieren als Männer. Bei den Frauen werden 14 % und bei den Männern 12 % auf mögliche Folgetage verlagert. Dies ergibt sich primär auch dadurch, dass Frauen am Arbeitsplatz deutlich weniger (-5 %) nachladen können. Beim nichturbanen Ladeenergiebedarf zeigt sich, dass dieser bei Männern deutlich höher ist als bei Frauen. Insbesondere bei den E-Ladeparks (entlang der Strecken) zeigt sich ein Unterschied von +4 %.

Betrachtet man explizit die untere Einkommensgruppe (Abbildungen 9 und 10) wird deutlich, dass die Abdeckung der Ladenachfrage am Wohnort mit -8 % deutlich geringer ist. Dies kann durch eine geringere Stellplatzverfügbarkeit, kürzere Arbeitszeiten etc. zurückgeführt werden. In Summe führen diese Faktoren dazu, dass in dieser Personengruppe ein externes E-Laden abseits des Wohn- oder Arbeitsorts einen höheren Stellenwert aufweist. Vor allem Freizeit- und Einkaufsorte (> 60 min Aufenthaltsdauer) sind mit ca. 12 % die wichtigsten Standorte für E-Ladestationen. In der unteren Einkommensgruppe kann jedoch der Ladeenergiebedarf deutlich besser in das bestehende Aktivitätenmuster eingebettet werden, als bei den anderen Einkommensgruppen. Im Szenario Bestand+ müssen 11 % des Energiebedarfs an den Folgetagen nachgeladen werden, im Szenarien Zukunft+ sinkt dieser Wert auf 5 %.

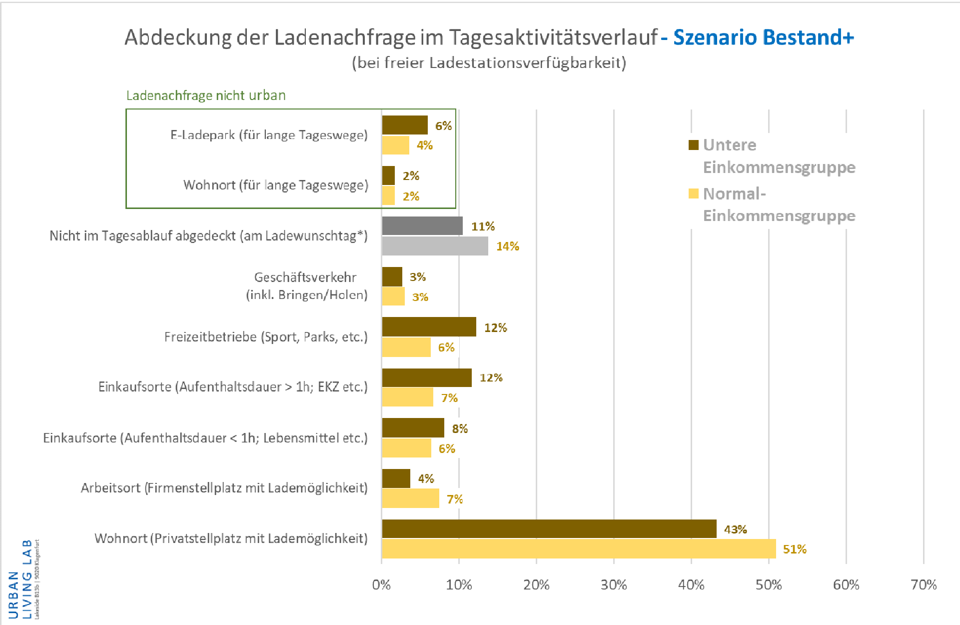

Abbildung 9: Abdeckung des Ladeenergiebedarfs im Tagesaktivitätenverlauf des Szenarios Bestand+ nach Einkommensgruppe

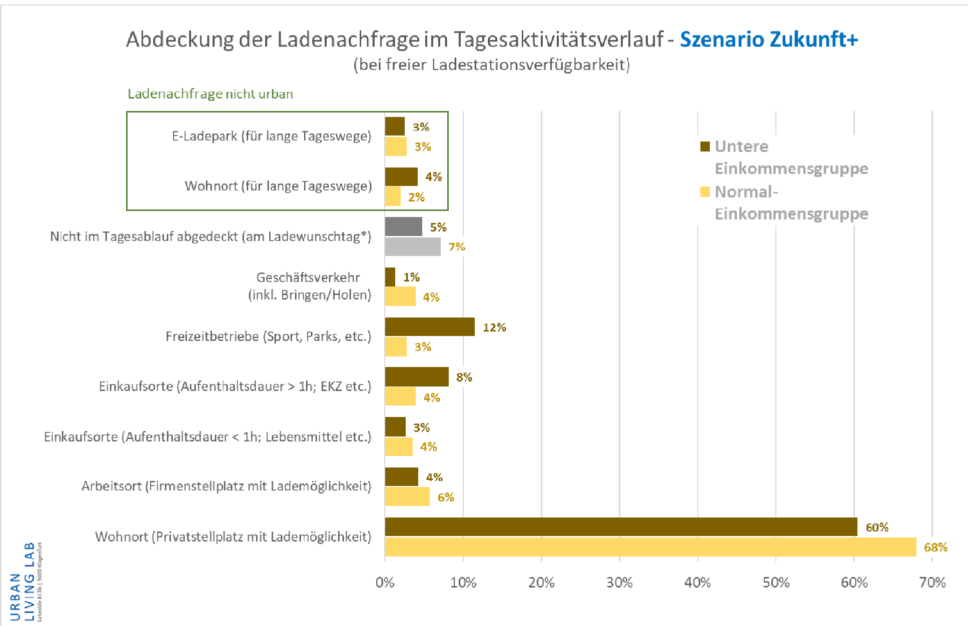

Abbildung 10: Abdeckung des Ladeenergiebedarfs im Tagesaktivitätenverlauf des Szenarios Zukunft+ nach Einkommensgruppe

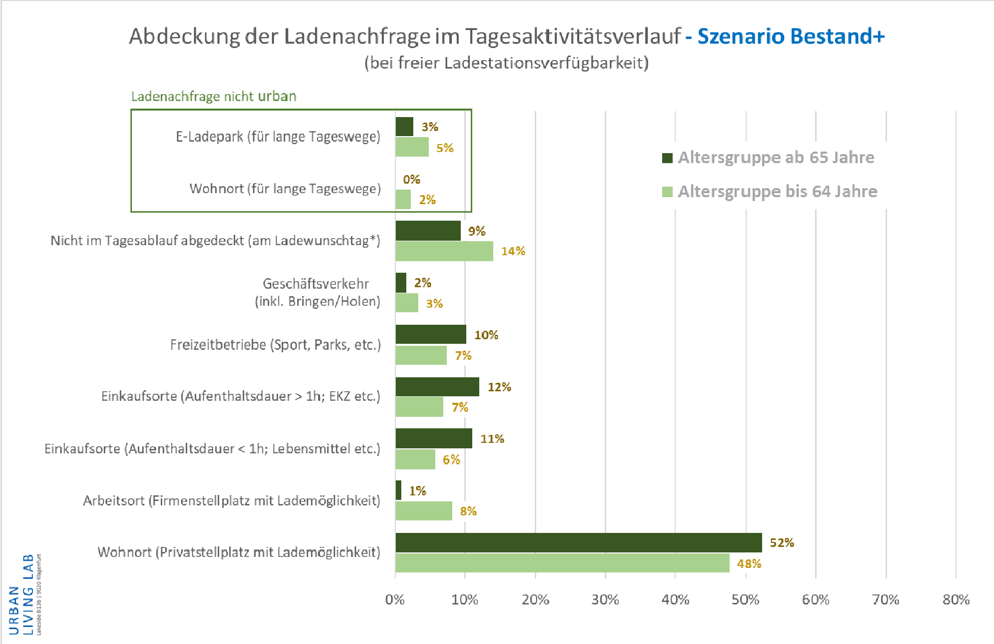

Abbildung 11: Abdeckung des Ladeenergiebedarfs im Tagesaktivitätenverlauf des Szenarios Bestand+ nach Altersgruppe

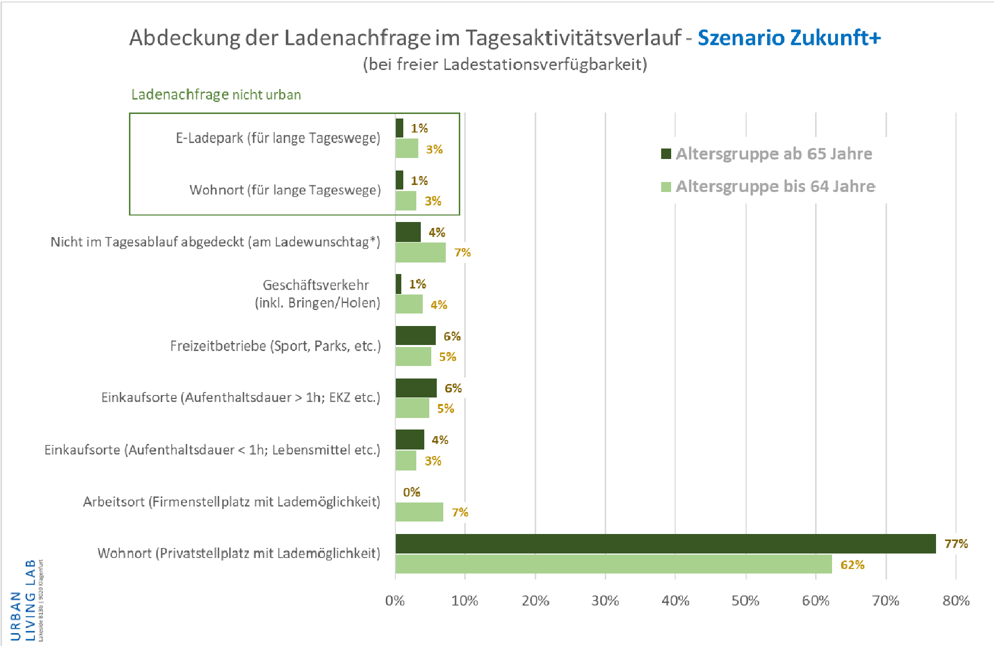

Abbildung 12: Abdeckung des Ladeenergiebedarfs im Tagesaktivitätenverlauf des Szenarios Zukunft+ nach Altersgruppe

7 ZUSAMMENFASSUNG

Zusammenfassend zeigt sich, dass mit Laden an den privaten Stellplätzen am Wohnort die Ladenachfrage am besten abgedeckt werden kann, wenn die dafür notwendige Infrastruktur (Wallbox) errichtet werden kann. Dies ist auf Grund technischer und juristischer Vorgaben jedoch nur eingeschränkt möglich. Bei der Betrachtung nach Gender und Einkommen zeigt sich, dass Frauen sowie die untere Einkommensgruppe beim Laden am Wohnort tendenziell benachteiligt sind. Beim Laden am Arbeitsort zeigt sich ein ähnliches Bild – auch hier verfügen Frauen und Einkommensschwache über einen schlechteren Zugang zu Lademöglichkeiten. Dies hat zur Folge, dass für diese benachteiligten Gruppen Ladestationen verstärkt im Umfeld von Einkaufsorten (> 60 min, z.B. Einkaufsviertel, Einkaufszentren), aber auch an Freizeitstandorten (mit höheren Aufenthaltsdauern, wie z.B. Kinos) errichtet werden sollten. In der vulnerablen Altersgruppe der über 64jährigen haben viele keine Möglichkeit zum Laden am Arbeitsplatz, dies kann aber nur bedingt durch ein verstärktes Laden am Wohnort bzw. durch eine Einbettung in das bestehende Aktivitätsmuster kompensiert werden kann. Daraus kann gefolgert werden, dass eine potenzielle Benachteiligung von Frauen und Einkommensschwachen durch ein breites Angebot an öffentlichen und semi-öffentlichen Ladestellen

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abgefedert werden kann. Für die vulnerable Gruppe der über 64jährigen bedarf es aber weiterreichender Maßnahmen – entweder seitens der Betroffenen, die Ladefahrten in ihre Aktivitätsmuster integrieren, oder durch Forcierung von E-Ladeinsfrastruktur an den Wohnorten älterer Menschen.

Die zukünftige technische Entwicklung bei Batteriekapazitäten und Ladedauern wird die Benachteiligung dieser beiden Gruppen verringern, aber nicht erübrigen. Folglich ist bereits jetzt eine vorausschauende, strategische Planung des Ausbaus von Ladeinfrastruktur zu empfehlen, um Unfairness im zukünftigen Mobilitätssystem zu vermeiden.

Die Ergebnisse dieser Arbeit beruhen auf zwei vereinfachenden Annahmen: Einerseits werden jetzige automobile Aktivitätsmuster in die Zukunft projiziert, lediglich mit einer Verschiebung vom fossilen zum elektrischen Antriebsstrang. Je stärker sich alternative Mobilitätsformen abseits des motorisierten Individualverkehrs mit Fahrzeugen im Privateigentum durchsetzen, desto geringer wird die private Ladenachfrage insgesamt. Andererseits liegt den Szenarien die Annahme einer ausreichend ausgebauten Ladeinfrastruktur zugrunde, d.h. dass eine Person stets eine freie Ladesäule vorfindet, wenn sie zu einem bestimmten Zeitpunkt und an einem bestimmten Aufenthaltsort laden will. Solange die Ladeinfrastruktur nicht voll ausgebaut ist, fallen die Minimalanzahl potentieller Ladevorgänge und der Bedarf nach Nachladen am Folgetag höher aus.

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Zur Co-Evolution von Stadtsystemen und Diffusion urbaner Innovationen: Charakteristika einer technologieoffenen Stadtentwicklung

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1 ABSTRACT

Motivation – Stadtentwicklung ist seit je her das Produkt gesellschaftlicher Bedarfe, technischer Möglichkeiten und funktional-räumlicher Interpretation (KOSTOF, 1993). Dabei fehlt nach abgeschlossener Literaturanalyse des Autors eine umfassende Zusammenführung von Stadtentwicklung und Technologiemanagement. Ziel der Forschungsarbeit ist die explorative Analyse urbaner Innovationszyklen der modernen Stadtentwicklung im globalen Städtesystem und der Validierung wiederkehrender Charakteristika für eine technologieoffene Adaption für smarte und resiliente Stadtentwicklung entlang der folgenden Fragestellungen:

Fragestellungen – Forschungshypothese A legt zugrunde, dass zwar einerseits Technologien nach ihrer Erfindung und Kommerzialisierung grundsätzlich weltweit verfügbar sind, aber Städte als "Akteure" diese unterschiedlich schnell in ihrer Entwicklung adaptieren (ROGERS, 2003) und davon von unterschiedlichen Eigenschaften (z.B. räumlich, strukturell, akteursbezogen) profitieren können. Die Forschungshypothese B nimmt an, dass durch den technologischen Fortschritt im Zuge der anhaltenden Digitalisierung auch eine Beschleunigung urbaner Innovationszyklen stattfindet. Diese könnten heutige Planungszyklen bereits überholt haben, so dass für die großen Herausforderungen der urbanen Transformation (REISS-SCHMIDT, 2016) auch angepasste Planungs- und Innovationsprozesse erforderlich werden.

Methodik – Als empirische Basis für das Forschungsdesign wurde mittels historischer und aktueller Dokumentenanalyse eine offene Datenbank über insgesamt 113 Städte und 132 urbane Innovationen aufgebaut, die – soweit aus der Literatur identifizierbar – eine Nachvollziehbarkeit des Diffusionsprozesses einer urbanen Innovation und deren Co-Evolution über mindestens die ersten zehn "Anwender" ermöglichen. Diese werden mit Methoden des explorativen Data Minings und tiefergehenden Fallstudien operationalisiert.

Schlussfolgerungen – In der bisherigen Arbeit zeigen sich bereits wesentliche Schlussfolgerungen, die im Full Paper dargestellt werden. Unter anderem belegen bisherige Datenauswertungen, dass sich Städte entlang der Diffusionstypen (ROGERS, 2003) einordnen lassen, dass die Co-Evolution von Stadtsystemen ein wesentliches Prinzip darstellt, dass einige wenige Städte der modernen Stadtgeschichte als "Innovatoren" und "Early Adopter" im globalen Städtesystem fungieren, dass mit Beginn des 21. Jahrhunderts urbane Innovationszyklen kommunale Planungshorizonte überholt haben und dass es wiederkehrende Muster der "Innovatoren" gibt, die eine schnellere Adaption unterstützen.

Einordnung – Die Bedeutung und Verwertung der wissenschaftlichen Arbeit liegt dabei in der Entwicklung und kritischen Reflektion eines ersten "Grundwortschatzes" (Ziel ca. 30-50 urbane Innovationsmuster) für eine anwendungsorientierte Mustersprache (IBA, 2015) für technologieoffene Stadtentwicklung von "Smart & resilient cities" als zentrale Domäne der Verkehrswende, der Digitalisierung und Klimawende sein.

Keywords: Co-Evolution, Stadtsysteme, urbane Innovation, Smart Cities, Mustersprache

2 EINFÜHRUNG

2.1 Technologieoffene Stadtentwicklung im 21. Jahrhundert

Die vorliegende Forschungsarbeit verfolgt das Ziel die wissenschaftliche Lücke zwischen Innovationsmanagement und Stadtentwicklung zu schließen und vor allem im Kontext heutiger Stadtentwicklung hin zu Klimaneutralität, Digitalisierung oder Resilienz praxisbezogene Lösungsansätze aufzuzeigen. Im Kontext der aktuellen Debatte über eine produktive Rolle des Konzeptes Smart Cities in der integrierten Stadtentwicklungsplanung sieht Reiß-Schmidt Städte vor der Frage, mit welchen Strategien sie unerwartete (sozio-technische) Entwicklungen auffangen und die soziale Stabilität, das Funktionieren der Infrastruktur und die Sicherheit ihrer Bevölkerung trotzdem sicherstellen können. Ein möglicher Ansatz wird dabei in einer erhöhten Anpassbarkeit, Belastbarkeit, Reaktions- und Widerstandsfähigkeit und damit robuste Raum- und Infrastrukturen gesehen (REISS-SCHMIDT, 2016). Angesichts der sich verschärfenden

Klimaschutzziele bis 2050, der zentralen Bedeutung von Städten in der zunehmenden Urbanisierung und der Trägheit in der Transformtation der gebauten Umgebung kommt einer technologieoffenen und damit zukunftsrobusten Planung eine fast essentielle Rolle zu.

Kurz gesagt: "Smart Cities" können noch so intelligent sein, wenn nicht die ausgeprägte Fähigkeit der Anpassung vorhanden ist, die auf zukünftige technologische Neuerungen (sei es in der Verkehrswende, der Energiewende, der Veränderung des Einzelhandels, der Neugestaltung der öffentlichen Räume, der Versorgung uvm.) reagieren kann. Um diesen Ansatz zu operationalisieren, sind im weiteren der Innovationsbegriff in der räumlichen Planung und urbane Innovationen als technisch-räumliches Konzept einzuführen. Gesucht werden in der Empirie möglichst allgemeingültige Handlungsmuster, die die Adaption und Diffusion von Innovationen im Sinne einer technologieoffenen Stadtentwicklung maximal unterstützen. Übergeordnetes Ziel für klimaneutrale und resiliente Städte muss es somit sein, von Wissenschaft bis Praxis eine möglichst enge "Co-Evolution" zwischen Technologie- und Stadtentwicklung zu schaffen, die sektorübergreifend und transformationsorientiert agieren kann.

Einführend sei hier das historische Beispiel "Eixample" vom prägenden Stadtplaner Barcelonas im 19. Jahrhundert, Ilfonso Cerdá, kurz beschrieben: Dies zeigt sehr deutlich die Relevanz räumlicher Planung für die Einführung technischer Innovationen auf. Mit dem charakteristischen Raster aus den abgekanteten Quadraten mit ca. 140m Kantenlänge schuf Cerdá nämlich nicht nur einen hochverdichteten und räumlich flexiblen Städtebau, der bis heute mit ihren Magistralen und dem aufkommenden Superblocks-Prinzip funktioniert.

Zugleich berücksichtigte er durch die achteckige Form und damit gewisse Kurvenradien auch das spätere Aufkommen von schienengebundener Mobilität, die zum Zeitpunkt des Masterplans noch gar nicht verbreitet oder kaum bekannt war. Er antizipierte aus den damaligen Pferde-Trams, dass sich wenige Jahre später auch elektrisch angetriebene Straßenbahnen mit höheren Geschwindigkeiten (und damit größeren Kurvenradien) durchsetzen warden. Mit dem Eixample-Prinzip war diese Technik-Innovation von Anfang an und ohne Umplanung der Straßenräume realisierbar – ein klassisches Beispiel technologieoffener Stadtplanung.

2.2 Innovation in der räumlichen Planung

Um Technologieoffenheit in der Stadtentwicklung hinreichend zu definieren, wird im Folgenden näher auf die Relevantz von (technischen bis systemischen) Innovationen in der räumlichen Planung eingegangen. In der Literatur der modernen Stadtentwicklung finden sich nur sehr begrenzte Diskurse zur Rolle von Systeminnovation in der Stadtentwicklung. Dies kann zum einen in der schwierigen „Griffigkeit" des Innovationsbegriffs in der Planungspraxis liegen, zum anderen aber auch in einer fehlenden Sensibilität für technischen Fortschritt als solches. Immerhin beschreibt Supe (SUPE, 1976) bereits vor über vierzig Jahren, dass zwei der bestimmenden Einflussgrößen auf die vergangene und zukünftige Stadtentwicklung der technische Fortschritt und das von ihm ausgelöste Wirtschaftswachstum sind. Er statiert dabei zum einen auch den möglichen Verlauf der Stadtentwicklung als technisch determiniert, was in Kontrast zur Systeminnovation (WEISSHAUPT, 2015) als nichtdeterministisches Konzept steht. Zum anderen vermutet er im technischen Fortschritt, also der zugrundeliegenden Basis von Systeminnovation, aber auch „ein aktivierbares Mittelpotenzial zur planvollen Lösung der städtischen Probleme und zur bewußten Gestaltung der Stadt von morgen (SAHR-PLUTH, 2007). Klaus Selle beschreibt die Innovation (allgemein) noch als „kleine Schwester" des Fortschritts (SELLE, 2004), gleichzeitig droht für einige der "gesellschaftliche Fortschritt" unter seinen eigenen Nebenfolgen zu verschwinden (LÜBBE, 1994).

Eine zentrale Problematik besteht nach Selle besonders darin, dass eine Übertragung des Innovationsbegriffs auf die Stadt- und Quartiersentwicklung nur sehr bedingt möglich scheint. Er trennt klar zwischen technischen Innovationen wie die des Rades oder der Glühlampe als bahnbrechende Neuerungen, die sehr schnell bisherige Problemlösungen (der Fortbewegung, der Beleuchtung) entwerteten und fast vollständig an deren Stelle treten, und komplexen Aufgabenstellungen räumlicher Planung und Entwicklung (wie: Bau einer Siedlung, Wiedernutzung einer Brache), bei der der innovative Gehalt immer wieder neu und ortsbezogen bestimmt und bewirkt werden muss. Ein schlichtes „Nachbauen" sei nur bei technischen Details möglich (SELLE, 2004).

Ibert (IBERT, 2015) unterscheidet, in Anlehnung an Schumpeter (1964), das Kriterium der Durchsetzung des (planerischen) Innovationsbegriffs zentral von dem in der anwendungsorientierten Planungsforschung.

Eine Differenzierung sieht er anhand Beispielen aus der Stadtplanung in der Bundesrepublik der letzten fünfzig Jahre, wie die (Planungs)Disziplin seit Beginn beständig Neuorientierungen hervorgebracht hat, die inzwischen selbstverständlich geworden sind. Die Einrichtung der Fußgängerzonen in den Innenstädten seit Mitte der 1960er Jahre und die Einführung der flächenhaften Verkehrsberuhigung in Wohngebieten in der ersten Hälfte der 1980er Jahre sind für ihn substanzielle und komplexe Richtungswechsel der bis dahin verfolgten Praxis, die weit reichende Konsequenzen für das Leben in den Städten hatten. Gemäß seines Innovationsbegriffs stellten dies jedoch keine Systeminnovationen dar, sondern die Fußgänger- und Tempo-30-Zonen Produktinnovationen, der Städtebauliche Rahmenplan und der Vorhaben- und Erschließungsplan eher Prozessinnovationen.

Der Begriff der Systeminnovation ist bisher im Kontext der Stadtplanung und –entwicklung nur bedingt präsent. Das Eco Innovation Observatory definiert diese grundsätzlich als Entwicklungen, die zu einer systematischen Veränderung sowohl in sozialen (Werte, Regulatorien, Haltungen etc.) als auch technischen (Infrastruktur, Technik, Werkzeuge, Produktionsprozesse etc.) Dimensionen, und vor allem in der Wechselwirkung zwischen beiden, führt. Systeminnovationen können dabei Elemente oder Kombinationen aller Innovationsarten (Produkt, Prozess, Marketing, Organisation, sozial) beinhalten und werden, gemäß Definition, von vielen Akteuren gemeinsam und kollaborativ entwickelt und umgesetzt. Analog definieren Schneidewind und Scheck (SCHNEIDEWIND, 2013) Systeminnovation als Veränderung, die weit über technische Neuerung hinausgreift und die Veränderung von Infrastrukturen, Institutionen, Nutzerverhalten und Bedeutungsaufladungen umfassen. Sie beziehen sich dabei explizit auf die nachfolgende Definition von Frank Geels und hinführende Vorarbeiten von Clark, Christensen und Utterback in den Neunziger Jahren. Im nächsten Abschnitt eine Definition für Systeminnovationen im Kontext der Stadtentwicklung als ‘urbane Innovation’ eingeführt.

2.3 Definition ‘Urbane Innovation’

Technologieoffene Stadtentwicklung beschreibt im Folgenden die bedarfsgerechten Anwendung “urbaner Innovation” als einen Veränderungsprozess der gebauten Umgebung, der sich auf jeweils unterschiedliche technologische Neuerungen einstellen kann. Als „urbane Innovation“ werden zur Operationalisierung diejenigen Innovationen im städtischen Umfeld (KERSTING, 2017) definiert, die direkten Einfluss auf technisch-räumliche Subsysteme einer Stadt (z.B. Smart Parking als Einfluss auf Flächennutzung des ruhenden Verkehrs) haben. In der Literatur finden sich erste Indizien, welche Merkmale systemische Innovationen, die für eine Stadt in ihrer Wirkung relevant sind, aufweisen können.

MATERN definiert technische Neuerungen in Infrastrukturen so, dass sie Skalensprünge in der Dichte oder der Ausdehnung von urbanen Räumen ermöglichen. Als historische Beispiele nennt sie für diesen technologischen Wandel etwa die Gaslaternen, die in deutschen Großstädten im späten 19. Jahrhundert durch die elektrische Beleuchtung ersetzt wurden oder elektrische Straßenbahnen, die Pferdebahnen als öffentliches Transportmittel in Städten ablösten. Auch GRIN und SCHOT haben Beispiele dafür benannt: unter anderem ist hier im Kontext von Hygiene und Wasserversorgung die Transition von Klärgruben zu Abwasserkanalisationen Mitte des 19. Jahrhunderts beschrieben: „An empirical example is the hygienic reform of waste disposal in the Netherlands during the late nineteenth century (based on GEELS, 2006a).”

Angesichts von mehr und mehr disruptiven Innovationen im Zuge der Digitalisierung, die einen Bruch mit vorher bestehenden Technologien oder Organisationsstrukturen bedeuten, nehmen diese damit gegenüber evolutionären Veränderungen zu. Darauf muss das System Stadt und damit die moderne Stadtentwicklungsplanung einstellen. Dabei steht aber der nachhaltige Einsatz von derartigen urbanen Systeminnovationen in Städten noch aus, dürfte aber in naher Zukunft beginnen (RICHTER, 2014).

3 METHODIK

In Anlehnung an die im vorigen Kapitel aufgeworfenen Forschungsfragen wird ein mehrstufiges Vorgehen wissenschaftlicher Methoden gewählt. Aufgrund des hohen Neuigkeitsgehalts der Thematik ist dieses durch ein meist exploratives Forschungsvorgehen gekennzeichnet. Der Fokus der Untersuchungen liegt dabei auf der Entdeckung von Invarianzen und Korrelationen feststellbarer Phänomene im Kontext der zu erforschenden Situation urbaner Innovationen:

(1) Verlaufsanalyse - Die erste Untersuchung setzt sich dabei mit der Frage des Aufkommens und der Funktion von urbanen Innovationen im zeitlichen Kontext stadträumlicher Planung und Entwicklung auseinander. Nachweis der Pfadabhängigkeiten von Stadtsystemen und deren Co-Evolution über Zeit.

(2) Diffusionsanalyse - Die zweite Untersuchung dient dazu aus den Frühphasen von Diffusions-verläufen urbaner Innovationen Aussagen über wiederkehrende Muster zu erhalten. Nachweis der Innovationsdiffusion zwischen Städten.

(3) Musterbildung (nicht Teil dieses Papers) – Im dritten Schritt werden über exploratives Data Mining charakteristische und wiederkehrende Muster identifiziert und entlang aktuellen Fallstudien validiert. Nachweis wiederkehrender Innovationsmuster, die einen Einfluss auf Diffusion aufzeigen.

Allen Schritten ist ein iteratives und reflexives Weiterentwickeln von belastbaren Innovationsmustern gemein, wobei die jeweiligen Zwischenergebnisse nach jedem Schritt zusammengefasst und hinsichtlich des Theorierahmens kritisch reflektiert wird.

3.1 Verlaufsanalyse (N=400)

Um dem Ziel einer möglichst breit angelegten Untersuchung über das Innovationssystem Stadt Rechnung zu tragen, wurde von Beginn an eine Datenbank mit über 400 Innovationen und Erfindungen aufgebaut, die in der Literatur im Kontext bzw. mit Bezug zur Stadtentwicklung seit der Industrialisierung identifiziert werden konnten. Diese ließen sich dabei nach System, Subsystem, Typ, Ort, Zeit, Kategorie, Erfinder, Art der Innovation und verwendeter Quelle klassifizieren. Damit entstanden insgesamt 13 Unterkategorien entlang städtischer Sektoren bzw. Stadtsysteme. In jeder Unterkategorie wurde darauf geachtet, dass eine Mindestanzahl von zwanzig Beispielen (z.B. „Entsorgung") erreicht wurde, in der größten Kategorie „Verkehr" wurden 65 Beispiele erfasst. Dabei wurde darauf verzichtet, die Datensätze hinsichtlich ihrer Relevanz für die Stadtentwicklung zu bewerten, da dies einen hohen Aufwand an Operationalisierung geeigneter Kriterien zu diesem Zeitpunkt bedeutet hätte. Über die logische Zuordnung von Innovationen zu den skizzierten Unterkategorien konnten historische Zeitleisten gebildet und in ihrer strukturellen Entwicklung beispielhaft beschrieben werden.

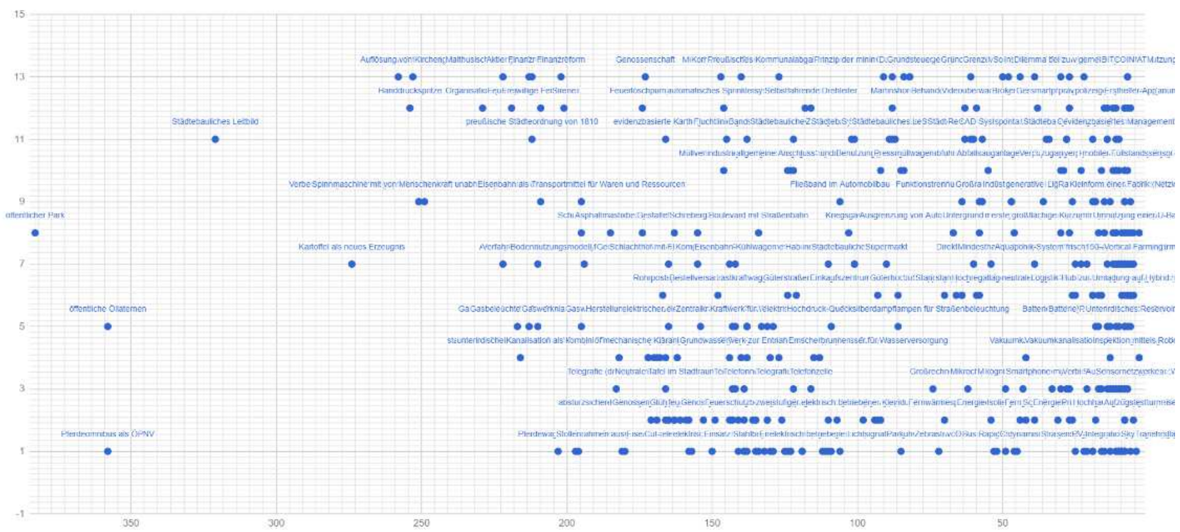

Abb. 1: Zeitliche Verteilung von 400 Innovationen im Stadtkontext von ca. 1600 bis heute (Quelle: eigene)

3.2 Diffusionsanalyse (N=132)

Für jede bestehende Infrastruktur oder Dienstleistung in heutigen Städten gab es eine allererste Anwendung bzw. Nutzbarmachung. In einer Stadt gab es das allererste Hotel, wie wir es heute kennen, in einer anderen Stadt die allererste Kanalisation, und in einer weiteren beispielsweise die erste LED-Straßenbeleuchtung. Manche Städte zeichnen sich dabei als Erstanwender („Innovatoren") aus, andere als mutige Nachahmer („Early Adopter") und weitere als Nachzügler („Late Mover"). Bereits Rogers hatte hierzu mit seinem Werk „Diffusion of Innovations" 1962 (ROGERS, 1962) eine Theorie aufgestellt, die Einsichten in die Diffusion von Innovationen in sozialen Systemen gibt. Er definiert fünf Anwendertypen für Adoptionsprozesse von Innovationen und ordnet diese entlang einer Gleichverteilung:

Die Untersuchung der Diffusionsanalyse orientiert sich im Wesentlichen an ähnlichen Vorgehen, welche bereits in früheren Musteruntersuchungen angewendet wurden (ROGERS, 2003; HÄGERSTRAND, 1973). Hierbei wird ein Sample an in der Vergangenheit nachweisbaren Diffusionen von urbanen Innovationen auf die darin wiederkehrend vorkommenden Ausprägungen hin untersucht. Das detaillierte Vorgehen, welches im Rahmen der vorliegenden Untersuchung kam, wird in den folgenden Abschnitten spezifiziert.

Vor dem Hintergrund der Zielsetzung, ein möglichst umfassendes Bild an Mustern über moderne Stadtentwicklung und deren infrastrukturelle Neuerungen aufzuzeigen, wurde es als relevant erachtet ein möglichst heterogenes Sample einzubeziehen. Auf eine Beschränkung auf einen bestimmten Sektor aus dem vorangegangenen Sample, z.B. Verkehr, oder eine bestimmte geographische Region, z.B. Europa, wurde daher bewusst verzichtet. Prioritär wurde darauf geachtet, dass jede Innovation sich über einen gewissen Diffusionszeitraum nachvollziehen lässt, d.h. sie in ihrer Entwicklung von einem gewissen Erfolg geprägt waren. Von einem Erfolg ist hierbei zu sprechen, wenn also nach der Pilotierung weitere Anwendungen in anderen Städten erfolgten. Dadurch wurden nur solche urbanen Innovationen im Sample berücksichtigt, für welche ein ausreichender (sprachlicher) Zugang zu Primär- und/oder Sekundärdaten gewährleistet werden konnte. Hier wurden deutsch- und englischsprachige Schriften berücksichtigt, vereinzelt wurden automatisierte Übersetzungen aus dem Niederländischen (z.B. Rotterdam) oder Portugiesischen (z.B. Porto Alegre, Curitiba) im Online-Bereich angewendet. Insgesamt konnten auf Basis dieser Kriterien ein Sample aus 132 urbanen Innovationen gebildet warden.

Die Beispiele urbaner Innovationen wurden auf Basis einer breit angelegten Recherche von Journal-Artikeln, Internetdokumenten, Praxisbüchern, Online-Datenbanken und Fachzeitschriften identifiziert, welche sich mit der Thematik von urbanen Infrastrukturen (z.B. Kanalisation, Car-Sharing), Planungsansätzen (z.B. Eixample, autogerechte Stadt) und innovativen Verwaltungsmaßnahmen (z.B. Bürgerhaushalt) sowie angrenzenden Themenbereichen (z.B. Systeminnovationen, Technikhistorie) beschäftigen. Hierzu wurden die jeweiligen Quellen systematisch nach Informationen über innovative Stadtentwicklung und deren zugrundeliegenden Innovationen untersucht und sukzessive in eine Datenbank übertragen. Die Datenerhebung orientierte sich dabei primär an einer einheitlichen Definition für urbane Innovation, welche im Vorfeld der Untersuchung aus der aktuellen Theorie abgeleitet wurde.

Neben der eingehenden Recherchebasis zur Auswahl der einzelnen Innovationen wurden in einem zweiten Schritt die recherchierten Zeitpunkte zur Einführung der Innovationen über alle Städte erfasst. Dies erfolgt in einem größtenteils iterativen Verfahren: Teilweise konnten bei manchen Innovationen auf strukturierte Sekundärliteratur zurückgegriffen werden, teilweise wurden die Ereignisse manuell über strukturierte Onlinerecherchen (z.B. „first underground tunnel Copenhagen“) erfasst. Ziel war es dabei mindestens fünf Zeitpunkte je Innovation zu identifizieren, so dass belastbare und vergleichbare Aussagen über Diffusion in den Frühphasen möglich waren. Insgesamt konnten so für 108 der 132 Innovationen entsprechende Zeitleisten festgestellt werden. Gleichzeitig ergaben sich als Nebenprodukt Datenpunkte in 117 Städten über vier Kontinente (davon 64,1% in Europa). Um Ergebnisse von möglichst hoher Qualität zu erzielen, wurde das oben beschriebene Forschungsvorgehen an den Gütekriterien empirischer Sozialforschung ausgerichtet. Dabei wurden primär die Hauptgütekriterien der Objektivität, Reliabilität und Validität berücksichtigt.

Insgesamt wurde damit folgendes quantitatives Datenset erhoben:

- 1.504 Datenpunkte
- 130 urbane Innovationen
- 113 charakterisierte Städte

3.3 Kritische Bewertung der Datenbasis

Eine große Herausforderung für den Aufbau der empirischen Studie war die zusammenhängende Verfügbarkeit von Quellen und Diffusionsprozessen urbaner Innovationen. Es galt zu klären, wo sich Wissenschaftler in der Vergangenheit bereits beispielsweise mit der räumlichen Verbreitung einer städtischen Lösung, zum Beispiel der Verkehrsampel, beschäftigt hatten. Andere Autoren hatten hier bei ähnlicher Herangehensweise dieselben Probleme. Eine Literaturrecherche im deutsch- und englischsprachigen Bereich zu empirischen Arbeiten zur Diffusion von urbanen Innovationen zeigte, dass nur wenige sektorübergreifende wissenschaftliche Beiträge zum Thema vorliegen.

Die in der vorliegenden Arbeit verwendeten Daten für die Diffusionsanalyse stammen aus einer umfassenden Literatur- und Domänenanalyse zu urbanen Innovationen gemäß der zuvor eingeführten Definition, zeitlich größtenteils historisch aus dem 18., 19. und 20. Jahrhundert bis hin zu aktuell ablaufenden Diffusionsprozessen heute. Methodisch wurde ausgehend von der allerersten Pilotierung oder Umsetzung einer Innovation in einer Stadt angestrebt möglichst den räumlich-zeitlichen Verlauf von dieser beispielhaft nachzuvollziehen und damit sowohl eine räumliche als auch eine zeitliche Entwicklung bzw. Diffusion zu belegen. Eine Übersicht der berücksichtigen Innovationen findet sich im Anhang. Für jede der 130 berücksichtigen urbanen Innovationen werden die folgenden Kennwerte bzw. Variablen erhoben:

- Nr. = durchlaufende Nummer für jede Innovation entlang ihrer zeitlichen Einführung
- MIN = jeweils frühester Zeitpunkt ("Zeitpunkt der ersten Anwendung")
- MAX = spätester erfasster Zeitpunkt (nicht relevant, da keine vollständige Betrachtung)
- N = Anzahl und Benennung der jeweils "erreichten" Städte von Pilotierung ab
- Differenz = Wiedergabe des zeitlich erfassten Intervalls (MAX-MIN)
- Count = Anzahl der erfassten Datenpunkte
- Differenz A = Dauer von ersten Anwendung (Stadt #1) bis zur nächsten (Stadt #2)
- Differenz B = Dauer von ersten Anwendung (Stadt #1) bis zur fünften (Stadt #5)
- Differenz C = Dauer von zweiten Stadt (Stadt #2) bis zur dritten (Stadt #3)

Es ist zu erwähnen, dass dadurch keine vollständige "Marktbetrachtung" (100%-Sättigung) möglich ist, wie sie bei Rogers und weiteren Innovationsforschern angenommen wird, sondern eine reine zeitliche Diffusion in einem Ausschnitt der Gesamtheit aller Städte. Dies stellt aber für das Forschungsdesign kein Problem dar, da es zu keinem Zeitpunkt um die vollständige Erfassung des globalen Stadtsystems geht, sondern nur um die Frühphasen bei der Entstehung und Verbreitung von urbanen Innovationen. Die nachfolgenden Grafiken stellen die beiden Ansätze graphisch gegenüber:

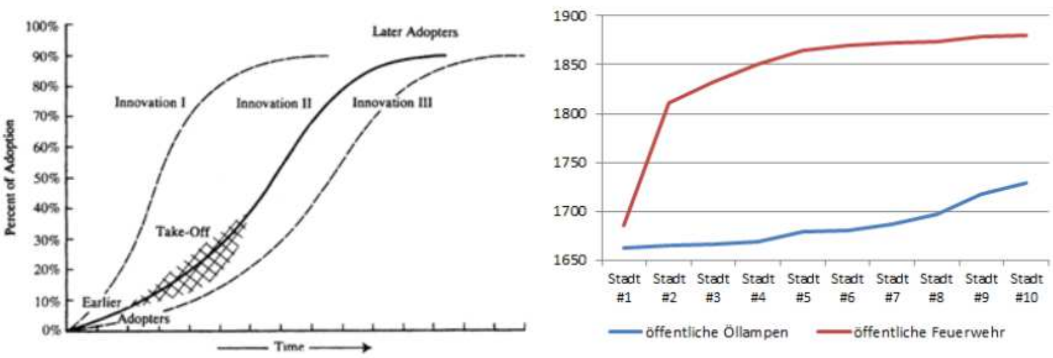

Abb. 2: links Diffusionsprozesse nach E. Rogers; rechts Diffusionsprozesse für zwei beispielhafte urbane Innovationen und zehn Städte der eigenen Analyse (Quelle: eigene)

Zusammenfassend lässt sich festhalten, dass bei kritischer Überprüfung der Anforderungen an eine empirische Analyse sicher keine vollständig befriedigende Situation vorliegt. Allein der Mangel an umfassenden Quellen, das Zusammenführen verschiedener Kategorien (Technik & Soziales) und der lange zeitliche Betrachtungsraum führen zu einer gewissen Unschärfe, die zu erwähnen ist. Dennoch lässt sich durch den explorativen Ansatz, die Festlegung auf einige wenige Kennwerte und die sich ergänzende Quellenlage ein relativ durchgängiges Bild über die Diffusionszyklen urbaner Innovationen über den Betrachtungszeitraum – zumindest für die frühen Innovationsphasen – erhalten.

4 ERGEBNISSE

Durch explorative und hypothesengestützte Auswertungen wurden unterschiedliche Aspekte identifiziert, die in der Retrospektive einen Einfluss auf die Diffusion von urbanen Innovationen im globalen Stadtsystem hatten. In diesem Papier wird aus Platzgründen auf die folgenden drei Aspekte eingegangen:

- Unterschiedliche Innovationsleistung von Städten

- Zunehmende Beschleunigung von Innovationzyklen
- Weitere qualitative Charakteristika

4.1 Unterschiedliche Innovationsleistung von Städten

Ziel der Diffusionsanalyse ist es belastbare Aussagen zum Diffusionsverhalten urbaner Innovationen als auch zur Innovationsleistung betreffender Städte abzuleiten. Je mehr eine Stadt eine aktive Rolle bei der Pilotierung einer urbanen Innovation oder deren Diffusion in den Frühphasen eingenommen hat, desto wichtiger scheint ihre Funktion sowie deren Rahmenbedingungen für die erfolgreiche Gestaltung von Innovation. Um hierzu einen einheitlichen Faktor zur vergleichenden Betrachtung zu ermitteln, wurde die Rangordnung einer Stadt je Innovation festgelegt: Hat eine Stadt eine Innovation als erstes pilotiert, erhält sie die Nr. 1; Hat eine Stadt eine Innovation als drittes pilotiert, erhält sie die Nr. 3 usw.

Hieraus ergibt sich ein Index zur Innovationsleistung einer Stadt, der gemäß der Diffusionstheorie von Rogers unterschiedliche Funktionen bei der Pilotierung und Adoption von Innovationen (z.B. Innovator oder Late Mover) berücksichtigt. Gleichzeitig lässt sich damit für einen bestimmten Zeitraum die Innovationsleistung einer Stadt bestimmen, z.B. bis zum Zeitalter der Industrialisierung oder nach Aufkommen des Internets. Durch dieses Vorgehen konnten alle Städte in der Erhebung einheitlich erfasst und bewertet werden. Nachfolgend sind die oberen 25 davon aufgelistet mit ihrem jeweiligen Innovationsindikator (Übersicht im Anhang):

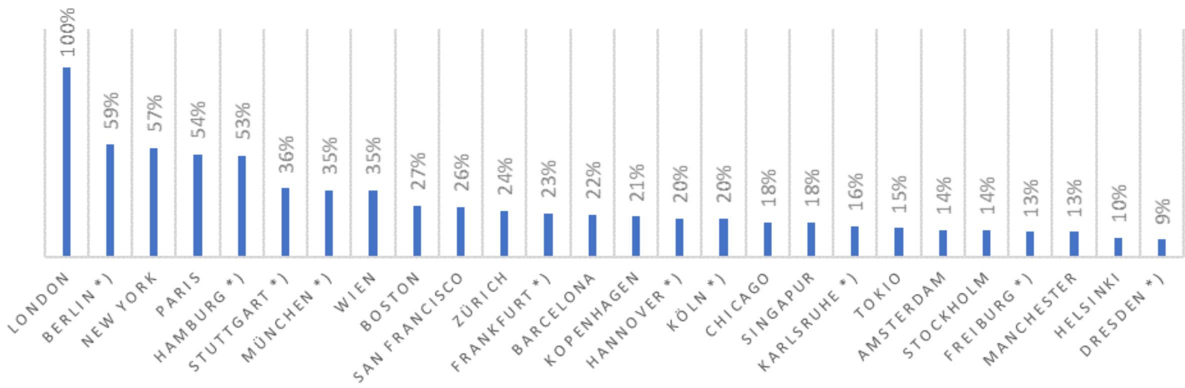

Abb. 3: Übersicht der Innovationsleistung der TOP-25-Städte aus der Diffionsanalyse heute (Quelle: eigene)

Durch diese Analyse ist es möglich die Rolle einer Stadt im globalen Innovationssystem anhand einer größeren Anzahl urbaner Innovationen (N=130) zu definieren. In der obigen Darstellung zeigt sich dabei die Verteilung von 25 der 113 erfassten Städte im Innovationssystem und über den gesamten Betrachtungszeitrum. Klar erkennbar ist die Sonderrolle der Stadt London (darauf wird später eingegangen) als ewiger “Innovator”, einer Reihe von “Early Adopters” (Berlin, New York, Paris, Hamburg) und einer “Early Majority”. Interessant sind dabei auch die Rohdaten der Innovationsleistungen, also

Stadt	In %	Nr. 1	Nr. 2	Nr. 3	Nr. 4-5	Nr. 5-10	Nr. 10+
London	100%	25	16	14	17	16	5
Berlin	59%	4	18	9	34	26	3
New York	57%	7	6	15	24	29	5
Paris	54%	6	17	15	18	16	5
Hamburg	53%	4	6	3	19	32	8

Tab. 1: Ausschnitt zur detaillierten Übersicht der TOP-5-Städte und dem Grad einer Innovationsadaption (Quelle: eigene)

Damit lassen sich folgende Ergebnisse ableiten:

- Das Modell von Rogers zur “Innovationsdiffusion” in einem System ist in in hohem Maße auf Städte als “Akteure” übertragbar.
- Einige wenige Städte sind für den Großteil urbaner Innovationen (UI) der modernen Stadtentwicklung verantwortlich (z.B. wurden 25 der 130 betrachteten UI in London pilotiert; Berlin nur 4, dafür aber die meisten “Nr.2-Adaptionen” (18)).

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- Die Innovationsleistung von Städten ist eine globale, die nicht an Ländergrenzen haltmacht und über Kontinente reicht.
- Alle innovationsstarken Städte sind nicht nur in einzelnen Sektoren (z.B. Innovationen im Energiebereich) ausgeprägt, sondern meist sektorenübergreifend (=systemisch).
- Die Innovationsleistung einer Stadt ist zeitlich veränderlich, allerdings für die dargestellten Städte (TOP 25) stabil (geringere Schwankungen gegenüber anderen Städten).

4.2 Zunehmende Beschleunigung von Innovationzyklen

Eine der wesentlichen Ergebnisse der explorativen Analyse ist die zunehmende Beschleunigung in der Diffusion von urbanen Innovationen und damit eine erhöhte Sensibilität im Kontext einer sonst langfristigen orientierten Stadtentwicklung. Über die kombinierte Auswertung der einzelnen Diffusionsverläufe aller betrachteten Innovationen erhält man ein grobes Bild, wie sich diese darstellen. Dabei wurden vier Variablen nebeneinandergestellt und im folgenden Streudiagramm abgebildet:

- Diffusionszeit von der 1. zur 2. Stadt
- Diffusionszeit von der 1. zur 5. Stadt
- Diffusionszeit von der 1. zur 8. Stadt
- Diffusionszeit von der 1. zur 10. Stadt

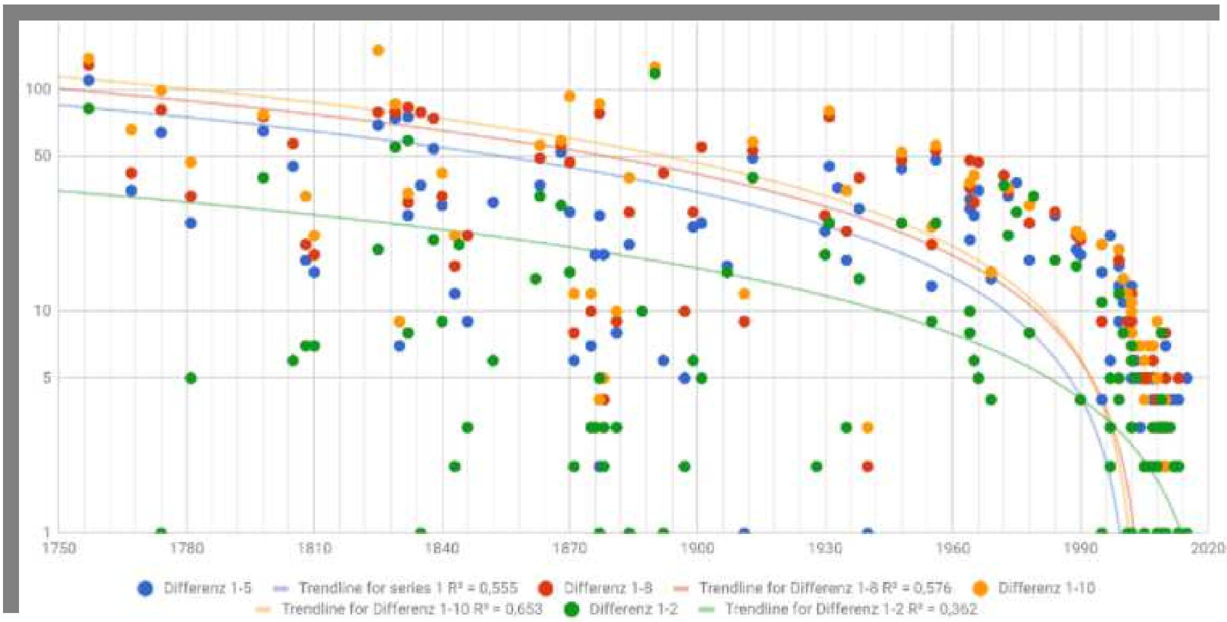

Abb. 5: Unterschiedliche Diffusionszeiten urbaner Innovationen von 1750 bis heute (Quelle: eigene)

Bei allen Diffusionszeiten zeigen sich klare Langzeittrends, die bis heute anhalten: Während im 18. Jahrhundert urbane Innovationen sich nur langsam verbreiteten (teilweise über mehrere Jahrzehnte), hat diese Zahl kontinuierlich abgenommen, so dass im 21. Jahrhundert bei den erfassten Innovationen Diffusionszeiten von weniger als fünf Jahren im Mittel vorliegen. Dies hat entscheidende Konsequenzen für die moderne Stadt- und Raumplanung, erfordert es doch ein neues Verständnis zur Innovationsfrüherkennung und Vorhalten geeigneter Zukunftsstrategien einer technologieoffenen Stadtentwicklung.

4.1.3 Weitere qualitative Charakteristika im Innovationssystem Stadt

Durch die Diffusionsanalyse ist es erstmalig möglich die Rolle einer Stadt im globalen Innovationssystem anhand einer größeren Anzahl urbaner Innovationen (N=130) zu definieren. Gleichzeitig ergeben sich explorativ weitere Erkenntnisse und mögliche Ableitungen, die aus Platzgründen hier nicht näher ausgeführt werden – aber der Nachvollziehbarkeit halber kurz skizziert werden:

- Hauptstädte mit internationaler Relevanz über mehrere Jahrhunderte hatten die Möglichkeit Wissen, Ressourcen und Macht (=Innovationen) zu konzentrieren.

- Neben den europäischen Welt- bzw. Hauptstädten fällt New York auf, welche erst 1624 gegründet wurde, aber eine weltweit relevante Rolle (vgl. GAWC) eingenommen und sich oft als Experimentierfeld verstand.
- Manche Städte sind eher Innovatoren, manche eher Adopter oder eine Mischung aus beiden.
- Das Ziel Innovationen selbst zu gestalten, erhöht auch die Fähigkeit andere leicht zu adaptieren.
- Während die meisten Nationen klare Zentren mit hoher Bevölkerung aufwiesen, war Deutschland lange bestimmt von föderalen Strukturen und einer Vielzahl von Königreichen mit starken Mittelzentren (um 1850 (außer Berlin) mit 50-150.000 EW).
- Das politische System einer Nation und die internationale Positionierung haben Einfluss auf das Innovationsverhalten einer Stadt, z.B. Mussolini-Regime für Rom im 20. Jahrhundert oder Habsburgermonarchie für Budapest im 19. Jahrhundert.
- Die baulichen und strukturellen Eigenschaften einer Stadt, z.B. Bevölkerungsdichte, haben Einfluss auf das Innovationsverhalten.
- Die wirtschaftliche Situation und die lokale Wirtschaftsstruktur einer Stadt hat Einfluss auf ihr Innovationsverhalten.
- Die Bevölkerungswachstumsraten einer Stadt scheinen (bei gewissem Entwicklungsgrad) mit ihrer Innovationsleistung zu korrelieren, d.h. mehr Wachstum bringt mehr Innovationsleistung.
- Zwischen einzelnen Städten bestehen nicht sichtbare Innovationspfade, die häufiger genutzt werden als andere. Dabei spielen auch sprachliche und politische Grenzen eine Rolle.
- Im Zuge der globalen Urbanisierung und Vernetzung entstehen auch demokratischere Strukturen für urbane Innovationen, d.h. mehr Befähigung.
- Durch den Wechsel von einem sozio-technischen System in ein anderes (z.B. Industrialisierung – Digitalisierung) erhalten auch Städte eine veränderte Rolle, z.B. San Francisco als „Labor“ des Silicon Valley.

5 DISKUSSION UND AUSBLICK

Der zugrundeliegender Ansatz einer technologieoffenenen Stadtentwicklung ist kein neuer, sondern ein Prinzip, dem sich Städte und Stadtstrukturen bereits in der Vergangenheit bedient haben. Erwiesen wurde ebenfalls, dass manche Städte sich diesem Prinzip erfolgreicher bedienen als andere. Dabei spielen eine Vielzahl von Einflussfaktoren eine Rolle, die hier nicht vollständig ausgeführt wurden, aber dennoch entscheidend sein können für die anstehende Transformation hin zu klimaneutralen Städten in weniger als drei Jahrzehnten.

In Bezug auf das eingangs eingeführte Beispiel von Eixample in Barcelona stellen sich weiterführende Forschungsfragen, wie in der Praxis die „Vorrüstung“ auf kommende Innovationen erfolgen kann. Was in der modernen Stadtentwicklung und den teils emotionalen Diskussion über Disziplinen, Technologieauffassungen und Expertisen meist übersehen wird, ist die Frage der grundsätzlichen Innovationsfähigkeit einer Stadt als Sub-System eines globalen Stadtsystems. Gerade in weitgehend gebauten Stadträumen der westlichen Welt sind Planungs- und Genehmigungsprozesse von langen Zeiträumen geprägt, so dass jeder nächste Schritt der “richtige” sein sollte.

Je mehr eine Stadt eine aktive Rolle bei der Pilotierung einer urbanen Innovation oder deren Diffusion in den Frühphasen eingenommen hat, desto wichtiger scheint ihre Funktion sowie deren operationalisierbare Einflussfaktoren vor Ort für die erfolgreiche Adaption von Innovation. Dies bedeutet auch, dass sich die kommunale und technologische Innovationspolitik (z.B. Modellprojekte Smart Cities (BMI), Zukunftsstadt (BMBF), solares Bauen (BMWi) zukünftig, zumindest in Deutschland, umstellen müsste, um viel gezielter Städte als Innovatoren, Adopter und Late Mover zu berücksichtigen. Die bisherige Praxis rein konzeptbezogene Einzelvorhaben zu fördern, bieten erwiesenermaßen nur ein begrenztes Transferpotenzial. Immerhin hat die Europäische Kommission bereits 2015 begonnen “Lighthouse & Follower Cities” über fünf Jahre in Modellvorhaben zu fördern, was aber in der nur begrenzte Effekte in der Fläche hat. Die wesentliche Aufgabe unserer Zeit in Wissenschaft und Praxis hierfür muss eine deutliche Verbesserung bei der

Entwicklung und Skalierung von dringend erforderlichen Systeminnovationen hin zu klimaneutralen Städten darstellen – eine technologieoffene und antizipierende Stadtentwicklung bietet hierfür Lösungsansätze.

5.1 Einordnung der Arbeit

Das vorliegende Paper stellt einen wesentlichen Methodenschritt in einer mehrjährigen Forschungsarbeit dar, die die Lücke zwischen Innovationsmanagement und Stadtentwicklung schließen und einen Beitrag zur Gestaltung zukunftsfähiger Stadträume leisten will. Der Schwerpunkt lag bisher auf einer mehrstufigen Literaturanalyse, der Beschreibung der Co-Evolution von Stadtsystemen anhand Verlaufsanalysen sowie der Diffusionsanalyse, die in diesem Paper im Vordergrund steht. Im letzten ausstehenden Methodenschritt werden aus den Diffusionsprozessen urbaner Innovationen wiederkehrende Handlungsmuster abgeleitet und validiert, die wiederum für die heutige Praxis und Innovationspolitik wertvolle Leitlinien bieten können.

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About Ecology in the City: an Attempt of Classification of the Political Trends

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1 ABSTRACT

The transition to an eco-compatible society is analyzed in terms of causes and reasons. At each time there is a “vision of Nature” made up of knowledge of the causes and knowledge of the reasons. There were successively the “geometrical Nature”, then the “artificial Nature” and today the “sustainable Nature”. The transition is long-lasting and complex because we have to pass from “artificial Nature” to “sustainable Nature”. The approach is applied to the Information Theory (that is to say the contribution of Information Technologies to the transition) and the precautionary principle. In the conclusion, the topic of political ecology in the cities is evoked.

Keywords: responsibility, transition, classification, eco-compatible society, political ecologymy

2 INTRODUCTION

The mainstream in the political change today (namely, policy aimed at the transition toward an eco-compatible society) is familiar, but not “for that, known”.No wonder if the process is long-lasting and complex, since we have to pass from a society relying on modernity and certainty to a society relying on the subtle “precautionary principle”. One can try the notions of Reform and Revolution, but it is not enough. There are not two Rs (Reform, Revolution) but five Rs (Revolution, Regeneration, Renovation, Reform and Regulation):

- Revolution. We do not need “hope”. One knows the answer of Hans Jonas in “The principle of responsibility” to the book of the German philosopher Ernst Bloch “The principle of hope”. Hope is when the humankind transforms the world. But, according to another German philosopher, Gunther Anders, “we have no more to change the world, but to preserve it”. According to Hans Jonas, we should consider Nature as a heritage to transmit to the next generations as safe as it is.
- Regeneration. It means to change the morals. Thus, greedy is criticized, for instance when an actor grabs some space to realize a project which is advantageous for himself, or when providers make pressure on customers (like in the case of “intellectual extractivism”, which is described later in the paper).
- Renovation. Renovation is the minimal version of the transition. Indeed, the transition is global. Renovation supposes that in some sectors, one has to replace the technologies and the behaviors by others, which are more adequate. But the transition is more than changes in a few sectors. Technical innovation is necessary to the transition, but does not define it.
- Reform. The transition will be the consequence of decades of reform. Of course, the support of Opinion is indispensable. It should exist. In this paper, the hypothesis of the German sociologistTonnies is accepted: according to him Opinion changes and is educated, slowly. The instantaneous Opinion is different,“gaseous” (spontaneous, unpredictable). But on the long term majorities will appear, supporting stakes like struggle against global warming, against pollution, or erosion of biodiversity etc. Majorities have already appeared on topics like tobacco, attrition of car traffic (and passing to electric vehicles), struggle against artificialization of landscapes, control of the quality of the food etc.
- Regulation. Regulation encapsulates the decisions taken when reforms occur. Of course, it is a stake, in the context of the transition. It will develop in more and more fields. The impact of humankind on the environment triggers more and more problems.

In this paper, we try to explain the complexity of the transition by speaking of causes and reasons.

The opposition between causes (Science) and reasons (sentiments, values) has been described by the French philosopher Cournot (he reversed the meanings of the two words). It has been resumed by the sociologist Tarde in his book on the Cournot’s works (Tarde, 2002). For Tarde, there are “logical duels” which concern the causes (Science) or the reasons (sentiments, tastes, values …). The outcomes of these logical duels, accumulate. For instance, if the topic is Nature, the outcomes of the logical duels concerning causes and

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reasons accumulate and a kind of "doctrine" or "vision" appears. Someday, this doctrine on Nature becomes obsolete because of the changes in society, and is more and more used to "save the phenomena". Another doctrine is needed. Again, there are logical duels concerning the causes and the reasons. In this paper, we shall argue that there have been three "visions" of Nature, succeeding one to the other: the "geometrical Nature", the "artificial Nature" and the "sustainable Nature". The complexity of the transition (to an eco-compatible society) is explained: one has to pass from a vision of Nature (artificial Nature corresponding to the industrial era) to another, sustainable Nature, when the impact of humankind on environment has to be taken into account.

In this paper, one insists on the symmetry between causes and reasons. One finds arguments (for the symmetry between causes and reasons) in the Castoriadis 's works ("The imaginary institution of society") and the Ostrom's works.

The causes and the reasons are different, intertwined[1] and articulated, and symmetrical.

The idea of artificial Nature comes from George Sorel.

The plan of the paper is the following:

- One sets out why the causes and the reasons, and their symmetry, matter
- One describes the successive visions of Nature.
- An example of the approach is given with the Information Theory (examining the contribution of the Information Technologies to the transition)
- Another example of the approach is the precautionary principle
- Conclusion (the stress is put on ecology and cities).

3 CAUSES AND REASONS, AND THEIR SYMMETRY

3.1 Causes and reasons

To describe what are the causes, a pertinent approach is to examine the birth of the first modern science, astronomy. The American philosopher Whitehead stated that the challenge was to overcome the gap between accurate data on the stars (Tycho Brae) and simple hypotheses, like mathematical laws, able to explain the data. It was achieved in a few centuries, from the time of Copernic to the time of Newton. This process is described in the Joseph Bertrand 's book on the founders of astronomy. On the same topic, Arthur Koestler wrote "The sleepwalkers", insisting more on the social atmosphere and the psychology of the "sleepwalkers" (the scientists). There was a strong need of faith in science, of motivation, since the effort was very uneasy. It is "serendipity". Arthur Koestler gives an example. Someday, by chance, Kepler remarked two numbers concerning the trajectory of Mars, equal. He thought that it could not be the hazard, and recovered his energy to continue his works. Indeed, it was not the hazard, but Kepler could not understand it, because the identity of the numbers requires analytical geometry, to be demonstrated. It was not available at this time. Scientific discovery is a play against Nature in which the hazard has its role, like in an adventure. That is why serendipity is necessary to scientists. Indeed, from the milieu of scientists, the idea of serendipity has diffused towards all the people (Messac, 1975).After a discovery, a presentation of science occurs, in accordance with "strength" or "power": it was necessary to discover these ideas, so a "corpus" appeared (Latour, 2006). There are incommensurable theories during the logical duel, and the indisputable when it ends. Scientific discovery is also a game between human beings. There are rival networks, each of them has to trigger interest to get the means allowing the scientific work (Latour, 2006). The sociology of science (Bruno Latour) has clarified the issue of how the knowledge of causes is generated.

Concerning the knowledge of reasons, we have to pay attention to the logical duels on values: "voices" in the Medias, debates on what is desirable for Society etc. Historically, the books on prophets show how the reasons are generated (for instance, the book on Mahomet by the poet Lamartine, or the book on Islam and Mahomet by the sociologist Le Bon).

[1] Examples are given later in the paper.

3.2 The necessary symmetry of causes and reasons

The Latour's book "We have never been modern" has for subtitle: "essay of symmetrical anthropology". Why "symmetrical"? Because in our world the objects are hybrid. One cannot oppose Science (concepts) and Society (beliefs). Objects are described by science, but are also "actants", depending on spokespersons. Hence the idea of the necessary symmetry of causes and reasons.

The causes without reasons are positivism. There is a famous example in literature, Bazarov, a character in the Turgenev 's novel "Fathers and sons". He pays attention only to scientific facts (having recklessly observed an epidemy of typhus, he dies because he has been contaminated). At the opposite, reasons without causes are mysticism. One opposes Descartes, proponent of causes, to Pascal, knowing science but thinking that the knowledge of reasons (philosophy, reflection on God) is above. Pascal said on Descartes: "useless and vain". Nietzsche, preferring the reasons, has written that "science is only an accumulation of syllogisms without particular meaning".

Even at the time of Galilee, there was some symmetry between causes and reasons. The progress of the knowledge of causes was possible, notwithstanding the power of the Church. Otherwise, the society would not have been so creative. The higher clergy tolerated that one sets out and discusses heliocentrism. But the lower clergy held for the tradition and the geocentrism of Ptolemaeus. It was not recommended to challenge geocentrism. Galilee did it in his book. More, he gave wrong scientific arguments (on the sun spots, on tides which were caused by … the sun). Also, he was 70 years old. In these conditions he was vulnerable. His trial occurred and he was obliged to renounce. At this time, the Jesuits who were at the Court of the Emperor of China, in Peking, helped the Chinese astronomers, using … heliocentrism (Koestler,2010).

More accurately, one finds arguments (on the symmetry of causes and reasons) in the works of Castoriadis and Ostrom.

In "The imaginary institution of society" Castoriadis argues that there are always two ontologies "ensemblistidentitary" and "historical social". The first is about the tools of a society, meaning how to use them (with a quantitative aspect, since efficiency in using tools supposes to count many things, the tools themselves, hours of work, performances of workers, objects which are useful to production, materials …). The second concerns the myths through which a society represents itself (origin, characteristics, destiny, future …). Here also, there is some symmetry: according to Castoriadis, the "historical social" ontology is "propped up" in the "ensemblistidentitary" ontology. "Propped up" supposes a kind of support, the "ensemblistidentitary" ontology strengthens the "historical social" ontology (that is to say: contributes to its meaning). When something is propped up in some material, it benefits from the robustness of this material. A society with an "historical social" ontology not propped up in the "ensemblistidentitary" ontology will decline, being inefficient in production, hence a lack of trust in itself (besides the material decay).

In the works of Elinor Ostrom, there are cases of collective management of natural resources showing that: the "culture" (values) and the governance, in some society, can match or not. An accord of reasons (values) and collective action (managing the resources) is needed. Otherwise, there is no efficient production (including the stake of sustainability). In the works of Elinor Ostrom, there are "laws" (which are the consequence of "culture") and "rules" (which are used to manage the resources). And laws and efficient rules can coexist, or not. Of course, a well-known example is the holy cows in India. Another example concerns a hypothesis on the end of the Maya civilization: rich people had such a taste (reasons are concerned) for thick walls in stucco for their houses that too many trees were cut to make this stucco. Then erosion of land or dryness destroyed the agriculture.

A symmetry of the knowledge of the causes and the knowledge of the reasons is needed, so a society with its "culture" is efficient in production.

4 SUCCESSIVE VISIONS OF NATURE

At some time, there is a "vision of Nature", made up of knowledge of causes and knowledge of reasons. Here we find some inspiration in the George Sorel's works. He was a thinker obsessed by the aim of transmitting a "serious" thought, void of idealism, metaphysics, dogmatism or charlatanism to the working class.[2] Therefore, he studied the theories of the past and at his time (around 1900) to discriminate the

[2] His school has been called "revolutionary syndicalism". Indeed, he never had an important role in syndicates.

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"useful" ideas and the other, in the context of the time (the "usefulness" of ideas is a criterium for theories which have to be robust and pertinent, and comes from the American philosopher Williams James). He starts in the Antiquity but we are interested in Nature for people at the time of Renaissance and after. Sorel describes a "geometrical Nature" and an "artificial Nature":

- Geometrical Nature is born from the progress of astronomy and Newtonism (mechanics). This appeared in the Kant's works since he wanted to make the synthesis of two "marvels", Newtonism in science and the Christian morals (Sorel, 2019). The geometrical Nature is homogeneous, infinite, regular (the phenomena obeys laws), deterministic. All the phenomena in the universe interact. There are mathematical laws of the universe. Concerning Man 's action, the perspectives are good: astronomy developed, the techniques for navigation upgraded etc. The geometrical Nature is intelligible. Hence the optimism.
- Artificial Nature is born with industry. It is completely different from geometrical Nature. According to Reuleaux (a German engineer who was also a theorist of industry) one can consider "machinic systems" (sets of machines which are operated together) which do not interact, are isolated one from the other (if there is enough distance between them). And probabilities are involved, because of the friction of the parts of the machines, which cannot be described accurately, but there is an average of the effects appearing. Hence wear and waste of energy and a limit of the performance of the machinic systems. Indeed, Reuleaux himself invented a gear, using geometry in a new way, to mitigate friction. The main science is thermodynamics. Man is in a struggle with Nature, will is needed because of this obstacle: dissipation of energy. Man creates an artificial Nature, made up of artefacts, the machines. And he forgets all in Nature that is not artificial Nature: it is "natural Nature". So, industry grows, artificial Nature is more and more known and mastered, while natural Nature remains forgotten. There is no interest for it, and it is neglected by science.

Of course, Sorel appears today as a productivist. Political ecology did not exist at his time. But he had a clear understanding of the "vision of Nature" needed by industry. Geometrical Nature became obsolete and used to "save the phenomena" at the beginning of the 19 th century. And artificial Nature have become obsolete because natural Nature can no more be neglected, forgotten. We have understood that natural Nature (that is to say environment, the Planet) is necessary to human life and that there is a terrible impact of industry on it. Therefore, a new vision of Nature has appeared and has developed, sustainable Nature.

In the vision of "sustainable Nature" the impact of human activity on environment has to be watched, and known. The new main sciences are scientific ecology, climatology, studies on pollution of waters, soil, air … We have become aware of the complexity of the ecosystems. Therefore, the impact of human activity on the ecosystems is uneasy to assess. The "will" (at the time of artificial Nature) is replaced by caution: we have to take into account how ecosystems which are not well known are impacted by human activities. Here the idea is to imagine the worse. Then one takes measures to avoid it. It is the precautionary principle.

5 THE INFORMATION THEORY AND ITS CONTRIBUTION TO THE TRANSITION

The Information Theory is kin to the artificial Nature. The "will", to struggle against dissipation of energy, is replaced by struggle against cluttering (the cluttering triggered by the signs of which a message is made up). The probabilities are everywhere: definition of the unit (the bit), definition of the goal (to mitigate the average distortion of the transmitted message), "noise" (the definition is modelled on thermodynamics). The deterioration of the transmitted message is studied according to the model of thermodynamics (dissipation of energy).

We have understood during the recent pandemic that Information Technologies provide great service thanks to telework. Also, they provide interesting services in the smart city: a traffic more fluid, less moves for the workers or technicians in charge of maintenance (IoT, Internet of Things, remote meter reading), gains in security … However there remain all the other problems: global warming, pollution of air, water, soil, declining biodiversity etc.

The kinship between Information Theory and artificial Nature leads to this question: and if Information Technologies allowed some "extractivism"? The answer concerns a possible "intellectual extractivism". Here the resource which is exploited is "attention". It has been studied by "attention economy". The attention of the web users is measured thanks to the hyperlinks, which are more or less used. Algorithms allow a profiling of a web user, hence specific offers to him (her), supposed to take into account his (her) tastes. The main notion is "popularity" and is measured thanks to the number of times a site is visited (the number of hyperlinks leading to it). The outcome is a constant pressure on the web user, requested to buy what is in accordance with his (her) tastes, guessed by the algorithms … The data on the attention of the web users have a value and are sold … Even, there is a mathematical support, the Perron Frobenius theorem, concerning the Markov chains, justifying the calculation of popularity. The algorithm used by Google, PageRank, is based on it (Cardon, 2013).

It is criticized from two points of view: (1) it is a violation of the autonomy of the individual (2) it leads to more and more consumption. Here the idea is: it is not the more popular products (services) which should be more and more consumed, but those which are compatible with a safe environment.

6 THE PRECAUTIONARY PRINCIPLE

The precautionary principle can be justified by three arguments, as a consequence of models, as a strategy, and as opposed to a myth, the myth of the "corrective action":

- The precautionary principle as a consequence of models. The methodology of our time is modelling thanks to the use of computers. But these models, even the most sophisticated, are not always as accurate as wished (Taleb, 2013). But they remain interesting: when several of these models suggest (indicate) some risk, one a has kind of alert. If one model is not very accurate (predictions are concerned) the convergence of several models allows an alert: some risk is probable. One uses to express it the words "imprecise information": the probability of some catastrophe is in a fork (between 95 % and 100 %, for instance). This justifies prudence when some decision (concerning production of energy, technologies used in agriculture, industry etc.) has to be taken. The models will become more and more accurate, since "natural Nature" is no more neglected, but, at the opposite, studied. But the ecosystems and their evolution are a very complex topic. For some time, the precautionary principle should remain a good choice.
- The precautionary principle as a minimax strategy. In game theory, a minimax strategy is that of a player who maximizes his gain, considering the worse occurrences (for him). So, one imagines a game "Society against Nature": One supposes that Nature inflicts the maximal loss, in each alternative. And Society chooses the smaller loss. For instance, an alternative can involve the possibility of a "black swan" (Taleb, 2013). A "black swan" is an event with a very small probability of occurrence, but huge effects if it occurs. If another alternative does not involve a "black swan" (a negative "black swan", in other words a possible catastrophe) this second alternative should be preferred to the first. To choose a minimax strategy means that the player making this choice is prudent. Considering the possible losses, he minimizes them.
- The precautionary principle, as opposed to the myth of corrective action. The efficiency of corrective action has existed, at the time of "artificial Nature". As it is explained by George Sorel, engineers conceived machines which were manufactured by fabricants then sold to entrepreneurs. These entrepreneurs wanted to carry out economies of cost. The goal was to minimize the consequences of wear. In case of breakdown, the machine should be repaired quickly. Spare parts were available. This was theorized by Reuleaux. Finally, breakdowns were not so serious. Corrective action was possible. But concerning ecosystems which are damaged, it is an illusion. For instance, the Aral Sea, which has dried up, cannot (probably) be restored. It is the same for the wet zones (rich in biodiversity and carbon wells). Even concerning forests, decades are needed for having a forest in the same state than before the destruction. Etc.

Again, our imperfect knowledge of ecosystems leads to the precautionary principle. Some ecosystems on which the humanity depends could be destroyed, if we are reckless. And possibly, it would be irreversible.

7 CONCLUSION

The transition (to an eco-compatible society) will be long-lasting and complex, and also global. Global, for two reasons, the threat itself (on environment, on the Planet) is global, and from an intellectual point of view, the "vision of Nature" has to change:

- the threat is global. Around 1900, at the time of John Muir (the founder of the Sierra Club) and the President of the USA Theodore Roosevelt (a preservationist), it was only an intuition: all the Nature was under threat because of industry. But now it has become a certainty. Almost every day, we are informed that environment is destroyed in some new field: biodiversity, then the waters of oceans, then glaciers (which have begun to melt), Antarctic continent etc. Some negative effect triggers another negative effect: global warming triggers acidification of oceans. There are cumulative processes: global warming triggers the melting of the permafrost, which strengthens global warming, hence more melting of the permafrost etc. Some researchers have spoken of a no-return point …
- we have to pass from a vision of Nature, made up of knowledge of causes and knowledge of reasons, in symmetry, to another one. Namely, we have to pass from "artificial Nature" to "sustainable Nature". This explains that the process will be long-lasting and complex. The five Rs evoked in the introduction are concerned. There are breakthroughs and steps back. Is it that the Opinion is a "magma" à la Castoriadis (that is to say a magma of representations which are ever changing in an unpredictable way)? Probably not, since there is this argument: there is a slow (perhaps too slow …) evolution of Opinion towards awareness on the necessity to take measures to save the Planet.

One shall conclude on the topic of ecology in cities. In History, the city has shown remarkable flexibility. So, one finds cities generated by the need of knowledge of the causes or knowledge of reasons:

- In the Antiquity, many scientists were in Alexandria. In the Middle Ages, a few renowned universities were located in some cities. Sometimes, a city was created for the purpose of knowledge of causes and …a need of secret. The king Henry of Portugal gathered in Sagres scientists (geographers, astronomers, navigators …) with the mission of mapping the universe (at least the maritime routes which were of interest for the Portuguese). Los Alamos (New Mexico, in the USA) where was carried out the Manhattan project (making the first atomic bomb) is also famous. Of course, today there are the technopoles.
- The most famous pilgrimage cities were generated by the knowledge of reasons.

One can propose a classification of cities (or places in cities) relying on knowledge of causes, knowledge of reasons and their symmetry. One finds criteria in the studies on Internet and the search engines like Google. These studies question the working of the search engines and the algorithms. They are used to measure popularity. But does popularity mean authority? It is the question of the "wisdom of the crowds". Let us retain the two criteria: popularity and authority (Cardon, 2013). Popularity corresponds to the knowledge of reasons. Authority corresponds to the knowledge of causes. Cities where a symmetry between causes and reasons exists, are more aware of the ecological stakes. There people are preoccupied with quality of life.

This classification appears in this table:

	Reasons	Causes	Symmetry between causes and reasons
Characteristics of he places	Popularity Visibility	Authority	Quality
Kinds of places Examples	Cinema: Hollywood Religion: Medugorje (Croatia) Feasts: carnivals (Rio), festivals (Cannes) Tourism: Venice Game: Las vegas	Technopoles Silicon Valley Shenzhen	Midsized cities reconciling economic dynamism and preservation of cultural and environmental heritage Annecy (France)

Annecy (France) is given as an example of quality. An ecologist municipal team has been elected in 2020.

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Change Communication als Instrument für erfolgreiches Anrainermanagement im Rahmen von nachhaltigen Betriebsansiedlungen am Beispiel Oberösterreich

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1 ABSTRACT

Durch Betriebsansiedlungen und -erweiterungen bzw. Standortentwicklung (im Folgenden kurz „Standortentwicklung“ genannt) wird eine Steigerung der Wertschöpfung am Standort bzw. die Schaffung von neuen Arbeitsplätzen erwartet. Aus diesem Grund sollen aus wirtschaftspolitischer Perspektive Unternehmerinnen und Unternehmer in die Standortentwicklung investieren.

Standortentwicklung birgt großes Konfliktpotenzial, zumal sie nicht nur Wirtschafts-, sondern auch Lebensräume betrifft. Sie bedeutet auch immer Veränderung und bedingt die Interaktion der unterschiedlichen Stakeholder. Deshalb sollten folgerichtig die Grundprinzipien des Change Managements Berücksichtigung finden: Effektives Change Management nutzt Change Communication zur geplanten, organisierten und strukturierten Kommunikation während des Standortentwicklungsprozesses.

Unter erfolgreichem Anrainermanagement wird hier das Zusammenwirken von Unternehmen, Bürgerinnen und Bürgern und lokalen bzw. regionalen Behörden rund um die Standortentwicklung verstanden. Ein wesentlicher Erfolgsfaktor ist die prozessuale Einbindung aller Stakeholder, insbesondere auch mittels strukturierter und faktenbasierter Kommunikation. Davon profitieren einerseits Unternehmen, indem sie ihr Projekt erfolgreich ohne große Reibungsverluste verwirklichen können, und andererseits Bürgerinnen und Bürgern, indem ihre Interessen besser Beachtung finden.

Keywords: Anrainermanagement, Standortentwicklung, Change Communication, Change Management, Betriebsansiedlung

2 EINLEITUNG

2.1 Status quo in Oberösterreich

Oberösterreich hat eine Anteil von rund 40 Prozent an der Wertschöpfung Österreichs sowie einen 25-prozentigen Anteil an der gesamtösterreichischen industriellen Wertschöpfung. Dies macht Oberösterreich zum führenden Wirtschafts- und Industriebundesland Österreichs.[1] Die Auslandsinvestitionsvorhaben internationaler Unternehmen betreffend liegt Österreich europaweit im Mittelfeld.[2] In Oberösterreich ist gesamt ein Zuwachs an Betriebsansiedlungen festzustellen.[3] [4] Aus der wirtschaftspolitischen Perspektive heraus sind Betriebsansiedlungen mit dem Ziel verbunden, Investitionen und somit Wertschöpfung am Standort zu steigern bzw. Arbeitsplätze zu schaffen.[5] [6] Diese Betriebsansiedlungen und -erweiterungen führen aber auch zu einer steigenden Nachfrage nach Standorten wie Betriebsflächen und -objekten und dies führt wiederum zu größerem Konfliktpotential. Standorte erfüllen mehrere Funktionen. Sie sind nicht nur Wirtschaftsräume, sondern auch Lebensräume, in denen Menschen arbeiten und leben.[7] Das Spannungsfeld rund um eine Standortnutzung, die wirtschaften, arbeiten und qualitätsvolles Leben zulässt, kann auch in Oberösterreich beobachtet werden.

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[1] Vgl. Wirtschaftskammer Oberösterreich – Sparte Industrie [Hrsg.]: Industrieland Oberösterreich – Daten & Fakten.

[2] FDI = Foreign Direct Investment.

[3] Vgl. STANDARD Verlagsgesellschaft m.b.H. [Hrsg.], Direktinvestitionen: Europa mit Rekord, Österreich schwächer.

[4] Vgl. Trading Economics – IECONOMICS INC [Hrsg.], Austria Foreign Direct Investment – Net Inflows.

[5] Vgl. Business Upper Austria – OÖ Wirtschaftsagentur GmbH [Hrsg.], Kräftiger Rückenwind für Investitionen in Oberösterreich.

[6] Vgl. Oberösterreichische Technologie- und Marketinggesellschaft m.b.H. [Hrsg.], Strategisches Wirtschafts- und Forschungsprogramm, S. 4, 6, 16, 30.

[7] Nachhaltige Standort- und Wirtschaftsentwicklung, Instrumente und Standards einer erfolgreichen Standort- und Wirtschaftspolitik auf der ökonomischen Mesoebene; Mathis, Gerald; Gastvortrag an der FH Technikum Kärnten, 2007, S. 1.

Eine Betriebsansiedlung bzw. Standortentwicklung stellt auch immer eine Veränderung dar. Es handelt sich um eine Veränderung der Umgebung für die Anrainerinnen und Anrainer. Aus diesem Grund müssen die Grundprinzipien des Change Managements und der Change Communication berücksichtigt werden.

2.2 Change Management und Change Communication

Change Management dient dazu, eine Veränderung – sei sie nun geplant und zielgerichtet oder zufällig – in eine Struktur zu bringen und zu lenken. Die vier Grundprinzipien des Change Managements sind Ganzheitlichkeit, Beteiligung, Respekt für unterschiedliche Interessen und das große Bild. Genau wie jede Veränderung und jeder Change-Prozess unterschiedliche Ausmaße annehmen können, so können die vier Grundprinzipien in jeder Veränderung unterschiedlich gewichtet sein und unterschiedlich viel Aufmerksamkeit benötigen. Die Grundprinzipien müssen aber bei jedem Prozess beachtet werden.[8] Effektives Change Management nutzt Change Communication zur geplanten, organisierten und strukturierten Kommunikation über den Prozess hinweg. Dies klingt sehr simpel, wird aber in vielen Change-Prozessen zu spät oder gar nicht beachtet. Vielmehr stehen andere Dinge wie Finanzen und Rentabilität im Vordergrund. Oftmals rühren Probleme im Change-Prozess von einer nicht gut durchdachten oder nicht vorhandenen Change Communication her: Wird eine wichtige Entscheidung getroffen und die Change Communication erst dann aktiviert, können Informationen bereits durchsickern, Gerüchte entstehen und die Change Communication muss zur Krisenkommunikation werden. Optimalerweise wird die Change Communication bereits vor dem Fällen einer Entscheidung miteinbezogen, um das Management auf verschiedene Kanäle, Methoden und Zeitpläne hinzuweisen, die gegebenenfalls sogar die Entscheidung beeinflussen können. [9]

Change Communication ist auch klar in den vier Grundprinzipien des Change Managements zu erkennen. Die Change Communikation muss jedenfalls bereits vor Beginn des Change-Prozesses konzipiert sein, wie oben genanntes Szenario veranschaulicht. Dies bedeutet nicht, dass der Kommunikationsplan auch so umgesetzt werden kann. Ein Change-Kommunikator soll diesen Plan aber auch bei unvorhergesehenen Entwicklungen oder Ereignissen als Unterstützung heranziehen können, um zu entscheiden, wann welche Information an wen ergeht.[10]

Ganzheitlichkeit heißt, dass nicht nur ein umfassendes Ziel formuliert werden muss, sondern auch die Schritte, die zu diesem Ziel führen. Alle Dimensionen des Change müssen ganzheitlich einbezogen werden. Diese umfassen das Umfeld mit seinen Chancen und Bedrohungen, die expliziten Zielsetzungen, die Strategie und ihre Schritte, Geschäftsprozesse und wie diese umgestellt werden müssen sowie die Struktur und etwaige Änderungen in diesem Bereich. Ebenso müssen Mitarbeiterinnen und Mitarbeiter und andere Stakeholder überzeugt werden, damit Change Erfolg hat, von allen mitgestaltet und mitgetragen wird.[11]

Die Dimension des Einbeziehens der Betroffenen und Beteiligten spiegelt sich auch im Grundprinzip der echten Beteiligung wider: Betroffene und Beteiligte sind frühzeitig einzubinden, damit keine Dissonanz bzw. keine Entfremdung zum Projekt stattfindet. Viele Change Manager und Change-Kommunikatoren verwechseln diesen Schritt oft damit, alle und jeden in das Projekt einzubeziehen. Vielmehr ist es hier wichtig, die richtigen Personen zu identifizieren, diese in den Prozess einzubeziehen und ihnen somit das Gefühl zu geben, dass ihre Interessen ernst genommen und berücksichtigt werden und sie auch emotional aufgefangen werden. Somit kann man Betroffene und Beteiligte zu Mitgestaltern machen. Sie übernehmen Verantwortung und identifizieren sich mit dem Change und werden schlussendlich zu Change-Botschafterinnen und Change-Botschaftern.[12]

Ein weiteres Grundprinzip ist Respekt, Respekt gegenüber anderen Interessen und Logiken. Für den Erfolg eines Change-Prozesses können fehlendes Verständnis und fehlende Empathie kritisch sein. Ein Change Manager muss es beherrschen, Perspektiven zu wechseln sowie Betroffene und Beteiligte von Inhalten zu

[8] Vgl. Doppler, K., & Lauterburg, C. (2014): Change Management: Den Unternehmenswandel gestalten. Campus Verlag.
[9] Vgl. Deutinger, G. (2013): Kommunikation im Change. Springer Berlin Heidelberg.
[10] Vgl. Doppler, K, & Lauterburg, C. (2014): Change Management: Den Unternehmenswandel gestalten. Campus Verlag; Deutinger, G. (2013): Kommunikation im Change. Springer Berlin Heidelberg.
[11] Vgl. Doppler, K., & Lauterburg, C. (2014): Change Management: Den Unternehmenswandel gestalten. Campus Verlag.
[12] Vgl. Doppler, K, & Lauterburg, C. (2014): Change Management: Den Unternehmenswandel gestalten. Campus Verlag; Deutinger, G. (2013): Kommunikation im Change. Springer Berlin Heidelberg.

überzeugen. Ebenso muss er Betroffene und Beteiligte dazu bewegen können, ihrerseits auch Perspektiven zu wechseln und Verständnis für andere Sichtweisen aufzubringen.[13]

Das Ziel und der Change-Prozess müssen auch in das große Ganze, das große Bild mittels richtiger Kommunikation eingereiht werden. Betroffene und Beteiligte müssen davon überzeugt werden, für die Erreichung des Ziels Kompromisse einzugehen und Opfer zu bringen. Auch hier soll wiederum so viel wie nötig erklärt werden, und nicht nur Teilaspekte des Change – Betroffene und Beteiligte müssen alles verstehen, um Change-Botschafterinnen und Change-Botschafter werden zu können.[14]

Man erkennt hier, dass Change und Change Communication viele psychologische Elemente umfasst, die oftmals eine größere Rolle spielen als klassische Werbeelemente. Deshalb braucht ein guter Change-Kommunikator fundiertes Wissen über Kommunikationsmedien, -methoden und -botschaften, aber genauso psychologisches Gespür und Empathie, um die aktuelle emotionale Lage bei den Betroffenen und Beteiligten zu erkennen und ob sie für den Empfang von Informationen offen sind.[15]

3 EXPERTENINTERVIEWS

Der im Artikel behandelte thematische Schwerpunkt findet in der wissenschaftlichen Literatur und Diskussion bis dato noch keine eindeutige Betitelung oder Abgrenzung. Um seinen Spezifika sowie der zunehmenden Bedeutung Rechnung zu tragen, betiteln wir diesen Schwerpunkt als „Anrainermanagement“. Unter erfolgreichem Anrainermanagement wird das Zusammenwirken von Unternehmen, Bürgerinnen und Bürgern und lokalen bzw. regionalen Behörden rund um die Entwicklung eines Betriebsstandorts verstanden.

Ein wesentlicher Erfolgsfaktor ist die prozessuale Einbindung von Betroffenen, insbesondere auch mittels strukturierter und faktenbasierter Kommunikation, da dies Vertrauen schafft und konsensuales Vorgehen ermöglicht. Davon profitieren einerseits Unternehmen, indem sie ihr Projekt erfolgreich und ohne große Reibungsverluste verwirklichen können, und andererseits Bürgerinnen und Bürger, indem ihre Bedürfnisse identifiziert werden und in die Projektentwicklung bzw. -umsetzung einfließen können.[16] Diese Aspekte werden im Artikel auch anhand von Best-Practice-Beispielen dargelegt.

Neben der Aufarbeitung der wissenschaftlichen Grundlagen, auf denen Anrainermanagement fußt, steht bei diesem Beitrag vor allem der praktische Umgang mit der Thematik im betrieblichen Alltag im Fokus. Ziel ist es, mittels Experteninterviews zu erheben und aufzuzeigen, wie Unternehmen das prozessuale Vorgehen gestalten und den mannigfachen Herausforderungen, die mit modernen und erfolgreichen Anrainermanagement verbunden sind, begegnen. Diese Thematik soll aus unterschiedlichen Blickwinkeln beleuchtet werden, indem einerseits die Erfahrung der Unternehmen und andererseits die von Mediatorinnen und Mediatoren berücksichtigt wird. Mit der Auswahl der Interviewpartner wurde eine Informationsbasis geschaffen, die der Komplexität des Themas Rechnung zu tragen vermag.

3.1 Standortentwicklungprozess – Interview mit Dr. Gerhard Ettmayer, MBA MSc

Gerhard Ettmayer ist vielfältig unternehmerisch tätig. Unter anderem arbeitet er auch seit vielen Jahren erfolgreich als selbstständiger Unternehmensberater und eingetragener Mediator in Zivilrechtssachen beim Bundesministerium für Justiz. Im Laufe seiner Karriere hat er viele Projekte im Rahmen des Anrainermanagements unterstützt und verfügt daher nicht nur über fundiertes Wissen, sondern insbesondere auch über einen reichen Erfahrungsschatz.

Alle von ihm betreuten Projekte müssen dem Anspruch der von ihm als die „3 Fs“ – fair, friedlich, freiwillig – bezeichneten Leitmotive und -gedanken gerecht werden. Diese beziehen sich auf alle Phasen „seines“ Anrainermanagementprozesses:

3.1.1 Einbindung der Gemeinde

In seiner Prozessgestaltung geht Ettmayer von dem Gedanken aus, dass Politik Verantwortung für die Gesellschaft bedeutet. Im vorliegenden Kontext gehe es eben nicht um Partei-, sondern um

[13] Vgl. Doppler, K, & Lauterburg, C. (2014): Change Management: Den Unternehmenswandel gestalten. Campus Verlag.
[14] Vgl. Doppler, K, & Lauterburg, C. (2014): Change Management: Den Unternehmenswandel gestalten. Campus Verlag; Deutinger, G. (2013): Kommunikation im Change. Springer Berlin Heidelberg.
[15] Vgl. Deutinger, G. (2013): Kommunikation im Change. Springer Berlin Heidelberg.
[16] Vgl. Wirtschaftskammer Österreich – Geschäftsstelle Bau [Hrsg.]: Projektkommunikation – Die Kommunikation bei Bauprojekten S. 4, 5, 7.

Wirtschaftspolitik, die Anliegen der Gemeinde sein muss.Daher werden von ihm in einem ersten Schritt der Gemeindevorstand und der Amtsleiter oder dieAmtsleiterin sowie allenfalls die Vertreterinnen und Vertreter der im Gemeinderat repräsentierten Parteien über das anstehende Projekt und seine Auswirkungen informiert. Ziel ist es, sie in ihre politische Verantwortung zu nehmen. In der Folge sollte die Gemeinde nicht nur die grundsätzliche Genehmigungsfähigkeit des Vorhabens klären, sondern auch etwaige bestehende Interessen in der Bevölkerung im Sinne von Betroffenheit (insbesondere Anrainerinnen und Anrainer) oder Beteiligung evaluieren.

3.1.2 Einbindung allfälliger Mitbewerber

Sofern es Mitbewerberinnen und Mitbewerber gibt, werden diese in diesem Prozessschritt abgeholt. Sie werden in transparenter Art und Weise über das Vorhaben informiert. Dabei geht es um die Klärung der Frage, unter welchen Umständen sie das Konzept der Standortentwicklung freigeben können und werden.

3.1.3 Einbindung der Betroffenen und Beteiligten

Danach werden die betroffenen Anrainerinnen und Anrainer bzw. die ob eines Interesses Beteiligten zu einer gemeinsamen Informationsveranstaltung geladen, in der in transparenter Art und Weise das Grobkonzept und die verfolgten Verhaltens-, Ergebnis- und Haltungsziele vorgestellt werden. Im besonderen Fokus stehen die Haltungsziele. Dabei geht es um die Sinnerkenntnis, die das Verständnis[17] und die Akzeptanz fördert. Klarheit, Offenheit und Wertschätzung sind wesentliche Prämissen der Informationsveranstaltung. Bei dieser werden auch jene Themen gesammelt, die es gemeinsam mit den Betroffenen bzw. Beteiligten (oder deren „gewählten“ Vertreterinnen und Vertreter) im Rahmen eines zu vereinbarenden Zeitplans zu bearbeiten gilt, damit diese das Projekt freigeben können. Gleichzeitig wird auch die Kommunikations- und Informationspolitik vereinbart. Neben den „3 Fs“ erscheint folgende Grundhaltung für Ettmayer wesentlich: Es gibt keine Probleme, es gibt nur Themen, bei deren Bearbeitung der Einfalt die Vielfalt entgegengesetzt wird.

In der Arbeit mit Betroffenen und Beteiligten – sei es im Rahmen der Veranstaltung oder im Anschluss daran, wenn noch Themen offen sein sollten – geht es wiederum um die Freigabefähigkeit des Konzepts, die bedingt, dass die Interessen der jeweils Betroffenen und Beteiligten bedacht werden. Stets ist besonderes Augenmerk auf die Klarheit auch insofern zu legen, als die Realität nicht beschönigt oder verzerrt wird. So muss immer auch klar sein und klar gemacht werden, dass unabhängig von diesem mediativen Prozess ohnehin Rechtsansprüche des Unternehmens bestehen.

3.2 Standortentwicklung – TEAM – MEDIATION – Interview mit DI Florian Leitl

Florian Leitl verfügt über langjährige Erfahrung als Unternehmer und eingetragener Mediator beim Justizministerium. Diese Dualität ermöglichte ihm, besondere Perspektiven zu entwickeln und in seine Projektbegleitung einfließen zu lassen.

3.2.1 Standortentwicklung – Ziegelwerk

Mit der Thematik Anrainermanagement wurde Leitl erstmals in seiner Funktion als Geschäftsführer eines Ziegelwerks konfrontiert: Dem Unternehmen wurde von Anrainerinnen und Anrainern sowie der breiten Öffentlichkeit vorgeworfen, im Rahmen des Produktionsprozesses gesundheitsgefährdende Stoffe zu emittieren. Anstrengungen seitens des Unternehmens zur konsensualen Bereinigung durch produktiven Austausch und sachliche Darlegung der tatsächlichen Umstände scheiterten. Aussagen und Messergebnisse, die das Unternehmen vorbrachte, wurden als geschönt bzw. verfälscht abgetan. „Es gab schlechthin keine Gesprächsgrundlage mehr. Es brauchte einen neutralen Dritten, der von beiden Seiten akzeptiert wurde.“ Der damalige OÖ Umweltanwalt wurde daher miteinbezogen. Auf Wunsch des Unternehmens wurde dieses auf eigene Kosten erneut auf schädliche Emissionen überprüft. Das Ergebnis bestätigte, dass keinerlei Verletzungen von Grenzwerten vorliegen. Die Präsentation des Ergebnisses durch den Umweltanwalt im Rahmen einer Veranstaltung mit breitem Teilnehmerkreis war der Wendepunkt – man hatte zu einem konsensualen Miteinander zurückgefunden.

[17] Verstehbarkeit zielt auf den Verstand ab, während Verständnis auf der Gefühlsebene stattfindet.

3.2.2 Standortentwicklung – Erweiterung Standort um Deponie

Ein Standortentwicklungsvorhaben eines schon ansässigen Unternehmens stieß insbesondere bei Anrainerinnen und Anrainern auf massiven Wiederstand. Der Betrieb sollte um eine Deponie erweitert werden. Nachdem das Vorhaben publik wurde und erste Beschwerden der Anrainerinnen und Anrainer an das Unternehmen und die Gemeinde ergingen, wurde Florian Leitl als vermittelnder Berater zum Projekt hinzugezogen.

Als erste Maßnahme wurde eine Informationsveranstaltung vor Ort abgehalten. Die Teilnahme stand allen offen, das Unternehmen bestand nicht auf den rechtlichen Anrainerstatus . Ziel der Veranstaltung war es, Transparenz und Austausch herzustellen. „Beide Seiten können durch aktives Zuhören Vertrauen aufbauen. Auf dieser Basis kann weiterführend ein Austausch entstehen und man gelangt von den offen dargelegten Positionen zu den meist versteckten, dahinterliegenden Interessen, welche die Entscheidungen beider Seiten maßgeblich beeinflussen", betont Leitl. Durch den Austausch zeigte sich, dass die Betroffenen und Beteiligten hauptsächlich eine massive Zunahme des Schwerverkehrs und dessen negative Folgen fürchteten. Das Unternehmen hatte für das Interesse der Betroffenen und Beteiligten durchaus Verständnis.

Die Zufahrtssituation, historisch gewachsen, konnte nicht grundlegend geändert werden. Im Sinne einer konsensualen Lösungsfindung kam man nach intensivem Austausch und Prüfung weiterer Möglichkeiten überein, einen Zeitplan für die An- und Abfahrten der Lkw zu entwickeln, der sowohl den wirtschaftlichen Interessen des Unternehmens als auch den Bedürfnissen der Betroffenen und Beteiligten bestmöglich gerecht wird.

3.3 Standortentwicklung – Nemak Linz GmbH -Interview mit GF DI Andre Gröschel

Der Standort der Nemak Linz GmbH liegt im Stadtteil Kleinmünchen im Süden der Landeshauptstadt Linz. Im direkten Umfeld des Betriebsgeländes befinden sich hauptsächlich Wohnanlagen, wenige Kleinunternehmen diverser Branchen sowie eine Bildungseinrichtung. An diesem seit 1946 historisch gewachsenen Industriestandort in Stadtlage werden zu Höchstzeiten von rund 550 Mitarbeiterinnen und Mitarbeitern mehr als eine Million Aluminium-Zylinderköpfe mittels patentiertem Verfahren hergestellt. Neben der Produktion dient der Standort auch als konzernweit führendes F&E-Zentrum.

Im Jahr 2006 trat eine Anrainerplattform mit einer Vielzahl an Beschwerden an die Behörden und das Unternehmen heran. Vertreterinnen und Vertreter der Medien griffen die Thematik auf. Die Inhalte der Beschwerden waren vielfältig und reichten bis zu Vorwürfen der schweren Gesundheitsschädigung durch Emissionen giftiger Luftschadstoffe. Zu diesem Zeitpunkt arbeitete Nemak jedoch mit einem Produktionsverfahren, das alle Mindestanforderungen an Umweltstandards weit übertraf. Das Unternehmen entschied sich dafür, die Mitglieder der Anrainerplattform, sonstige vermeintlich Betroffene bzw. Beteiligte unabhängig einer etwaigen gesetzlichen Parteistellung und die Behörden umgehend zu einer Informationsveranstaltung vor Ort einzuladen. Die Veranstaltung sollte ein erstes Zeichen dafür sein, dass man den Menschen auf Augenhöhe begegnet, ihre Beschwerden ernst nimmt und als Unternehmen offen für Dialog ist. Bei dieser ersten Veranstaltung wurde den Teilnehmerinnen und Teilnehmern der Betrieb gezeigt und das Unternehmen präsentierte Hintergründe zum Produkt, Prozess und zum Unternehmen selbst. „Lediglich ein verschwindend geringer Prozentsatz der Menschen ist mit dem Vorgang des Aluminiumgießens vertraut. Man muss die Menschen abholen, mit ihnen Fachwissen teilen, um es ihnen zu ermöglichen, auch plausibel erscheinende Statements als fachlich falsch zu verifizieren", sagt Geschäftsführer Andre Gröschel. Im Rahmen der Veranstaltung wurden alle Themen gesammelt und schriftlich festgehalten, ein kontinuierlicher quartalsweiser Austausch vereinbart und als Sofortmaßnahme die Einrichtung einer 24-Stunden-Hotline beschlossen.

Die Themen wurden umgehend vom Unternehmen selbst evaluiert und Lösungsvorschläge erarbeitet, zur Analyse komplexerer Themen wurden externe Spezialistinnen und Spezialisten beigezogen.

Die Betroffenen und Beteiligten störten sich unter anderem an der Nutzung des öffentlichen Parkraums in der direkten Umgebung durch die Unternehmensmitarbeiterinnen und Unternehmensmitarbeiter. Trotz Ermangelung rechtlicher Ansprüche entschied sich das Unternehmen, auf eigene Kosten eine Parkanlage für Mitarbeiterinnen und Mitarbeiter zu schaffen, um die Konsensorientierung zu signalisieren. Die verbesserte Parksituation stellte gleichzeitig auch einen Benefit für die eigenen Mitarbeiterinnen und Mitarbeiter dar.

In den folgenden quartalsweisen Veranstaltungen wurden die Ergebnisse der Analysen sowie der Bearbeitungsstand bzw. Lösungsansätze der eingebrachten Themen vorgestellt und besprochen. Die Analysen der externen Spezialistinnen und Spezialisten zeigten eindeutig, dass keine gesundheitsschädlichen Stoffe vom Unternehmen emittiert oder Grenzwerte überschritten werden, auch wenn eine geruchsneutrale Produktion nicht erfolgt und möglich ist: „Es ist wichtig, den Menschen aufzuzeigen, dass man bemüht ist, die Situation zu verbessern, jedoch man eindeutig im gültigen rechtlichen Rahmen agiert und gewisse Forderungen nicht umgesetzt werden. Es muss Verständnis von beiden Seiten für beide Seiten geben. Mit klarer, ehrlicher und kontinuierlicher Kommunikation haben wir das erreicht“, sagt Gröschel.

Im weiteren Verlauf konnte ein bis heute anhaltendes gutes Verhältnis zwischen dem Unternehmen und Betroffenen sowie Beteiligten geschaffen werden: Die Bürgerinnen- und Bürgerplattform hat sich aufgelöst, die Hotline ist weiterhin 24 Stunden besetzt, die Informationsveranstaltungen sind fester Bestandteil des Anrainermanagements. Sie dienen auch der proaktiven Kommunikation von Informationen, die für das Umfeld von Interesse sind. Das Anrainermanagement ist in die Abteilung HSE (Health Safety Environment) eingegliedert, deren Leitung diesbezüglich in steter und direkter Abstimmung mit der Geschäftsführung steht. Die diesbezügliche Unternehmenskultur bringt Gröschel wie folgt auf den Punkt: „Anrainermanagement hat bei uns oberste Priorität. ‚Denkt dran, wir haben Nachbarn!‘ ist ein gelebter Leitsatz unter unseren Mitarbeiterinnen und Mitarbeitern.“

4 FAZIT

Eine Standortentwicklung bedeutet Veränderung und somit kann man behaupten, dass sich das Unternehmen in einem Change-Prozess befindet. Aktuell werden bei diesem Prozess nicht alle Betroffenen und Beteiligten standardisiert einbezogen. Anrainermanagement findet also als Teilaspekt der modernen Unternehmensführung in Oberösterreich noch wenig Beachtung. Insbesondere wird es nur selten proaktiv betrieben. Vielmehr bedarf es aktuell zumeist überhaupt erst eines drohenden Konflikts, damit das Unternehmen Methoden aus dem Change Management (i.e. Change Communication) anwendet und somit Betroffene und Beteiligte in den Prozess miteinbezieht. Anrainermanagement, das sich lediglich auf Anrainerinnen und Anrainer im rechtlichen Sinne bezieht, greift zu kurz. Vielmehr sollten all jene Beteiligte miteinbezogen werden, die potenziell eine Änderung ihrer Lebensbedingungen im weitesten Sinne befürchten könnten.

Um den künftigen Herausforderungen, die sich aus der immer knapper werdenden Ressource Boden ergeben, bestmöglich gewachsen zu sein, sollte Anrainermanagement eine kontinuierliche Aufgabe der obersten Unternehmensebenen darstellen. Gleichzeitig sollte dieses in der Unternehmenskultur verankert werden.

Die gewonnenen Erkenntnisse aus den geführten Interviews spiegeln die theoretischen Ansätze wider. Richtige Kommunikation macht einen erfolgreichen Anrainermanagementprozess aus. Sie zielt immer auf konsensuale Lösungen ab. Konsens setzt klare, offene und kontinuierliche Information voraus.

Wichtige Aufgabe der Information durch das Unternehmen ist die transparente Vermittlung der Ziele und des Sinns des Vorhabens. In manchen Fällen bedarf es auch der Beiziehung eines neutralen Dritten, der den Prozess begleitet. Nach dem das Unternehmen die Informationen auf den Tisch gelegt hat, werden die Themen der Beteiligten und Betroffenen gesammeln. Diese Themen sind ernst zu nehmen. Es gilt, den Betroffenen und Beteiligten Raum zu geben, die hinter ihren offengelegten Positionen liegenden Interessen zu erkennen und zu benennen. Dies setzt Vertrauen voraus, welches nur auf Basis wertschätzender Kommunikation entstehen kann. Wesentliche Bestandteile derselben sind beidseitiges aktives Zuhören und Empathie. Dadurch soll das wechselseitige Verständnis erwachsen, auf dessen Fundament Lösungsmöglichkeiten gemeinsam entwickelt werden.

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CITYFOOD - Upscaled Urban Aquaponics and the Food-Water-Energy Nexus

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1 ABSTRACT

To address the most pressing global problems of sustainable development, the UN formulated 17 goals in 2015 (UN, 2015). The current review shows that while progress has been made, efforts need to be significantly increased to achieve the sustainable development goals (SDGs) (UN, 2020) and therefore a "Decade of Action" was proclaimed to fulfil the 2030 Agenda (UN, 2021). This call by the United Nations was taken up by the German Federal Government through the revision of its sustainability strategy, which now contains six transformation areas, including the circular economy as well as sustainable agricultural and food systems (BReg, 2021).

One food production technology that belongs to these two transformation areas is aquaponics, the coupled production of fish and plants (Naegel, 1977; Baganz et al., 2021a). Given the rising importance of urban agriculture (Lohrberg et al., 2015), the project CITYFOOD posed the question of whether and to what extent it makes sense to bring aquaponics into cities (Baganz et al., 2020; Proksch & Baganz, 2020) The urban Food-Water-Energy (FWE) Nexus describes the interlinkages and interdependencies between food, water and energy in coupled systems in an urban context, whereas all three sectors have also strong impacts on climate, environment and land use (Lehmann, 2018). Within the FWE-Nexus concept, we applied a food-centric approach to reduce the complexity of the connections between these three resource sectors, taking Berlin as a case study.

Food. The starting point is Berlin's demand: with a population of about 3.75 million in 2020, approximately 21 kilotonnes (kt) of freshwater fish and fish products, 108 kt of fresh tomatoes and tomato products, and 27 kt of lettuce are needed per year to cover the demand, including the non-marketable portion, e.g. waste from fish processing. To estimate the environmental footprint, we used the results of a work conducted as part of the CITYFOOD project, which modelled aquaponic facilities with a greenhouse size of 5000 m² and year-round vegetable production for a life cycle assessment (LCA) (Körner et al., 2021). The gross area for the entire facility of about 6000 m² results from increasing the sum of the aquaculture and greenhouse net areas by 10%.

Different combinations of fish (tilapia, catfish) and plants (tomato, lettuce) were studied, resulting in four variants of aquaponic facilities that differ considerably in production parameters, e.g. fish stocking density. To enforce the aquaponic principle for the total demand of the city and balance the fish production with the vegetable production so that there is no excess production or unnecessary effluent on either side, the following proportion of preselected aquaponic combinations have been calculated: Catfish/Tomato 56%, Catfish/Lettuce 13%, Tilapia/Tomato 31%, and Tilapia/Lettuce 0%. This makes it possible to achieve the required annual yield with 370 facilities on a total area of 224 hectares (Baganz et al., 2021b).

Water. A key feature of aquaponics is the dual use of water, which is used first to raise the fish and then to irrigate and – at least in part – for plant nutrition (Kloas et al., 2015). Compared to the water footprint of the German market mix for fresh tomatoes and lettuce (LCA impact category water consumption), aquaponic production of both vegetables for Berlin would save about 2.0 billion cubic metres of water. In terms of the LCA impact category of water scarcity, about 1.4 billion cubic metres of water would be saved, especially as

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a significant proportion of the tomatoes consumed in Berlin are produced in the Spanish region of Almeria, where the rapid development of greenhouse agriculture has affected the availability of groundwater resources (Castro et al., 2019).

Energy. The LCA has shown that the energetic disadvantages of greenhouse production in Berlin, especially in winter, compared to southern European cultivation areas can be compensated by e.g. thermal coupling of rooftop aquaponics with the waste heat of a supermarket's cooling system. But even then, the energy savings from upscaled urban aquaponics are not particularly high.

Conclusion. It could be shown that aquaponics can make a relevant contribution to sustainability in Berlin. An essential prerequisite for this year-round scenario is building integration for thermal coupling needed in the cool season and the heating demand can be significantly reduced by the application of low-energy greenhouses. We identified significant aquaponic variables which influence the three sectors of the FWE nexus directly or via causal chains and which thus are useful for a designer or operator of an AP to control its environmental impacts. We further discussed the impacts of production-location, dietary shifts, and trade-offs on the FWE nexus.

Keywords: Urban Aquaponics, Food-Water-Energy Nexus, CITYFOOD, Sustainability, Berlin

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Competences of Smart City Planners: the Alpha and Omega

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1 ABSTRACT

Revisiting previous research in the course of the DevOps project 'DevOps Competences for Smart Cities' (Kaufmann et al., 2020), this paper aims to zoom in the interrelationship between Smart City domain priorities, collaboration and competences regarded to be a paramount fundament for urban management. After a discussion of literature on this triptych, a conceptual framework is synthesized. The hypothesized conditional importance of competences is analyzedand confirmed by additional descriptive and explanatory quantitative research on the DevOps data on smart city planners having applied partial least square analysis.

Keywords: Collaboration, Planning, Competences, Smart City, DevOps

2 INTRODUCTION

Smart cities (SC) can be considered as the holy grail of modern urban management. The body of knowledge on smart cities in relation to the domain of urban management is growing from different perspectives. Currently, planning, organization and administration of transformational value increasing processes of cities and towns led to the development of innovative paradigms entailing, for example, participatory, collaborative and decentralized decision making and activating the city stakeholders, specifically its citizens (Malek, Lim and Yigitcanlar, 2021; Gafoor and Al-Wehab, 2020) facilitated by modern digital data and ICT technologies(Semyachkov and Popov, 2020).Anexus for urban management unfolds embracing three factors regarded paramount for urban management: newly required smart city competencies, planning priorities (domains) and collaboration (e.g. Allam, 2019; Appio et al., 2019; Lytras and Serban, 2020; Raspotnik et.al. 2020; Kaufmann et al., 2020).

However, recent studies have pointed to still existing gaps for this triptych to unfold smoothly. Lytras and Serban (2020), for example, recently pointed to existing shortcomings on competences and capacities of public administration personnel to promote new e-governance services and systems in smart cities. Related to priorities, Agbali et al. (2017) and Charalabidis et al. (2020) recommend future research to improve on their proposed frameworks.With regard to competences, a comprehensive typology of competences has been created, piloted and trained in MOOCs courses by the DevOps project comprising transversal competences, general IT competences, IT specific competences and idiosyncratic Smart city related competences (Kaufmann et al., 2020). The paper proposes a synthesized conceptualization on the essential triptych of competencies, collaboration and domain priorities and hypothesizes that closing the competence gap should be prioritized in comparison to 'collaboration and priorities' and should be regarded conditional for urban management.

Specific Objectives of the study:

Reviewing the literature on the interrelationship betweenSC competencies, priorities and collaboration.

To derive at explanations of the nature of the relationship between the three factors by expanding on previous findings of the DevOps project (Kaufmann et al., 2020) by additional descriptive and explanatory analysis.

To develop ahypothesized framework on the triptych to suggest avenues for future research.

3 LITERATURE REVIEW

This section is going to discussa selection offrameworks on SC and urban managementregarded as relevant in the context of this study.

3.1 The meaning of "smart"

In the urban planning context, smartness is treated as a normative claim and an ideological dimension, and being smart entails strategic directions. Governments and public agencies are embracing the notion of smartness to distinguish their strategic policies for targeting sustainable development, sound economic growth, and better quality of life for their citizens (Center on Governance, 2003). The label 'smart city', however, is a fuzzy concept and is used in ways that are not alwaysconsistent. There is neither a single template of framing a smart city nor a one-size-fits-alldefinition of a smart city (Albino et.al. 2015).

Pointing to higher levels of authenticity between claims and reality, Hollands (2008) recognized a smart city as an "urban labelling" phenomenon, and calls a smart city to back upits emphasis on the many aspects which are hiddenbehind self-declaratory attributions to this label.

Nam and Pardo (2012) review the meaning of the term 'smart' in the smart city

context. In marketing terminology, smartness is regarded to be centered on a user perspective due to the need for appeal to a broader base of community members.The association with the term 'Smart'with being user-friendlyseems to be more appropriate than the term 'intelligent' Albino et al., 2015) which is connoted with having aquick mind and being responsive to feedback. This interpretation implies that 'smartness' is realized only when the system adapts itselfto the user and citizen needs.

3.2 Smart City Models and Frameworks on priorities, collaboration and competences

Many models on smart cities' development have not revolved aroundthe nexus between thethreeissues of priorities, collaboration and competences regarded central by the authors of this paper. Their relevance has already been established in numerous studies albeit not in an integrated manner. Cukusic et al. (2019) discussed the challengesand priorities for developing smart city initiatives. This study implies a focus on collaboration (engagement and community)as well as on priorities on specific smart city domains such as economy, housing, energy, waste, water, mobility, security and health care. The main contribution of the paper is to expose the most challenging strategic factors (priorities) in the national context of a country i.e. Croatia.

Charalabidis et al. (2020) contributed to fill the knowledge gap on the level of the convergence and divergence between municipalities and citizens on smart city action priorities.Furthermore, the authors developed a novel methodology where a detailed taxonomy of possible smart cities actions (priorities) has been developed based on previous literature.

In the same vein, Agbali etal.(2017) proposed a framework consisting of domain priority issues for the smart and healthy city development which includes smart infrastructure (measured by the availability of smart grid/robust energy, secured and innovative transport system, availability of sustainable health care facilities), smart institutions (measured by an innovative and proactive security system, tourist potential, entrepreneurship), orsmart people (measured by social awareness, quality education, increased productivity). However, whilst this comprehensive study focused on priority issues it did notaddress competencies and collaboration issues in more depth.

In addition, Allam (2019), via focus group discussions, explored some priority issues for smart urban regeneration. Interestingly,comparing smart cities with an organism and its life generating reactions, the author's smart city metabolism includes social infrastructure cluster (namely sustainability and livability), business support (including public and government funds where most of its funds are spent for administrative resources to generate revenues for the retention of the business), collaboration (between public and private sector namely for encouraging business; better managing public assets and disaster management), smart infrastructure (including parking, IT connectivity and big data or any other data management system for urban planning), culture (including the need to encourage artists to perform in the public places, cultural landmarks, culture as a branding tool and the potential of cultural digital goods), governance (highlighting health care, law enforcement, targeting inclusive policies and security). In this study collaboration has been mentioned as an integral factorwithout expandingon the nexus between more detailed priorities, collaboration and competences required.The study also mentioned the need of a more comprehensive and detailed model.

Interrelating domain priorities, smart government, and characteristics of e-government with innovative factors such as market flexibility, government efficiency, and the legal system as well as institutional and structural factorsto achieve improved economic performance, a comprehensive model is provided by Lytras and Serban (2020). According to the authors of the study, "the main contribution of this study is two-fold: From one side it provides an integrated study with emphasis on the impact on social science and economics research to future smart cities research and on the other side it brings forward several soft factors for the adoption of smart city services in the context of government transformation and provision of ubiquitous e-services to citizens" (p.65313). Whilst market flexibility, government efficiency, the legal system and the characteristics of e-government imply certain competences, detailed instrumental competences are suggested to be added. Economic convergence implies collaboration without explicitly mentioning the term.

Focusing their study on one particular competence, Garg, Mittal and Sharma (2017) extensively discussed e-training and depicted a framework by means of differentantecedents like knowledge, skills, development, learning, workshop, coaching, and teaching. The authors aimed to reveal the influence of e-training on building smart citizens(by means of educating them though training), and eventually smart governance and smart business enterprise. According to the authors, "this research brief mainly concentrate of administration, people and knowledge creation for developing organization's e-training platform helping in building smart cities with digital enterprise (smart business), administration (governance) and people or smart citizens. The paper tries to put forward the concept and designing of e-learning platform to provide instant training and education for shaping the new generation citizen" (p. 24).Thus, it can be noted that this paper has tried to 'marry'smart city competences and specificsmart city priorities albeit limited to e-training.

Raspotnik, Gronning and Herrmann (2020) measured the effectiveness of three different arctic cities in three countries (United States, Norway and Finland) in terms of smart city priorities which are smart people, smart energy, smart environment, smart mobility, and smart governance. The main contribution of the paper is to develop a metrics for smart city development. To do this the authors have first surveyed smart city literature and develop smartness metrics based on smart city priorities which the authors named "smart framework". Thus, the paper has also only focused on a single dimension of the suggested nexus in terms of smart city priorities.

Umar (2018) proposed an extensive research framework on smart collaboration.According to the authors, "the paper contributes in presenting an alternative perspective that is based on smart collaborating hubs and a smart global village to serve smaller communities. As can be observed these hubs provide inexpensive and highly specialized services in health, education, public safety, public welfare, and other vital sectors for the underserved populations across the globe" (p.1) .This paper is a bright example of an extensive model of smart city collaboration between entities utilizing smart competencies. The paper is suggested to expand in more detail on the constructs of other more detailed and comprehensive smart city priorities and on transferring required competences.

Concentrating on a specific type of collaboration, Canels etal. (2017) call for public-private collaborations for transforming urban mobility. In their study they suggest this collaboration for new mobility services based on four categories: shared mobility, product innovation, consumer experience and data driven decision making. Further priorities and requested competencies are suggested to be researched in future as well.

Ojasalo and Kauppinen (2016) conducted a significant study on collaborationin terms of open innovation platforms for smart cities. The study focused on collaborative innovation highlighting unforeseeable innovation potential, open data innovations, and sustainable solutions through long-term innovative partnerships.In the following, the authors, summarize the main contribution of the paper: "despite the rapid increase of public–private–people partnership (PPPP) programs at the global scale, the scientific knowledge of collaborative innovation in cities is scarce. All smart city initiatives emphasize collaborative innovation for better services and products to address the needs and problems of modern cities. Indeed, there is an evident need for both scientific and practical knowledge in this area. Based on an extensive empirical study of open innovation platforms in smart cities, this article seeks to address this knowledge gap by increasing the knowledge of opportunities and challenges of collaborative innovation between a city and external actors, including companies, third sector organizations, research institutions, and citizens" (p.49). The paper confirms the collaboration gap and focuses on competences in terms of innovation.

In general terms, Appio et al. (2019) developed a framework coming closest to the main theme and call of this paper in terms of integrating priorities, collaboration and competences. The driving factor is the envisioned increase of the citizens quality of life (dividing social life in live/play and learn/work) achieved by a fundamental physical infrastructure and by collaborative and innovative SC ecosystems addressing Griffinger's (in Appio et al., 2019) six SC domain priorities. Competences are generally referred to within the domain of Smart people and its sub-component of human capital comprising skills and competences. The framework entails factors in line with Allam's (2019) SC priorities metabolism and is suggested to be used as a 'guiding model' for future qualitative or quantitative research.

Summarizing, from the prior recent literature, it is concluded that there is almost no study that has developed a detailed model to establish the nexus between the three integral smart city elements serving as a basis to train SC administrators and related stakeholders. Revisiting our previous paper (Kaufmann et al., 2020), this study is attempting to fill this gap in the literature by proposing a synthesized integrated framework (figure 1) suggested to be the quintessential triptych of urban management, also aiming to inspire further conceptual developments.

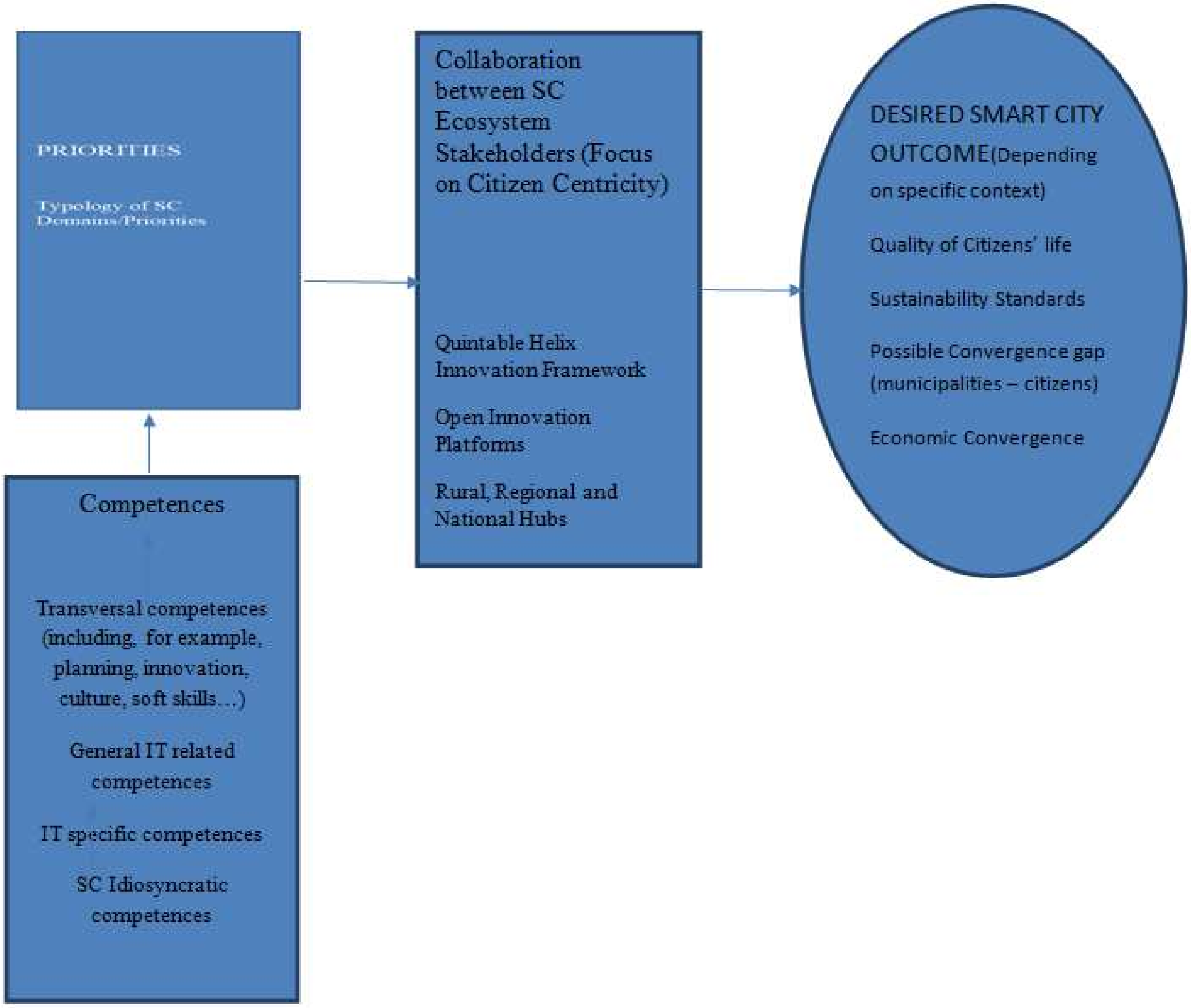

Figure 1: Proposed Integrated Framework. Source: developed from the authors based on Agbali et al. (2017) Allam (2019), Appio et al. (2019), Charalabidis et al. (2020),Cukusic et al. (2019),Garg, Mittal and Sharma (2017), Kaufmann et al. (2020), Lytras and Serban (2020), Ojasalo and Kauppinen (2016), Umar (2018)

4 METHODOLOGY

With regard to priorities, collaboration and competences, the DevOps project – based on an extensive secondary research, initial descriptive quantitative research and a consecutive validating qualitative empirical phase (Kaufmann et al., 2020) revealed a comprehensive typology of competences differentiated for three different levels of smart city administrators: Smart City Planners, IT Managers/CDOs and IT Officers. This study additionally pointed to interrelationships with the other elements of the suggested nexus: priorities and collaboration. In the progress of the DevOps project, the competence typology served as a basis for the design of innovative MOOCS courses on DevOps competences for Smart City administrators and other SC ecosystem stakeholders. The MOOCs courses were piloted and implemented in the partner countries of the project members. For more information on the MOOCs courses, please, go to the following website: https://all-digital.org/smart-devops-specialisation-courses-under-way/

This paper adds additional explanatory findings – based on the previous study- having applied partial least square analysis to investigate the nature of the relationships on the tripartite.

4.1 Data generation & sampling

From received 63 questionnaires of smart city planners across the DevOps partner countries (Kaufmann et al., 2020), the non-probability sample needed to be reduced to 60 due to three questionnaires not being usable because of missing data. Notwithstanding considerable efforts undertaken by the researchers, the sample size could not be increased for several reasons. Therefore, later stages of the project shifted the emphasis on validating the quantitative research by qualitative research.

4.2 Descriptive statistics

Focusing first on IT/IoT competences, the analysis uncovered the top three ones which are needed from the perspective of smart city planners: Teamwork (36 participants mentioned this aspect), urban innovation (32) and user experience (28), while the top three for chief digital officers/internal IT officers – perceived from SC planners- are big data management (36), system operation skills such as database and network administration, coding as well as software architecture (32).

However, the highest perceived training demands are expected to be in IoT specific knowledge (31), DevOps (integrating software development and operations, 28) and machine learning as well as deep learning (27). Moreover, there is a will to co-operate with external partners for the acquisition of the following top three competences: mobile development (35), IT/cyber security as well as artificial intelligence (32 for both competences). The average of 20.4 participants perceive a training demand (M = 21.0, SD = 5.0) for a specific competence while co-operation with external partners is preferred from 25.8 participants on average (M = 25.0, SD = 4.2). Interestingly, the competences in which training is mostly needed do not overlap with those competences which are chosen for co-operation. Therefore, we conclude that these competences are rated as very important, so that these should be trained and be existentin-house instead of relying on external competences.Appendix 1 provides an overview of all results.

The participants were also asked to rate in which transversal/generic competences they perceive a need for training or co-operation. Appendix 2 summarizes these results. The overall conclusion is that in all dimensions the competences with the highest needs for training among smart city planners differ from those where external experience (e.g. consultants, IT experts) is often mentioned to be required. So, if there is a high need in training, smart city planners with regard to a certain competence (e.g. technical skills to switch from operational to strategic tasks, 34), then external co-operation is selected less frequently (here: 22). In this regard, we again conclude that smart city planners do need trainings in certain competences in order to generate own additional human capital.

However, external knowledge is also required, especially in those competences in which fewer demands for training have been identified. On average 24.2 participants (M = 25.0, SD = 4.2) perceive a need for training for smart city planners, and on average 21.9 participants (M = 22.0, SD = 4.1) perceive a need for training for chief digital officers/IT officers, while on average 17.4 participants (M = 17.0, SD = 4.0) perceive a need for external knowledge.

Beyond our analysis on highlighting the importance of trainings, we also provide insights on the preferences of the sample on how employees should be trained. As to the preferred option of knowledge transfer, 28 respondents intend to train employees via consultants and 27 via online and distance learning (i.e. massive open online courses (MOOCs)). Moreover, under- and/or postgraduate courses as well as professional training/vocational courses at a university, courses from professional training providers or software producing companies are chosen from 11 to 16 participants, while only six participants prefer another kind of training (appendix 3).

4.3 Results of Partial Least Squares Structural Equation Modelling Analysis

PLS-SEM (partial least squares structural equation modelling) was used for analyzing the generated data, as it enables researchers to predict and to make use of small sample sizes (Hair et al., 2017a; Hair et al., 2017b).

Moreover, PLS-SEM is being used widely across business research (Sarstedt, 2019). In this research project, it was the overall aim to understand relationships, instead of achieving the best fit between data and a model, as it would be in covariance-based Structured Equation Modelling (CB-SEM) (Hair et al., 2017a). The SmartPLS version 3.2.8 was applied in this data analysis (Ringle et al., 2015) which is the most extensive software (Henseler, 2017).

Regarding the sample size, we followed the rule of ten, so that a minimum sample size for this analysis of 60 questionnaires (normally distributed data is not required when applying PLS-SEM) was necessary(Hair et al., 2017a).

Since all the constructs are formative measures, we tested the collinearity issues using the variance inflation factor (VIF), which should be below 5 (Hair et al., 2017a).

In order to assess the structural model, goodness-of-fit indexes should not be used in PLS-SEM (Henseler and Sarstedt, 2013), but the VIF was used again (Hair et al., 2017; Sarstedt et al., 2017) and led to results between 1.000 and 1.617, so no issues of multi-collinearity have to be reported in the structural model. In addition, the R^2 values have been analyzed for the endogenous variables as they are a mean for the in-sample prediction/predictive accuracy (Sarstedt and Cheah, 2019; Hair et al., 2017a; Hair et al., 2017b). R^2 values for endogenous latent variables within the structural model are described as substantial (0.67), moderate (0.33) and weak (0.19) (Henseler et al., 2009; Chin, 1998). Moreover, we analyzed the f^2, meaning the effect size, in order to identify if an effect is meaningful (Hair et al., 2017a) by following Cohen's (1988) differentiation between small, medium or large effects (0.02, 0.15, 0.35).

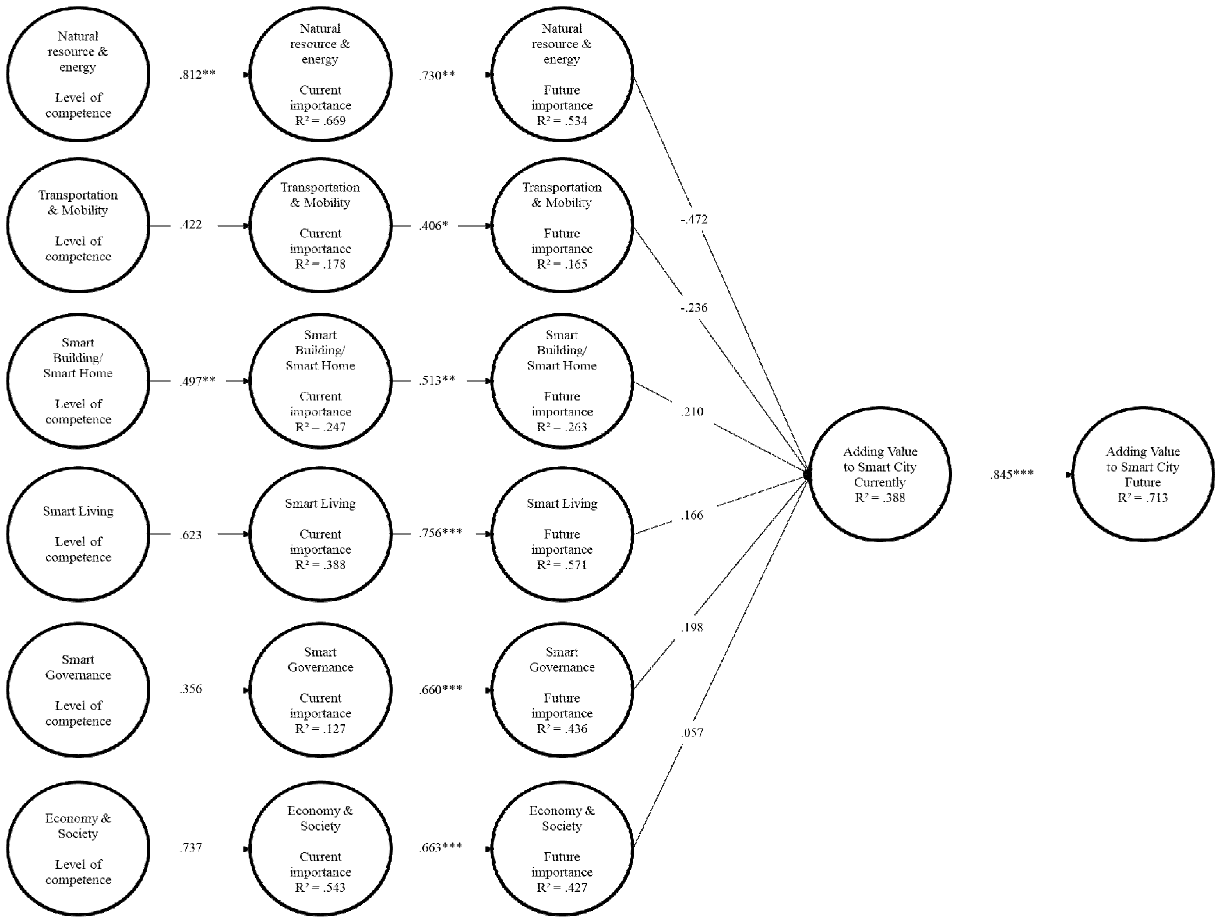

Figure 2: Relationships between level of competence and current and future importance of domain priorities. Note: * < .05, ** < .01, *** < .001

Figure 2 visualizes that one third of the relationships between level of competence and current importance are significant and positive whilst two third are not significant but also positive. This indicates that an increase of competences leads to a higher current importance of every subdomain, presumably because the participants can either assess the relevance as they are competent enough to do so, or because they consider it important as they are competent in this field.

Moreover, all relationships between current and future importance of each subdomain are significant and positive. The explained variance in the constructs applying for future importance differs from a weak $R^2 = .165$ (transportation & mobility, which also has the lowest p-value) and moderate $R^2 = .571$ (smart living). In general, as all of these relationships are significant and positive, indicating that a higher current importance of each subdomain of smart cities leads to a high importance of smart city subdomains in future. In addition, the relationship between the adding value to smart cities in current and in future is also positive and significant ($\beta = .845$, $p < .001$) and .713 of the variance is explained (substantial). The findings based on the positive and significant relationships between the subdomains current and future importance as well as the positive and significant relationship between adding value to smart cities in current and in future underlines the authors' understanding that the existence and relevance of smart cities including their subdomains is not only a short-term trend, but an important aspect for the cities' future. Therefore, the competence level of each subdomain should be as high as possible among the relevant groups of people (here: smart city planners).

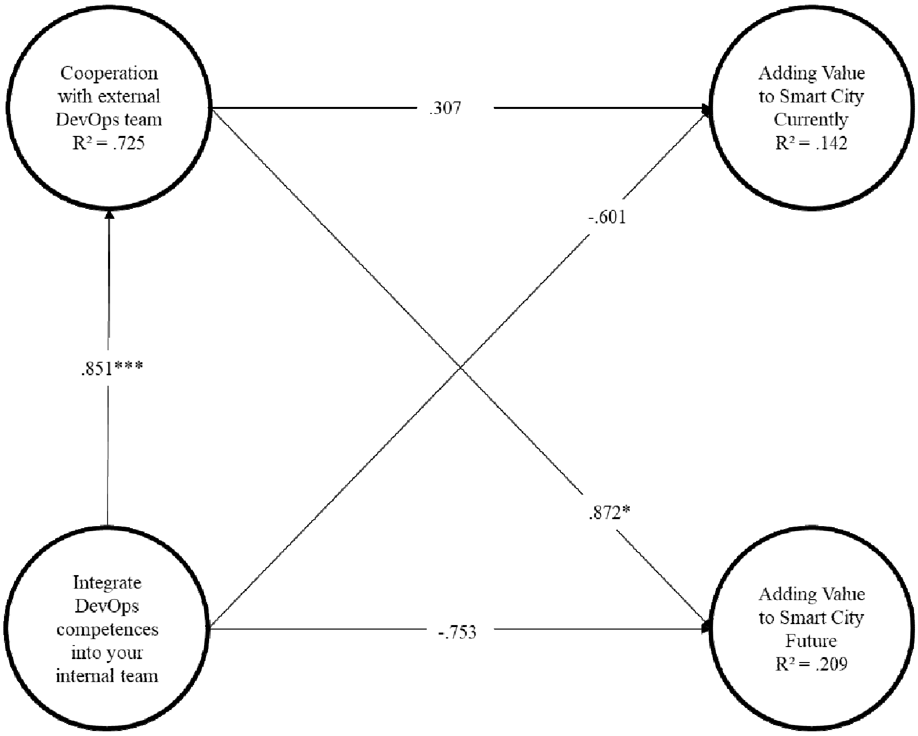

Figure 3: Results of structural equation modelling, own depiction. Note: * < .05, ** < .01, *** < .001

The results of the PLS-SEM provide two significant relationships. If companies are integrating more DevOps competences into their internal team, the cooperation with external DevOps teams is more likely ($\beta = .851$, $p < .001$). This also explains .725 of the variance of the target construct, which is classified as substantial (cf. Henseler et al., 2009; Chin, 1998). This relationship indicates that a certain degree of DevOps competences is necessary as a starting point, leading to an inclusion of external competences through co-operation.

Moreover, the relationship between cooperation with external DevOps teams and adding value to smart cities in future is also positive and significant ($\beta = .872$, $p < .1$), but explaining the variance of the endogenous construct ($R^2 = .209$) weakly. This relationship highlights, that the adding value increases, in times companies co-operate with external DevOps teams. This indicates that working together with different teams raises the adding value. The other relationships are not significant, but their path-coefficient indicate the strength and direction of each depicted relationship.

5 CONCLUSIONS

Related to the 'triptych model' (nexus between competences- priorities- collaboration), the research confirms the existence and training of competences to be conditional for priority setting and requested collaboration with external partners. Suggestions for future research refer to considerably increase the sample size and replicate the quantitative research by detailed operationalization and investigating possibly existing moderating or mediating effects of the variables in the synthesized framework (figure 1). With emphasizing competences and its relationship to priorities and collaboration, the DevOps project put a good foundation for more detailed conceptual work. The findings reflect that smart city planners perceive and do need trainings in certain competences in order to generate own additional and sustainable human capital. Competences regarded as most important should be trained and existing in-house instead of outsourcing these competences externally. An increase of competences lead to a higher current and future importance of every priority subdomain. On the other hand, if SC administrations are integrating ever more DevOps competences into their internal team, the co-operation with external DevOps teams is more likely leading to a perceived adding value increase.

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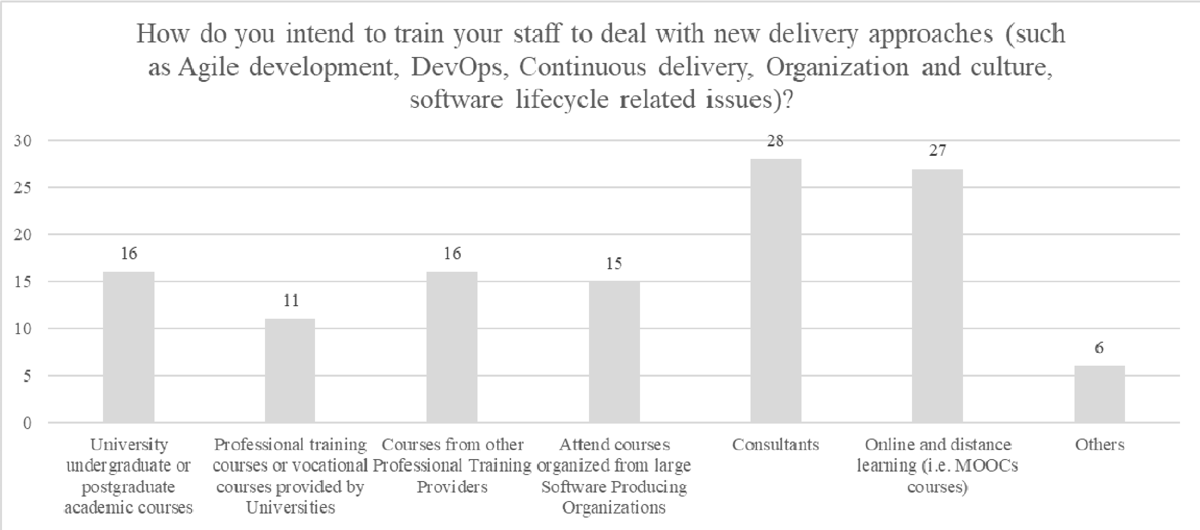
8 APPENDIX

Competence	Smart City Planner	Chief Digital Officer/Internal IT Officer	Co-operation with External IT experts, consulting service provider, Universities	Training demand
Teamwork	36	26	22	20
Urban innovation	32	21	22	26
User experience	28	20	21	20
Agility approaches	23	22	24	24
Business analysis & intelligence	23	19	22	21
Quality assurance	22	19	29	21
System operation skills such as database and network administration	20	32	24	21
Coding	20	32	20	15
IT and cyber security	19	29	32	23
Platform developer	19	20	31	17
IoT specific knowledge	19	18	29	31
Networks	19	30	28	19
IT product design, product discovery and management	19	17	26	17
Big data management	19	36	25	23
Artificial intelligence	18	12	32	23
Continuous integration	18	29	31	0
Vertical system integration	18	26	25	23
Business transformation	18	21	23	23
Simulation	18	20	18	17
Data science and advanced data analytics	17	26	22	25
Testing	17	26	19	19
Website management	16	21	29	15
Device management support	16	27	24	22
Spatial data infrastructure	15	22	27	22
Additive manufacturing and 3D print	15	14	27	21
DevOps (integrating software development and operations)	15	20	19	28
Mobile development	14	17	33	20
Software architecture	14	32	29	17
Machine learning and deep learning	14	14	26	27
Augmented reality	14	15	25	22
Cloud computing	13	26	31	21
Microservices	13	19	25	17
Continuous delivery	13	22	20	14
Hardware interfacing	12	18	29	20
Automation	12	18	27	20
Multi agent systems	9	12	30	22
Autonomous robots	9	14	25	17
Average	*17.7*	*21.9*	*25.8*	*20.4*
Mean	*18.0*	*21.0*	*25.0*	*21.0*
Standard deviation	*5.5*	*6.0*	*4.2*	*5.0*

Appendix 1: Which IT/IoT related competences do you require in your SC planning role (Smart City Planner); which competences do you see required for Chief Digital Officers and internal IT Officers, and as to which competences do you prefer to co-operate with external partners? Where do you perceive training demand?

Dimension	Competence	Smart City Planner	Chief Digital Officer/IT Officer	Required from External IT experts, Consulting service provider, University
General technical competences	Technical skills to switch from operational to strategic tasks	34	23	22
	Broad and deep process understanding due to higher process complexity	31	26	19
	Creativity	28	16	21
	Technical skills to evaluate and apply the integration between geospatial tech and traditional IC tech & engineering processes	24	34	19
	Media skills (i.e. smart media, i.e. smart glasses)	21	25	19
	Rudimentary understanding of technology (data analytics, the ability to leverage and communicate that know-how)	20	22	22
	IT, Media or IoT-specific skill	17	27	20
	Familiarity with ICT hybrid media literacy	17	22	26
	IoT architect or an IoT security specialist	17	27	24
	IoT supportive skill	15	27	26
	Understanding IT security	14	31	23
	Combination of existing skills that are augmented to some degree with IoT expertise	13	27	25
Methodological competences	Design thinking	28	20	17
	Efficiency orientation	26	26	18
	Conflict solving	25	21	19
	Research skills and continuous learning	25	20	26
	Entrepreneurial thinking (corporate entrepreneurship; social entrepreneurship)	24	19	22
	Problem solving	24	22	16
	Decision making	24	21	16
	Analytical skills	24	22	17
	To be able to co-operate in ad-hoc fashion (to take individual or socially constructed ideas into action)	22	19	19
Social competences	Create relationships	30	28	15
	Ability to merge different skills	30	22	14
	Being co-operative	29	22	14
	Resilience	29	24	19
	Ability to work in a team	28	28	17
	Social skill	28	21	12
	Intercultural skills	27	17	20
	Diversity Management	27	13	14
	Ability to transfer knowledge (explicit and tacit)	26	20	17
	Language skills	25	24	27
	Networking skills	25	28	17
	Ability to be compromising	25	22	16
	Action-related competencies	24	16	12
	Communication skills (including virtual communication skills)	24	23	16
	Past professional experiences	23	22	17
Personal competences	Sustainable mindset	30	17	18
	Strategic vision	28	21	15
	Open-mind behaviours	27	24	13
	Project and process management	27	19	12
	Compliance	26	25	16
	Leadership skills (every employee becoming a leader)	25	24	15
	Flexibility	25	25	14
	Ambiguity tolerance	25	12	16
	Spatial thinking	25	17	16
	Emotional intelligence	25	23	12
	Ability to work under pressure	24	24	15
	The ability to mediate conflicts	24	21	15
	Motivation to learn	23	24	20
	Attitudes, communication	23	21	12
	Reflective	22	18	14
	Leadership capacity	22	21	10
	Empathy	21	20	11
	Output oriented	21	18	15
	Autonomous	19	24	11
Legal compe-tences	Legal aspects of public procurement	23	20	17
	Contractual issues involved in public-private partnerships	21	18	20
	Legal notions regarding big data/open data management	20	22	15
	Data security	19	23	21
City Planning cap-abilities	Territorial planning	31	18	18
	Management of urban facilities	27	20	17
	Urban innovation	26	16	21
Civili-zational compe-tences	Engaging citizens	24	17	17
Average		*24.2*	*21.9*	*17.4*
Mean		*25.0*	*22.0*	*17.0*
Standard deviation		*4.2*	*4.1*	*4.0*

Appendix 2: In which of the following transversal/generic competences do you perceive training or co-operation needs?



Appendix 3: Intention to train staff

Facilitating Transit Oriented Development in the Purple Line Corridor: The Plans and Regulations Information Tool

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1 ABSTRACT

The Plans and Regulations Information Tool (PaRIT) is a computing interface that enables spatial queries to identify and access the many plans and regulations that apply to a given place. These plans and regulations are created by various government, intergovernmental, and non-governmental organizations and are created at different times with different functional, spatial, and temporal scopes. As argued elsewhere (Hopkins & Knaap, 2016), we should neither expect these plans to be consistent nor try to make them consistent. PaRIT accesses multiple plans and regulations to give decision-makers emergent information in support of several plan-using tasks: plan commission staff report, affordable housing location opportunities, developer location opportunities, aggregating ideas across plans for advocacy such as bikeways or affordable housing (National Center for Smart Growth, 2019), neighborhood group advocacy/opposition, looking for consistency or contradictions related to particular goals such as hazards or climate change mitigation (Berke, Malecha, Yu, Lee, & Masterson, 2019).

We demonstrate the capabilities of PaRIT in applications to the Purple Line light rail transit project in Montgomery and Prince George's Counties, Maryland, north of Washington, DC. This tool operationalizes concepts for creating Information Systems of Plans (Finn, Hopkins, & Wempe, 2007; Kaza & Hopkins, 2012), structured databases for collecting, indexing, and querying the many plans that typically apply and relating these plans to regulations. The tool relies on an extensive database of geo-spatially defined plans that express intentions or visions of important organizations in both Counties. These plans range from traditional neighborhood level land-use plans to county-wide general plans but also include educational facility master plans and bicycle and pedestrian plans. Regulations included in the tool include legally binding rights, incentives or constraints on land development in the corridor such as zoning, impact fees, and economic development incentive zones.

Funded by the Federal Transit Administration, the tool is designed to facilitate transit-oriented development across the Purple Line Corridor. Spatial queries can be defined in several ways: by street address; by drawing a point, line, or polygon; by uploading shapefiles; and a buffer can be added to any of these queries. Queries can use filters to focus on particular types of plans or regulations. Query results present important attributes of each plan or regulation that applies to that location and include links to PDFs and websites for the complete documents. A summary report can be formatted in printable format.

Keywords: plans, transit oriented development, Information system, regulations, web tool

2 THE PURPLE LINE CORRIDOR

2.1 Background

As part of a larger effort to spur equitable transit-oriented development (TOD) around Maryland's forthcoming Purple Line light rail, researchers at the University of Maryland's National Center for Smart Growth Research and Education (NCSG) have built a tool to provide access to land use planning information in the Purple Line corridor.

Upon completion, Maryland's Purple Line project will span Montgomery and Prince George's counties from New Carrollton to Bethesda and connect to the existing Metro transit system. It's a massive infrastructure investment that is already bringing further investment to the area. This economic development presents massive benefits to locals such as increasing transportation access, decreasing pollution, and creating jobs.

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The value of commercial and residential real estate in the area is increasing, as well; but it's not great for everyone. Increasing cost burdens may displace residents and businesses from the corridor, and they won't share in the project's benefits.

2.2 The community development agreement.

To combat this potential outcome, the Purple Line Corridor Coalition (PLCC) formed a community development agreement among businesses, nonprofits, government agencies, and community groups to make sure the Purple Line benefits are shared equitably among all residents and workers in the area. NCSG is the administrative home of the Purple Line Corridor Coalition. The PLCC coalesced around four major goals:

- Housing choices for all
- Support and grow local business
- Build a thriving labor market
- Support vibrant communities

2.3 The complex regulatory environment

PLCC's key strategies to fight displacement of residents include increasing the supply and diversity of housing and preserving existing affordable housing in the corridor. But there's a barrier to doing so: the complex regulatory environment that governs land use in the two counties. Overlapping, interdependent, and conflicting factors regarding land use are difficult to pull together for any given place in the corridor. For example, which areas are being considered for upzoning?

3 PLANS, USING PLANS, PLANNING SUPPORT TOOLS

Plans communicate intent, aspirations or visions, and possible actions in the face of uncertainty. Plans are thus information about the likelihood of decisions, not full commitments to action. The implications of this definition have been developed extensively, building on Friend and Jessop (1969) and Hopkins (2001). Recent elaborations emphasize the autonomous nature of organizations that plan (Hopkins & Knaap, 2016) and the likelihood that these plans will be inconsistent (Berke, Malecha, Yu, Lee, & Masterson, 2019; Yu, Brand, & Berke, 2020). There is thus an opportunity to create tools that will help planners and stakeholders work with these many plans.

Regulations define rights and incentives that are legally enforceable (Barzel, 1989; Hopkins, 2001). Regulations are thus distinguishable from plans but closely related. Plans may serve as legal backing for the enforceability of regulations, especially of zoning in the United States (Ohm, 2021). Plans with high credibility as commitments by a government agency may yield behaviors similar to responses to regulations. Regulations with low credibility of enforcement may yield behaviors similar to responses to plans (Hopkins, 1984). It makes sense, therefore, to provide access to the information in plans and to the myriad of regulations that apply to a particular place.

3.1 Plans as signals

If we are creating tools to access plans, we must ask how plans can be and are used. At one level we can ask in what ways plans can work. Hopkins (2001) identifies plans working as agendas of things to do, visions as expressions of aspirations, policies as rules of what to do in repeated situations, designs to be implemented, and strategies to act over time in the face of uncertainty. Millard-Ball (2013) emphasizes the causal pathways from plans to decisions and actions. Focusing on plans as information about intents, aspirations, and potential actions, we use the idea of plans as signals (Hopkins & Knaap, 2016) to identify use cases on which to base the capabilities of our plans and regulations information tool. Plans are interpreted as one means of communicating expectations over time in an ongoing conversation among various players in urban development (Boyer & Hopkins, 2016). Rather than viewing plans as done deals or "denials of conflict", plans as signals may be intentionally vague to account for ambiguities of authority and power (Buhler, 2021). Players may use plans to signal their intent to other potential players, to gather evidence of opportunities based on the actions of others, to support advocacy for or opposition to particular proposals, to identify inconsistencies among plans, to highlight conflicts between expressed goals and likely actions, and similar tasks. We make these use cases more concrete in describing the tool below.

3.2 Planning Support Systems

Most planning support systems, computing tools to support planning, focus on the task of making plans (Brail, 2008; Goodspeed, 2020) and thus on the tasks of modeling, forecasting, and evaluating changes in urban development patterns. Building tools to use plans requires thinking about plans as data (Hopkins, 1999; Hopkins, Kaza, & Pallathucheril, 2005; Kaza & Hopkins, 2012). An early framing of a tool to use plans was the Cincinnati, Ohio Planning Guidance System (Kleymeyer & Hartsock, 1973), though its focus was on finding and resolving contradictions among the various plans of agencies of government. Building on earlier practices of compiling a compendium of plans before launching a new planning effort, the concept of an Information System of Plans (Finn, Hopkins et al. 2007) created a simplified database of plan attributes and maps in comparable formats.

Developing computing tools is an iterative, continuous improvement process that often flips between high aspirations and creating "minimum viable products" that can be released to users in order to gain the feedback necessary to continue improving. We first considered the extreme possibility of a learning system that could "scrape" content from plans on the web and organize content in the elaborate data models of earlier work. We immediately recognized that this was beyond the target of two years to a released product for actual use by the members of the Purple Line Corridor Coalition, our primary target audience. After several months developing a purpose-built database to implement one of our data models, we confronted the infeasibility of supporting and sustaining the data encoding that would be required. We then implemented a version of the tool using ESRI's StoryMap application, which successfully demonstrated the kinds of information that could be queried and displayed. Working within StoryMap, however, severely limited the capabilities to make spatial queries: What plan or regulation applies here? Thus, the current version is built using the more customizable ESRI WebApp Builder and other database tools.

4 THE PLANS AND REGULATIONS INFORMATION TOOL

Planning and regulatory complexities take resources to navigate. That's why we created the Plans and Regulations Information Tool, which provides easy access to a curated database of plans and regulations in the corridor. Most of our data comes from outside sources like government open data portals.

The Plans and Regulations Information Tool (PaRIT) is a web-based, graphical computing interface that enables map interaction and spatial and non-spatial queries to identify and access the many plans and regulations that apply to a given place or the places to which plans and regulations apply. The interface can access either plans or regulations data, and there are two important components to each mode: the web application itself and the data accessed by the application.

For the purposes of this tool, we define "plans" and "regulations" broadly. In this case, regulations are any legally binding rights, incentives, or constraints on land development. Plans are any documents that express intentions or visions of important organizations within the corridor. This loose definition is important because the tool includes non-governmental documents that might have direct or indirect effects on the corridor, like WMATA's strategic plan or the Capital Trails Coalition's network vision.

The real power of the tool is to (very quickly) answer the general question underpinning those mentioned above: "What plans or regulations apply to this place?" And since the Purple Line corridor spans multiple jurisdictions, we bring all the data together in one place.

4.1 Web Application

We built the plans and regulations web applications using ESRI's Web AppBuilder (WAB), a no-code platform for designing and implementing custom web-mapping applications. The application consists of a web map with geographic data (described in the next section) and several "widgets", or interactive functionalities, available to users within the application. The widgets include contextual information and basic map interaction functions. The map interaction functions include a toggle list of geographic plan and regulation data contained in the application (the "Layer List" widget), which allows a user to visualize only the layers of interest, and a data table (the "Attribute Table" widget), which allows a user to view and select individual features within a data layer, and their important attributes, including links to PDFs and websites to access the complete documents. Using these functions to interactively visualize plan and regulation data layers and the geographic extents of individual plans and regulations answers the question “To what places do these plans and regulations apply?”.

In addition to these basic map interaction functions, the application includes two customizable query functions. Using the first query function (the “Group Filter” widget) a user can define an SQL query on a limited number of data attributes using a dynamic interface. The plan or regulation data matching the query conditions displays on the map. Using the second query function (the “Screening” widget) a user can define a spatial query on a custom area (or areas) of interest. The user can define an area of interest for the spatial query in several ways: by street address; by property parcel tax ID; by drawing a point, line, or polygon on the map; by uploading geographic data (such as a shapefile); by allowing location access; or, by choosing a feature already visualized on the map. For any of these methods, users can add a custom diameter buffer to the area of interest. A spatial query on the area of interest results in a report of all the plans or regulations that spatially intersect the area of interest, answering the question “What plans and regulations apply to this place?”. The report generated by the spatial query displays important attributes of each plan or regulation, including links to PDFs and websites to access the complete documents, and a summary report of the results can be exported in printable format (PDF) or as spreadsheets or geographic data (shapefile or geodatabase).

The various widgets can be used in tandem, for instance, by first defining a query on data attributes, then defining a spatial query on the first query’s results.

4.2 Data

Two separate geodatabases underlie PaRIT: plans and regulations. Each geodatabase is structured as a set of geographic data layers. A single regulation data layer contains the geographic extent of a single regulation (such as “Tax Increment Financing Districts”) over the study area, which may be a single polygon feature, multiple polygon features, or a single multipolygon feature. A single plans data layer contains the geographic extents of multiple plans of the same type (such as “Sector Plans”), and is made up of multiple polygon features. In addition to the geographic data, non-geographic data attributes are associated with the feature(s) in both databases, including contextual information – like the year a plan was published or a regulation was passed – and links to external sources – such as a plan document or an information page about a regulation. In some cases, data attributes will point to other information systems. In addition to plans and regulations, each database also contains some contextual data layers, such as the extent of the study area (the Purple Line Corridor), the right of way and station locations of the Purple Line, and the property parcels within the study area.

The plans and regulations geodatabases are constructed with data from multiple sources. We accessed a majority of the plans and regulations data through public data portals hosted by federal, state, and local governments. We gathered the remainder of the data through formal data requests, personal communication with staff of agencies and non-governmental organizations whose plans we were seeking, and doing our own data creation by exploring public documents and georeferencing and tracing images of the boundaries of plans or regulations. After data collection, we processed the geographic data to conform to the study area boundary and the non-geographic data attributes to be human-readable.

4.3 User options

Users have many options to define an area of interest in the tool such as inputting an address or property parcel ID; drawing a point, line, or shape on the map; and uploading their own geographic data. From there, users can query which plans or regulations apply in the designated area and export a sharable report of the results.

These capacities allow housing developers to cut through regulatory complexity, thus removing barriers to investment in the Purple Line corridor and reducing the resources required to do so. Instead of spending time and resources repeatedly compiling plans and regulations for a prospective site, they can quickly pull the full list.

Though real estate development in the Purple Line corridor is an obvious use case, we built the tool to equip any stakeholders within the corridor that need to identify the stack of land use plans and regulations in a given area. A number of other use cases already exist (and we envision many more):

- A housing advocacy group working across the corridor uses the tool to identify alignments, gaps, or mismatches in housing plans and policy to help them advocate against displacement.
- A nonprofit developer uses the tool in tandem with their own data to identify and pursue deeply affordable housing opportunities.
- A small business development group uses the tool to identify ongoing plans for wayfinding and signage in certain areas of interest to engage with the planning processes.

The plans and regulations accessed by the tool are intentionally not comprehensive; they are curated by staff at NCSG with input from PLCC members and other stakeholders to reflect information relevant to development in the corridor. (If you think something should be included that is missing, let us know!)

Of course, this tool is not going to single-handedly prevent all negative effects of the Purple Line. However, it can be a piece of the larger effort to make sure the benefits of the Purple Line investment accrue equitably.

5 CONCLUDING COMMENTS

The Purple Line Corridor Coalition is an unusual informal planning and advocacy organization that can only "implement" plans by coercing, conjoling, and coordinating the actions of others. It has no regulatory or planning authority and even less budget. For this reason the Plan and Regulatory Information Tool is one important means for promoting its agenda. How successful it is in that regard, and the extent to which the PaRIT furthers that success remains to be seen. We believe the tool itself, however, represents an important enhancement in conceptualizing, and operationalize a system of plans approach to urban development.

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7 APPENDICES

User Documentation: https://docs.google.com/document/d/1tCeGaPnYsRJ4en4EA_0clnFU_4t6WzBsr6doxBvn1mA/edit#heading=h.es0774b5se9y

Technical Documentation: https://docs.google.com/document/d/1cexRA51Uz-GiEvFhvATmtsEo4Us5eVh9XDaylhsugDo/edit

Flexible Bike Parking: New Ways of Thinking Bicycle Racks

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1 ABSTRACT

With the steadily increasing number of cyclists in Austrian urban agglomerations over the past decade, the gaps and deficiencies in the cycling infrastructure also becomes more visible, especially parking problems with bicycles. The DrückMichi project focuses on an expansion of the usage of existing car parking lots on streets towards an equal access for bicycles.

Therefore, an idea competition was organized in spring 2020; the general public was invited to submit their ideas, which resulted in a multitude of approaches and ways to conceptualize flexible bicycle racks. A new type of bike rack – which is flexible in its usage as it can be pulled into the parking space whenever needed – enables bicycles to be parked on car parking lots, primarily dominated by motorized vehicles. The outcome of the contest shows that bicycle racks can be thought and designed differently to the classic, omnipresent models such as the Wiener Bügel. This paper provides an overview of some of the submitted ideas of the competition and thus aspires to inspire and motivate to rethink bicycle parking.

This project is funded by the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK) as part of the “Mobility of the Future” program. Funding is handled by the Austrian Research Promotion Agency (FFG).

Keywords: climate neutrality, shared parking spaces , bicycle rack, flexible bike parking, mobility

2 INTRODUCTION AND THEORETICAL FRAMEWORK

A sustained boom in cycling over the past decade is particularly evident in urban agglomerations (BMVIT 2017) and underlines necessary redistribution of space and usage accessibility. Some counting stations, i.e., in Vienna, even showed record values in 2020, when cycling was besides walking one of the healthiest and safest means of transport for a wide range of individual necessary journeys during the corona crisis (Radlobby 2021). What is more, only a third of the Viennese street area is intended for walking and cycling, two thirds of the area are lanes for motor vehicle traffic. However, the share of active mobility in daily trips is 33 percent, that of car trips is only 29 percent (MA23 2018, Wiener Linien 2018).

The moderately developed cycling infrastructure can in many cases not keep up with this growing demand. It is often described as poor or incomplete, especially when it comes to bicycle parking (ORF 2020). Amongst various other aspects, the availability and quality of parking spaces has a major impact on the use of a vehicle, including bicycles (Aldred et al. 2013: p. 613). Nevertheless, bicycle parking tends to be forgotten when discussing cycling infrastructure (Heinen and Buehler 2019). In the Austrian city of Graz for example, there were 6,000 public bicycle racks in 2013 – the citizens though owned around 150,000 bicycles at the same time (Kozina 2018: 23). Especially in inner-city areas (e.g., in historically shaped Gründerzeit-style districts) the shortage is greatest and the alternatives due to urban planning conditions (such as limited space, properties with a mezzanine floor or a lack of barrier-free access, few cellars or courtyard areas etc.) are rare. In Graz and Vienna, i.e., it can be observed that more and more bicycles are parked informally, for example on road signs and house walls (Kozina 2018: p. 23, ORF 2020). Simultaneously, there are more and more discussions about a reorganization of the urban street space to create a more equitable allocation of space for non-motorized activities. The transport policy guideline 2020 of Graz, i.e., states that sustainable modes of transport should have long-term consistent priority over motorized individual transport by for example increasing the availability of parking spaces for bicycles by 500 new racks annually (Stadt Graz 2015: p.15, bicy.it 2011, Kozina 2018: 24)

In Austria, bicycles can be legally parked on sidewalks, assumed the sidewalks are at least 2.5 meters wide and bikes do not hinder pedestrians (§68 Abs 4 StVO) which is often not the case, i.e. in Vienna >40% of the sidewalks are smaller than 2m (Österreichischer Verkehrssicherheitsfonds 2011, Open Data 2016). In regard to the corona pandemic and the necessary compliance with the minimum distances on the often-narrow sidewalks, it is important to improve bicycle parking infrastructure apart from the sidewalks. At present, according to the Austrian traffic regulations, bicycles can be parked on parking spaces (§23ff StVO); it needs to be ensured, though, that parked bicycles cannot fall (§68 Abs 4 StVO). It is questionable whether this can be achieved with a kick stand alone. A lack of awareness and a lack of protection against theft are further obstacles for cyclists to use parking lots. In a survey in spring 2020, over 60% from 545 interrogated Austrians think that parking bicycles in parking lots is not allowed (Zeitelhofer 2020). In the opinion of the research team, a respective infrastructure is needed to make parking lots usable for safe bicycle parking that is in accordance with the legal framework (this though is not necessary for tricycle cargo bikes for example, which are stable by their way of construction).

At the same time a flexible bicycle rack turns a monofunctional parking space into a multifunctional one, with benefits in terms of daily, seasonal or weather-related fluctuations in the choice of the means of transportation. This also applies to places affected by recurring fluctuations as for example at schools, outdoor swimming pools and street spaces with mixed use. A flexible bicycle rack further might facilitate the reorganization of the urban space and grant greater shares to active forms of mobility. A dual usage possibility can be a door opener for decision-makers to smoothly transition the use of space without preferring one type of transport. This project also aims to raise awareness for an equal use of parking spaces between cyclists and motorists. Now the question is, how should a bike rack look like to be able to meet all of these requirements. Today there are already numerous design variants of bicycle parking systems but the majority, however, permanently occupies an area due to permanent installation. Approaches to a flexible or temporary use of the scarce public inner-city space can be found relatively sparse, such as from Bergs (2017).

3 METHOD

In order to obtain the technical expertise and possible further creative contributions for the flexible approach, a user inclusion was pursued through an idea competition. The objectives were set as competitions on the so-called "Open-Innovation-Platform", operated by the Mobility Lab Graz.[1] The number of submissions per participant was not limited. The contest was launched in spring 2020 and was endowed with € 1000 for the main prize, € 700 and € 400 for second and third place. The first ranked idea was then constructed – the focus of this paper, though, is to show the diversity and variety of all the submitted ideas.

The project consortium defined minimum requirements for all submissions before they are allowed to be evaluated by the jury. Bonus points could also be achieved with nice-to-have criteria which resulted from technical standards. Normally, the criteria for bicycle parking facilities vary depending on the location. However, general demands can be placed on bicycle parking systems: According to the common recommendations, bike racks should have at least one leaning option, ideally also a front wheel holder. On the one hand, this provides secure standing (even when loaded with a child) and, on the other hand, increased protection against theft. A pure front wheel mount should not be considered (Radlobby Wien 2017). All in all, the aim of the call was that the bracket must allow flexible use of the parking lot.

• Stability of the bike (also with child)	• Minimum height when unfolded of 700mm
• When unused or when folded, it must be possible to drive over the bike rack (max. height when folded up 110mm)	• The construction or mechanism must be evident from a technical sketch or a detailed plan
• The opening mechanism must not be triggered unintentionally	• Observe the parking lot dimensions of 2m wide and 5m long
• Damping device or weight damping to avoid uncontrolled falling to the ground	• At least the bicycle frame or frame and front wheel can be locked to the bike rack

Table 1: Minimum requirements for the general assesment admittance. Source: own representation.

[1] https://mobilitylabgraz.neurovation.net/node/308242 [German only]

• Wheel bracket should be self-explanatory	• Little effort required for the (release) mechanism
• Hardly or no costly special manufactures	• Low-maintenance construction
• Mechanical or digital counter can be included	

Table 2: Nice-to-Have-Requi-Criteria for bonus points. Source: own representation.

In addition to its online presence, the competition was also actively advertised by directly contacting the following Austrian and also some German institutions through written and verbal activation: More than 73 higher vocational schools, technical colleges and universities with a focus on product development, industrial design, mechanical engineering and technical hobbyists. After the extended submission period has expired, the applicants could rate the ideas of other applicants (except for their own idea): two submitted ideas were randomly presented and the user could select his or her preferred idea. The user rating would be particularly suitable as a preselection if there were a large number of submitted ideas. Since the number of submitted ideas was manageable, an interdisciplinary jury of experts with practical relevance (consisting of two construction engineers from Innovametall GmbH, a civil engineering professor from TU Wien and an engineering student from BOKU University) were able to rate each submission individually. The ideas were rated by using a considered set of weighted criteria in the categories maturity of the idea, road safety, ability to lock the bicycle, compatibility in the street space, usability, production costs and durability. The final ranking then developed within a qualitative discussion of the submissions.

4 RESULTS

Fortunately, the idea competition brought a creative range of professional submissions. 22 actors ultimately took part with different technical and design approaches. Out of all the ideas, 15 met the minimum requirements. The submissions ranged from sketchy ideasdrawn sketches to professionally executed construction plans and can be assigned to two categories: leaning bars and front wheel holders. All ideas had an individual trigger mechanism, locking functions, mostly also included different suspension and locking systems. The spectrum of constructions extends from simple bollards with a rotating mechanism, to ones with a double joint, sliding and folding system or pure pulling mechanisms. Some submissions consist of triangular legs and pollards with tilting, rotating and folding mechanisms. The category of pure front wheel brackets shows different trigger mechanisms by turning and pulling handles or by pushing the front wheel of the bicycle or by a foot pedal or a combination of these elements. Most of the submitted bike rackets are intended for installation on the parking lot surface or on the edge of the roadway, but a few also below the surface of the road or within the curb.

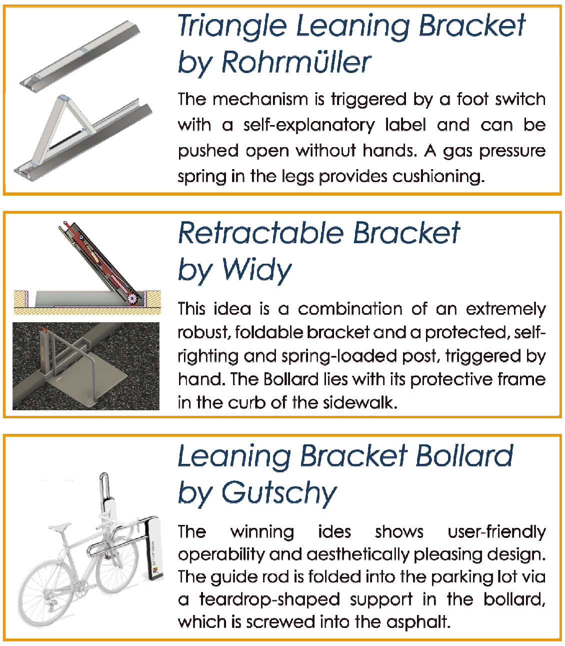

Fig. 1: Three examples from the competition. Source: own representation.

Ten ideas ultimately proved to be feasible by the jury. Since the evaluation criteria contained certain deficiencies or were not applicable to all ideas in the course of the evaluation, a qualitative assessment of the ideas was also carried out by the jury. Based on their practical experience, once again all the advantages were compared with the expected disadvantages. Many of the ideas fulfilled, e.g., the required flexible usage options, in particular the creation of a flat surface when not in use. In the further assessment, however, some would be difficult to construct and implement in terms of their components or mechanism. Some designs turned out to be too filigree and unstable, containing many moving parts and highly precision mechanics, which could not guarantee an expected longevity, functionality and protection against vandalism and theft. A simple way of installation was another evaluation criteria in order not to exceed the financial limits of the time-limited research project and to ensure that the bicycle rack would be attractive to municipalities due to its cost-efficiency. The jury favored mechanisms or modes of operation that enable anchoring in the ground without disproportionate effort (such as breaking up the asphalt). It was also most important that the folding mechanism could not be triggered unintentionally, for example by being run over by a car or walking over it. To be on the safe side, the jury preference was for wheel brackets that are located to the side of the road and enable safe and controlled folding, swinging, turning etc.

Idea Code	Storage Type	Construction	Operating Mode	Triggered by	Suspension / Weight Decay	Flat Surface when Unused	Useability	Production Costs	Idea Maturity	Follow-Up Potential
A	Leaning Bracket	Bollard with Bar	Pulling + Swieveling	Hand	Rubber Layer	No	High	Low	High	High
B	Leaning Bracket	Bollard with Bar	Pulling + Folding	Hand	Pneumatic Spring	Yes	Moderate	Moderate	High	High
C	Wheel Holder	Bar in Depression	Teetering	Front Wheel	No/Not Necessary	Yes	High	Moderate	High	High
D	Wheel Holder	Bar in Depression	Folding	Foot	Spring + Cable	Yes	Low	High	High	Low
E	Leaning Bracket	Triangular Bars	Folding	Hand	Rubber Layer	Yes	Low	Moderate	High	Low
F	Leaning Bracket	Triangular Bars	Folding	Hand	No/Not Necessary	Yes	Low	High	Moderate	Moderate
G	Leaning Bracket	Bollard with Bar	Pulling + Swieveling	Hand	No/Not Necessary	No	Moderate	Low	High	Low
H	Leaning Bracket	Bar in Depression	Teetering	Hand	No/Not Necessary	Yes	Low	Moderate	High	Low
I	Leaning Bracket	Bar on Ground	Pushing + Folding	Foot	Spring	Yes	Low	Moderate	Moderate	Low
J	Wheel Holder	Bar in Depression	Folding	Front Wheel	No/Not Necessary	Yes	Low	Moderate	Moderate	Low
K	Leaning Bracket	Bollard with Bar	Folding	Hand	No/Not Necessary	No	Moderate	Moderate	Low	Moderate
L	Leaning Bracket	Sheet on Ground	Folding	Foot + Hand	Neopren Bearings	Yes	Moderate	Moderate	High	High
M	Leaning Bracket	Triangular Bars	Folding	Foot	Pneumatic Spring	Yes	Low	Moderate	Moderate	High
N	Leaning Bracket	Bar on Ground	Folding	Foot	Pneumatic Spring	Yes	Moderate	High	High	Low
O	Leaning Bracket	Bollard with Bar	Folding	Foot + Hand	Dual Disc Spring	Yes	Moderate	Low	High	Low

Table 3: Overview of individual technical and evaluation aspects of the 15 ideas that met the minimum requirements. A total of 12 leaning bars and 3 front wheel holders were submitted. Seven of them are operated by hand, 4 with the foot and two each with hand and foot or the front wheel. The usability results from a point system for "self-explanatory functionality of the mechanism", "easy implementation of the folding mechanism", "avoiding hand use" and "little effort required to trigger the mechanism". The column production costs are calculated from the costs of the components and the assembly. Certain ideas are suitable for following up the plans or still require revision or post-processing in certain aspects. Source: own representation.

Fig. 2: The DrückMichi prototype being tested at a parking lot at the hospital in Graz. Source: own representation.

This outcome primarily shows that bicycle racks can be designed differently to the classic, omnipresent models such as the “Wiener Bügel”. The winning ideas impress with their simplicity in use with a simple mechanism and optics and also meet all technical requirements and are also inexpensive to manufacture and install. Therefore, in the opinion of the jury, a classic front wheel holder in the sidewalk edge was also counted to the top three inventions, even though it should actually no longer be used in public spaces according to the latest technical cycling recommendations. The now constructed and tested prototype is produced by the consortium partner innovametall GmbH based, on the competition outcome. The first produced foldable wheel bracket consists of a vertical bollard with a rotating disc mechanism, from which the guide bar or the leaning bracket can be pulled out into the parking lot without great effort. It is therefore mounted on the edge of the road or on the edge of the sidewalk and only requires minimally invasive installation. Due to the small area required by the bollard of just a few square centimetres, there are several installation options that are also suitable for niche areas. The DrückMichi is now being tested at the Holding Graz car park for material behaviour and first user experiences under real conditions.

5 DISCUSSION

The idea competition offers a creative range of technical approaches in flexible bicycle parking systems. Five out of 15 technical approaches would be suitable for further development under certain conditions (higher financial resources, human resources, liability issues, ...). Working with virtual platforms enables new ways of working with creative and specialized staff outside of your own project boundaries. This selective inclusion of people is intended to reduce the organization's management effort. The competition combines specific tasks with the appropriate skills of the users who become active independently through incentive mechanisms. Their results were made available to the project team as commons free of charge or were compensated for in terms of prices. This instrument creates a paradoxical principle: an individualized form of organization in which individuality plays a major role, but hardly the individual as such – only their contribution to the platform (Al-Ani et al. 2015). From a social science perspective, it would be interesting to ask the participants about their intrinsic motivation and expectations, how they found out about the competition and how they experienced the evaluation process. This could possibly provide information, among other things, that different prices or specifications, payment guarantees if the minimum requirements are met, etc. could lead to a different submission quota, changes to the qualitative or quantitative planning content, shifts in the gender distribution or to improvements to the platform itself.

Although numerous ideas come close to the original idea of a retractable or foldable wheel bracket in or on the asphalt, there are limits to the implementation and manufacture of creativity. The DrückMichi-prototype that has now been produced cannot fully disappear when unused. – Which means that when the bar is folded in, a bollard remains on the edge of the road or sidewalk. Improvements would have to result in a flat surface when the wheel bracket is not used. For this purpose, the prototype can be further developed, so the bollard can also be folded and laid down. Likewise, in the case of non-occupancy by a bike, a self-regulating extension of use could be achieved by automatically folding up the bracket. Nevertheless, in Austria it is a first attempt to make parking spaces more equally usable for cyclists.

As planners we do have an influence on stimulating certain tendencies of usages. Whether the folding bike racks bring an improvement or a deterioration in the flexibility of the use of space and promoting active mobility, cannot be answered out of a theoretical context. This also applies to what extent the used model proves to be practicable, whether it leads to greater acceptance or use. In order to be able to achieve well-founded statements, the new racks would have to be tested in public streets under appropriate conditions.

6 CONCLUSION

The ideas competition was able to prove that there is a wide range of creative ideas. One submitted idea has already been registered as a patent. The current prototype does not yet represent the solution for flexible bike parking in public space, but further developments and adjustments of the prototype (e.g., by disappearing at ground level when unoccupied) could certainly promote flexibility and dynamism for space utilization. In the DrückMichi case, which uses the first-come first-serve approach, authorities try to avoid possible conflict situations, even if they may not even occur in practice as first surveys on private ground showed. Furthermore, missing legal bases in the Road Traffic Regulations for allowing an experimental use in public street space complicate the development of new creative innovations in this field.

Flexible, shared parking spaces for bicycles and motorized vehicles address some of the most urgent mobility-related challenges in urban settings: (1) Smartness: the flexible mode of the bicycle rack enables a dynamic and efficient use of limited urban street space. The parking space is adaptable to current situations and needs. (2) Sustainability: the bicycle rack addresses the issue of equity in urban street space allocation and delivers a vision of how street space might be shared differently. It stimulates debate, raises awareness for both sustainable mobility and use of street space. Thus, it might alter individual perceptions and potentially lead to a change of usage behaviour. (3) Climate neutrality: in the short term, the flexible bicycle rack leads to a more efficient use of the existing parking space. Long-term, the bicycle rack supports the smooth transition from cities shaped by fossil-fuelled mobility to more climate-neutral types of urban mobility. (4) Resilience: bicycle usage strengthens the resilience of cities when it comes to both climate change and global pandemics such as the current COVID-19 crisis. In order to promote bicycle usage, an adequate bicycle infrastructure needs to be available. Since built structures change only extremely slowly compared to the means of transport and usage requirements, the street space as a space for transformation is once again in the special focus. The subject of parking spaces, regardless of whether it is a car or bicycle parking space, will be an ongoing issue. The authors consider it valuable to be able to react flexible to future requirements with corresponding constructions. Awareness of cycling infrastructure is currently growing, so the corona situation should be understood as a reason for action, in which, together with the rapidly increasing proportion of cyclists, a lot can be achieved in various planning processes.

7 ACKNOWLEDGEMENTS

In this regard, we would like to thank the Graz Holding and the Regional Hospital (LKH) Graz, for providing a testing space on their premises for the prototypes. Furthermore, we would like to thank everyone again for their submitted ideas, who have not only invested valuable time and know-how in this tender, but are also the driving forces for changes in public space. DrückMichi is funded by the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK) and Austrian Research Promotion Agency (FFG) as part of the "Mobility of the Future" program.

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Interaktives Erzeugen von thematischen Karten mit CentropeMAP und CentropeSTATISTICS

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1 ABSTRACT

Centrope ist eine grenzüberschreitende-Region zwischen den Staaten Österreich, Slowakei, Ungarn und Tschechien. Seit dem Jahr 2005 gibt es das Geoportal CentropeMAP mit dem Folus auf Daten auf regionaler und Gemeindeebene, um grenzüberschreitende Aufgabenstellungen in der Planung zu erleichternDazu werden Datensätze aus den aneinander grenzenden und in der Centrope-Region vereinten Landesteilen in einer gemeinsamen Oberfläche darstellt und grenzüberschreitend betrachtet.

Das Geoportal verfügt über eine umfangreiche Erweiterung zur Darstellung statistischer Daten: Mit dem interaktiven grenzüberschreitenden Statistikinformationssystem CentropeSTATISTICS können Bevölkerungs-, Wirtschafts- und Landnutzungsdaten innerhalb der Centrope-Region, d. h. grenzüberschreitend zwischen vier Staaten, verglichen, analysiert und graphisch dargestellt werden.

Der Schwerpunkt von CentropeSTATISTICS liegt auf Daten der Gemeindeebene; dadurch unterscheidet sich CentropeSTATISTICS deutlich von fast allen anderen grenzüberschreitenden Statistikportalen, die oftmals nur grob nach NUTS-3- oder NUTS-2-Regionen gegliederte Zahlen anbieten und so kaum Mehrwert gegenüber den gesamteuropäisch frei verfügbaren Eurostat-Tabellen bieten. Mit der Möglichkeit, Daten auf Gemeindeebene anzuzeigen und im Geoportal zu visualisieren, ist auch eine kleinräumige Betrachtung sinnvoll möglich.

Der Funktionsumfang von CentropeSTATISTICS ist in den letzten Jahren stetig gewachsen. Um die Einstiegshürde flacher zu gestalten, wurden im Jahr 2021 Videotutorials veröffentlicht, die einige Arbeitsschritte innerhalb von Centrope vorzeigen und so neuen Benutzern einen leichteren Zugang zu diesem komplexen Werkzeug ermöglichen.

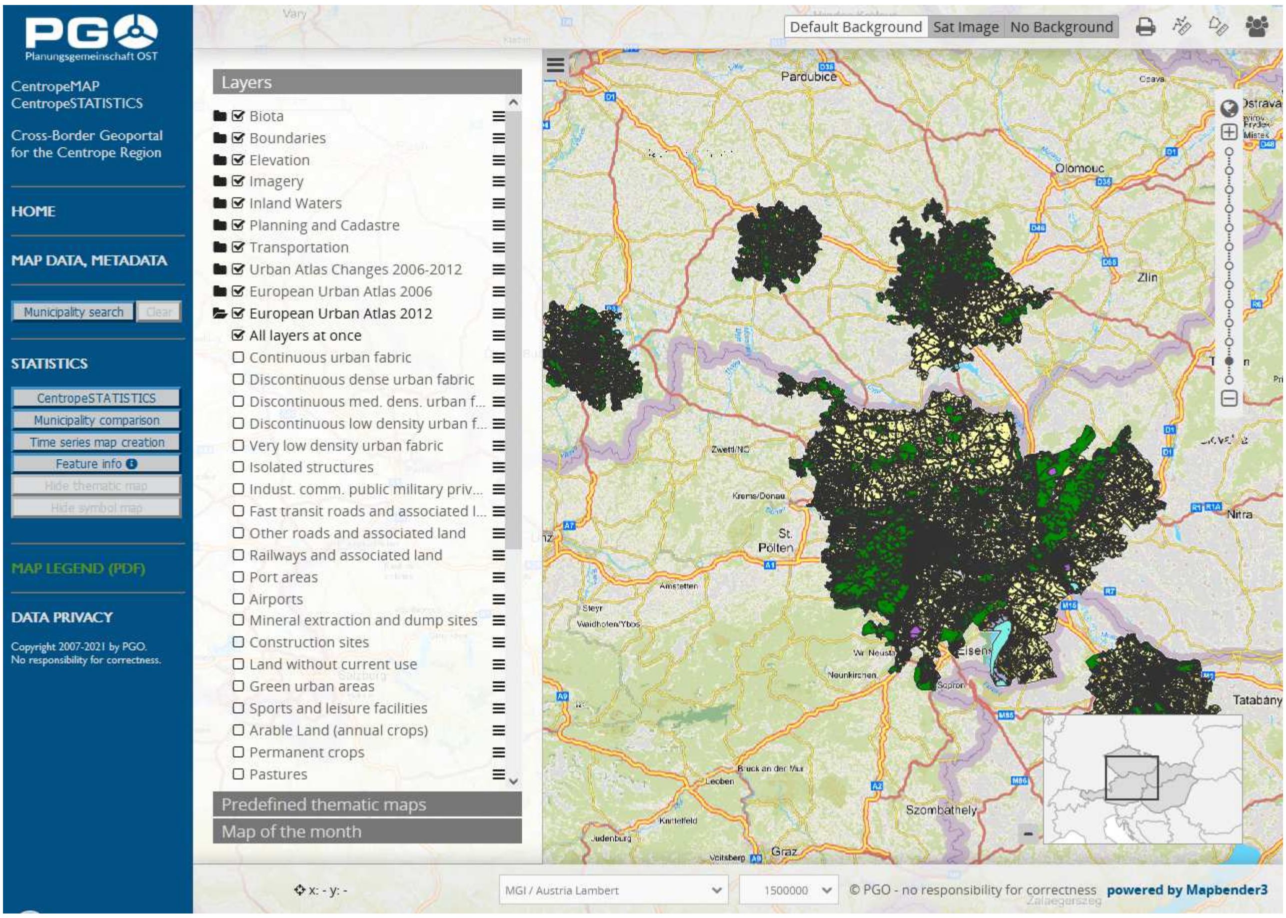

Abb. 1: Das Geoportal CentropeMAP.

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2 HINTERGRUND

Die Centrope-Region liegt in den Staaten Österreich (Wien, Niederösterreich, Burgenland), Tschechische Republik (Jihočeský, Jihomoravský), Slowakei (Bratislavsky, Trnasky) und Ungarn (Győr-Moson-Sopron). Ihre Gründung erfolgte 2003 durch den Vertrag von Kittsee im Rahmen eines INTERREG-IIIA-Projekts. In einem ersten Pilotprojekt galt es, Geodaten aus allen Teilregionen zusammenzutragen und auf einem gemeinsamen Datenträger allen interessierten Partnern aus der Region zur Verfügung zu stellen. Jedoch war diese Datensammlung auf CD-ROM zu wenig präsent und schwierig aktuell zu halten.

2005 wurde durch die Initiative der Planungsgemeinschaft Ost schließlich CentropeMAP/ CentropeSTATISTICS ins Leben gerufen und wird in Zusammenarbeit mit den Statistik- und GIS-Stellen der Länder Burgenland, Niederösterreich und Wien sowie Partnern der Centrope-Region laufend ergänzt und weiterentwickelt.

In der mehr als fünfzehnjährigen Projektlaufzeit hat sich eine ausgezeichnete Kommunikations- und Austauschbasis der Partner etabliert. Das ist insbesondere den regelmäßigen nationalen und internationalen Workshops zu verdanken, in denen der Stand der Technik diskutiert, neue Ideen ausgetauscht und Datenbestände harmonisiert werden. Trotz der Widrigkeiten der Corona-Pandemie konnte die grenzüberschreitende Zusammenarbeit aufrecht erhalten werden, wenngleich die gemeinsamen Workshops nicht als reale Treffen, sondern nur als Online-Meetings abgehalten werden konnten.

3 WAS MACHT CENTROPEMAP EINZIGARTIG?

3.1 Grenzüberschreitende Geodaten

CentropeMAP ist eine internetbasierte Anwendung und benötigt daher keine Softwareinstallation, sondern ist auf jedem handelsüblichen Rechner mit Internetanschluss lauffähig. CentropeMAP konzetriert sich auf Daten, die für die Raumplanung und verwandte Fachgebiete von Interesse sind. Zur Verfügung stehen

- zahlreiche räumliche Informationen: Grenzen, Naturraum, Gewässe, Verkehr, Landnutzung, Siedlungsraum, Versiegelungsgrad etc.;
- statistische Daten zu den Themen Demographie, Migration, Bildungsstand, Wirtschaft/Arbeitsmarkt etc.;
- Zeitreihen, wodurch auch die Entwicklung der Region leicht nachvollziehbar ist.

CentropeMAP bezieht seine Geodaten direkt von den Servern der datenhaltenden Stellen. Es sind dies GIS-Stellen der österreichischen Bundesländer Wien, Niederösterreich und Burgenland, das österreichische land- und forstwirtschaftliche Rechenzentrum LFRZ, geoland.at, die Europäische Umweltagentur, die Tschechische Umweltinformationsagentur CENIA, die tschechischen Kreise Jihomoravský und Vysočina und die slowakische Umweltagentur SAZP. Ungarische Geodaten sind leider aufgrund einer von den Gepflogenheiten der übrigen Partnerländer abweichenden Geodatenpolitik nicht kostenlos verfügar; ein Ankauf wäre zwar grundsätzlich möglich, dies würde aber den Prinzipien von CentropeMAP widersprechen, das Angebot ausschließlich mittels frei verfügbarer Daten (Open Government Data) zu bestreiten.

3.2 Grenzüberschreitende Statistikdaten

Die Statistikdaten in CentropeSTATISTICS werden direkt von den statistischen Ämtern der Partner Wien, Niederösterreich, Burgenland, Tschechische Republik, Ungarn und Slowakei zur Verfügung gestellt. Es handelt sich hierbei mehrheitlich um Bevölkerungsdaten, die in Zeitreihen ab dem Jahr 2002 bzw. 2008 zur Verfügung stehen und jährlich aktualisiert werden. Diese Daten werden ergänzt durch diverse Ergebnisse der Volkszählungen (2011, in Vorbereitung: 2021).

Fast der gesamte Statistikdatenbestand in CentropeSTATISTICS bildet die Gemeindeebene ab. Dies hat den Vorteil, dass vor allem in Grenznähe sehr kleinräumige Analysen möglich sind, was bei der vier Länder übergreifenden Centrope-Region naturgemäß einen hohen Stellenwert einnimmt. Aber auch abseits der Grenzgebiete erlaubt die feine Auflösung (3.507 Gemeinden im Vergleich zu lediglich 18 NUTS-3-Regionen in der Centrope-Region) eine detaillierte Betrachtung der Region; Statistikdaten dieser Genauigkeit für vier Länder gleichzeitig sind ein einzigartiges Angebot, das es in dieser Form nicht einmal im öffentlichen Bereich des europäischen Statistikportals Eurostat gibt.

3.3 Harmonisierte Daten

Eine Harmonisierung von Geodaten ist europaweit im Zuge der Umsetzung der INSPIRE-Richtlinie im Laufen. Dieser Prozess ist in den letzten Jahren nur langsam fortgeschritten und es stellt sich die Frage, ob und wie die Ergebnisse aus INSPIRE für Geoportale wie CentropeMAP nutzbar sein werden. Wir beobachten den Fortschritt von INSPIRE kontinuierlich und sind technisch darauf vorbereitet, allfällig verfügbare gesamteuropäisch harmonisierte Datenbestände übernehmen zu können.

Im Statistikbereich ist die Datenharmonisierung auf Gemeindeebene eine besondere Herausforderung. Daten aus den Partnerregionen dürfen nur dann in eine gemeinsame Tabelle übernommen werden, wenn sie auf gleiche Art und Weise erhoben bzw. verarbeitet wurden. Dies ist bei Bevölkerungsdaten zwar recht einfach zu bewerkstelligen, doch wenn es in andere Bereiche wie Arbeitslosenstatistik oder Haushaltsgröße geht, treten vielfältig gelagerte Probleme auf, da die Begriffe „arbeitslos“ oder „Haushalt“ in den unterschiedlichen Ländern nicht ident definiert sind, sondern einander teilweise erheblich unterscheiden. Ebenfalls sind die Erhebungsmethoden verschieden, beispielsweise werden in manchen Ländern Arbeitslosendaten nach Stichtagen gebildet, in anderen Ländern wiederum nach Monats- oder Jahresmittelwerten. Auch die Bezugsgrößen sind nicht einheitlich.

Es ist zwar möglich, diese Unterschiede durch Aggregation der Daten zu eliminieren. Dadurch geht jedoch die Genauigkeit verloren und es entstehen Daten mit relativ geringer Aussagekraft, da die Abweichungen in den Definitionen zu stark sind.

Bei der Abbildung von Daten auf Gemeindeebene sind auch die Anforderungen des Datenschutzes besonders zu beachten. Bei Kombination verschiedener Merkmale wären vor allem in Gemeinden mit sehr geringer Bevölkerungszahl (im niederen zweistelligen Bereich) Rückschlüsse auf Einzelpersonen möglich, weshalb einige Daten auf der Gemeindeebene nicht länderübergreifend zur Verfügung stehen. Dennoch bekennt sich CentropeSTATISTICS zur Arbeit mit Gemeindedaten, da nur diese Daten eine detaillierte Betrachtung in regionalanalytischen Maßstäben ermöglichen.

4 DIE MÖGLICHKEITEN DES GEODATEN- UND STATISTIKPORTALS

4.1 Fünfsprachige Website

DIe Website https://www.centropemap.org/ ist fünfsprachige aufgebaut (Englisch, Deutsch, Tschechisch, Slowakisch, Ungarisch) und bietet einen Überblick zur Region und zu den Inhalten von CentropeMAP und CentropeSTATISTICS samt Handbüchern, häufig gestellten Fragen (FAQ) etc. Die Geo- und Statistikdatenportale sind jedoch nur in englischer Sprache verfügbar, das Handbuch zu CentropeSTATISTICS wird in Deutsch und Englisch angeboten.

4.2 Kartendarstellung

Über das Geoportal CentropeMAP können nicht nur sämtliche eingebundenen Geodatenlayer aus allen vier Partnerländern angezeigt, sondern auch die in CentropeSTATISTICS eingepflegten Statistikdaten als thematische Karten visualisiert werden. Die Wahl der Darstellung läuft in wenigen Schritten ab, erfordert aber ein wenig Vorwissen aus dem Bereich GIS bzw. Kartographie, um sinnvollen Output erzeugen zu können. Daher gibt es auch zum schnellen Nachschlagen und für Benutzer ohne kartographische Vorkenntnisse vordefinierte thematische Karten, die direkt aus dem Menübaum heraus abgerufen werden können.

Für die Karte des Monats wird aus den vielen Inhalten von CentropeMAP und CentropeSTATISTICS jeweils ein zum Monat passendes Thema aus dem Geodaten- oder dem Statistikbereich redaktionell ausgewählt und über einen eigenen Karteireiter im Menü des Geoportals zugänglich gemacht. Die Karte des Monats wird von einem kompakten Erläuterungstext begleitet.

4.3 Diagrammdarstellung

Die in der grenzüberschreitenden Datenbank CentropeSTATISTICS vorhandenen Daten können auch in Diagrammform dargestellt werden. Mit wenigen Mausklicks ist die Erstellung von Säulen-, Balken-, Kreisdiagrammen und ähnlichen Darstellungsformen möglich. Da vor allem demographische Daten als jährliche Zeitreihe vorliegen, eignet sich die Diagrammdarstellung optimal zur Visualisierung von Bevölkerungsveränderungen in den letzten 20 Jahren.

Die Diagramme sind entweder als direkt am Bildschirm angezeigte Grafikdateien verfügbar oder als PDF inklusive der für die Diagrammerstellung verwendeten Statistikdaten in Tabellenform.

Das nachstehende Diagramm wurde aus einer benutzerdefinierten Tabelle erzeugt. Benutzerdefinierte Tabellen erlauben individuelles Kombinieren von Daten unterschiedlicher Tabellen und die Berechnung eigener Tabellenspalten.

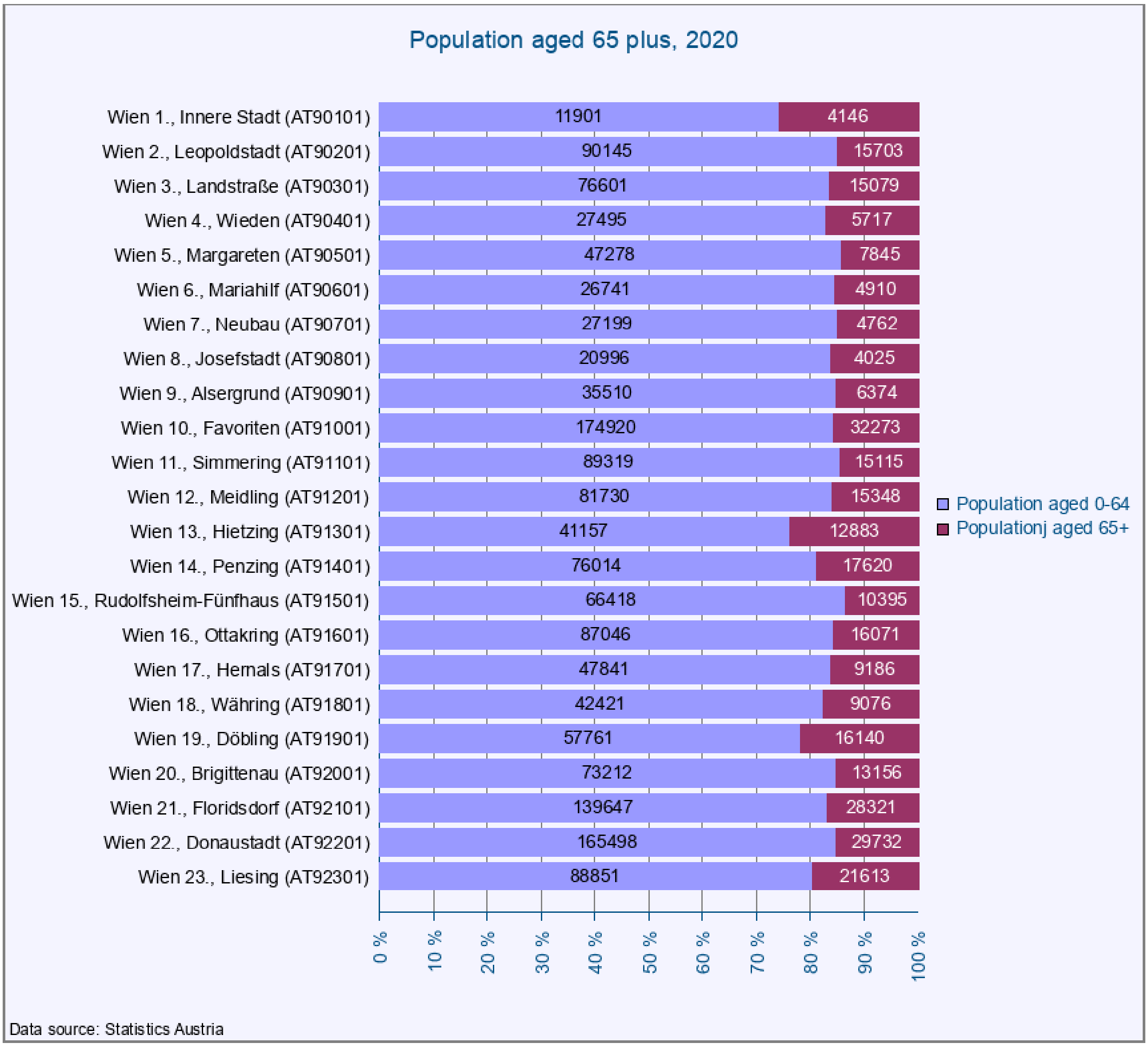

Abb. 2: Diagramm: Bevölkerung 65plus nach Wiener Gemeindebezirken.

4.4 Datenimport und Datenexport

Alle Daten in CentropeSTATISTICS sind nicht nur innerhalb des Geo- und Statistikdatenportals ohne Einschränkung verfügbar, sondern sind auch zum Download bereitgestellt. Alle Tabellen können wahlweise im CSV- oder Excel-Format heruntergeladen werden. Die Weiterverwendung außerhalb von CentropeSTATISTICS ist mit entsprechender Quellenangabe gestattet.

CentropeSTATISTICS bietet auch die Möglichkeit, zusätzlich zu den vorgegebenen Tabellen temporär eigene Tabellen zu erstellen. Diese Tabellen können mit Daten aus CentropeSTATISTICS befüllt werden und eignen sich somit zur Berechnung von Indikatoren, für die man Daten mehrerer Tabellen benötigt. Zusätzlich können auch eigene Daten importiert werden, die in der benutzerdefinierten Tabelle mit CentropeSTATISTICS-Daten kombiniert und ebenfalls für die Karten- oder Diagrammerstellung verwendet werden können.

4.5 Gemeinde- und Regionsvergleich

Ähnlich wie bei den meisten nationalen Statistikportalen gibt es auch bei CentropeMAP die Möglichkeit, verschiedene Daten zu einer Gemeinde auf einen Blick betrachten zu können und zu Vergleichszwecken die Daten einer weiteren Gemeinde direkt gegenüberstellen zu können. Die Bedienung erfolgt in fünf simplen Schritten:

- Auswahl des Vergleichsmodus,
- Auswahl der Gemeinde(n) oder Bildung einer benutzerdefinierten Region,
- Auswahl der gewünschten Indikatoren,
- Auswahl der gewünschten Zeitreihe (Jahreszahlen),
- Ausgabe der Daten.

Anders als bei den nationalen Statistikportalen ist dies bei CentropeSTATISTICS selbstverständlich grenzüberschreitend möglich. Die Daten werden, so weit verfügbar, als Zeitreihe dargestellt; die Ausgabe erfolgt sowohl als Diagramm als auch als Tabelle, sowohl am Bildschirm als auch im PDF-Export.

4.6 Tutorial-Videos

CentropeSTATISTICS ist ein komplexes Werkzeug mit umfangreichem Funktionsangebot. Dies kann für Neueinsteiger eine gewisse Hürde darstellen oder abschreckend wirken, sodass wir uns im Jahr 2020 entschlossen haben, Videotutorials zu erzeugen, in denen grundlegende Funktionen von CentropeMAP und CentropeSTATISTICS erklärt und mittels Bildschirmaufzeichnung vorgeführt werden. Die Videos sind kompakt gehalten und konzentrieren sich neben einem einführenden Überblicksvideo in jeweils unter 2 Minuten Dauer auf konkrete Anwendungsfälle.

5 WEBLINK

http://www.centropemap.org

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Metropolitan Peripheries as New Urban Landscapes. Designing a Co-Creative Toolbox for the Integrated Development of the Vienna City Region

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1 ABSTRACT

Contemporary processes of structural change, such as growing regional disparities as well as pressing challenges of social and climatic change, permeate and shape many metropolitan areas worldwide. Moreover, in the face of continuous population growth and limited spatial resources, many cities have grown beyond their administrative borders, pointing to strong rural-urban interdependencies as well as necessary cross-border cooperation. With big cities as the dominant urban core, it is often the peri-urban municipalities of urban regions that have to deal with the consequences of extensive urban sprawl and lacking public transportation infrastructure. As the ongoing urbanisation trend transforms cities, towns and villages into fragmented hybrid urban landscapes, where the use of conventional planning instruments quickly reaches its limits, integrated and multidimensional development strategies for metropolitan areas are needed. The case study of the Vienna city region not only illustrates the negative effects of uncoordinated spatial planning that stops at administrative borders, but also shows alternative future-oriented development potentials.

The development of future visions for metropolitan areas and the moderation of complex regional planning and design processes are some of the many services provided by the MetroLab.[1] Building on the case study of the SuperWien Metropole[2] – a vivid vision for the greater Vienna region stretching from Vienna and Wiener Neustadt to Bratislava – the transnational and interdisciplinary team succeeded in initiating a discussion on metropolitan planning by means of innovative tools and approaches. The profound analysis and provocative-artistic visualisation of the spatial-functional development of this agglomeration as well as the launched International Dialoge on Metropolitan Planning are essential components of a comprehensive co-creative toolbox[3] specifically designed to discuss and tackle challenges of cross-border spatial development. Taking up the approach of translocal learning and drawing on international examples and the fruitful knowledge exchange between international and local experts, the first two MetroLab Forums have shown that settlement and mobility development must be thought of together more strongly than has been done so far. Sprawling peripheral concurbations and, in particular, their residents are thus included in further case study processing to reimagine and reshape development opportunities by translating metropolitan visions and strategies into local actions. The project aims to not only strengthen sustainable intra-regional growth by focussing on the multi-level and cross-border development of those new hybrid urban landscapes located at what is usually referred to as periphery, but also to explore the interplay between comprehensive strategy development on a metropolitan scale and the identification of place-based solutions on a local scale. Finally, this implies drawing further conclusions in terms of integrated multilevel governance considering horizontal networking as well as vertical connectivity as essential strategic levels.

Keywords: urban growth, sprawl, co-creation, cross-border development, dialogue-oriented planning and design, planning tools, metropolitan strategies, place-based solutions

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[1] The MetroLab is a Think Tank and Consulting Service for the integrated development of metropolitan areas and city regions. It was founded in 2020 by the partner offices Superwien urbanism and CoCo architecture. and is currently supported by the Vienna Business Agency ("Vienna Calling: Creatives" funding programme): http://metrolab.design/

[2] The vision is presented in the book of the same name: Mayr, Stefan; Ramière, Cédric (Editors) (2018): SUPERWIEN METROPOLE. A New Capital for Europe. Bolzano and Vienna: Folio Publisher

[3] We build on previous experiences from our projects in Latin America and the Caribbean: KREBS, Roland; TOMASELLI, Markus: Urban Design Lab Handbook - Dialogue-Oriented Urban Transformation Processes and Practical Approaches from Latin America and the Caribbean. Jovis Berlin, 2019.

2 "SUPERWIEN METROPOLE"

2.1 A cross-border Vision for the Vienna City Region

As unsustainable spatial developments in Europe and worldwile have reached a critical level, it is time to better understand and adequatly address the lack of integrated multi-level responses to contemporary metropolitan challenges. New mobility demands, climate change impacts or uncoordinated urban growth do not stop at administrative borders. As the continuous urbanisation trend increasingly transforms our cities and their surrounding areas into complex functional regions that also break with existing administrative delineations, there is a high demand not only for coherent spatial development, but also for the creation of a common development perspective for all places within the extended urban area, including its periphery. Against this background, the SuperWien Metropole as a cross-border vision stretching from Vienna and Wiener Neustadt to Bratislava (see Fig. 1) was born. It enables the establishment of a new image and identity for the common living space and introduces a cross-border perspective pointing to unifying factors rather than differences and at the same time emphasizing the uniqueness of all involved places.

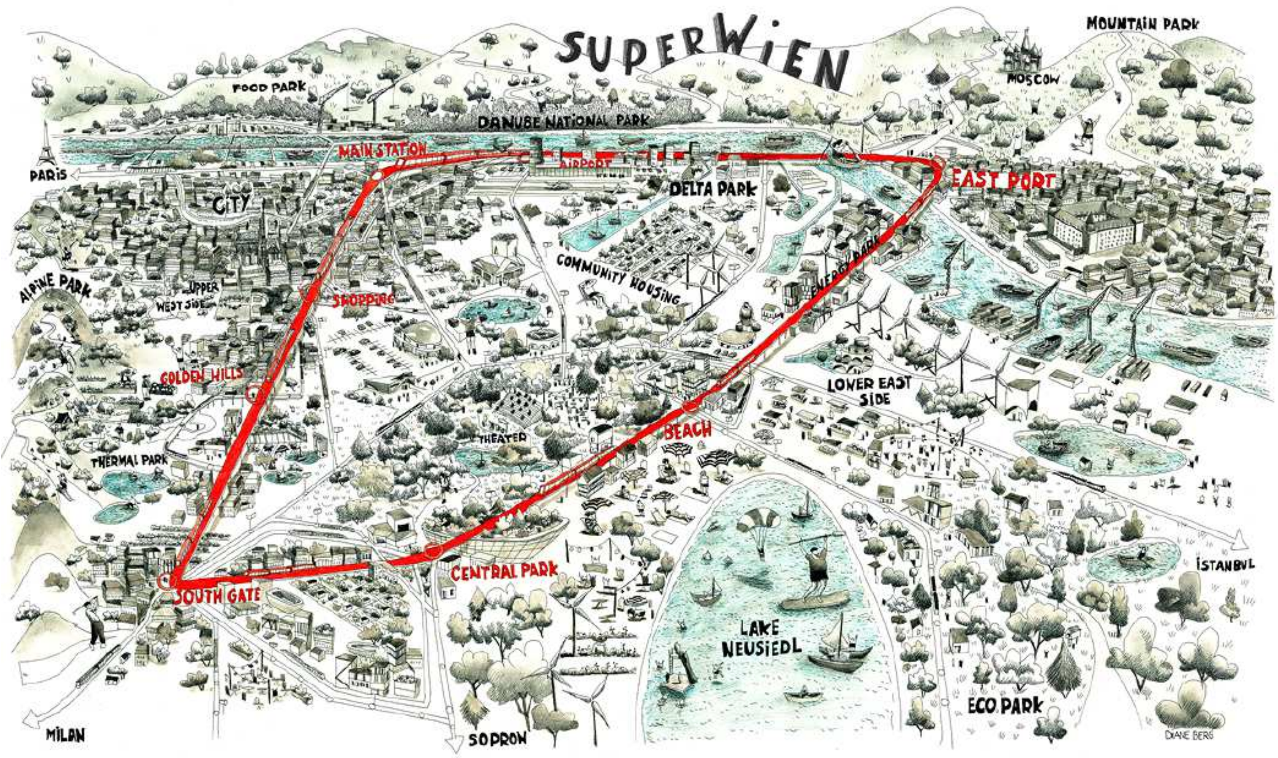

Fig. 1: SuperWien Metropole Vision (credits: Diane Berg).

The provocative term SuperWien Metropole[4] stands for a strong, compact and heterogenously intertwined metropolitan area. It is part of three nation states of the European Union (Austria, Slovakia and Hungary) with more than 400 municipalities and an estimated future population growth of 50 000 inhabitants per year. In the Eurpoean context it reflects on the region's global statute, its image and social concept to finally serve as a hub for trans-border collaboration connecting Vienna and Bratislava, which are only 50 km apart, making them geographically the closest capitals within Europe.

The principle objective of the SuperWien Metropole vision is to create a solid ground for the development of cross-border strategies for a well-balanced region. The functionally mixed and sustainable urban network allows for various lively centres interconnected by the "SuperRing" (see Fig. 2), a trans-border city transport system linking new centers and recreational areas, places of residence and business districts.

[4] The term was first used in the book of the same name: MAYR, Stefan; RAMIÈRE, Cédric: SUPERWIEN METROPOLE. A New Capital for Europe. Folio Publisher Bolzano and Vienna, 2018.

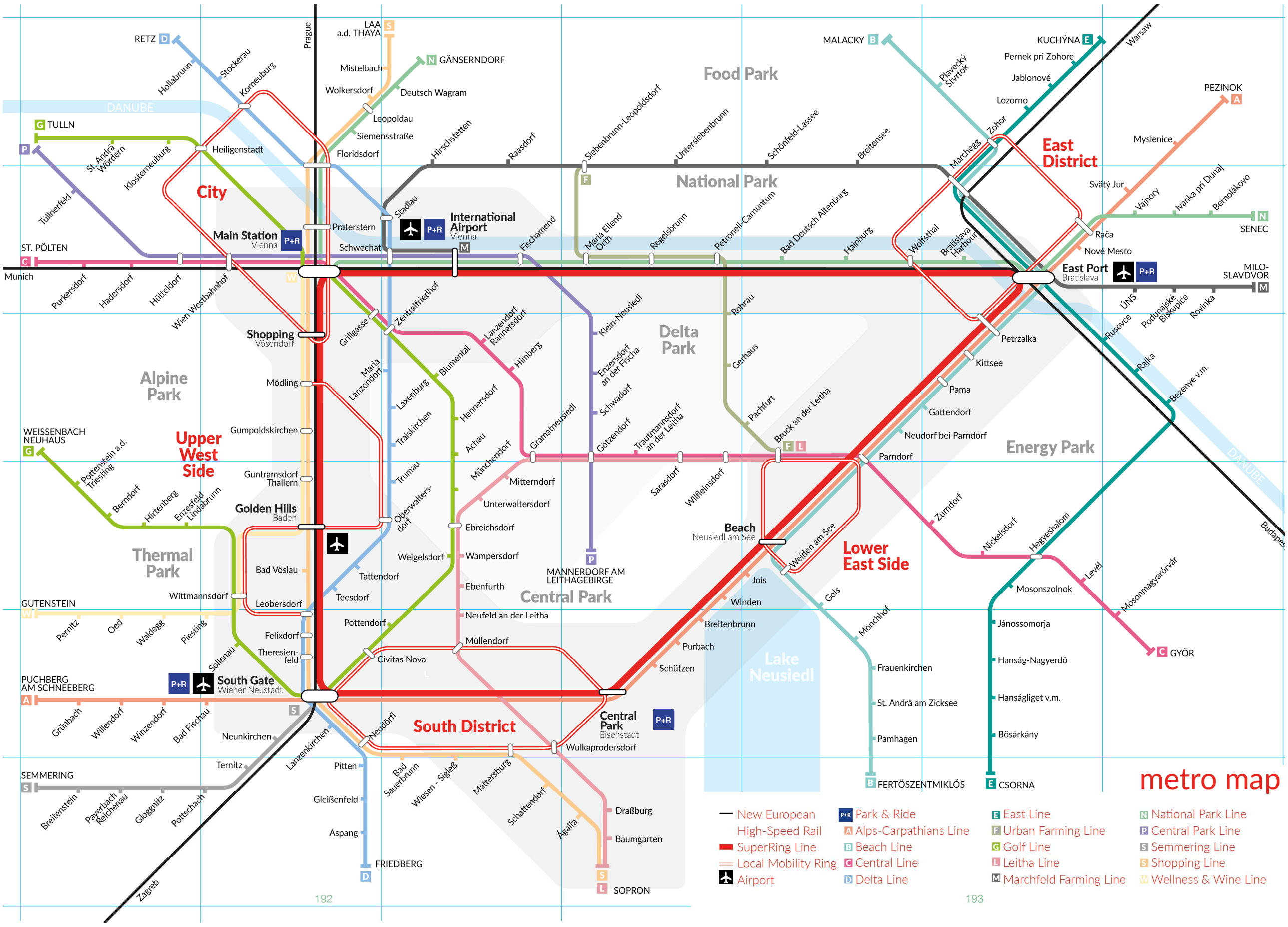

Fig. 2: SuperWien Metro Map showing the network of the SuperRing.

Questions such as “Where does our food come from?”, “How to manage growth?” or “Is there a centre?” serve as a guideline to understand the respective area as a functional urban region with multiple layers that fulfill different purposes but show a high degree of interconnectedness. Typical spatial patterns and phenomena are recontextualised through atypical images such as the Metro Map (see Fig. 2), leading to a new understanding and a striking re-branding of the metropolitan area and its hybrid urban landscape. SuperWien Metropole thus becomes a radical idea generator for planners and municipalities as well as their residents who inhabit this common living space.

3 THE METROLAB APPROACH

3.1 From Creative Vision Building to initiating a Metropolitan Dialogue

The creation of this alternative vision for the SuperWien Metropole followed the intention to provoke a discussion about metropolitan development across administrative borders and beyond encrusted institutional structures and planning approaches. This ambition gave rise to the MetroLab[5], which serves as a common starting point from which interdisciplinary and cross-sectoral connections are spun onwards and a broader process of integrated metropolitan development is envisioned. As a Metropolitan Think Tank and Consulting Service, the MetroLab advocates for a new type of metropolitan planning, which as a discipline of practice promotes a co-creative and dialogue-oriented urban planning and design approach.

As a first step, our team has launched an International Dialogue on Metropolitan Planning – a series of public events, so called MetroLab Forums, each of which is devoted to a specific topic of metropolitan planning and development and offers a varied program of interactive and discursive formats. Taking up the approach of translocal learning, an exchange of knowledge on best practices and instruments of metropolitan planning and development takes place by means of international lectures. Whether and to what extent the various

[5] MetroLab is a cooperation between the partner offices Superwien urbanism and CoCo architecture, was founded in 2020 and is currently supported by the Vienna Business Agency (“Vienna Calling: Creatives” funding programme): http://metrolab.design/

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approaches and innovative tools presented can be transferred to the Viennese context of city-regional development is then discussed in panels with local experts.

The first MetroLab Forum #1 METRO on the topic of the future of metropolitan mobility was kicked-off in autumn 2020. The presented international examples, such as the transformation of Barcelona's Metropolitan Avenues into a sustainable mobility network or the Grand Paris Express, Europe's largest infrastructure project establishing multimodal hubs in the Paris region, showed that cross-border cooperation is key to drive urban transformation along mobility links. Especially when it comes to creating new metropolitan centers within a polycentric network, mobility is an essential part of the integrated development of a city region. However, transforming our mobility system and rethinking mobility infrastructure is strongly linked to processes of social change, and, thus, awareness building is an important component of a transition towards an ecologically just city region.

Also the second MetroLab Forum #2 GROWTH, which was dedicated to the question of how to manage urban growth, gave valuable insights into international good practices and reflected on how to use them in the context of the SuperWien Metropole. The contents were deepened by the Urban Design studio "MetroLab Growth" organised in cooperation with the Urban Design Institute of the Vienna University of Technology. Examples from the Netherlands, France and Switzerland (among others) highlighted the importance of metropolitan narratives and intra-regional strategies that must be followed by place-based solutions in order to coordinate urban growth. Moreover, the need to integrate (more) co-creative approaches into metropolitan planning practices was discussed among international and local panelists.

These first MetroLab Forums[6] will be followed by two more events (in autumn 2021) on resilient metropolitan landscapes and the question of how to establish cross-border governance structures and create a common metropolitan identity.

3.2 From International Dialogue to Local Action

Building on the valuable experience gained from the International Dialogue on Metropolitan Planning and learning from various projects in different metropolitan areas all over the world, the next step will be to get to the heart of the vision of the SuperWien Metropole and translate it into sustinable local strategies and actions. The central findings of the MetroLab Forums serve as a basis for focusing more strongly on the case study of Vienna and concretizing this overarching vision at the local level. Thus, the MetroLab aims not only to remain on a theoretical level and discuss among experts, but, to initiate a direct exchange with residents as well as decision-makers from different municipalities within the metropolitan area.

In the framework of a traveling exhibition along the "SuperRing", presenting striking visualizations of the idea of an integrated SuperWien Metropole, the vision is to be spread within the cross-border city region Vienna – Lower Austria – Burgenland. Stopping in several municipalities, the goal is to jointly reflect on questions of which role the respective place can play within the metropolitan area and what potentials, as well as risks are being expected from such a visionary image of an intertwined city region.

The interactive exhibition provides insights into the morphological and functional development of Vienna's metropolitan region and raises forward-looking questions – e. g. "What is the limit of growth and how can it be managed?", "How are decisions made?", "How will we move in the future?", or "How can natural space be integrated into our daily lives?". Using an online survey, visitors are invited to relate to their current lifestyle and answer these questions from their own perspective.

By presenting the traveling exhibition in public spaces near train stations, its provocative visionary images not only encourage people to imagine what future cross-border spatial development could look like, but also point to the importance of a coherent transportation network as the backbone of metropolitan development. In combination with the exhibition, co-creative workshops will be conducted onsite focussing more on the local situation and breaking down the overarching, visionary future image of the SuperWien Metropole. Against the background of current spatial developments, the main focus will be on the question of what significance and role the respective municipality will have within the overall city-regional context and to what extent it can benefit from inter-municipal cooperation. For example, what does the vision of the

[6] Their main results are documented and deepeneed in the printed and online editions of the MetroLab Magazines which give valuable insights, for example through interviews with local experts from the fields of urban planning, sustainable mobility and transport planning or housing etc., the magazines are available on the website: http://metrolab.design/

SuperWien Metropole mean for the spatial, social, economic and ecological development of the municipality? Under what conditions can it take advantage of this cross-border perspective and where do the concerns lie? And to what extent can the overarching vision be integrated into local planning policies and processes?

Fully aware of the fact that the vision of the SuperWien Metropole is somewhat provocative and utopian, we persue the intention of spreading the idea of an intertwined and strongly connected agglomeration to gain a better understanding of the extent to which the image of a cohesive urban region can be anchored at the local level. By putting a strong emphasis on the close cooperation of disparate partners, we aim to not only break with existing administrative borders, but also with divisions of competences. Therefore, representatives of politics, administration, planning and civil society are invited to discuss the role of their municipality within the metropolitan area and create their own image of the future, taking into accout the overall metropolitan vision. In this way and with the help of different co-creative tools, incentives are to be provided to initiate inter-communal projects.

3.3 Creating a Toolbox for Metropolitan Development

The specific MetroLab approach outlined in this paper using the SuperWien Metropole case study aims to explore the interplay between the development of comprehensive visions and strategies on a metropolitan scale and the identification of place-based solutions on a local scale. This goes hand in hand with the idea of strengthening cross-border cooperation within a well programmed polycentric network, shaped by the unique potential and special role of all spatial units. Therefore, multi-level governance structures based on horizontal networking and vertical connectivity are key to strengthen intra-regional synergies.

To meet common challenges of sustainable development in metropolitan areas and to support integrated multi-level governance mechanisms, the MetroLab works with an elaborated Toolbox for integrated metropolitan development and planning that can be applied to different metropolitan areas affected by similar transformation processes. This expandable MetroLab Toolbox results from the experiences of previous projects[7] and is constantly tested and extended in the context of current projects. It is a very flexible set of co-creative and dialogue-oriented planning instruments and builds on a generalized planning process which can be divided into three phases, each followed by a specific outcome (see Fig. 3). Depending on the needs, different tools can be used in one or more phases.

3.3.1 Phase 1: Creative Vision Building - understanding metropolitan phenomena to create a new image of the functional area

Creative vision building aims to understand and reinterpret metropolitan phenomena. It creates the basis to develop cross-border strategies and a new image and identity for the metropolitan area. The outcome of this first phase is the visionary representation of the functional urban area through various forms and media such as art installations, printed media, exhibitions etc. To enable a new understanding of the space a set of research, analysis and presentation tools supporting the collection, interpretation and visualisation of data can be applied.

3.3.2 Phase 2: Metropolitan Dialogue - discussing metropolitan strategies by initiating a dialogue between stakeholders

Taking the creative vision as a starting point, the aim of the metropolitan dialogue phase is to collectively discuss and develop a comprehensive metropolitan strategy including the identification of emerging topics. By initiating a dialogue between decision-makers, planning authorities, city administration, urban researchers and designers as well as external (international) experts, a creative knowledge exchange is established. In the long term, this platform can continue to exist as a wider cross-sectoral and interdisciplinary network.

[7] For example, we build on experiences from our projects in Austria as well as in Latin America and the Caribbean: KREBS, Roland; TOMASELLI, Markus: Urban Design Lab Handbook - Dialogue-Oriented Urban Transformation Processes and Practical Approaches from Latin America and the Caribbean. Jovis Berlin, 2019.
ANDEXLINGER, Wolfgang; KRONBERGER, Pia; MAYR, Stefan; NABIELEK, Kersten; RAMIÈRE, Cédric; STAUBMANN, Claudia: TirolCITY. New urbanity in the Alps. Folio Verlag Bozen und Wien, 2005.

3.3.3 Phase 3: Local Action - translating metropolitan visions into sustainable local strategies and actions

Translating the metropolitan strategy into local action is the goal of the third phase. In addition to the stakeholder involvement during the Metropolitan Dialogue, it aims to strongly engage the local community to co-creatively develop Local Action Plans. This should not only stimulate the implementation of first temporary interventions, but also give long-term perspectives. This results in identifying with the overall metropolitan vision and at the same time contributes to local empowerment and capacity building.

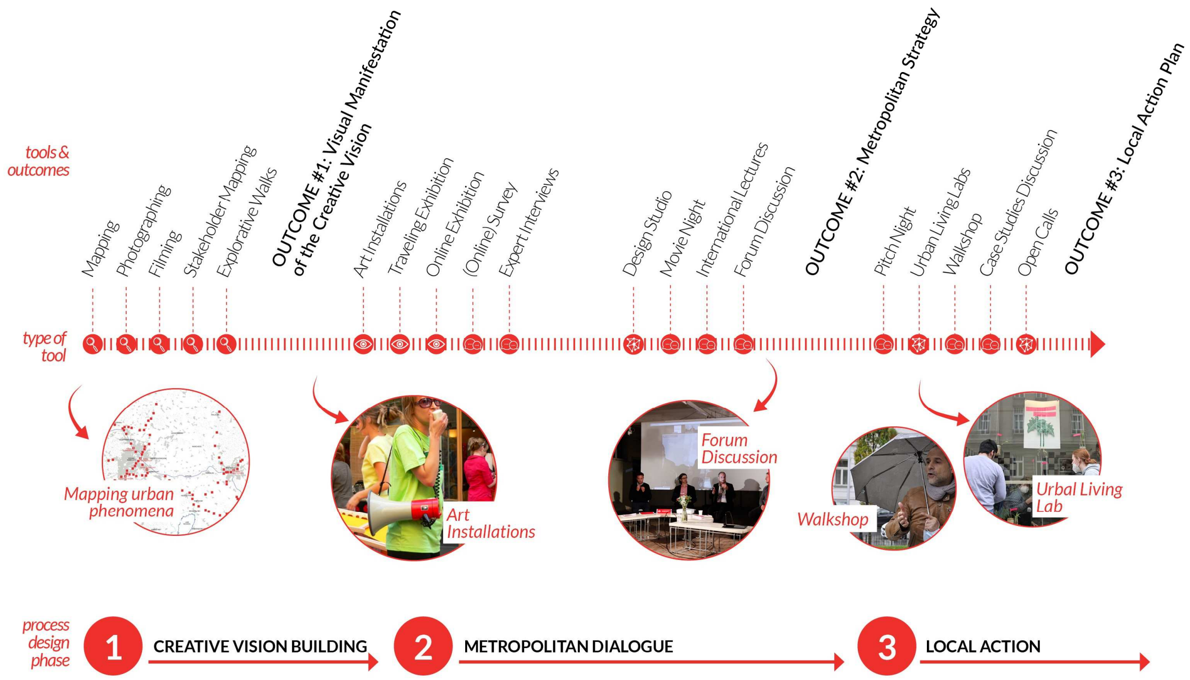

Fig. 3: MetroLab Toolbox in action

The different tools included in the toolbox can be flexibly combined in various ways and are roughly clustered according to these three phases of process design, although some tools can also be applied to all phases. The multifunctional Toolbox, which is an integral part of MetroLab's research and application-oriented approach, consists of research and analysis tools, presentation tools as well as interactive and dialogue-oriented tools. Accordingly, the different types of tools are used for various purposes: researching and analysing, presenting as well as stimulating dialogue and co-creating metropolitan visions, strategies and actions.

Finally, the MetroLab Toolbox can be adapted to the specific needs of city regions, districts, and municipalities, and yet is able to address metropolitan wide urbanization and sustainable development challenges such as jointly designing and managing urban growth, coordinating land use and transportation projects. By recognising the need for tailored solutions and applying it in a targeted way, we can succeed in qualifying the periphery of urban regions as new urban landscapes contributing to an overall territorial balance and sustainable futures for all places and their inhabitants.

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Mobility Measures for Residential Buildings in Urban Areas – a Promising Investment?

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1 ABSTRACT

Numerous scientific studies prove that urban design and the transport system influences people´s mobility behaviour. The range of infrastructure and mobility services in the direct vicinity of residential areas plays a certain role, because 80% of all daily activities start and end at home. In practice, it can be observed that the integration of mobility measures is becoming increasingly important in the planning of new housing developments, but at the same time little is known about the actual effects that mobility measures have on residents. Due to the lack of evaluation, it is difficult to assess to what extent those measures, such as high-quality bicycle parking facilities, free public transport tickets for residents, car and bike sharing or parcel stations within a housing complex, are target-oriented and can be seen as promising to encourage people to adopt a more environmentally friendly mobility behaviour.

As part of the diploma thesis "Integration and impact of mobility measures in the housing sector for the promotion of environmentally friendly mobility", mobility surveys were conducted with residents of several new housing developments in Austria (Salzburg/Vienna) in spring 2020. With the example of the neighbourhood "Quartier Riedenburg" (Salzburg) – a recently completed residential quarter with a wide range of mobility services – this paper provides first-hand information about which mobility measures are particularly important for residents. A comparative study of the actual mobility behaviour of the residents before and after they moved to Quartier Riedenburg is set out in this paper. For the first time scientific evidence of the impact and relevance of mobility measures in residential areas is proved.

Keywords: Mobility measures, housing sector, mobility survey, mobility behaviour, environmentally friendly mobility

2 INTRODUCTION AND MOTIVATION

In recent years, the integration of mobility measures in the planning of new housing developments has received greater attention. In Austria for instance, it can be clearly noticed, that the number of newly developed neighbourhoods with a focus on additional mobility infrastructure and mobility services is steadily increasing. Since scientific studies prove that urban design and transport systems have effects on people's mobility behaviour (e.g. Koszowski et al., 2019 or Ewing & Handy, 2009), there is high expectation that mobility measures in the direct vicinity of the residential areas have the potential to motivate residents to adopt a more environmentally friendly mobility behaviour. At the same time, however, hardly any research has been done to determine which of these measures are actually effective and seen as useful by the residents. There is huge demand for evaluation pointed out by all stakeholders (e.g. municipal administration, housing developers, architects, mobility providers…). More clarity on this topic is highly requested. Seeing this gap in research, the goal of the study was to get a clearer picture of mobility measures in the housing sector and their effects on daily mobility to derive recommendations for appropriate measures for new developments. This paper will focus specifically on the results of the mobility survey of Quartier Riedenburg (Salzburg), which was one of the study areas.

3 MOBILITY MEASURES FOR THE HOUSING SECTOR

There is a solid number of publications available to the public describing the most common mobility measures for the housing sector. Therein, measures address different means of transport varying from entirely infrastructural measures on the one hand to informative, service and incentive measures on the other. (Köfler et at., 2019; De Tommasi et al., 2014; Franz, 2019; Gehl, 2016; Braun/Reiter, 2016; Bai et al., 2018)

Figure 1 provides an overview of the most commonly used mobility measures in practice, differentiated by means of transport and by complexity of the measure (Krombach, 2020).

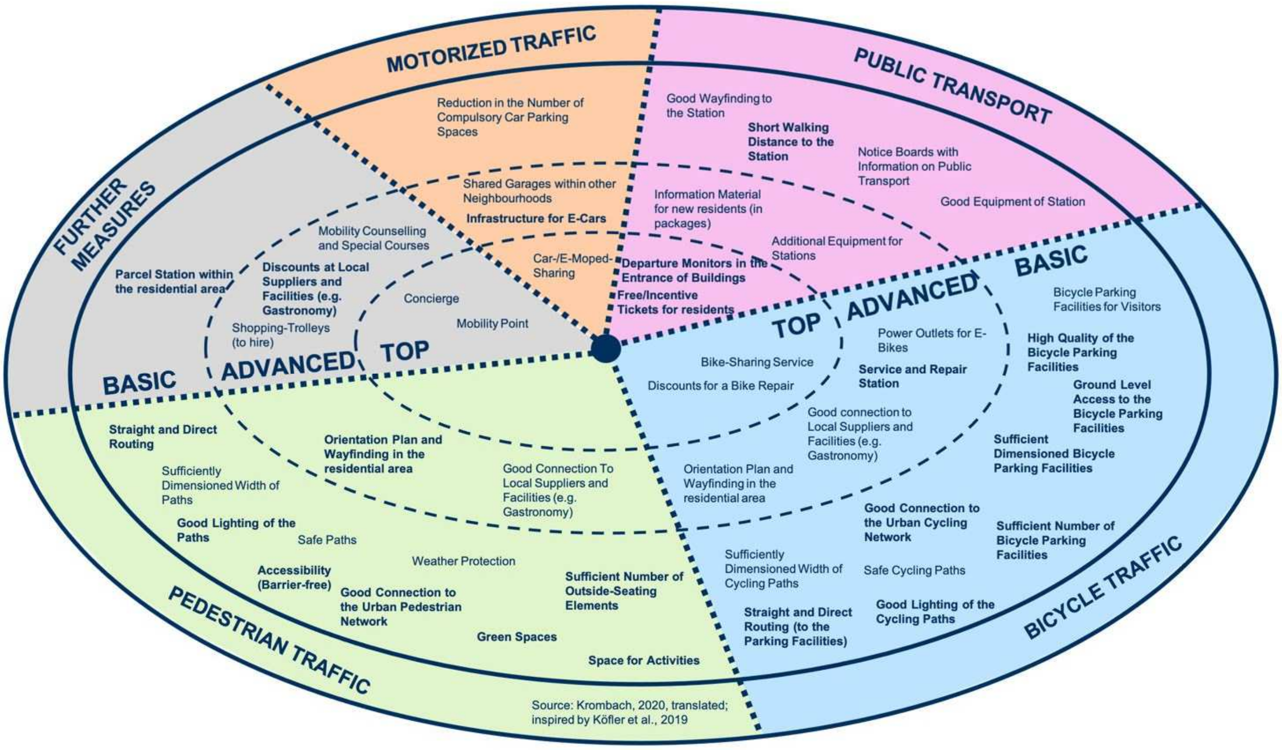

Fig. 1: Mobility Measures in the housing sector; Source: Krombach, 2020, translated; inspired by Köfler et at., 2019

4 STUDY AREA

The recently completed (2018/2019) neighbourhood Quartier Riedenburg (QR) is centrally located at just 1 km distance from the historic city centre of Salzburg. Quartier Riedenburg has 316 flats accommodated in 22 residential buildings, out of which 18 were developed by a subsidised housing company and four by a privately financed housing company. The area was chosen as an ideal study area since it offers a wide variety of mobility measures. This includes a car-free area in the centre of the residential area, a spacious park area open for the public and a uniform wayfinding and signage system within the residential area. In terms of bicycle infrastructure, there are more than 800 high quality parking spaces for the residents ranging from barrier-free inside parking spaces located in the entrance areas of the buildings to underground parking facilities (access by ramp or lift) as well as lockable bike pavilions. Furthermore, the neighbourhood has an excellent connection to the public transport system as a bus station is nearby. In terms of car parking, a shared underground parking garage was built for the neighbourhood. There has been a reduction of the number of compulsory car parking spaces. Additionally, there are also parking spaces for electric cars in the neighbourhood. (Krombach, 2020)

5 MOBILITY SURVEY

5.1 Preparation and organisation

In March 2020 a mobility survey was carried out in Quartier Riedenburg, targeting all residents aged over 18 years. Based on mobility questionnaires, such as "Mobility in Cities – SrV" (Hubrich et al., 2019) and "Active Mobility: Better Quality of life in Metropolitan Areas" (Gerike et al., 2020) a comprehensive questionnaire in paper format was developed, covering questions about the resident's mobility behaviour before and after moving to Quartier Riedenburg. By comparing the results, it was possible to draw conclusions on whether there were actual changes in mobility behaviour after moving to a residential area with a wide range of mobility measures. Furthermore, participants were also asked to rate mobility measures by their importance. (Krombach, 2020)

5.2 Realisation and Data Processing

Since a full survey was intended to be carried out, all questionnaires were handed over at the residents' front doors. Completed questionnaires were returned by residents via return boxes that were installed in a central location within the residential area. To increase the response rate, an advertisement strategy with posters, website and an information day were pursued. Furthermore, there was email support as well as a telephone hotline available to all participants. Due to COVID-19 measures (lockdown) the face-to-face distribution of questionnaires had to be terminated from mid-March 2020 onwards, which resulted in a lower sample size than originally expected (see table 1). (Krombach, 2020)

Moreover, several drop out stages (see table 1) occurred over the course of the survey, which further reduced the sample size. These included Unit-Nonresponses, when residents could not be reached at their doors, did not return their questionnaires or when questionnaires failed the plausibility check. Item-Nonresponse resulted when there were individual answers that dropped out due to a lack of plausibility. (Steinmeyer et al. 2012; Hubrich, 2017)

	Quartier Riedenburg, Salzburg
Number of all Residents aged above 18 years living in the residential area	Number not available to the public **(Number of Households: 316)**
Number of Questionnaires handed over (at front doors)	**229 Questionnaires** (handed out to 140 households)
Number of Returned Questionnaires	**82 Questionnaires** (= 54 households reached)
Usable Questionnaires (after plausibility check)	**82 Questionnaires** (= 54 households reached)
Response Rate: usable questionnaires in relation to all questionnaires distributed	**36 %**
Response Rate: usable questionnaires in relation to all households living in the residential area	**17 % of all Households reached** (approx. every 6th household)

Table 1: Response Rates of the Mobility Survey; Source: Krombach, 2020, translated

Overall, woman made up nearly two thirds (67 %) of the survey sample of residents of Quartier Riedenburg and men made up one third (33 %). The majority of all respondents moved to Quartier Riedenburg in the first year after the completion of the residential area (73 %). In terms of age distribution 32 % of all respondents are in the age group of 31-40 years, in comparison to the age groups of 18-30 years (24 %); 41-50 years (17 %); 51-60 years (13 %) and the group of 60 years and older (14 %). The majority of respondents live in a two-person-household (43 %), followed by 22 % who live in a single-household. (Krombach, 2020)

5.3 Effects on Mobility Behaviour

The results of the mobility survey show that the mobility behaviour of the participants changed after they had moved to Quartier Riedenburg in favour of a more environmentally friendly mobility behaviour. In general, there has been an increase in walking, cycling and in the usage of public transport while car usage has dropped (see table 2). (Krombach, 2020)

		Quartier Riedenburg, Salzburg (n_{max}=82)
Car Ownership: car per household (before and after the move)		1,34 → 1,06
Bicycle Availability: percentage of people who have access to a bicycle (before and after the move)		87 % → 82 %
Ticket Ownership: percentage of people who are owner of public transport season cards (before and after the move)		33 % → 34 %
Changes in Overall Mobility Behaviour: Frequency of daily use (Tendency after moving to the new neighbourhood)	by foot	Increase
	by bicycle	Increase
	by public transport	Increase
	by car	Decrease
General Usage of Shared Mobility Services: car or bike sharing		Before and after the move: (almost) no usage

Table 2: Mobility Behaviour Before and After Relocation; Source: Krombach, 2020, translated

Moreover, it can be highlighted that the number of cars owned by a household dropped from 1,34 to 1,06. Although the average availability of bicycles slightly decreased (-5 %) after the relocation, it must be

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emphasized that the percentage is still at a very high level. This may be because Salzburg is generally known to have good conditions for cycling (City of Salzburg, 2017). Regarding the ownership of season tickets for public transport, the percentage did not change significantly after the relocation. Finally, shared mobility services, such as car and bike sharing, seemed to be insignificant since there was (almost) no usage before and after the relocation to Quartier Riedenburg. (Krombach, 2020)

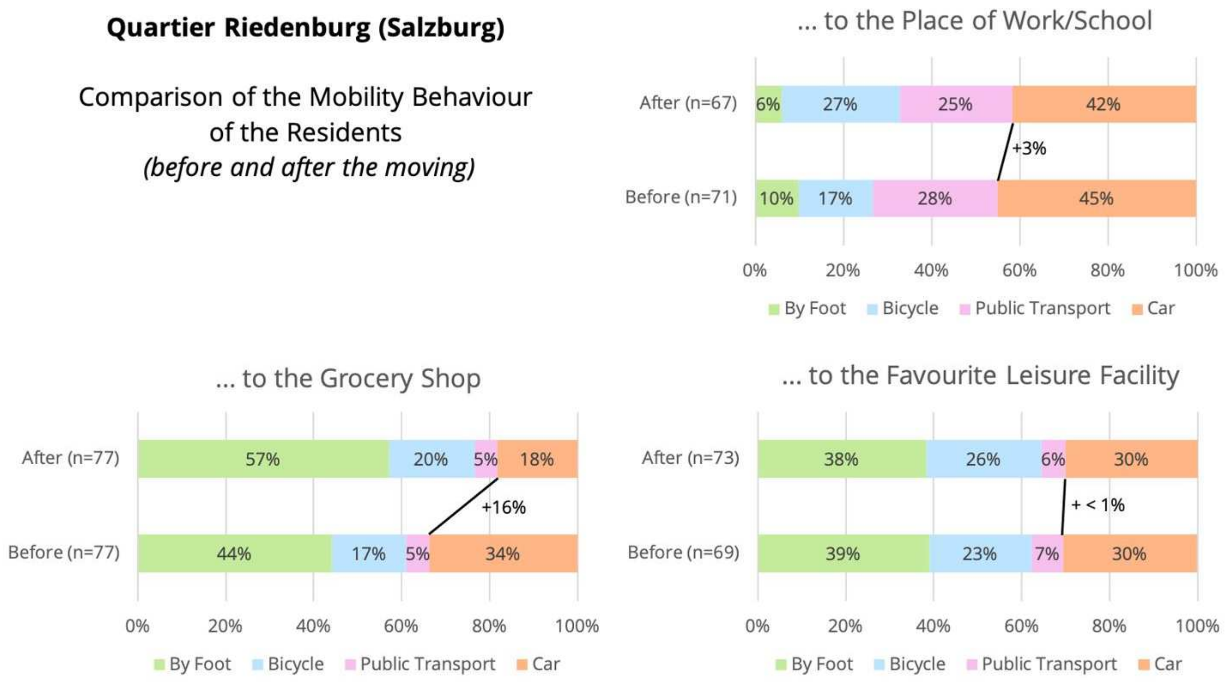

Fig. 2: Mobility Behaviour of the Residents of Quartier Riedenburg; Source: Own illustration, data from Krombach, 2020, translated

Figure 2 provides more details on the chosen means of transport differentiated by the journey destinations. It is clearly noticeable that the greatest shift in favour of environmentally friendly means of transport happened on journeys made in the immediate vicinity of the residential area (+16 %). This contrasts with journeys to the workplace or to school as well as to the favourite leisure facility, where there were only small changes in mobility behaviour measureable. (Krombach, 2020)

5.4 Rating Individual Mobility Measures

The second part of the mobility survey was dedicated to the importance of individual mobility measures. Therefore, the survey participants were asked to rank mobility measures by importance varying from 1,00 (not important) to 4,00 (important). (see figure 3)

Almost all pedestrian traffic measures were ranked (rather) important by the participants of the survey. With a mean value of 3,71 green spaces are especially important for residents. With regard to cycling, the seamless urban bicycle network access as well as quantity and quality of bicycle parking facilities are seen as essential by the survey participants. In terms of public transport measures, good connection to a nearby public transport stop was ranked outstandingly high. With a mean value of 3,74 this measure was the overall highest ranked measure. Considering motorized transport, only e-charging stations were viewed as rather important. In terms of future potential measures, parcel stations within the residential estates were stressed by the participants. Measures with less importance for the residents were sharing mobility measures (car, bike and moped sharing) as well as information packages for new residents and shopping trolleys for hire. (Krombach, 2020)

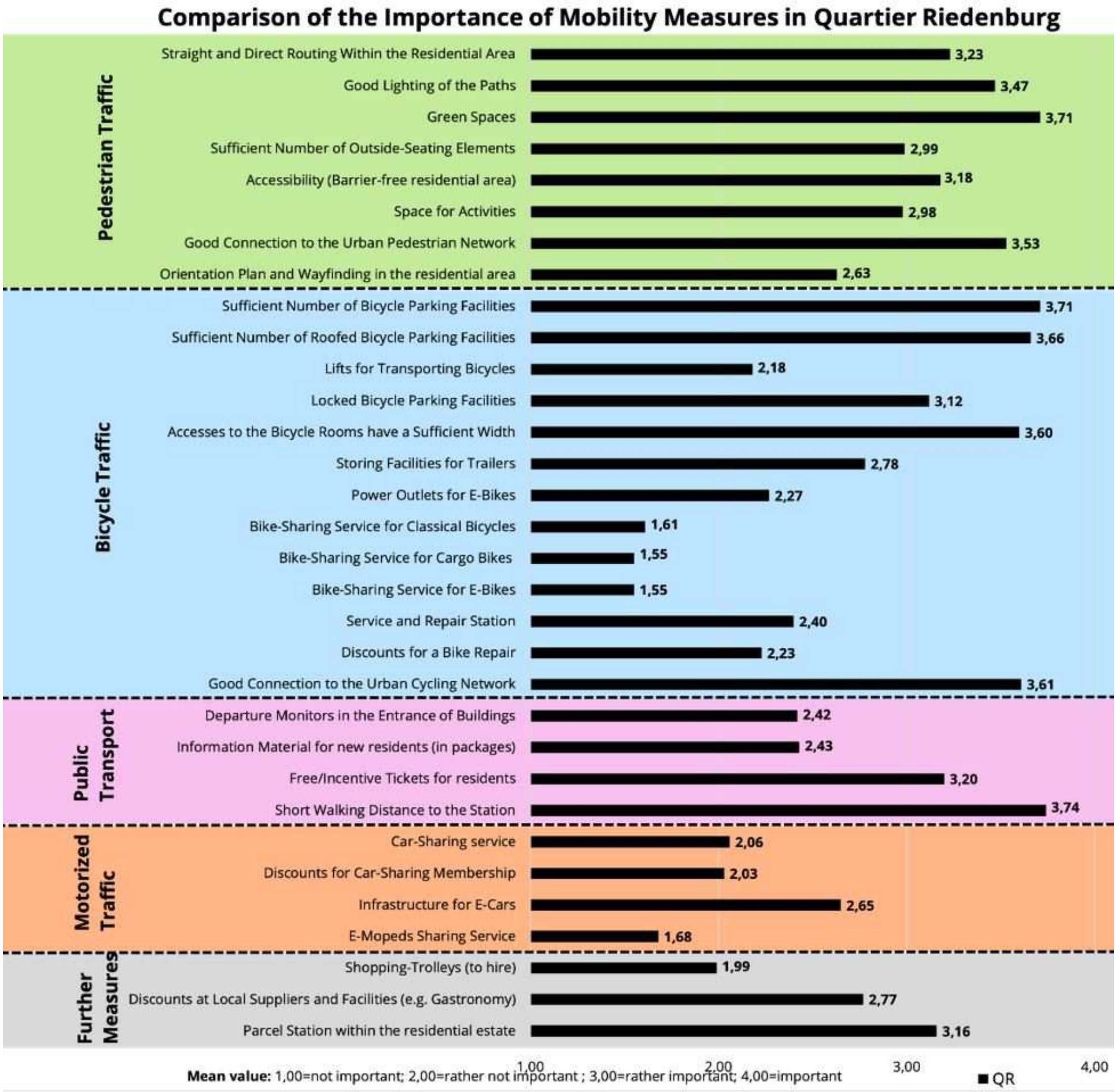

Fig. 3: Comparison of the Importance of Mobility Measures in Quartier Riedenburg; Source: Own illustration, data from Krombach, 2020, translated

6 CONCLUSION

With the diploma thesis (Krombach, 2020) the impact and relevance of mobility measures in residential areas was comprehensively analysed for the first time. The presented survey results on Quartier Riedenburg (Salzburg) show that with the relocation into a neighbourhood with additional mobility infrastructure and services the mobility behaviour of new residents has shifted in favour of a more environmentally friendly mobility behaviour. It led to an overall increase in walking, cycling and public transport use while the car usage and the number of owned cars on the other hand declined. A more detailed examination of the choice of means of transport revealed that the journeys in the immediate vicinity of a residential area are the ones which have the highest potential in terms of shifts to a more environmentally friendly mobility behaviour.

The comparison of the importance of individual mobility measures gives first-hand information on which measures are considered as promising by the residents and should be kept in mind when planning new housing. Within this study it is shown that (nearly) all pedestrian traffic measures, especially green spaces, are ranked highly. In terms of bicycle traffic, the connection to the urban cycling network as well as the quantity and quality of parking facilities are important. The overall most important mobility measure in the ranking turned out to be the availability of and proximity to public transport stops. Furthermore, infrastructure for electric cars and parcel stations within the residential areas are the measures considered to have future potential, whereas sharing mobility measures turned out to be insignificant for the residents.

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Once Upon a Time a Genius Loci Conceived a Place

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1 ABSTRACT

Amongst the concepts employed in urbanism perhaps the most magical is genius loci. This paper, initially, will briefly recall some basic postulates of the old Roman concept, calling the published works of one of its more enthusiastic authors, Norberg-Schulz. Next, it will focus on the Real Corps 2021 call for papers statement that 'more than 6 billion people will live in cities in 2050', together with 'how quality of life can be maintained and improved' in this situation. On perusing about creating habitats for the Third Millennium, the paper observes two of the actions most typically employed in the changing cities realm. These practices usually comprise two remarkably simple actions: inventing and reinventing places – preferably in locations blessed with a touch of genius loci. Place is certainly my most challenging subject in contemporary urbanism, and recent literature in the topic is prodigal in presenting practical examples of the two circumstances, examining them as 'placemaking', in the case of inventing new places; and 'resilience' of disused spaces, in the case of reinventing them. In my personal writings I have observed both thoughts, trying to appraise them under two of the consequential configurational patterns they will tend to assume: punctuated creations and punctuated re-creations. As for their morphological results it will be enough to recall the insertion of newly invented places, so typical of postmodernist interventions; and to the reuse of existing structures such as old brownfields, also typical in postmodern environments. Sustainability and resilience are clearly implicated in both circumstances, surely encompassing beneficial accomplishments in terms of enhancing the environment, such as to refrain urban growth from land sealing and to control urban sprawl. Finally, the paper will also address trendy planning strategies studied in contemporary literature through ground-breaking strategies known as: 'Loose space' (FRANCK; STEVENS, 2007), 'Tactical urbanism' (LYDON; GARCIA, 2015), some new phenomena I personally call 'placeLeaks' (THWAITES et al., 2013), and innovative reflections about urban transformations in global cities (such as London) (ALLIES; HAIGH, 2014) and on the global south (such as Porto Alegre, south Brazil, exploring a recent project under the guidance of Jaime Lerner's team).

Keywords: sustainability, placemaking, genius loci, place, resilience

2 A MAGICAL CONCEPT

2.1 To make practical towns and buildings is not enough

When we truly realise that one of architecture's most important basis is to understand the vocation of the place where it will happen, as says Norberg-Schulz (1980) when investigates the concept of genius loci, we have no alternative but to allign our minds with it. Genius loci can be considered a magical concept, once it makes this happen. In an unprecedent pandemic situation as lived today, we come to this exact feeling: we have to change our minds, we have to reconsider the way we plan and build. If we do not recognize that we are an integral part of the environment, as we did the last decades if not centuries, we will not get out of this human alienation and consequently environmental disruption. Therefore our daily lives will hopefully bring us back to a natural balance, once our surroundings get balanced. When we regain the consciousness of the spirit that inhabits us and the spirit that vibrates in a place, this balance should prevail. For this to happen, a deeper perception is needed and an holistic view of our existence is necessary, in order to achieve the quality of living we are in need of, to really reach the level of correspondence between man and environment that is necessary. One major point is that we have to learn to live well right now, with the conditions we have at the present moment– and this comes up from two main thoughts: only when we are able to think positively about today we can imagine and plan even better conditions now and in the future. And to feel good today it is a sine qua non condition to be aware of who and where we are, to experience the important belonging feeling, to know the spirit of the place we live in or we want to work with, to recognise the genius loci that will enable a coherent place to be then conceived. That is why it is a magical concept – it can change everything, starting with the way we observe and open up our minds to relate with the world in a sensitive way. In an holistic and not only analytical mode of consciousness. It is a different way of observing, characterized by active seeing instead of passive reception of visual impressions – according to Bortoft (1996) in Goethe´s

Scientific Consciousness. To build practical towns is not enough, they must allow for a healthy way of living, that means caring about each item that composes our well being as, for example, social interaction and climate comfort.

2.2 Troubles with the Anthropocene

The problems and difficulties we are living in the Anthropocene are directly related to the perception crisis we find ourselves now, shown through our disconnection with the natural world. Starting with what we eat (packaged, frozen, fake food), passing by to where we look at the whole day (artificially iluminated rooms, computer and cell phone screens), ending at the allienation we experience in our daily lives, with no identification to the place we experience. This makes us insecure, fragile and depressive. In sum, this brings our lives to a very poor quality as a whole. The big question is how this quality can be improved and maintained? It seems clear that changing the points above mentioned is a considerable good start. We need options for healthier and local eating, for more nature in our everyday activities and for more connections and relations to what really composes our world – other people, animals, plants, sunlight – in short, recognizing the spirit that runs through everything in a place – its genius loci. The interesting fact is that it is not fixed. It changes according to the seasons, to the time of the day, to the alterations man-made presence imposes and to the situation we are now immersed. When we have this in mind we can see how the two most tipical actions practiced in order to change the cities realm can happen: by inventing and reinventing places. This is where our different ways of perception come to scene, when we are able to again perceive the subtle characteristics of a place, and be touched by it. We are consequently moved from a lethargic survival situation to a conscious proactive action on our own behalf.

2.3 The Third Millenium

It is the view of many that places are the salt and pepper of a city, pleading for the production of cities well seasoned with places morphed through experiences motivated by perceptual stimuli – as we run into the third millenium, this is fundamental. That is why ‘places’ is one of the most challenging subjects in contemporary urbanism. Inventing new places within the existing city and also bringing new meanings when re-inventing places in desuse are the most interesting ways of increasing the quality of life in cities in a relative shorter period of time. They are also relevant solutions when we face the problem of disorganized growth and problematic cities’ sprawls – which implicate in lower quality of living because of unexisting infrastructures, the need of more transport possibilities and for sure the insane destruction of the nature we see occuring in many urban peripherical areas nowadays. Sustainability and resilience surely encompass beneficial accomplishments in terms of enhancing the environment, in new created places and in the reuse of existing structures such as old brownfields, which are also frequent in postmodern environments. The reuse of old structures not only for living and working but also for pleasure, as well as letting the genius loci of a place revive in a natural way (filling in the lack of greenery for example) are very interesting ways of achieving the purpose of sustainability – besides the fact of bringing creative new spots in densified cities. Resilience then comes up when blue-green infrastrucutres replace gray, fixed, high maintenance ones, with the introduction of vegetation, uncovering water courses and depaving areas that do let natural flows run and even decreasing heat islands within the cities. To protect and conserve the genius loci of a place in fact means to concretize its essence in every new historical contexts. And to concretize it can mean not only to build but also to turn visible to our senses what that place has and brings from its interior.

3 TRENDY PLANNING STRATEGIES

To be successful in this new era, planning strategies must call for actions that bring together resilience, sustainability and vivid experiences. Contemporary literature contribute with innovative concepts that are obtaining good results: the concepts of loose spaces, tactical urbanism and placeLeaks. These kind of hints for new projects and experiments are now more common and show promising effects. The concept of loose spaces is exposed in a book edited by Karen Franck and Quentin Stevens (2007), bring new possibilities for public living, where the notion of looseness considered relative and sometimes ephemeral is a big contrast to regulated and under pressure organised places. Its social environmental psichological approach shows how life can take place in most varied places and most different moments, when it meets the possibility. This is an example of how to live better, happier, with what we have now. The concept of Tactical Urbanism embraces the idea of short term action, long term changes, brings at the same time a different way of seeing/using/living places as well as revises the idea that something quick and easy can not be effective, confirming that small scale actions can serve to larger purposes (LYDON;GARCIA, 2015). When the purpose is to increase life quality in big cities, it is for sure a fertile field for creative ideas and flexible responses to problems that pop up every minute in urban aglomerations. It is possible to find a different method for developing local resilience, when citizens and government simply talk and match their priorities, releasing the tension normally existing between bottom-up and top-down initiatives. It is about the process, about learning, testing, improving and expanding limits of design. One of its major qualities can be mentioned as being responsive – the need is there and the right observation of the context (or the place itself, or its genius loci!) can bring the response to it in a very clear and objective way. Lastly, bringing into light the topic of placeLeaks (THWAITES et al., 2013) it has to do with a phenomenon recently observed in modern metropolises which refers to the spreading of environmental stimuli emitted by the energy of a place that somehow leak into its adjacent spaces, thus opening opportunities for the creation of a new place.

These three new approaches are important because they build up new connections to existing and to new places, solving old deadlocks with new ideas. Making citizens to identify themselves with the environment offers a remarkable gain and an essential feeling for a stronger existential foothold in our uncertain world of today.

4 REFLECTIONS ABOUT URBAN TRANSFORMATIONS IN GLOBAL CITIES

Yes, it seems there are newer and friendly ways to face the urban troubles of the Anthropocene. It also seems that some of the approaches are already advancing in global cities. This is not difficult to recognize when watching new phenomena that go along with urban transformations occurring in some of these cities. Whilst most of them deal with important changes in urban planning and in urbanism principles, they usually do not require more than just an strategic head start, typical of a simple urbanism without effort move to a more radical, though spontaneous, corollary of a placeLeak. It seems relevant to highlight that notwithstanding the differences, most of the changes display a certain allusion to the mystical manifestation of an innate genius loci.

The more we become conscious about the importance of our settlements being organically related to the environment, the more successful and pleasant the results of our planning and our architecture can become. The dinamic development of our living spaces brings challenges that can be taken as opportunities, since we face them in a creative and positive manner. Knowing that a place is more than a location – that it holds an environmental character, that it sometimes expresses something not touchable but just perceptual – signifies for spaces that they hold an innate adherence to the old concept of genius loci to produce thriving metamorphoses. Our knowledge, materialized in man-made elements, transforms nature into a cultural landscape, that can enhance or dismiss the connection and the sense of belonging of someone to a determined place. If we worry about our creations being a connector, what is built can even ‘explain’ the environment and make its character evident, as Norberg-Schulz (1980) essayed to teach us. Global cities are a fruitful field for such interventions, since they hold also the biggest problems. Cities are frequently taken as the opposite of natural environment – but this can be a false assumption, specially if we consider the built environment as a process, where new and more complex relations occur between culture and nature. Even more importantly, we humans are the creators as well as the users of these relations taking place in our cities. Simone Prochnow, the co-author of this paper, got her PhD defending a thesis discoursing about the concept of Fourth Nature. This concept has been recently studied (2020) and argues about the future relation about man and nature, consequently about human perceptions and reactions facing or recognising the presence of subjective essentials in each place, in each environmental fragment, specially in big cities. How we can reconnect to it and the importance of this relation for our survival in the planet. It enhances the way we influence the scenery as well as the way it influences us, bringing up the idea that this mutual perception exists, always, we just have to open up our senses to live it. The importance of such studies is that simple actions, or better, simple changes in our actions can immediately bring quality to our lives and to our cities. The way our consciousness lead to our thoughts and the manner our thoughts create what we see is amazing. We inhabit a world of meanings, which are brought to surface by ourselves. So, if we want to live in ‘better’ cities, we must start perceiving what we already have, and knowing what we want to have next. This is where the genius loci contributes for the creation of places. It is not only about huge performances of immense characteristics – it is about everyday life, from the tree we pass by in our walkways to the park –

sometimes not even caring that they exist. It is about the famous holistic view of the world, where everything is connected and makes sense only if we expand our minds and really notice how we participate in the world we live. The supposed polarity between subjective and objective happens simultaneously since we are in the scene (KAPLAN; DAVIDOFF, 2014) and therefore we can be responsible for the genius loci outcroping. Here resides the magical touch of the concepts: the mere observation turns the ordinary into magic. Only by the fact that if we are not present to perceive it and to make it real, it has no meaning. It is an honest conversation with our own world and with ourselves, it is about reciprocity. This is where all changing begins. The place where the problems exist is the same place from where the solutions come, as a new manifestation of who is now percieving and using it. We could say that the Fourth Nature concept comes before the three other new concepts described previously, since they are 'actions' and the Fourth Nature is about consciousness.

If we are able to be conscious about ourselves, to find reasons and values within our existence, we will be able to find value and reasons in everything else, for example, our cities. Global cities are a reality, there is no doubt about it, but even if in diverse contexts and circumstances, their problems have a commom denominator: health. Human health as well as environmental health, are profoundly and totally interconnected.

Porto Alegre, as well as London, experienced a rapid urban growth in the last years. "But is now attempting to resist outward expansion in favour of regeneration from within" (Allies and Haigh, 2014, p. 10). This is typical of a resilience proccess, either in iconic buildings or in sites and contributes to the sustainability proccess.

To illustrate we can take two groups of examples, one in Europe and one in South America. In London, in an urban scale, the Tate Modern building shows a clear example of an old power station in disuse adapted into a new museum, through a light conversion. Similarly, in Porto Alegre, the old building of the Usina do Gasometro, with its iconic chimney, was preserved. In both cases, formerly isolated and derelict areas became new places of vitality and urbanity. (Figures 1 and 2). Relating to the concepts mentioned before, it is possible to observe that in both examples there are clearly manifested placeLeaks, revamped loose spaces, and also features that remind of tactical urbanism operations.


Fig.1 and Fig.2: Tate Modern in London. Usina do Gasometro in Porto Alegre.

The big lake called Guaiba, in Porto Alegre, has been neglected and disconsidered for a long time, specially in its interface with the historic center, what was really regrettable. A project recently being implemented has changed completely the area as well as its surroundings. In the so called 'Orla do Guaíba' (Guaiba Shores), it is possible to identify the three strategies mentioned above, even simultaneously. Likewise in London, the King's Cross Central is "…one of Europe's largest regeneration projects. The 24 hectare site is bordered by the new Eurostar line from france and bissected by the Regent's Canal.." (Allies and Haigh, 2014, p. 13).

For a tentative illustration of this matter simply try to add a suitable caption to the photographs in Figures 3 and 4, using the following terms, for example:

Fig.3 and Fig.4: At London's Kings Cross Central (left) and Porto Alegre's Orla (rigth) a piece of tactical urbanism without effort situated on a loose space blessed with genius loci.

People were craving for the possibility of reaching the amazing visual of the waters as well as the unique sunset show that happens because of the west orientation – something rare in Brazil (Figure 5). It was a huge loose space, in which the gatherings happened spontaneously just because of the great atmosphere that empty space already offered, despite all setbacks. Under the design of Jaime Lerner's team, the water shore was divided in three different phases for constructing. The first one is complete and the second one is almost ready too. Different pathways as well as sitting facilities are some of the new features that transformed it in a beloved place in the city. The landscape was treated in some points only, leaving the main role for the water itself and the sun. Tactical urbanism details such as expositions, allowing food trucks to be in the area, bikelanes available, brought life in a tremendously short time to the project. Obviously, a considerable leak of this place atmosphere invaded the whole downtown nighbourhood, starting with the small business close to the shore, as well as heating up the real estate development – for so many years stagnant. In this year of 2021 a new enterprise recovered part of the adjacent area (close to an also revitalised coal power station) bringing new leisure possibilities in open air places – something very substantial in this pandemic times. Unfortunately, the brownfield composed by old warehouses has not yet been revitalised, which will imply in additional area for private and public actions, activating the desire of new experiences of the majority of the city inhabitants. By now, the 19.000 square meters recently opened already created an enjoyable asset for the city to enjoy its genius loci, which became meaningful again – conceived as a real place of urbanity for the city as a whole. Many different acts and happenings take place in this new scenario, where the beautiful sunset finally recovered its value.

Fig.5: The sunset at water edge in the city of Porto Alegre recovers its value in a new scenario.

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5 CONCLUSION

It is not easy to be optimistic in pandemic times. Notwithstanding, in our field of urbanism one must keep confident as far as the future of cities is involved. This article registered some possibilities opened to the field even in difficult times. The text discussed possibilities in terms of urban planning strategies that might offer advances in urban-architectural endeavours: the management of loose space; the rise of placeLeaks; and some practices of tactical urbanism (LYDON; GARCIA, 2015). Ultimately, all three schemes involve procedures that share managerial strategies as their common determinator. In addition, contemporary times contribute with other beneficial prospects, the most precious of them obviously the one concerned with the field of social networks and its valuable contributions to the area which we call “Architecture of Places” in our research program (PROPAR).

Hannah Arendt, the German American philosopher, attributed to the public space the condition of being the specific place where people (in all its immense diversity – rich, poor, white, black, etc.) could (and should) be seen and heard. It is quite stimulating to consider that today, in the reasoning of Arendt, one can envisage that this public space would not necessarily need to be a space at all. Indeed, the public sphere (AVERMAETE et al, 2009) can take many forms. It can even take the form of a medium, it can even be a written media, a newspaper, it does not need to involve space. It can create small public spaces where citizens can think together about themes of a joint nature, of a collective nature, common, public things, their thoughts in resonance, bringing up identification and mainly, connections. This leads us to another important reflection, that a fundamental vehicle for this public sphere is located within the mass media (newspapers, TV, books), informing about ideas, demands, protests. It has the strength to bring together a lot of people, to enable people to discuss matters of public interest, to express considerations that, altogether, end up bringing a new type of place: the Internet. It is the WWW that provides conditions similar to those of the mass media and allows the generation of a public sphere predominantly a-spatial.

Today, more than ever, the space of a square or the editorial of a newspaper do not need to have a fixed spatial location. A multitude of people can be mobilized in a noticeably short period of time, capable to potentially make a huge contribution to local culture, to motivate actions, to convey information, to promote consciousness, and therefore change perceptions, minds and lives.

This is also a remarkable predicate of the contemporary city, its unique a-spatial genius.

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Planungsbezogene Stadtklimatologie: Werkzeuge und Maßnahmen auf unterschiedlichen räumlichen und zeitlichen Skalen

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1 ABSTRACT

In Österreich macht sich die Klimakrise von Jahr zu Jahr stärker bemerkbar. Auch bei starken Klimaschutzmaßnahmen sind deren Auswirkungen bereits spürbar und unvermeidbar (APCC, 2014). Vor allem das gehäufte Auftreten von heißen Tagen und Hitzewellen stellt für die Bevölkerung nicht mehr nur eine reine Komfortfrage, sondern mitunter ein ernstzunehmendes Gesundheitsrisiko dar (Hutter et al., 2017; Haas et al., 2014). Eine strukturelle Anpassung an die bereits stattfindenden Folgen des Klimawandels als komplementäre Maßnahme zu konsequenten Klimaschutzmaßnahmen (Marx, 2017) ist demnach dringend.

Um Lebensqualität, Wohlbefinden und Gesundheit von Menschen in Städten auch zukünftig zu sichern, müssen Stadtentwicklungsprozesse schon heute im Einklang mit stadtklimatologischen Faktoren gestaltet und Maßnahmen zur Reduktion der thermischen Belastungen und der Erhöhung des Sommerkomforts getroffen werden. Instrumente, die dazu beitragen, die Ausprägungen klimatischer und klimaökologischer Faktoren im urbanen Raum zu erfassen, um sie im nächsten Schritt durch planerische Maßnahmen gezielt positiv zu beeinflussen, spielen demnach eine große Rolle in der klimasensiblen Stadtplanung und in der Anpassung an den Klimawandel. Dabei gilt es je nach Planungsebene – von der gesamtstädtischen Ebene über die Quartiersebene bis hin zu einzelnen Plätzen, Straßenzügen oder Bauplätzen – unterschiedliche stadtklimatische Phänomene und Fragestellungen zu berücksichtigen. Methoden, Werkzeuge, Anpassungsstrategien und konkrete Maßnahmen variieren demnach abhängig von der Skalenebene.

Ziel dieses Beitrags ist es, Einblicke und praktische Erfahrungsberichte zur Zusammenarbeit mit Städten und Gemeinden sowie dem interdisziplinären Austausch mit den Fachbereichen Stadtplanung, Landschaftsplanung, Architektur etc. in der Gestaltung klimaresilienter Städte zu geben. Dabei wird auf die jeweiligen stadtklimatologschen Informationsgrundlagen und Werkzeuge und die Entwicklung von Maßnahmen und Strategien auf unterschiedlichen räumlichen und zeitlichen Skalen eingegangen.

Keywords: Stadtklimaanalyse, Klimawandelanpassung, Stadtklimatologie, räumlich-zeitlich, interdisziplinär

2 STADTKLIMATISCHE PHÄNOMENE AUF UNTERSCHIEDLICHEN RÄUMLICHEN SKALEN

Übergeordnetes Ziel und Aufgabe einer planungsbezogenen Stadtklimatologie ist vor allem die Verbesserung der lufthygienischen und thermischen Bedingungen im städtischen Raum (VDI, 2008). Daraus leiten sich u.a. folgende Subziele ab:

- Abbau von Wärmeinseln (Wärmeinsel als Indiz für den thermischen Komfort);
- Optimierung der städtischen Belüftung (Luftaustausch, Luftleitbahnen);
- Vermeidung von Luftstagnation bei Inversionswetterlagen, Vermeidung von Barrieren für den Luftaustausch;
- Erhaltung und Förderung von Frischluft- oder Kaltluftentstehungsgebieten für den Luftaustausch und somit zur Verbesserung der lufthygienischen Situation.

Für eine erfolgreiche Umsetzung dieser Ziele bedarf es einerseits einer detaillierte Kenntnis darüber, welche meteorologischen Phänomene auf welcher Handlungs- bzw. Planungsebene relevant sind und andererseits einer korrekten Identifikation der wesentlichen Fragestellungen für einen bestimmten Standort in Abhängigkeit der stadtklimatischen Ausgangslage. Damit variieren die Untersuchungsmethodik, die übergeordnete Anpassungsstrategie und die Entwicklung von Maßnahmen in Abhängigkeit dieser beiden Faktoren. Je kleiner die Handlungsebene (Einzelobjektplanung), umso wichtiger werden die kleinräumigsten (mikroklimatischen) Phänomene, wie Sonneneinstrahlung und Abschattung. Auf der größeren gesamtstädtischen Planungsebene (Mesoklima) sind hingegen die großräumigeren Phänomene, wie

Luftzirkulation, Kaltluftbahnen und etwaige Wechselwirkungen zu beachten. Und je nach stadtklimatischer Ausgangslage ist die Berücksichtigung unterschiedlicher Fragestellungen für einen bestimmten Standort (Sommerkomfort, Windkomfort,…) von besonderer Bedeutung. Die Ergebnisse stadtklimatologischer Untersuchungen werden für die Planungsdisziplinen zumeist als Karten unterschiedlicher räumlicher Auflösung dargestellt (VDI, 2008).

2.1 Gesamtstädtische Ebene

Ausgangspunkt aller stadtklimatologischen Überlegungen und zentrales Werkzeug auf gesamtstädtisher Ebene ist eine Stadtklimaanalyse (SKA). Denn das Klima jeder Stadt ist unterschiedlich: auf Grund ihrer geografischen Lage, dem Regionalklima, in das sie eingebettet ist, den naturräumlichen und stadträumlichen Gegebenheiten, ihrer Größe/Einwohnerzahl sowie der unterschiedlichen Bebauungsstruktur und Dichte. Somit müssen die stadtklimatischen Verhältnisse für jede Stadt gesondert festgestellt werden, um diese Informationen gezielt in der Stadtentwicklung umsetzen zu können.

Eine Stadtklimaanalyse (bestehend aus Klimaanalysekarte und Planungshinweiskarte, nach VDI 3787/Blatt 1) ist ein stadtklimatisches Gutachten und liefert eine flächendeckende, systematische Analyse der stadtklimatischen Ist-Situation. Basierend auf Klimadatenanalyse, Geodatenanalyse und numerischer/statistischer Klimamodellierung liefert die Klimaanalysekarte Informationen über die klimatischen Eigenschaften einer ganzen Stadt: Sie bildet die räumliche Verteilung von Klimatopen (Gebieten mit ähnlichen lokalen Klimabedingungen) ab, schafft eine Zusammenschau der thermischen und dynamischen Komponenten des Stadtklimas und zeigt regionale Zusammenhänge und Abhängigkeiten auf.

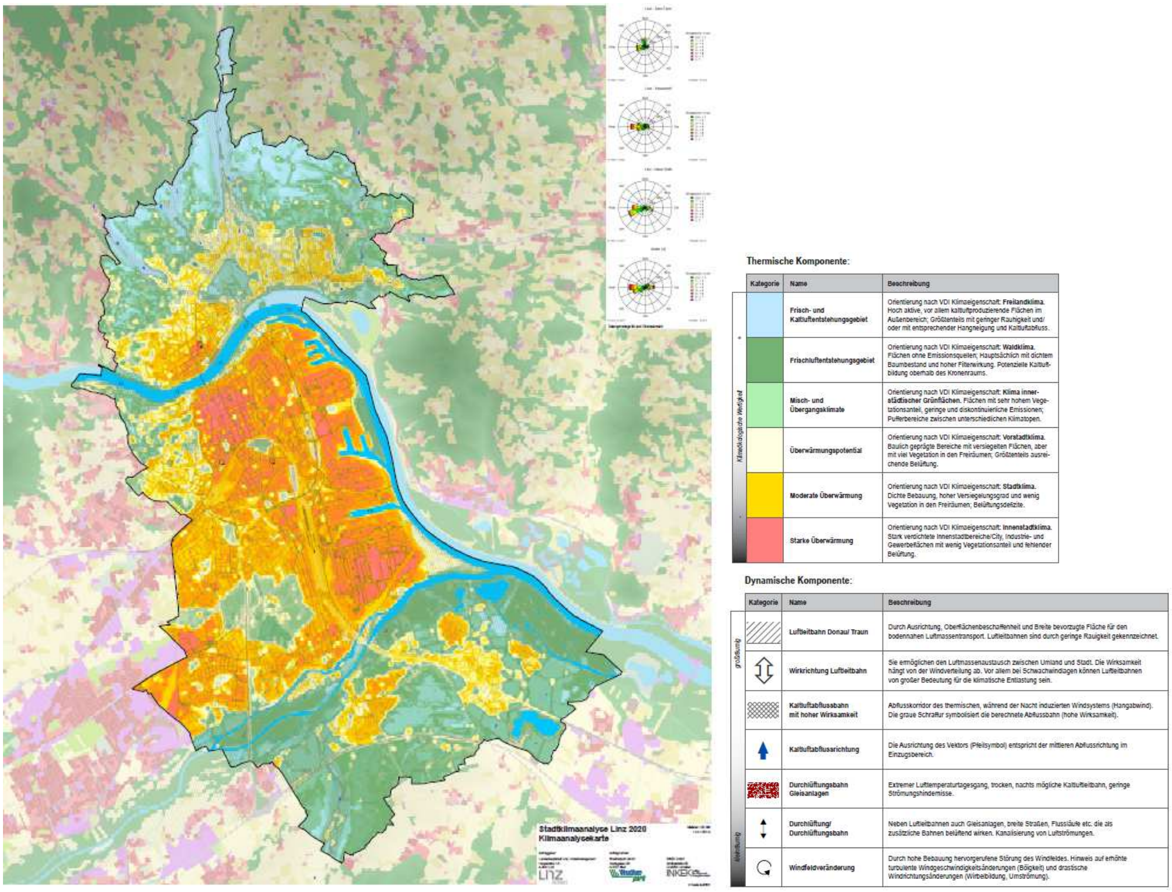

Abb. 1: Klimaanalysekarte Linz (Download: https://www.linz.at/medienservice/2021/202105_110520.php)

Diese Analyse der gesamten Stadt ist wichtig, um die großräumigen meteorologischen Phänomene (Luftzirkulation, Kaltluftströme und städtische Wärmeinseln) zu untersuchen. Diese Dimension zu betrachten ist essenziell, um langfristige, strategische Maßnahmen für eine klimasensible Stadtentwicklung bereitzustellen: Wie entwickelt sich und wächst die Stadt? Welche Bereiche sind besonders stark überwärmt? In welchen Bereichen wären städtebauliche Vorhaben möglich und wo würden sie zu nachteiligen Beeinträchtigungen umliegender Siedlungsgebiete führen? Wo befinden sich Kaltluftströme und -leitbahnen, die aufgrund ihres Potenzials zur nächtlichen Kühlung der Stadt geschützt werden müssen? All diese Fragen können durch die Interpretation der Klimaanalysekarte beantwortet werden. Diese erleichtert somit auch die Entscheidung, wo und welche lokalen Anpassungsmaßnahme im kleinen Maßstab priorisiert werden sollen bzw. welche Detailuntersuchungen des Stadtklimas (Sommerkomfort, Kaltluft, Durchlüftung, Windkomfort) bei Stadtentwicklungs- oder Bauvorhaben in einem bestimmten Bereich durchgeführt werden sollten. Außerdem liefert sie Grundlagen für die räumliche Interpretation der Klimawirkung von Vegetation, Baudichten bzw. Bauhöhen.

Abb. 1 zeigt exemplarisch für ein Ergebnis einer Stadtklimaanalyse die Klimaanalysekarte der Stadt Linz, die im Mai 2021 fertiggestellt und veröffentlicht wurde (Stadt Linz, 2021)

Eine Stadtklimaanalyse ist von strategischer Bedeutung für die klimasensible Entwicklung unserer Städte. Für die praktische Anwendung in den verschiedenen Planungsdisziplinen werden die für die Gesundheit und das Wohlbefinden der Menschen relevanten Ergebnisse der Stadtklimaanalyse in einer Planungshinweiskarte bewertet und mit konkreten Planungsempfehlungen versehen. Anhand der Planungshinweiskarte können somit auf einen Blick grundlegende Aussagen und Empfehlungen für einen Standort getroffen werden. Das erleichtert die Projektplanung von Beginn an.

Abb. 2 zeigt wieder exemplarisch die Planungshinweiskarte der Stadt Linz (Stadt Linz, 2021).

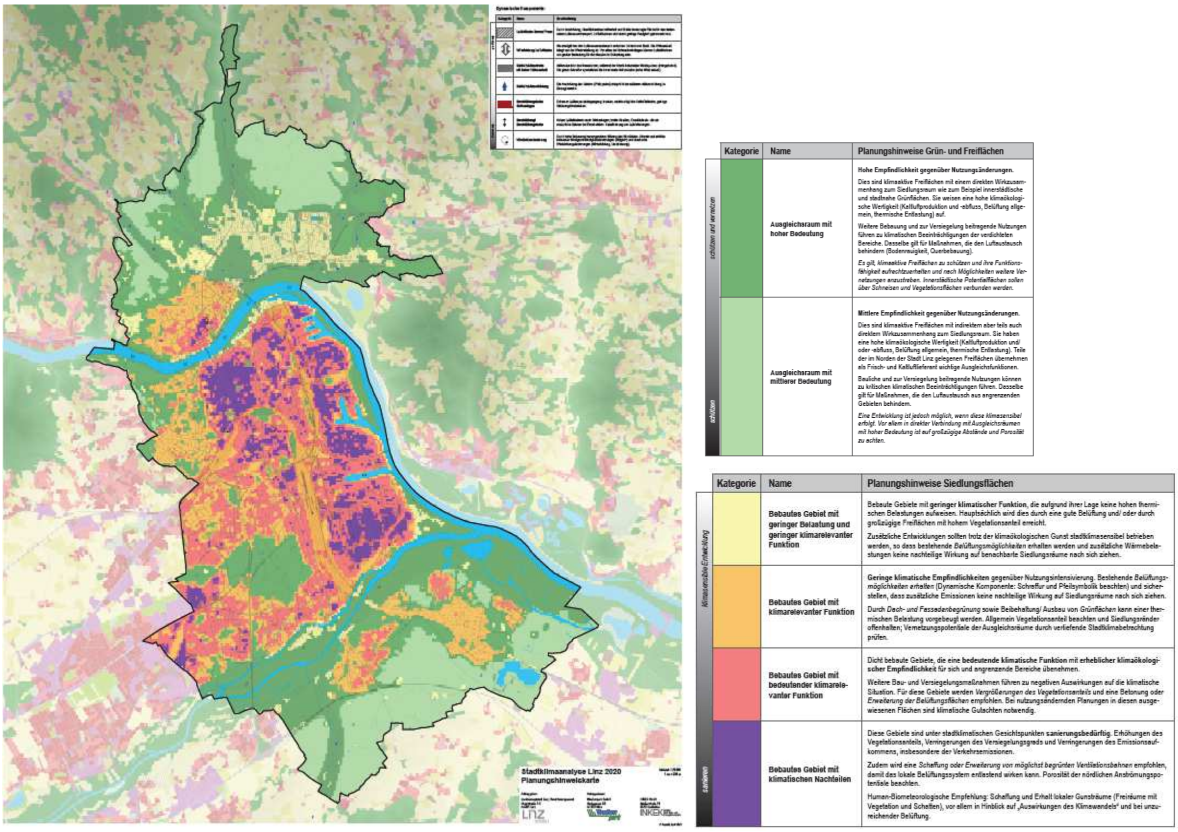

Abb. 2: Planungshinweiskarte Linz (Download: https://www.linz.at/medienservice/2021/202105_110520.php)

Weatherpark und INKEK arbeiten derzeit an der Erstellung der Stadtklimaanalysen für die Städte Wien und Innsbruck. Die Stadtklimaanalyse Linz wurde im Mai 2021 fertiggestellt und der Öffentlichkeit präsentiert. In der Zusammenarbeit mit den Städten hat sich gezeigt, dass die SKA oft als erster Schritt eines ganzheitlichen Transformationsprozesses und einer umfassenden Strategie gegen die Hitze in der Stadt genutzt werden und weiterführende, strategische Prozesse anstoßen.

Dafür ist es neben der Erstellung der Ergebniskarten wichtig, das Projekt von der Datenerhebung bis zur Anwendung und Verwendung der Ergebniskarten interaktiv mit der Stadt zu gestalten und die Stadt von Beginn an in den Entstehungsprozess zu involvieren (Workshops und Schulungen, Interviews mit relevanten Stakeholdern, um Wünsche und Ziele abzustecken), um schlussendlich zu gewährleisten, dass die Ergebnisse wirkungsvoll genutzt werden. Zur erfolgreichen Umsetzung von Anpassung an den Klimawandel ist es von zentraler Bedeutung, strategisch passende Schritte hin zur Vision einer klimafitten Stadt zu setzen. Somit sollte die SKA als Grundlage für die Überarbeitung und Anpassung aller Planungsprozesse dienen. Darüberhinaus leben bis 2050 rund 80% der Europäischen Bevölkerung in Städten (Eurostat, 2016). Daher

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ist es auf Grund des fortschreitenden Klimawandel dringend notwendig, die strategisch passenden Schritte auf allen Ebenen zu setzen, vom Umbau einzelner Straßen, über die Objektplanung bis hin zur Entwicklung von neuen Stadtteilen.

2.2 Quartiersebene

Bei der Betrachtung großer Maßstäbe, von gesamten Städten hin zu Stadtquartieren und öffentlichen Plätzen, Straßenzügen oder Bauplätzen, gewinnen mikroklimatische Faktoren und damit der adäquate Mix an kurz- bis mittelfristig umsetzbaren Einzelmaßnahmen an Bedeutung: Verschattung, Elemente grüner und blauer Infrastruktur, Entsiegelung von Flächen, Orientierung, Höhe, Albedo, Volumen und Material von Gebäuden.

Die quantitative Wirksamkeit der lokalen Maßnahmen kann durch Detailstudien für einen spezifischen Standort bestimmt werden. Wie schon erwähnt, gibt die Interpretation der Stadtklimaanalyse Auskunft darüber, welche stadtklimatologischen Detailuntersuchungen an einem bestimmten Standort notwendig sind. So sind etwa für Planungsvorhaben in Gebieten, die sich in Kaltluftentstehungsgebieten oder in Kaltluftleitbahnen befinden, Detailuntersuchungen zur Beurteilung der etwaig nachteiligen Beeinflussung des Kaltluftabflusses bzw. der Durchlüftung durch das Bauvorhaben sinnvoll. In thermisch überlasteten Gebieten ist wiederum die Untersuchung des Sommerkomforts von hoher Bedeutung.

Als Sommerkomfort definieren wir die Quantifizierung der Auswirkungen der geplanten Bebauung und Gestaltung auf die Hitzebelastung tagsüber sowie die sommerliche Wärmeinsel nachts. Ziel einer Sommerkomfortuntersuchung ist es, die städtebauliche Planung in der praktischen Umsetzung soweit zu optimieren, dass die thermischen Belastungen im Freien untertags auch bei hohen Lufttemperaturen (beiwpielsweise während Hitzewellen) auf ein erträgliches Maß begrenzt bleiben und sich die Wärmeinsel in der Nacht nicht verstärkt, sodass auch bei häufigeren Tropennächten (Stangl et al., 2021) erholsamer Nachtschlaf möglich bleibt. Ausgewertet wird die Lufttemperatur, um Aussagen über die Auswirkungen auf die städtische Wärmeinsel zu treffen. Als Maßzahl für die thermische Belastung der Benutzerinnen und Benutzer und somit der Verweilqualität im Außenraum wird das Komfortmaß PET (Physiologische Äquivalenttemperatur) evaluiert.

Die Berücksichtigung von Faktoren und die Planung von Anpassungmaßnahmen, die das thermische Empfinden auf lokaler Ebene beeinflussen, sind nicht nur in Großstädten wichtig, sondern gewinnen mit fortschreitendem Klimawandel auch in kleineren Gemeinden an Bedeutung. Die 2020 von Weatherpark mitgegründete Initiative „KlimaKonkret“ zur Unterstützung österreichischer Städte und Gemeinden bei der Anpassung an den Klimawandel zeigt im „KlimaKonkret-Faltplan“ (siehe Abb. 3) 46 Maßnahmen gegen die Hitze in der Stadt.

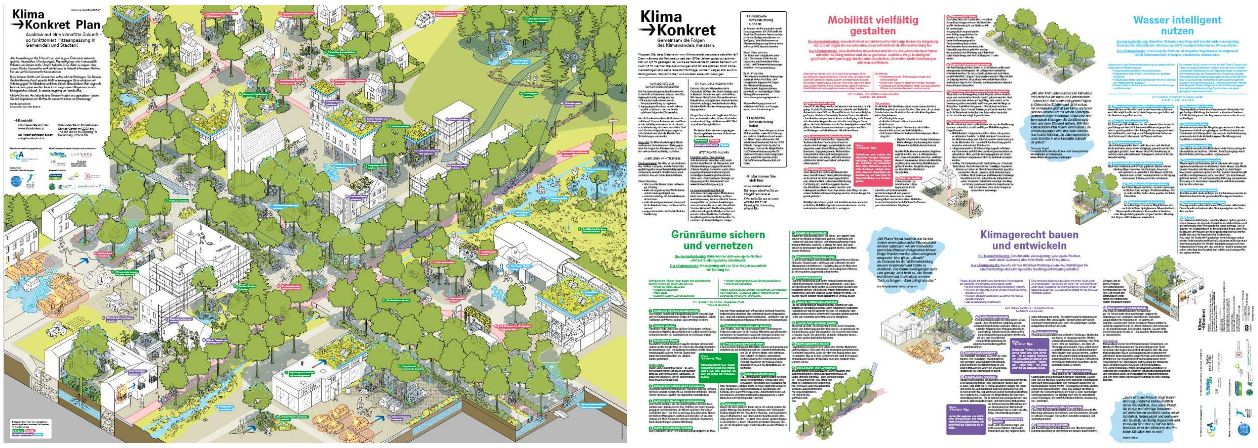

Abb. 3: KlimaKonkret-Faltplan (Quelle: www.klimakonkret.at)

Um sich dem Thema Hitzeanpassung ganzheitlich zu widmen, braucht es Expertise aus unterschiedlichen Fachbereichen. Die Gestaltung des Faltplans erfolgte in interdisziplinärer Zusammenarbeit mit den Fachbreichen Klima (Weatherpark GmbH), Raumplanung (Raumposition), Freiraum (3:0 Landschaftsarchitektur), Mobilität (con.sens verkehrsplanung) und Kulturmanagement (Catrin Neumüller).

Der interdisziplinäre Ansatz bei der Gestaltung dieser Karte hat gezeigt, wie wichtig es ist, mit verschiedenen Expertinnen und Experten unterschiedlicher Disziplinen zusammenzuarbeiten, um Know-how und Expertise zu verbinden und adäquate, ganzheitliche Lösungen zu finden.

3 FAZIT

Die stadtplanungsbezogene Stadtklimaotlogie schafft wissenschaftlich fundierte Argumentationsgrundlagen, die eine sachgerechte Beurteilung von stadtplanungs- und stadtklimabezogenen Entscheidungen ermöglicht. Diese Grundlageninformationen über die stadtklimatologischen Charakteristika stellen oft Anstoß und Ausgangspunkt für einen langfristigen Transformationsprozess in Städten dar, in dem die klimasensible Stadtentwicklung gefördert und konsequent priorisiert wird. Das Know-how und die Werkzeuge für die Umsetzung dieser Maßnahmen sind da; nun gilt es, diese in integrierten Ansätzen über verschiedene zeitliche und räumliche Skalen in Stadtplanungsprozesse zu integrieren, interdisziplinäre Planung in die Tat umzusetzen und Klimawandelanpassung bei jeder Investitionsentscheidung und jeder Umgestaltung mitzudenken und zu berücksichtigen. Ein idealer Ablauf in der Planungspraxis würde etwa wie folgt aussehen: Ausgehend von einer Vision und einer Stadtklimaanalyse als Grundlage für die langfristige Strategie über das Ablesen notwendiger Detailuntersuchungen aus der Klimaanalysekarte und der Berücksichtigung entsprechender Planungsempfehlungen aus der Planungshinweiskarte hin zur Erarbeitung lokaler Maßnahmenvorschläge und einer Quantifizierung der Wirkung der Maßnahmen durch Simulationen und einer Umetzung in der Planung und Realisierung vor Ort.

So trägt die Berücksichtigung stadtklimatologischer Belange in Stadtentwicklungsprozessen und die damit einhergehende Entwicklung konkreter Anpassungsmaßnahmen auf unterschiedlichen räumlichen und zeitlichen Skalen dazu bei, die Lebensqualität in Städten zu erhöhen und diese im Einklang mit den aktuellen und zukünftigen Klimabedingungen zu gestalten.

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Planungsgrundlagen für das Energie- und Klimakonzept in Niederösterreichs Gemeinden

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1 ABSTRACT

Im Niederösterreichischen Raumordnungsgesetz ist mit Rechtswirksamkeit vom 1.1.2023 ein Energie- und Klimakonzept auf örtlicher Ebene verankert. Im Vorfeld werden landesweit einheitliche fachliche Grundlagen für die Gemeinden erarbeitet. Sie umfassen vornehmlich die energieraumplanerischen Standorträume, die sich besonders für die Nah- und Fernwärmeversorgung (aus erneuerbaren Energieträgern) und für die klimafreundliche Mobilität eignen. Die Anwendung dieser Planungsgrundlagen wird in einem Handlungsleitfaden dokumentiert und von Weiterbildungs- und Beratungsangeboten für die Raumplanerinnen und Raumplaner und Entscheidungsträgerinnen und Entscheidungsträger auf örtlicher Ebene begleitet.

Keywords: Niederösterreich, Energieraumplanung, Gemeindeplanung, Energie- und Klimakonzept, Örtliche Raumplanung

2 RECHTLICHE GRUNDLAGE

Gemäß dem Niederösterreichischen Raumordnungsgesetz 2014 (NÖ ROG) ist die (örtliche) Raumplanung gefordert, zur Schaffung der räumlichen Voraussetzungen für eine Verringerung von Energieverbrauch und Treibhausgasemissionen, für den verstärkten Einsatz alternativer/erneuerbarer Energie sowie für die Anpassung an den Klimawandel beizutragen: Gemäß §1 (2) Abs. 1.b) werden unter anderem die „sparsame Verwendung von Energie“, der „Ausbau der Gewinnung von erneuerbarer Energie“ sowie die „Reduktion von Treibhausgasemissionen“ als generelle Leitziele genannt, die bei der Vollziehung des Gesetzes beachtet werden sollen. Für die örtliche Raumplanung wird zudem gemäß §1 (2) Abs. 3.b) der „verstärkte Einsatz von Alternativenergien“ angestrebt.

Diese Ziele wurden mit der am 22.10.2020 im Niederösterreichischen Landtag beschlossenen Novelle zum Raumordnungsgesetz um weitere energierelevante Aspekte ergänzt: In §13 (3) werden die grundsätzlichen Aussagen zur Gemeindeentwicklung, die im örtlichen Entwicklungskonzept zu treffen sind, präzisiert. Dabei werden auch Aussagen zur angestrebten „Energieversorgung und Klimawandelanpassung“ ausdrücklich genannt. Weiters wird entsprechend dieser Novelle in §13 (5) zur nachvollziehbaren Begründung der Festlegungen des örtlichen Raumordnungsprogrammes ein „Energie- und Klimakonzept“ verankert, das auch die „Potenziale für die Nutzung erneuerbarer Energien und allfälliger Handlungsnotwendigkeiten für Maßnahmen zur Klimawandelanpassung“ einschließt. Die letztgenannte Bestimmung wird erst am 1.1.2023 rechtswirksam.

3 DAS ENERGIE- UND KLIMAKONZEPT

Das Energie- und Klimakonzept in Niederösterreichs Gemeinden dient der Formulierung raumrelevanter Strategien zur Energiewende, zum Klimaschutz und zur Klimawandelanpassung. Politische Meinungsbildungs- und Entscheidungsträgerinnen und Entscheidungsträger in den Gemeinden sind aufgerufen, die Energiewende und den Klimaschutz als zentrale Aufgabe (auch) im lokalen Umfeld wahrzunehmen und den weltweiten Handlungsbedarf in konkrete Strategien auf örtlicher Ebene umzusetzen. Dabei steht aus Sicht der (Energie)Raumplanung die Gewährleistung der räumlichen Voraussetzungen für ein Gelingen der Energiewende im Vordergrund der Betrachtungen. Ein besonderes Augenmerk ist dabei auf die Erhaltung, Weiterentwicklung bzw. Schaffung energieeffizienter und klimafreundlicher Raum- und Siedlungsstrukturen gerichtet. Zu diesem Zweck müssen energie- und klimarelevante Aussagen in die örtliche Raumplanung integriert werden, und die Strategien der Raumplanung dürfen nicht losgelöst von energie- und klimapolitischen Anliegen betrachtet werden.

Die Energieraumplanung weist wie die Raumplanung selbst eine ausgeprägte strategische Komponente auf. Sie stellt den Anspruch, in die interdisziplinär ausgerichteten raumordnungspolitischen Meinungsbildungs- und Entscheidungsprozesse zusätzlich energie- und klimapolitische Aspekte zu integrieren und damit die Abwägung verschiedener raumrelevanter, teilweise widerstreitender Interessen um eine Facette zu bereichern. Eine wichtige Voraussetzung für die strategischen Entscheidungen der (Energie)Raumplanung,

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die beispielsweise im Rahmen des örtlichen Entwicklungskonzeptes getroffen werden, bildet die Erweiterung der lokalen Wissensbasis um strategische Kenntnisse über die Raumrelevanz von Energiewende und Klimaschutz sowie um deren konkrete Ausprägung auf kommunaler Ebene.

4 PLANUNGSGRUNDLAGEN

Derzeit werden am Institut für Raumplanung, Umweltplanung und Bodenordnung (IRUB) der Universität für Bodenkultur (BOKU) Wien GIS-gestützt landesweite Planungsgrundlagen für das Energie- und Klimakonzept in Niederösterreichs Gemeinden erarbeitet. Dabei handelt es sich vornehmlich um eine räumlich und sachlich hoch aufgelöste Modellierung des Energieverbrauches unter besonderer Berücksichtigung von Wärmebedarf und Wärmebedarfsdichten sowie um eine Analyse der Nutzungsstrukturen innerhalb der Gemeinden hinsichtlich Vielfalt und Dichte. Darauf basierend werden unter Berücksichtigung weiterer Parameter energie- und klimarelevante Standortqualitäten landesweit beurteilt bzw. Standorträume für Nah- und Fernwärme sowie für klimafreundliche Mobilität ausgewiesen. Zu diesem Zweck wird die vom IRUB in einem Vorprojekt für die Steiermark[1] erarbeitete Methode zur flächendeckenden Beurteilung der Eignung von Siedlungsgebieten für eine energieeffiziente und klimafreundliche Entwicklung unter besonderer Bedachtnahme auf Wärmeversorgungs- und Mobilitätsaspekte verfeinert und weiterentwickelt.

Neben dem Flächenbedarf für die Gewinnung erneuerbarer Energie bilden die Wärmeversorgung und die Mobilität jene beiden energie- und klimarelevanten Handlungsfelder, die einen besonders starken Raumbezug aufweisen. Im Falle der Wärmeversorgung stellt sich insbesondere die Frage, welche Siedlungsgebiete dezentral mit Wärme versorgt werden sollen und welche Siedlungsgebiete einer Gemeinde vornehmlich aufgrund ihres Wärmebedarfs die räumlichen Voraussetzungen für eine zentrale, leitungsgebundene Wärmeversorgung aufweisen. Sie soll allerdings nur im Falle der Nutzung erneuerbarer Energieträger, hocheffizienter Kraft-Wärme-Kopplung oder bedeutender Abwärmepotenziale forciert werden. Nah- und Fernwärmeversorgungssysteme sind in vielen Fällen nicht nur aus gesundheitspolitischen Überlegungen (Verringerung der Schadstoff- und Feinstaubimmissionen) eine Alternative zur dezentralen Wärmeversorgung, sondern auch angesichts ihres nicht unerheblichen Beitrages zur Energiewende und zum Klimaschutz: Sie weisen eine hohe Flexibilität im Hinblick auf den/die eingesetzten Energieträger bzw. die Integration innovativer Technologien auf; sie können die Volatilität der erneuerbaren Energieträger (Wind-, Sonnenenergie) kompensieren; und sie kommen künftig als ein wichtiges Element der Sektorkopplung (d.h. der Kopplung verschiedener Sektoren der Energiewirtschaft) in Betracht. In diesem Sinne eignen sie sich besonders für die mittel- bis langfristige Substitution fossiler durch erneuerbare Energie in der Wärmebereitstellung. Allerdings bedürfen leitungsgebundene Wärmeversorgungssysteme einer investitionskostenintensiven Infrastruktur, und ihre Effizienz und Wirtschaftlichkeit ist nur bei hohen Anschlussgraden bzw. bei kurzen Transportwegen mit minimalen Wärmeverlusten gewährleistet. Der (Energie)Raumplanung kommt daher die Aufgabe zu, die maßgeblichen räumlichen Rahmenbedingungen für die Nah- und Fernwärmeversorgung aufzuzeigen und durch eine entsprechende Steuerung der Siedlungsentwicklung langfristig abzusichern. Dabei ist die künftige Verringerung der Wärmebedarfe angesichts des mit dem Klimawandel einhergehenden Temperaturanstiegs ebenso zu bedenken wie die abnehmenden Wärmebedarfe aufgrund einer fortschreitenden energetischen Sanierung der Gebäude.

Im Falle der Mobilität gilt es die Frage zu beantworten, welche Siedlungsgebiete einer Gemeinde angesichts der Vielfalt und Dichte der Nutzungen nach dem Prinzip der kurzen Wege organisiert sind, sodass die räumliche Zuordnung einander ergänzender Funktionen gute räumliche Voraussetzungen für den Fuß- und Radverkehr sowie für die Verknüpfung von Wegen zu Wegeketten schafft. Darüber hinaus gilt es, jene Siedlungsgebiete innerhalb der Gemeinde zu erfassen, die aufgrund der hohen Attraktivität der öffentlichen Verkehrserschließung für die Nutzung von Bahn und Bus besonders gut geeignet sind. Beide Phänomene tragen zu einer Verlagerung von Verkehrsleistungsanteilen des motorisierten Individualverkehrs auf den Fuß-, Rad- und öffentlichen Verkehr und damit zur Verringerung des Energieverbrauches und der Treibhausgasemissionen bei. Damit sind auch weitere positive Auswirkungen auf die Umwelt (Verringerung der Luft- und Lärmbelastung, Verminderung der Flächeninanspruchnahme für die Verkehrsinfrastruktur)

[1] vgl. Abart-Heriszt, L.; Preiß, D.; Redik, M. (2021): Das Sachbereichskonzept Energie in der Steiermark: In: Giffinger, R.; Berger, M.; Weninger, K.; Zech S. (Hrsg.): Energieraumplanung – Ein zentraler Faktor zum Gelingen der Energiewende. Wien: reposiTUm, S.18-27. DOI: 10.34726/1021.

sowie auf die Gesellschaft (Abdeckung der Mobilitätsbedürfnisse aller Bevölkerungsgruppen) verbunden. Zudem sichert eine ausreichende Mantelbevölkerung in den Einzugsgebieten von Dienstleistungseinrichtungen sowie Haltepunkten des öffentlichen Verkehrs deren Auslastung und Wirtschaftlichkeit bei gleichzeitig attraktivem Angebot. Die (Energie)Raumplanung ist daher gefordert, den räumlichen Rahmenbedingungen für eine klimafreundliche Mobilität künftig besondere Bedeutung beizumessen.

Die fachlichen Grundlagen für das Energie- und Klimakonzept in Niederösterreichs Gemeinden zielen demnach darauf ab, jene kompakten, funktionsgemischten und angemessen dichten Siedlungsstrukturen mit attraktivem öffentlichen Verkehrsangebot zu identifizieren, die im Hinblick auf die Versorgung mit Nah- und Fernwärme sowie für den Fuß-, Rad- und öffentlichen Verkehr eine gewisse Mindesteignung und -größe aufweisen. Wie das Vorprojekt in der Steiermark gezeigt hat, kommt neben der Ausweisung von Standorträumen für Nah- und Fernwärme sowie für klimafreundliche Mobilität deren Überlagerung und damit der Identifikation (zumindest) eines energieraumplanerischen Standortraumes in jeder Gemeinde besondere Bedeutung zu. Damit werden die Grundlagen für Strategien zugunsten energie- und klimaoptimierter Siedlungsstrukturen erarbeitet, die sich weitgehend mit Strategien der Innenentwicklung decken. Denn sie bieten nicht nur optimale räumliche Rahmenbedingungen für leitungsgebundene Wärmeversorgung und klimafreundliche Mobilität, sondern wirken sich auch positiv auf einen sorgsamen Umgang mit Grund und Boden aus. Die energieraumplanerischen Standorträume werden unabhängig von administrativen Grenzen ausgewiesen, sodass die Entscheidungsgrundlagen nicht ausschließlich für die Strategieentwicklung auf der örtlichen Ebene zur Verfügung stehen, sondern auch für die Zusammenarbeit von Nachbargemeinden (z.B. im Falle grenzübergreifender Wärmenetze) oder im regionalen Rahmen (z.B. für Mobilitätskonzepte) genutzt werden können. Mit den energieraumplanerischen Standorträumen werden einerseits Schnittstellen zwischen den Zielsetzungen der Energiewende bzw. des Klimaschutzes und der Raumplanung und damit neue Synergien angesprochen sowie andererseits bewährte Grundsätze der Raumplanung – im Hinblick auf die Abstimmung von Siedlungsentwicklung und Mobilitätsangeboten – präzisiert und räumlich verortet.

Ergänzend zu den fachlichen Grundlagen betreffend die Ausweisung energieeffizienter und klimafreundlicher Siedlungsstrukturen wird flächendeckend für alle niederösterreichischen Gemeinden ein Überblick über die auf lokaler Ebene zur Verfügung stehenden Energiepotenziale gegeben. Entsprechend der Vorgehensweise in der Steiermark sollen Energieeffizienzpotenziale, die aus der energetischen Sanierung der (Wohn)Gebäude resultieren, Substitutionspotenziale, die auf den Stellenwert fossiler Energie Bezug nehmen, und die erneuerbaren Energiepotenziale dargestellt werden. Dabei ist die Überlegung zu berücksichtigen, dass ländliche Regionen eine wichtige Funktion zur Versorgung städtischer Räume mit erneuerbarer Energie erfüllen. Im Gegenzug übernehmen städtische Regionen wichtige Funktionen für den ländlichen Raum (z. B. die Versorgung mit Arbeitsplätzen, Ausbildungsmöglichkeiten, Gütern des mittel- und langfristigen Bedarfes etc.). Die Bestrebungen einzelner Gemeinden nach Energieautarkie sind vor diesem Hintergrund zu relativieren und in einem regionalen Kontext unter Berücksichtigung der Wechselwirkungen zwischen Räumen mit unterschiedlichen Potenzialen und Funktionen zu betrachten.

5 HANDLUNGSLEITFADEN

Um das Energie- und Klimakonzept in Niederösterreichs Gemeinden basierend auf den dargestellten Planungsgrundlagen landesweit in weitgehend einheitlicher Struktur zur Anwendung zu bringen, wird ein Handlungsleitfaden erarbeitet, der sich vornehmlich an die Raumplanerinnen und Raumplaner und an die Entscheidungsträgerinnen und Entscheidungsträger auf örtlicher Ebene richtet. Erfahrungen aus der Entwicklung des Leitfadens zum Sachbereichskonzept Energie in der Steiermark[2] sollen dabei genutzt werden. Letzterer widmet sich zunächst der Verankerung energie- und klimarelevanter Zielsetzungen, die den Zielkatalog des Örtlichen Entwicklungskonzepts ergänzen und als Grundlage für die Verankerung energieraumplanerisch fundierter Festlegungen dienen. In der Folge werden die einzelnen Arbeitsschritte zur Analyse und Interpretation der fachlichen Grundlagen sowie zur Entwicklung energieraumplanerischer Strategien ausgeführt: Basierend auf den energieraumplanerischen Standorträumen sollen Perspektiven zur

[2] vgl. Das Sachbereichskonzept Energie – Ein Beitrag zum Örtlichen Entwicklungskonzept. Leitfaden. Version 2.0. https://www.verwaltung.steiermark.at/cms/dokumente/11682131_79305527/4a990a26/Leitfaden_Sachbereichskonzept_Energie_2019_web.pdf

räumlichen Entwicklung der Gemeinde aufgezeigt werden, die energieeffiziente und klimafreundliche Raum- und Siedlungsstrukturen absichern können. Abschließend gibt der Leitfaden einen Überblick über die Optionen, die zur Umsetzung der energieraumplanerischen Strategien in Betracht kommen. Im Vordergrund steht das Instrumentarium der Raumplanung auf örtlicher Ebene, insbesondere das Örtliche Entwicklungskonzept, aber auch der Flächenwidmungsplan und der Bebauungsplan. Daneben kommen weitere Maßnahmen (z.B. der Einsatz bodenpolitischer Instrumente, die energetische Sanierung gemeindeeigener Gebäude) in Betracht. Darüber hinaus kann unter Umständen ein Ausblick auf weiterführende Überlegungen auf der projektplanerischen Ebene gegeben werden (z.B. im Hinblick auf das Erfordernis einer Wärmenetzplanung). Sie sind jedoch nicht mehr unmittelbar Gegenstand der Energieraumplanung.

Im Zuge der Anwendung des Handlungsleitfadens auf die Problemstellungen in den einzelnen Gemeinden haben die Ortsplanerinnen und Ortsplaner die Verantwortung, ihre besondere Kenntnis der örtlichen Gegebenheiten sowie der gegenwärtigen bzw. zu erwartenden demographischen und wirtschaftlichen Entwicklung vor Ort in die Interpretation der energieraumplanerischen Standorträume und in die Entwicklung darauf basierender Strategien zur Siedlungsentwicklung einzubringen.

6 WEITERBILDUNGS- UND BERATUNGSANGEBOT

Die Erarbeitung des Handlungsleitfadens zum Energie- und Klimakonzept in Niederösterreichs Gemeinden wird ergänzt um ein Weiterbildungs- und Beratungsangebot für die Entscheidungsträgerinnen, Entscheidungsträger, Raumplanerinnen und Raumplaner in den Gemeinden. In Anlehnung an entsprechende Angebote in der Steiermark soll basierend auf den angeführten Planungsgrundlagen Bewusstsein für die Raumrelevanz der Energiewende und des Klimaschutzes geschaffen, ein gemeinsames Verständnis der Ausgangssituation herbeigeführt und die Notwendigkeit für die Umsetzung energie- und klimarelevanter Strategien auf Basis der energieraumplanerischen Standorträume und in Anwendung des Handlungsleitfadens unterstrichen werden.

7 SCHLUSSFOLGERUNG

Das Sachbereichskonzept Energie als Beitrag zum Örtlichen Entwicklungskonzept und die dafür landesweit bereitgestellten Planungsgrundlagen im Digitalen Atlas Steirmark[3] haben dieses Bundesland in eine Vorreiterrolle im Hinblick auf die Umsetzung der Energieraumplanung versetzt. Dazu hat nicht unwesentlich die Initiierung eines eigenen Förderungsprogrammes beigetragen, das aus Mitteln des Ökofonds Steiermark dotiert wird. Weitere Bundesländer (beispielsweise Niederösterreich) greifen den in der Steiermark entwickelten Ansatz auf und lassen derzeit vergleichbare Grundlagen für die Energieraumplanung auf örtlicher Ebene erarbeiten. Dabei gewährleistet die landesweite Herangehensweise, dass allen Gemeinden eines Bundeslandes vergleichbare, auf einheitlichen Datensätzen und einer standardisierten Methode basierende Planungsgrundlagen zur Verfügung gestellt werden, die unmittelbar in die Bestandsaufnahme und Bestandsanalyse eingehen. Darauf basierend können sich die Gemeinden verstärkt mit der Entwicklung von energieraumplanerischen Strategien auseinandersetzen, die Abstimmung energie- und klimarelevanter Anliegen mit weiteren raumbezogenen Agenden vornehmen und sich dem zielgerichteten Einsatz des raumplanerischen Instrumentariums zugunsten von Energiewende und Klimaschutz widmen.

Mit den Planungsgrundlagen wird sowohl ein Spezialthema der Energieraumplanung, nämlich die leitungsgebundene Wärmeversorgung, aufgegriffen als auch der typisch querschnittsorientierte Ansatz der Raumplanung gepflegt, der insbesondere über die Aspekte der Wärmeversorgung, der Nutzungsstrukturen und der Mobilität fachübergreifende Aussagen zur Siedlungsentwicklung und zum haushälterischen Umgang mit dem Boden zulässt. Darüber hinaus stellen die Planungsgrundlagen eine strategische Orientierungshilfe für weitere raumrelevante Entscheidungen auf kommunaler Ebene dar, und da eine Vielzahl von Entscheidungen im kommunalpolitischen Aufgabenspektrum eine Raumrelevanz aufweist, gibt es zahlreiche Anknüpfungspunkte für eine Berücksichtigung der Planungsgrundlagen im Rahmen einer klimafreundlichen Ausgestaltung der künftigen kommunalen Entwicklung.

Die Planungsgrundlagen tragen dazu bei, raumordnungspolitische Meinungsbildungs- und Entscheidungsprozesse nachvollziehbar und transparent zu gestalten, Handlungsspielräume und

[3] vgl. https://www.landesentwicklung.steiermark.at/cms/ziel/141976122/DE/ -> Planung und Kataster.

Handlungsbedarfe aus Sicht der Energieraumplanung offenzulegen und dadurch eine fundierte Argumentationsbasis gegenüber dem Land als Aufsichtsbehörde, dem Bund, Nicht-Regierungsorganisationen und der Öffentlichkeit zu schaffen.

Mit dem Sachbereichskonzept Energie in der Steiermark sowie dem Energie- und Klimakonzept in Niederösterreichs Gemeinden wird ein Beitrag zum Örtlichen Entwicklungskonzept geleistet und damit das wichtigste strategische Planungsinstrument der örtlichen Ebene um energie- und klimarelevante Aspekte erweitert. Damit wird die vielfach geforderte Energieraumplanung mit Inhalten erfüllt und kann die (örtliche) Raumplanung ihrem gesellschaftlichen Auftrag gerecht werden, zur Unterstützung der Energiewende und des Klimaschutzes durch die Sicherung der entsprechenden räumlichen Rahmenbedingungen beizutragen.

Raumansprüche für E-Ladeinfrastruktur im öffentlichen Raum dichtbebauter Stadtquartiere

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1 ABSTRACT

Auch zukünftig wird Personen-Autoverkehr ein Teil der urbanen Mobilität bleiben. Abhängig vom Fahrzweck, Fahrziel, Zeit und anderen Rahmenbedingungen kann es das sinnvollste Verkehrsmittel sein. Autoverkehr sollte allerdings klimaneutral und ressourceneffizient abgewickelt werden. E-Mobilität ist derzeit und in naher Zukunft das Energiekonzept, auf das gesetzt werden muss, um mittelfristig umwelt- und klimarelevante Wirkungen zu erzielen. Die Herausforderung besteht darin, die Infrastruktur an dieses Energiekonzept anzupassen. Im vorliegenden Beitrag werden die Ergebnisse einer Untersuchung des Raumbedarfs im Rahmen des Forschungprojekts FEMcharge[1] vorgestellt. Zur Ermittung des Raumbedarfs wurden über 970 Parkvorgänge beobachtet und nach unterschieldichen Merkmalen ausgewertet um den Flächenbedarf in Abhängigkeit des Fahrzwecks ermitteln zu können. Als Hinweis auf den Fahrzeweck werden die Anzahl von Begleitpersonen und/oder die Anzahl und Größe von mitgeführten Gegenständen herangezogen. Abschließend werden die Häufigkeiten der Nutzung des Fahrzeugumfeldes ausgewertet und so der Raumbedarf abgeleitet um daraus Grundlagen für die Ermittlung der Abmessungen zu generieren.

Keywords: E-Mobilität, öffentlicher Raum, Multimodalität, E-Ladestation, Raumbedarf

2 EINLEITUNG

Der Vorgang des Ladens eines E-Kfzs unterscheidet sich grundsätzlich vom Tankvorgang eines fosil-betriebenen Kfzs. Während das Tanken als „kurzzeitiges Event” im Rahmen einer Fahrt von A nach B abgewickelt werden kann, muss das Laden als „eigener Vorgang” zeitlich und örtlich geplant werden. Grund dafür ist, dass das Laden, je nach Ladezustand des Akkus, je nach (nachfolgendem) Energiebedarf, je nach Ladelesitung der E-Ladesäule, längere Zeit in Anspruch nehmen kann. Insofern macht es Sinn Ladeinfrastruktur an Orten zu positionieren, an denen sich Personen und damit ihre Fahrzeuge über längere Zeiträume aufhalten. Längere Aufenthalte fallen am häufigsten mit den Aufenthaltszwecken Wohnen und Arbeiten zusammen. Überlegungen bestehende Tankstellen zu Ladestationen in Zukunft umzubauen greifen deshalb zu kurz, da diese in der Regel außerhalb von Wohnbereichen, stadtrandnah, an stark frequentierten Straßen, fern von Arbeitsorten oder anderen Orten mit sinnvollen Aufenthaltsmöglichkeiten, zu finden sind.

Die Sichtweise der öffentliche Hand, dass die Bereitstellung von Tankinfratsruktur keine öffentliche Aufgabe war und ist und somit auch die zukünftige Organisation von E-Ladeinfrastruktur privat geregelt werden soll, ist nachvollziehbar. Allerdings sprechen u.a. das politische Ziel zur Erreichung von Klimazielen durch Anhebung der E-Mobilität und die Tatsache, dass Laden anders gedacht werden muss als Tanken (wie oben beschrieben), dafür, dass im öffentlichen Raum (privatrechtlich betriebene) Ladeinfrastruktur zur Verfügung gestellt werden sollte und entsprechend Flächen von der öffentlichen Hand vorzuhalten sind. Dies ist insbesondere in Stadtquartieren erforderlich, die dicht bebaut sind und in denen keinerelei Möglichkeit besteht im privaten Bereich Ladestationen zu errichten.

Im Rahmen des Projekts FEMCharge wird u.a. untersucht, welche Anforderungen an einen Stellplatz mit Ladestation in Bezug auf die umgebende Fläche und Infrastruktur zu erfüllen sind. Diese Ansprüche stellten einen Teil des im Projekt entwickelten Kriterienkatalogs und Entscheidungstools für die Standortanalyse dar, die es öffentlichen Verwaltungen ermöglicht soll, sinnvolle Standorte für die Positionierung von öffentlich zugänglicher Ladestationen ausfindig zu machen. Die Forschungsfrage in Bezug auf Flächenanspruch lautet: Unterscheiden sich bzw. inwiefern unterscheiden sich gesellschaftliche Gruppen in ihrem Verhalten bei Benutzung von Kfz-Stellplätze bzw. E-Ladestationen im öffentlichen Raum? Dahinter steht die Idee zu einer genderrelevanten Ausrichtung von E-Ladeinfrastruktur, um nicht Benachteiligungen auf lange Zeit zu

[1] FFG-Forschungsprojekt im Rahmen der 6. Ausschreibung FEMtech Forschungsprojekte: FEMCharge: Gender- und diversitätsgerechte Positionierung und Ausstattung von Ladeinfrastruktur. FFG Projektnr. 873011

zementieren. In dieser Arbeit werden vorläufige Ergebnisse zum Flächeninanspruchnahme von E-Ladestationen im öffentlichen Straßenraum dargestellt.

3 UNTERSUCHUNGSANSATZ

Ausgangspunkt der Überlegungen zum Projekt stellten die Analysen von technischen Vorgaben dar, die sich u.a. in Bauordnungen mit Mindestabmessungen finden. Allerdings ergeben sich keine Hinweise auf räumliche Anforderungen für Ladestationen, auf Aspekte wie Ansprüche an die unmittelbare „Umgebung“ oder auf Kriterien, die den Blickwinkel von Gendergruppen einbeziehen. Deshalb wurde als Methode zur Ermittlung belastbarer Beurteilungskriterien die Beobachtung von realen Vorgängen gewählt. Dabei wurden bei über 970 beobachteten Parkvorgängen Merkmale der Umgebung (Raumtyp, Barrieren), der Personen (Geschlecht, Alter, Fahrzweck – soweit erkennbar – Begleitpersonen, mitgeführte Gegenstände) und des Vorgangs an sich (Raumbedarf, verwendete Fahrzeugseiten, verwendete Türen, verwendete Hilfsmittel, Einschränkung durch Barrieren, Dauer, etc.) erhoben. Die Beobachtungen fanden in der Stadt Graz / Österreich sowohl in Bereichen ohne Ladeinfrastruktur als auch bei bestehenden Ladestationen (Graz – tim-Ladestationen) im öffentlichen Raum an insgesamt 10 verschiedenen Standorten, die drei verschiedenen Raumtypen (siehe Tabelle 1) zugeordnet wurden, statt.

Merkmale	Raumtyp A „Zentrum	Raumtyp B „Vortstadt”	Raumtyp C „Nebenzentrum”
Hauptwohnsitze	+	+++	+++
Arbeitsplätze	+++	+	++
Einkaufsmöglichkeiten	+++	++	+
Aufenthalts- und Verweilmöglichkeiten	+++	+	++
ÖV-Angebot – Haltestellen	+++	++	++
Fahrradabstellmöglichkeiten	+++	+	++
Soziale Sgregation	+++	+	++
+++ … hohe Ausprägung ++ … mittlere Ausprägung + … geringe Ausprägung			

Tabelle 1: Definition der Raumtypen über Ausprägung der Merkmale

In der vorliegenden Arbeit werden die zur Analyse der Daten aus den Beobabachtungen Personengruppen auf sechs verschiedenenen Ebenen definiert und ausgewertet (siehe Tabelle 2). Ziel ist es damit (räumliche) Ansprüche an E-Ladeinfrastruktur von unterschiedlichen gesellschaftlichen Gruppen möglichst umfassend zu bechreiben.

EBENE	PERSONENMERKMALE				
PG1 Begleitfunktion und Alter	Anzahl 0	Anzahl >0	Anzahl >0 Kind	Anzahl >0 Senior	Anzahl >0 Erwachsener
PG2 Gegenstände	nein	Ja – Ladung	Ja – Hilfsmittel	Ja – Ladung und Hilfsmittel	
PG3 Stellplatz Typ	Kfz-Stellplatz: Standard	Kfz-Stellplatz: mobilitätseingeschränkte Personen	Kfz-Stellplatz: E-Ladestation		
PG4 Raumtyp	Raumtyp A	Raumtyp B	Raumtyp C		
PG5 Geschlecht	weiblich	männlich	divers		
PG6 Alter	< 20 Jahre	20 – 34 Jahre	35 – 64 Jahre	> 64 Jahre	

Tabelle 2: Definition der Personengruppen

- Die Personengruppe PG1 wird nach der Begleitfunktion der Lenkerinnen und Lenker unterschieden. Es wird dabei nicht differenziert, ob die Lenkerinnen und Lenker begleiten oder ob diese begleitet werden. Das Hauptunterscheidnungsmerkmal stellt die Anzahl der Begleitpersonen dar (entweder „0“ oder „>0“). Bei den Personen mit Begleitung werden die Begleitperson(en) nach dem Alter in drei Gruppen – Kind, erwachsener, Senior – unterschieden.

- Die Personengruppe PG2 wird nach mitgeführten Gegenständen unterschieden. Insgesamt ergeben sich vier Teilgruppen: Personangruppe ohne Gegenstände, Personengruppe mit Ladung (Tasche, Rucksack, Schachtel, …), Personengruppe mit Hilfsmittel (Kinderwagen, Rollator, Rollstuhl, ..) und die Personengruppe, die sowohl Ladung als auch Hilfsmittel mitführt.
- Die Personengruppe PG3 wird nach drei Stellplatz-Typen unterschieden. Für die Untersuchung wird die Hypothese aufgestellt, dass das grundsätzliche Verhalten der beobachteten Personen beim Parkvorgang (Ein- und Aussteigen, Be- und Entladen) unabhängig von der Art des Stellplatzes bzw. Antriebstechnologie des Fahrzeuges ist. Ausgenommen davon sind die von Personen getätigten Manipulationen zur Vor-/Nachbereitung des Ladevorgangs und der damit differierenden Flächeninanspruchnahme, weshalb zwischen den Stellplatz-Typen unterschieden werden muss.
- Die Personengruppe PG4 wird nach den oben bereits beschriebenen Raumtypen unterschieden.
- Die weiteren Personengruppenebenen PG5 und PG6 unterscheiden nach Geschlecht und Alter.

Die Auswertungen erfolgt sowohl für jede Gruppe als auch kreuzweise verschänkt insbesondere ausgehend vom Merkmal Raumtyp und Geschlecht.

4 ERGEBNISSE

4.1 Personegruppe PG1: Merkmal Begleitpersonen

Die Auswertung der PG1 zeigt, dass ein Viertel der beobachteten Vorgänge mit Begleitpersonen absolviert wird. Am häufigsten können Erwachsene (20 bis 64 Jahre) als Begleitpersonen festgestellt werden. Bei 25% der Vorgänge mit Begleitpersonen werden Kinder beobachtet (siehe Abbildung 1).

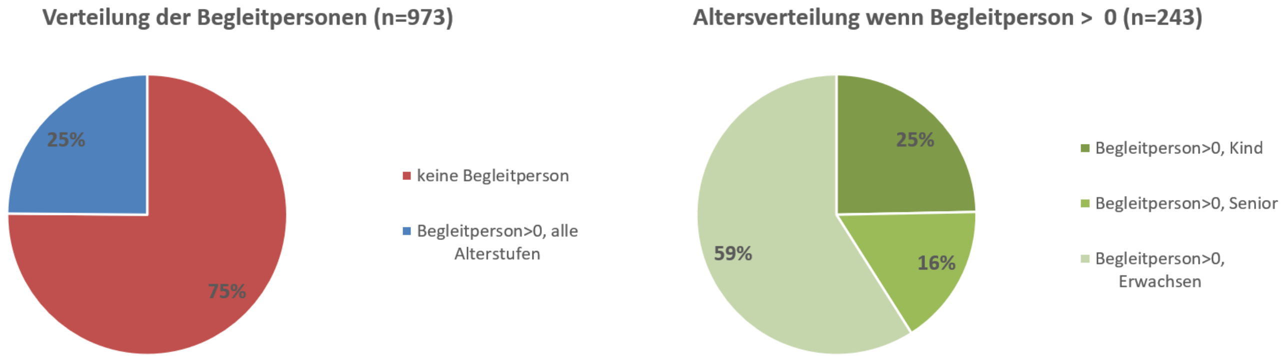

Abbildung 1: Ergebnis für PG1: Merkmal Begleitpersonen

4.2 Personengruppe PG2: Merkmal Gegenstände und PG3: Merkmal Stellplatztyp

Bei rund 50% der beobachteten Vorgänge werden Gegenstände mitgeführt, wobei bei 46% der Gesamtvorgänge der Gegenstand aus Ladung besteht. In Kombination kommen Hilfsmittel und Ladung bei vier Prozent der Beobachtungen vor. Da einerseits die Anzahl der Stellplätze mit Ladeinfrastruktur im Beobachtungsgebiet gering ist und andererseits die Manipulation vor und nach Ladevorgängen jeweils selten beobachtet werden können, sind mit rund 1 % der Vorgänge wenige Beoabchtungen mit E-Lade-Manipulationen zu verzeichnen (siehe Abbildung 2).

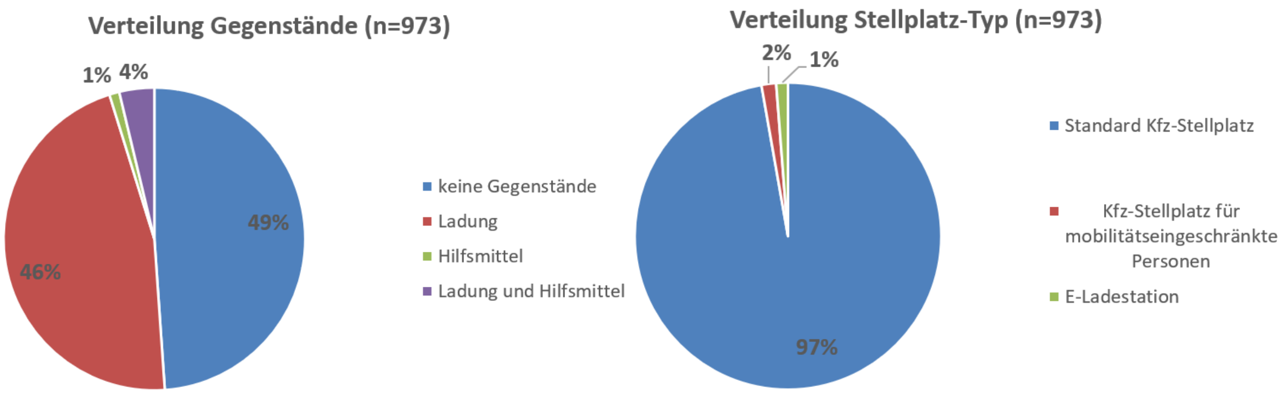

Abbildung 2: Ergebnis für PG2: Merkmal Gegenstände und PG3: Merkmal Stellplatz-Typ

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4.3 Personengruppe PG4: Merkmal Raumtyp

Für die Personengruppen mit Unterscheidung des Merkmals Raumtyp werden die Auswertung nach

- Fahrzeugart / Antriebstechnologie (fossil betreibenes Kfz / Elektro- oder Hybridfahrzeug),
- Begleitpersonen (keine Begleitperson, eine oder mehrere Begleitpersonen),
- Begleitpersonen nach Alter (Kind, Erwachsener, Senior) und
- Gegenstände (kein Gegenstand, Ladung, Hilfsmittel, Kombination Ladung und Hilfsmittel) unterschieden (siehe Abbildung 3).

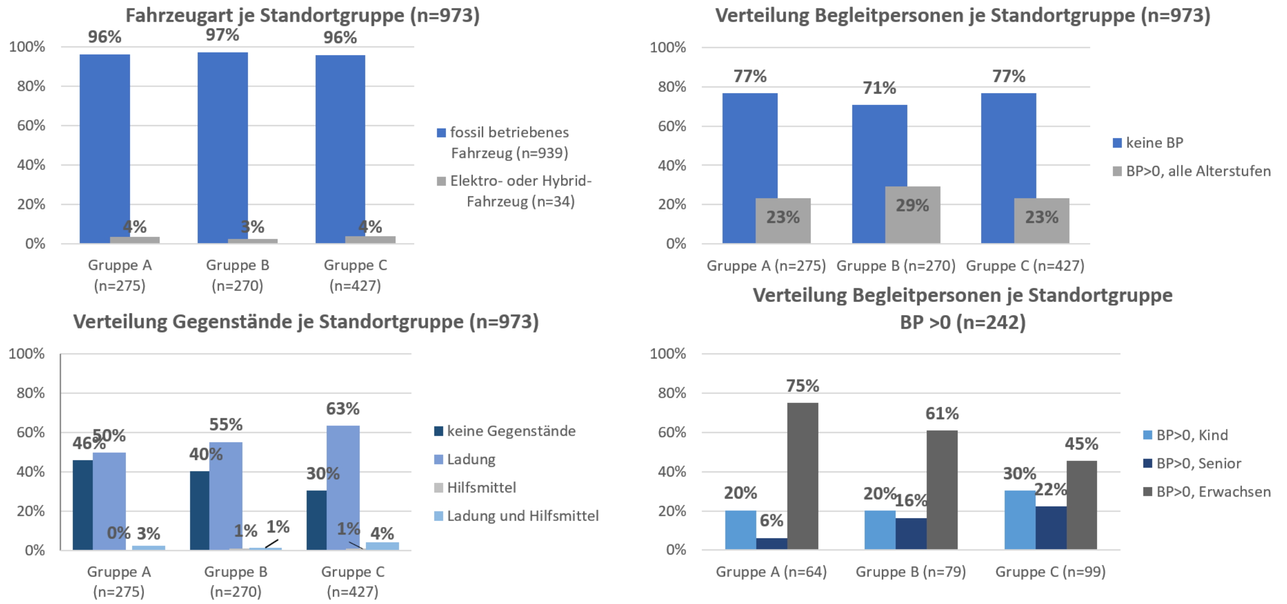

Abbildung 3: Ergebnis für PG4: Merkmal Raumtyp (Standortgruppe)

Keine Unterschiede zeigen sich bei der Verteilung der beobachteten Fahrzeugarten. Geringe Unterschiede ergeben sich beim Anteil der Vorgänge mit Begleitpersonen: Am häufigsten (29%) werden Vorgänge mit Begleitpersonen im Raumtyp B „Vorstadt“ (Standortgruppe B) beobachtet. Bei den mitgeführten Gegenständen zeigen sich deutliche Unterschiede zwischen den drei Raumtypen. Während beim Raumtyp A „Zentrum“ der Anteil „ohne Gegenstände“ und „mit Ladung“ in etwa gleich groß ist, zeigt sich beim Raumtyp C der Anteil der Vorgänge „mit Ladung“ mehr als doppelt so hoch wie der Anteil „ohne Gegenstände“. Stellt man dem die Verteilung der Altersgruppen von Begleitpersonen gegenüber zeigt sich, dass beim Raumtyp A „Zentrum“ der Anteil der „Erwachsenen“ mit ¾ überwiegt. Dieser Anteil reduziert sich bis Raumtyp C „Nebenzentrum“ auf weniger als 50%. Demgegenüber wachsen jeweils die Summen aus anteiligen „Senioren“ und „Kindern“ bei den Begleitpersonen. Insofern kann ein Zusammenhang zwischen Art und Umfang der Gegenstände und Alter der Begleitpersinen interpretiert werden: Steigt die Anzahl der Begleitpersonen in den Altersgruppen <20 und >64, ist mit einem Ansteigen des Anteils an mitgeführten Gegenständen zu rechnen. Auswirkugen zeigt dies gegebenenfalls bei der Dimensionierung der Stellplätze für Ladestationen.

4.4 Zielwert: Flächeninanspruchnahme

Als Zielwert der Auswertung wird die Flächeninspruchnahme ermittelt. Dazu werden die bei jedem Parkvorgang benutzten Seiten des Fahzeuges nach der Häufigkeit der Nutzung und dem ebenfalls beobachteten Abstand von der Fahrzeugseite (in 0,5m Schritten mit Abstandsbreiten von 0m bis 1,5m senkrecht auf die Fahrzeugseite) herangezogen. Daraus wird zum Vergleich eine theoretische Manipulationsfläche (unter Annahme einer theoretschen Fahrzeuglänge von 5,0m und einer theoretischen Fahrzeugbreite von 2,0m) berechnet. Abbildung 4 zeigt, dass die Manipulationsfläche beim Merkmal Begleitfunktion für die Altersgruppe Senior mit 13,5m² am höchsten ist. Beim Merkmal Gegenstände errechnen sich rund 13m² für Vorgänge mit einer Kombinationen aus mitgeführter Ladung und Hilfsmittel. Plausibel lässt sich auch der höchste Flächenverbrauch beim Merkmal Standortgruppe (Raumtyp) C feststellen, da hier der Anteil der Vorgänge „mit Ladung“ als auch „mit Senioren“ als Begleitpersonen jeweils sehr hoch liegt. Die höchste theoretische Manipulationsfläche errechnet sich allerdings zu 14,8m² beim Merkmal Stellplatz-Typ „E-Ladestationen“ (siehe Abbildung 4).

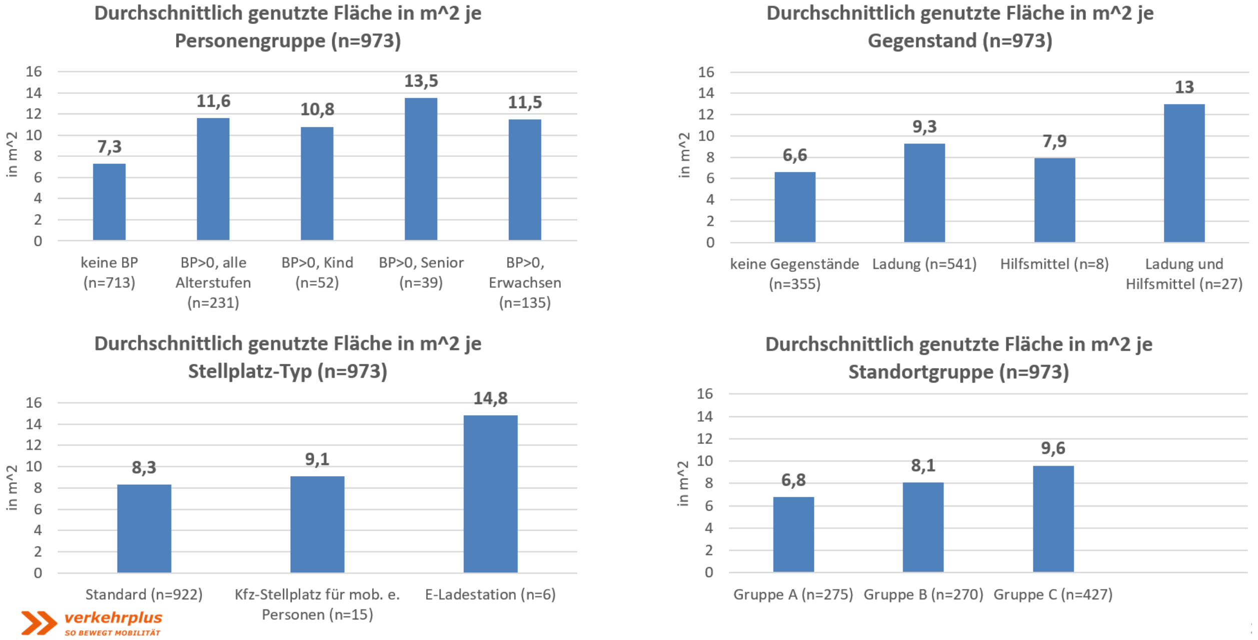

Abbildung 4: Ergebnisse für den Zielwert Flächeninanspruchnahme

5 ABLEITUNG VON ANSPRÜCHEN AN DEN ÖFFENTLICHEN RAUM

5.1 Flächenanspruch: Geometrie und Abmessungen

Zur Ermittlung der erforderlichen Abmessungen von E-Ladestationen werden im Folgenden für alle Personengruppen die Häufigkeit der Nutzung der Seiten je Fahrzeug ermittelt. Abbildung 5 zeigt von links nach rechts die Draufsicht eines Kfzs mit der Front in Richtung Seitenanfang („nach oben“). Dargestellt sind im jeweiligen Abstand von 0,5m die (beobachteten) genutzten Seitenabstände vom Fahrzeug. Ein „weiß“ eingefärber Bereich wird gar nicht bis sehr selten genutzt (<25%), während ein ganz „dunkelgrün“ gefärbter Bereich zwischen 75% und 100% genutzt wird. Dargestellt sind folgende ausgewählte (Teil-)Personengruppen von links nach rechts:

- aus PG1: Personen ohne Begleitfunktion
- aus PG1: Personen mit Begleitfunktion – Altergruppe Kind
- aus PG1: Personen mit Begleitfunktion – Altergruppe Senior
- aus PG2: Personen mit mitgeführtem Gegenstand – Ladung
- aus PG2: Personen mit mitgeführtem Gegenstand – Ladung und Hilfsmittel
- aus PG3: Personen an E-Ladestationen

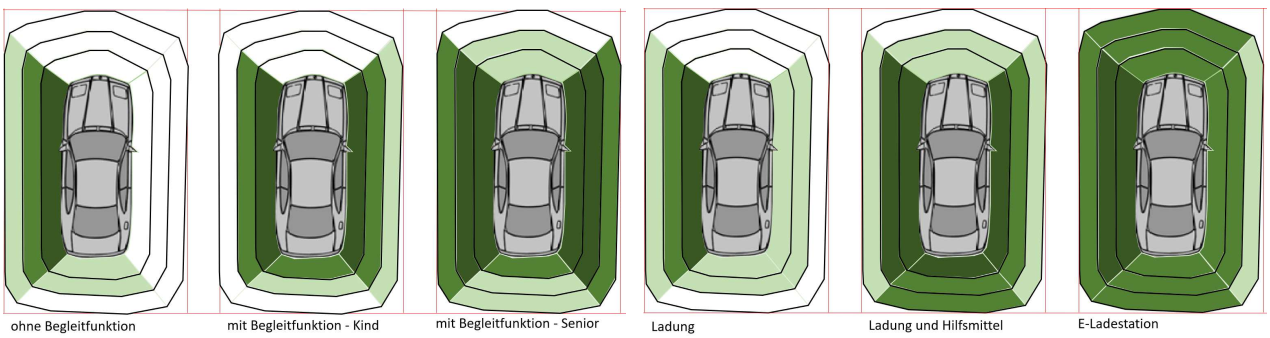

Abbildung 5: Häufigkeit der Nutzung von Fahrzeugseiten und Zonen mit unterschiedlichen Abständen zum Fahrzeug für ausgewählte Personengruppen

Um ein detailliertes und aktuelles Bild des Flächenanspruchs für E-Ladestationen zu erhalten, werden die aktuellen Zulassungszahlen für E-Fahrzeuge im Frühjahr 2021 für Österreich analysiert (Statistik Austria 2021). Daraus ergibt sich, dass das mit 25% am häufigsten neu zugelassene E-Kfz gleichzeitig 92% aller neu zugelassenen E-Fahrzeug-Modelle bezogen auf die Länge des Kfzs repräsentiert und 87% aller neu zugelassenen E-Fahrzeug-Modelle bezogen auf die Breite des Kfzs repräsentiert. Insgesamt ergibt sich für ein E-Fahrzeug der stattlichen Flächenbedarf von 4,70m mal 1,85m. Das am häufigsten neu zugelassene Fahrzeug wird in weiterer Folge für die Konstruktion von E-Ladestationen als „Bemessungsfahrzeug“ herangezogen.

Wie dargestellt werden je Personengruppe unterschiedliche Seiten des Kfzs und unterschiedliche Abstände zum Kfz genutzt. Die Häufigkeit der Nutzung von Abständen kann als Komfortmaß interpretiert werden. Insofern können aus Sicht der Verfasser dieser Arbeit zwei Qualitätsstufen unterschieden werden: Qualitätsstufe „Häufigkeitsstufe bis 100%“ – hier werden Bereiche (Fahrzeugseiten mit Abständen) um das Fahrzeug jeweils mit 75% bis zu 100% Häufigkeit genutzt. Qualitätsstufe „Häufigkeitsstufe bis 75%“ – hier werden Bereiche (Fahrzeugseiten mit Abständen) um das Fahrzeug jeweils mit bis zu 75% Häufigkeit genutzt. Die Abbildungen 6 und 7 zeigen als Beispiele die unterschiedlichen Abmessungen für 45°-Aufstellung für das ermittelte Bemessungsfahrzeug jeweils für die Qualitätsstufe 100% und Qualitätsstufe 75%. Deutlich zeigt sich die unterschiedlichen Abmessungen besonders am Fahrzeugheck und der Breiten der Stellflächen.

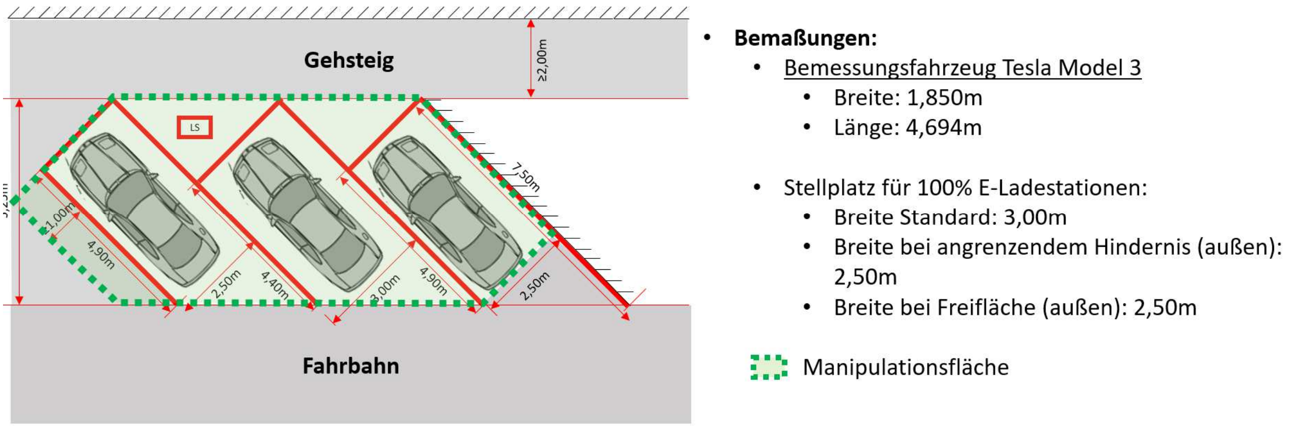

Abbildung 6: Bemessungsfahrzeug 45°-Aufstellung – Tesla – Qualitätsstufe 100% – PG3: E-Ladestation

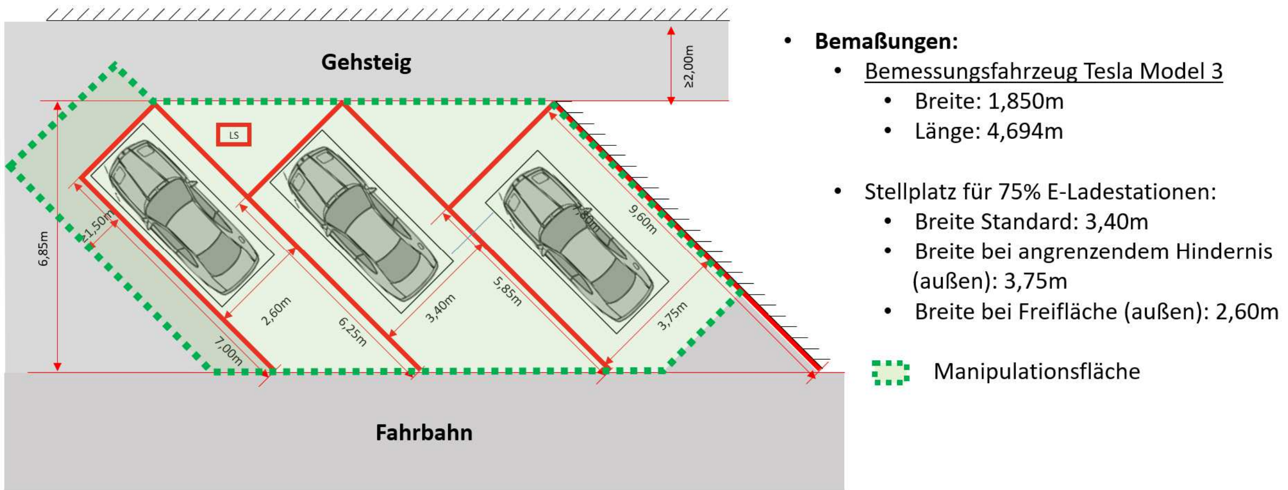

Abbildung 7: Bemessungsfahrzeug 45°-Aufstellung – Tesla – Qualitätsstufe 75% – PG3: E-Ladestation

5.2 Umfeld/Positionierung der E-Ladestation im Stadtgefüge

Die Beispiele zeigen, dass im öffentlichen Raum das unmittelbare Umfeld mit betrachtet werden muss. Der anstehende Gehsteig, anstehende Hindernisse und Barrieren und aufegehndes Mauerwerk müssen bei der Flächenermittlung berücksichtigt werden. Eine weitere Forderung für Ladeinfrastrukturen im Wohnumfeld ergibt sich aus der Logistik eines Ladevorgangs. So muss der E-Ladestellplatz nach Abschluss des Ladevorgangs verlassen werden, sodass dieser für weitere Ladevorgänge nutzbar wird. Dazu sollten insbesondere im Wohnumfeld „Wechselstellplätze“ vorhanden sein. Wie zu Beginn dieser Arbeit hergeleitet, macht es Sinn, Ladeinfrastruktur an Orten zu positionieren, an denen sich Personen und damit ihre Fahrzeuge über längere Zeiträume aufhalten. Längere Aufenthalte fallen am häufigsten mit den Aufenthaltszwecken Wohnen und Arbeiten zusammen. Ein weiterer Ansatz wäre es für mittlere Aufenthaltsdauern (<1,5h) Ladeinfrastruktur im Umfeld von POIs wie Einkaufsmöglichkeiten, Gaststätten, Freizeiteinrichtungen etc. zu positionieren. Insofern sind in die Überlegung zur Positionierung von E-Ladeinfrastruktur das mittelbare Umfeld, die Nutzungen entlang eines Straßenzuges oder Quartiers ebenfalls mit einzubeziehen.

6 ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNG

Auch zukünftig wird Personen-Autoverkehr ein Teil der urbanen Personenmobilität bleiben. Autoverkehr sollte allerdings klimaneutral und ressourceneffizient abgewickelt werden. E-Mobilität ist derzeit und in naher Zukunft das Energiekonzept, auf das gesetzt werden muss, um mittelfristig umwelt- und klimarelevante Wirkungen zu erzielen. Im Rahmen des Forschungsprojekts FEMCharge[2] werden die Ansprüche zum Flächenbedarf ermittelt. Ziel ist es für die unterschiedlichsten Fahrzwecke und die damit verbundenen Begleit- und Transportfunktionen der Fahrzeuglenkerinnen und Fahrzeuglenker Abmessungen für Ladestationen abzuleiten. Dazu werden über 970 beobachtete Parkvorgänge nach unterschiedlichsten Kriterien ausgewertet. Es lassen sich für verschiedene Vorgänge (mit und ohne Begleitpersonen, mit und ohne Beladung, mit und ohne Manipulation für Ladevorgänge) unterschiedlich große Flächanansprüche ableiten. Insgesamt zeigt der beobachtete Vorgang für die Manupulation eines E-Ladevorgangs den höchsten Flächenanspruch, da hier offensichtlich nahezu alle Fahrzeugseiten mit großer Häufigkeit begangen werden müssen. Für die schlussendlich ableitbaren Abmessungen sind folgende Aspekte von Bedeutung:

- Eine Ladestation besteht aus der Stellfläche (Fläche für das stehende Kfz) und einer darum erforderlichen Manipulationsfläche inkl. Ladesäule. Hierfür stellen die Kenntnis des Bemessungsfahrzeuges und – in Abhängigkeit von den Qualitätsansprüchen – die Kenntnis der erforderlichen Abstände rund um das Fahrzeug – die Grundlage dar.
- Die Manipulationsfläche ist abhängig u.a. von der Anzahl der Begleitpersonen und/oder mittransportierten Gegenständen und/oder für Vor- und Nachbereitung des Ladevorgangs. Es zeigt sich dass – u.a. wegen der umfangreichen Manipulationen bei E-Kfz in Ladestationen der höchste Flächenanspruch entsteht.

In der Diskussion zur Positionierung von Ladeinfrastruktur im öffentlichen Raum sind folgende Aspekte zu berücksichtigen bzw. in die weiteren Diskussion einzubeziehen:

- Ladeinfrastruktur ist an Orten zu positionieren, an denen sich Personen und damit ihre Fahrzeuge über längere Zeiträume aufhalten. Diese treten bei den Aufenthaltszwecken Wohnen und Arbeiten am häufigsten auf.
- In die Festlegung der Örtlichkeiten ist das unmittelbare Umfeld einzubeziehen: Gehsteig, Fahrbahn, weitere Stellflächen.
- Ebenfalls von Bedeutung ist das mittelbare Umfeld, da hier für mittellange Aufhalte eine ensprechende Dichte an POIs, Einkaufs-, Freizeit- und Aufenthaltsmöglichkeiten erforderlich ist.

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Seamless Distributed Traffic Monitoring by Distributed Acoustic Sensing (DAS) using existing Fiber Optic Cable Infrastructure

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1 ABSTRACT

Accurate real-time traffic sensing is of key importance, especially in the urban environment to be able to optimize traffic flow by intelligent traffic systems (ITS). Often the high density of traffic sensors, needed to achieve an accurate real-time monitoring of important arterial roads, is difficult to implement due to technical contraints or because of installation cost. Furthermore, existing traffic sensing technology uses sensors that are only able to measure traffic flow on a cross-section of the road where they are installed (typically on a junction), giving no information on the situation in between. An alternative "seamless" measuring technology, is to use floating car data, with Google Maps being the most prominant example. This technology allows to derive traffic information over wide road sections, however it is unable to deliver real-time information, and it relies on the "cooperation" of the data providers (the fleet owner or the mobile phone users). Distributed acoustic sensing (DAS) is a relatively new technology that allows a seamless, real-time monitoring of the road traffic situation over large distances of up to 50 km using the existing telecom fiber optic cable infrastructure. We present first result of traffic speed estimation performed on a real highway with DAS, over a distance of 19 km and compare them to reference measurements from induction loops.

Keywords: intelligent traffic systems, distributed acoustic sensing, real-time, traffic monitoring, traffic sensors

2 INTRODUCTION

Roads always been the backbone of transportation in the urban environment. Therefore, permanent traffic monitoring is crucial to ensure continuous traffic flow. The data provided by real-time road traffic monitoring can potentially provide information regarding traffic jams and accidents. With such information, traffic management centers are enabled and supported to react quickly to incidents and intelligent transportation system (ITS) measures, such as the closure of a lane or temporary usage of the hard shoulder, can automatically be imposed.

Different technologies are currently used for traffic monitoring systems where sensors are either installed overhead, under, or next to the road to detect traffic flow [1]. Such sensors could be lasers scanners [2], infrared [3], radar [4], [5], ultrasonic [6], [7], magnetic [8], [9], acoustic [10] or video cameras [1], [4]. Passing vehicles can cause changes in the magnetic field that are then processed to measure the flow of vehicles [8], [9]. Acoustic-based monitoring measured by a microphone array were also proposed [10]. Another method for traffic monitoring is through crowd-sourcing of smartphone connection data [11] or from fleets of vehicles equipped with GPS systems ("floating car") [12]. Sensors installed under the road surface come with the disadvantage of high cost due to constant need for repair and maintenance while sensors placed overhead or next to the road such as cameras are susceptible to adverse weather conditions [1].

Distributed acoustic sensing (DAS) is a technology that allows a seamless, real-time monitoring of the traffic situation over large distances of up to 50 km without additonal roadside installations. It uses fiber optic cables, already installed next to the roads for data- and communication-networks (telephone, internet), as a distributed detector. The advantage is that the fiber cable infrastructure typically installed at high density in the urban environment can be reused, as it is, for traffic sensing by connecting an optical "interrogator" instrument to one end of an unused fiber. The technique allows the detection of very small changes in the optical fiber cable, such as the mechanical strain caused by microscopic deformations from vibrations of the cars running nearby.

DAS measurement results on road traffic flow have already been presented in smaller studies in the urban environment and over relatively short distances of 1000 m and were compared to measured vehicle counts [13]. In this work, we present first results of distributed acoustic sensing (DAS) for road traffic monitoring over a long distance of approx. 19 km between the location of the interrogator device and the monitored road section and we compare the derived average speed to reference speed measured with a conventional roadside loop detector.

3 DISTRIBUTED ACOUSTIC SENSING

DAS systems work by sending short laser pulses through a fiber optic cable where the light is scattered via Rayleigh scattering and the light returning to the source is analyzed to infer information. In DAS systems, optical fibers with a length up to 50 kilometers can be used. The fibers used are typically already installed in the ground, parallel to a highway, for telecommunication purposes where it can be kilometers long and any disturbances along the fiber can be measured. An interrogator device connected to one end of the fiber transmits a series of laser light pulses into the fiber cable, as shown in Figure 1.

In the glass of the optical fiber there is an effect present that causes a continuous "reflection" of the light along the fiber. Rayleigh scattering is caused by inhomgenities in the glass and is actually a different mechanism than reflection, but for the sake of simplicity one can depict the Rayleigh scattering effect as light being reflected on a myriad of microscopic mirrors embedded in the glass. Therefore, for a single laser pulse being coupled into the fiber, instead of many distinct reflected pulses a continuously distributed signal is returned from the fiber. The scattered light has the same frequency as the impinging light wave and can be analysed by optical means. The vibrations generated by the passing cars and trucks stretch and compress the optical fiber affecting its optical path length. This induces a measurable phase shift in the back scattered light which is sensed by interferometric methods. Probing the fiber with a laser pulse of high repetition frequency (2 kHz) allows to analyse the vibration spectrum produced by nearby vehicles, distinguishing them from other vibration sources and tracking their time-location trajectories along the cable. In this work we demonstrate that with these changes in the signal induced by passing vehicles, relevant traffic information can be derived.

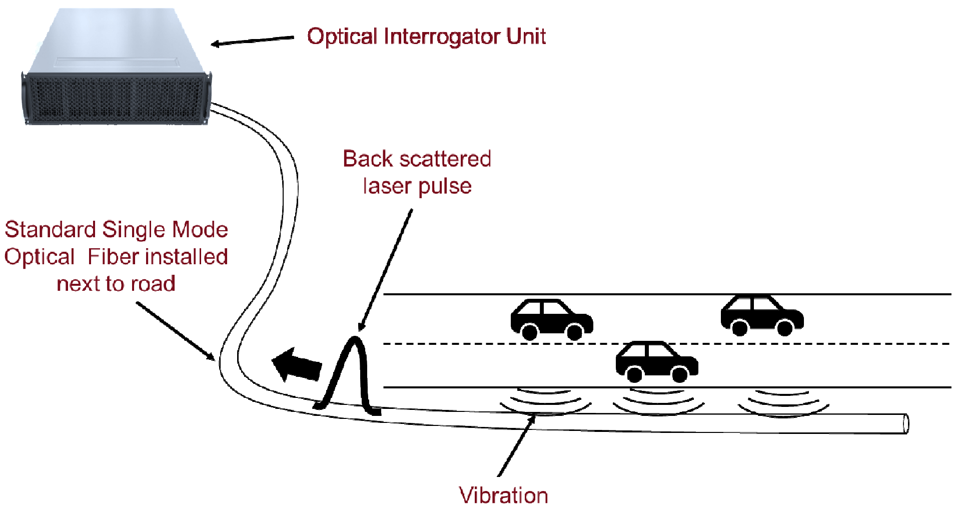

Fig. 1: Principle of the DAS measurement for traffic situation monitoring.

4 EXAMPLE TRAFFIC MONITORING RESULT

We have performed traffic flow measurement from a highway section of approx. 600 m length and with 19 km distance from the interrogator device, recorded over 60 minutes, with the fiber optic cable being installed next to the road. From the image representation of the spectral power of raw DAS signals the trajectories of the vehicles running on the road have been identified. After threshholding of the spectral power diagram, we obtain a binary 'image' of vehicle tracks as a time-location diagram (cf. Figure 2). From this representation we have extracted the incident angles of the tracks that represent the vehicles' speed. We have used image processing techniques, specifically Hough transformation, to extract the angles from the image data and averaged the speed results over 1 minutes time intervals.

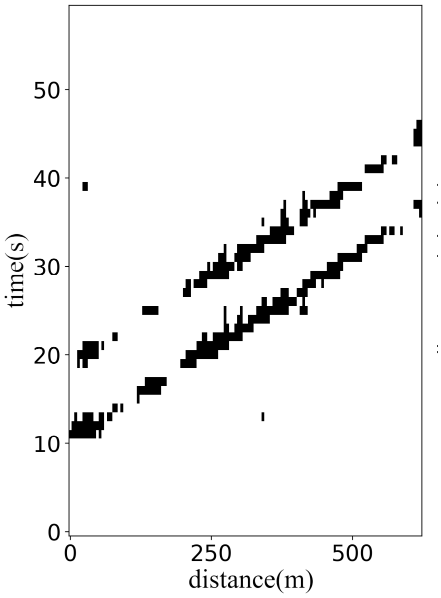

Fig. 2: Binary image vehicle trajectory representation of two vehicles produced from raw DAS data.

Comparision with loop counting data reveiled that the DAS signal mainly contained the truck trajectories. The resulting estimation has therefore been compared to the average speed reference of the trucks. Figure 3 shows that the majority of the deviations in the 1 minute averages between speeds from DAS trajectories and measured truck speeds is below ±10 km/h .

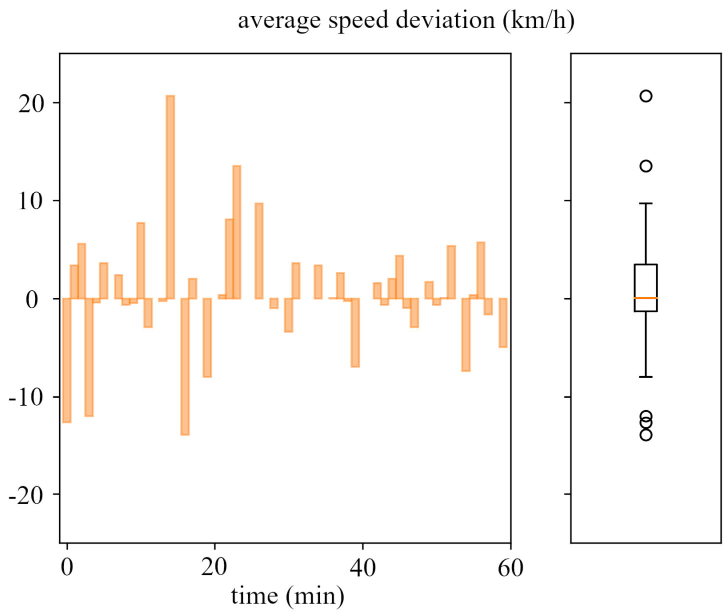

Fig. 3: Average 1-min. speed deviation between DAS speed estimation and reference induction loop data for trucks. The boxplot is based on interquantile range with whiskers = 1.5 and line depicting median point.

5 CONCLUSION

In this paper we demonstrated the potential of distributed acoustic sensing (DAS) for traffic situation monitoring applications using existing fiber optical infrastructure for telecommunication. Real-time traffic

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information on average vehicle speed has been estimated and compared to reference data from induction loops. The results show that the majority of the 1-minute time intervals showed less than 10 km/h deviation from the reference value. Given that DAS systems only require the installation of an interrogator device connected to one end of an existing fiber-optic cable infrastructure, the presented solution requires low-cost road-side maintenance and installation. An additional advantage of a DAS-based traffic situation monitoring system is its long-range capabilities with minimal sensors required. Even though our current algorithm was only able to detect trucks near the fiber-optic cable, we plan to further improve the sensitivity of the detection algorithm to reliably detect passenger vehicles and also vehicles on lanes farther away from the cables.

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Smartes Wohnen für Generationen – wie Nachverdichtung Chancen für leistbares, alternsgerechtes und klimafreundliches Wohnen bietet

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1 ABSTRACT

Städte sind aktuell mit vielfältigen Entwicklungen konfrontiert, die sie vor neue Herausforderungen stellen. In der Stadt Wien treffen ein starker Bevölkerungszuzug und ein Wachstum der Stadt auf einen fortschreitenden demographischen Wandel und einen Anstieg an älterer Bevölkerung. Die Nachfrage nach Wohnraum, insbesondere nach leistbarem Wohnraum steigt. Neben der Errichtung von neuen geförderten Wohnanlagen ist auch die Nachverdichtung und Modernisierung bestehender Wohnanlagen ein zentrales Thema um aktuellen Herausforderungen zu begegnen, wobei insbesondere Siedlungen aus den 1950er bis 1970er Jahren in den Fokus der Stadtentwicklung und Stadterneuerung gelangen. Immer wichtiger werden dabei auch die Anforderungen an alternsgerechtes Wohnen und an die partizipative Mitgestaltung von (älteren) Bewohnerinnen und Bewohnern in Wohnanlage und Quartier. Gleichzeitig bietet sich die Chance, in Zeiten des Klimawandels, auch Klima- und Energieherausforderungen im Quartier mit innovativen Lösungen zu begegnen. Das Smart Cities Demonstrationsprojekt „Smartes Wohnen für Generationen“ ist im Kontext dieser übergeordneten Themen wachsende Stadt, alternsgerechtes Wohnen, Sanierungsbedarf im geförderten Wohnbau der Nachkriegszeit, Klima- und Energieherausforderungen und Partizipation von Bewohnerinnen und Bewohnern verortet. Konkret beschäftigt sich das Projekt mit einem Nachverdichtungsprozess in einer Wiener Wohnanlage der 1970er Jahre, um diesen mit innovativen Maßnahmenbündeln zu begleiten und einen Mehrwert für Bewohnerinnen, Bewohner und Quartier zu ermöglichen. Die Maßnahmen zielen immer sowohl auf einen sozialen als auch auf einen klima- und energierelevanten Impact ab. Dabei werden soziale, technologische, bauliche und klima- und energierelevante Aspekte berücksichtigt und auch Lernerfahrungen für weitere Projekte generiert und verfügbar gemacht.

Keywords: Leistbares Wohnen, Klimaresilienz, Urbane Transformation, Nachverdichtung, Alternsgerechtes Wohnen

2 NACHVERDICHTUNG ALS CHANCE FÜR LEISTBARES, ALTERNSGERECHTES UND KLIMAFREUNDLICHES WOHNEN

Das Smart Cities Projekt „Smartes Wohnen für Generationen – Multidimensionale Transformationsprozesse im Wohnquartier mitgestalten“, das von der Stadtteilarbeit der Caritas der Erzdiözese Wien, dem gemeinnützigen Wohnbauträger Schwarzatal, der österreichischen Energieagentur und der FH Campus Wien gemeinsam durchgeführt und vom Klima- und Energiefonds gefördert wird, möchte die verschiedenen inhaltlichen Perspektiven und die Chancen, die mit Nachverdichtung im geförderten Wohnbau verbunden sein können, ausloten und aufzeigen.

2.1 Nachverdichtung und leistbarer Wohnraum in der wachsenden Stadt

Wien ist eine stark wachsende Stadt. Von 2008 bis 2016 ist die Zahl der Einwohnerinnen und Einwohner um knapp 200.000 von 1.670.000 auf 1.840.000 gestiegen und Prognosen gehen von einem weiteren Wachstum auf über zwei Millionen Einwohnerinnen und Einwohner im Jahr 2029 aus. Wachstum bedeutet vielfache Herausforderungen für die Stadtentwicklung. Der Bedarf an Wohnraum steigt, insbesondere der Bedarf an leistbarem Wohnraum. Für ganz Wien wird der Bedarf an gefördertem Wohnraum von der Arbeiterkammer auf mindestens 9.000 neue Wohnungen pro Jahr geschätzt. Die Stadt reagiert auf dieses demographische Wachstum mit zahlreichen neuen Stadtentwicklungsgebieten. Um die geförderte Neubauleistung zusätzlich zu erhöhen, wird darüber hinaus auch nach Potenzialen im Bestand gesucht. Wohnbauträger werden dazu angeregt, bestehende Wohnanlagen und Liegenschaften in Hinblick auf Flächenreserven und Möglichkeiten der Nachverdichtung zu prüfen. Nachverdichtungen können in diesem Kontext ein wichtiges Instrument darstellen, um zusätzlichen leistbaren Wohnraum zu schaffen und gleichzeitig der weiteren Zersiedelung mit ihren ökologischen Folgen entgegenzuwirken.

2.2 Nachverdichtung und Modernisierung von Wohnsiedlungen der Nachkriegszeit

Die Modernisierung von Wohnanlagen aus der Nachkriegszeit ist mittlerweile ein zentrales Thema geworden. So sieht die Stadt Wien im aktuellen Stadtentwicklungsplan STEP 2025 einen Aktionsplan 50/60/70 vor, der die Modernisierung von Nachkriegswohnbau zum Thema hat. Die quantitative Dimension dieser Herausforderung ist beachtlich. Es gibt heute in Wien, laut Statistik Austria, 215.000 Wohnungen mit Hauptwohnsitzmeldung, die in den Jahren zwischen 1945 und 1970 erbaut wurden und 16.000 Mehrparteien-Gebäude aus diesem Zeitraum.

Modernisierungsmaßnahmen für Bestandsobjekte aus dieser Zeit fokussieren aktuell zu einem großen Teil auf bauliche Maßnahmen wie thermische Sanierung oder die Verbesserung von Barrierefreiheit, wohingegen Aspekte der sozialen Nachhaltigkeit und weitere Aspekte im Umgang mit dem Klimawandel bislang noch wenig Berücksichtigung finden. Dabei weisen die Wohnanlagen der 1950er bis 1970er Jahre gerade in Hinblick auf soziale Aspekte große Verbesserungspotenziale auf, da sie häufig von mangelnder Infrastruktur und kaum gestalteten Freiräumen gekennzeichnet sind und meist auch über keine Gemeinschaftsräume verfügen. Bislang wurden die Potenziale, die eine Nachverdichtung im geförderten Wohnbau auch für die Modernisierung von bestehenden Wohnanlagen und für Bestandsbewohnerinnen und Bestandsbewohner haben können, noch kaum ausgelotet. Der Ausgangspunkt des Smart Cities Projekts „Smartes Wohnen für Generationen“ ist die Annahme, dass durch Nachverdichtung nicht nur zusätzlicher Wohnraum geschaffen werden kann, sondern auch soziale Infrastrukturen und Angebote entstehen können, die einen potenziellen Mehrwert für die gesamte Siedlung bzw. das Quartier darstellen.

2.3 Nachverdichtung und alternsgerechtes Wohnen

Eine weitere aktuelle gesellschaftliche Herausforderung stellt der demographische Wandel mit einer kontinuierlichen Zunahme der älteren Bevölkerung dar. Der Anteil der Über-65-Jährigen liegt in Wien bei rund 17% und wird laut Prognose – trotz Zuwanderung jüngerer Bevölkerungsgruppen – in den nächsten Jahrzehnten konstant steigen. Bis 2030 ist ein Anstieg um 31,7% prognostiziert. Vor allem die Gruppe der Über-75-Jährigen wird im Zeitraum 2014 bis 2024 mit 37% das im Vergleich mit allen anderen Altersgruppen mit Abstand größte Wachstum verzeichnen. Dabei ergeben sich besondere Anforderungen an Wohnen, wenn es für verschiedene Altersgruppen bedürfnisgerecht sein soll – diese reichen von baulicher Barrierefreiheit über soziale Einbettung in Wohnanlage und Quartier, über besondere Kommunikations-bedürfnisse bis hin zu Ansprüchen an Mobilität.

Gerade in Siedlungsstrukturen der 1950er bis 1970er-Jahre zeigt sich der demographische Wandel besonders stark, da noch ein hoher Anteil an Erstmieterinnen und Erstmietern darin lebt. Gleichzeitig werden genau hier die Ansprüche an alternsgerechtes Wohnen bisher nur wenig erfüllt. Nachverdichtung kann hier ebenfalls ein Potenzial für die verbesserte Wohnqualität von älteren Bewohnerinnen und Bewohnern bieten. Maßnahmen wie ein sozial begleitetes Umzugsmanagement in den barrierefreien Neubau, die generationengerechte Gestaltung von Freiräumen und Gemeinschaftsräumen und speziell auf ältere Menschen sensibilisierte Hausbesorgerinnen und Hausbesorger sind Ideen für alternsgerechtes Wohnen, die in dem vorliegenden Projekt innovative Umsetzung finden. Große Potenziale haben auch Smart Home Lösungen im Sinne des Ambient Assisted Living für alternsgerechtes Wohnen, wobei hier noch wesentliche Lücken im Wissen über die Anwendung im geförderten Wohnbau und die Annahme der Technologien durch die Bewohnerinnen und Bewohner bestehen. Innovative Schritte sollen im vorliegenden Demonstrationsprojekt daher im Bereich der partizipativen Entwicklung und Anwendung von AAL-Technologien u.a. auch in Kombination mit Energiemanagement gesetzt werden.

2.4 Nachverdichtung und Klima- und Energieherausforderungen

In der Smart City Rahmenstrategie bekennt sich die Stadt Wien zu ihrem Beitrag zur Erreichung der Europäischen Klimaziele 2030 und 2050 auf lokaler Ebene. Klimaresilienz, Ressourcenschonung und technologische Innovationen sollen in Wien dabei immer mit hoher Lebensqualität für alle Bevölkerungsgruppen und mit gesellschaftlicher Inklusion zusammengedacht werden.

Nachverdichtungen von Wohnanlagen stellen in diesem Zusammenhang eine wichtige ressourcenschonende und sozial wie ökologisch nachhaltige Vorgehensweise in der Schaffung von neuem Wohnraum dar. Durch innerstädtische Nachverdichtung kann das Bauen auf der grünen Wiese und somit Versiegelung von noch unbebauten Grünflächen vermieden werden und die Vorteile der kompakten Stadt, wie kürzere Wege und bereits vorhandene öffentliche Verkehrs- und Infrastrukturanschlüsse, wirken sich klima- und energiebezogen positiv aus.

Bisher wenig Beachtung gefunden haben darüber hinaus gehende klima- und energierelevante Aspekte von Nachverdichtungen im Wohnbau der 1950er bis 1970er Jahre. Der mehrdimensionale Veränderungsprozess bietet die Möglichkeit durch die professionelle Begleitung der Transformation auch experimentelle Aktivitäten und Innovationen in Bezug auf Klima- und Energiethemen umzusetzen. Das Demonstrationsprojekt „Smartes Wohnen für Generationen" lotet aus, welche klima- und energierelevanten Ergebnisse durch neue Formen des gemeinschaftlichen Wohnens und Zusammenlebens sowie durch Partizipations- und Kommunikationsprozesse vor Ort erzielt werden können. Konkret wird auf Energiesparpotenziale von gemeinschaftlichem Wohnen eingegangen, sowie auf die partizipative Entwicklung von alternativer Mobilität, Urban Gardening und Smart Home Lösungen.

2.5 Nachverdichtung und Mitgestaltung von Transformationsprozessen im Wohnquartier

Zudem stellt die Nachverdichtung bereits bestehender Wohnanlagen in der Regel auch eine Herausforderung für die Bestandsbewohnerinnen und Bestandsbewohner und das soziale Gefüge im Wohnquartier dar. Die damit verbundenen Transformationsprozesse werden von den Bewohnerinnen und Bewohnern meist als sensible Veränderungsprozesse wahrgenommen, die selten von ihnen selbst initiiert wurden und gleichzeitig ihr unmittelbares Wohnumfeld direkt betreffen. Sie rufen Unsicherheiten, Fragen, Ängste, Sorgen und mitunter auch Widerstände hervor, insbesondere bei schon lange in der Anlage lebenden (älteren) Bewohnerinnen und Bewohnern. Hier gilt es, Anliegen ernst zu nehmen und Beteiligungsmöglichkeiten zu schaffen, die Mitgestaltung und Mitsprache eröffnen. Da es in den meisten Anlagen eine Durchmischung an bereits länger vor Ort lebenden Bewohnerinnen und Bewohnern und neu zugezogenen Bewohnerinnen und Bewohnern und an älteren und jüngeren Bewohnerinnen und Bewohnern gibt, stehen Herausforderungen im nachbarschaftlichen Gefüge sowie des intergenerativen Wohnens im Fokus der Begleitung von Veränderungsprozessen. Dabei sollen die vielfältigen Bedürfnisse von Bewohnerinnen und Bewohnern verschiedenen Alters, verschiedenen Geschlechts und verschiedener Kulturen berücksichtigt werden und das Entstehen neuer nachbarschaftlicher Strukturen gefördert werden. „Smartes Wohnen für Generationen" versteht Altern als Prozess und möchte Wohnformen für verschiedene Generationen und sich verändernde Bedürfnisse ermöglichen.

3 INNOVATIVE MAßNAHMENBÜNDEL ENTWICKELN UND ERPROBEN

Im Rahmen des Smart Cities Projekts werden – ausgehend von identifizierten Bedarfslagen und Potenzialen – in einer konkreten Wohnanlage aus den 1970er Jahren Maßnahmenbündel entwickelt und realisiert, die soziale, technologische, bauliche und klima- und energierelevante Aspekte adressieren und verknüpfen.

3.1 Die Wohnhausanlage Meißauergasse 2a

Die Wohnhausanlage Meißauergasse 2a, errichtet im Jahr 1975, besteht aus zwei Wohnblöcken mit zehn bzw. elf Obergeschossen und in Summe 426 Wohneinheiten mit ca. 700 Bewohnerinnen und Bewohnern. Im Haus gibt es drei Hausbesorgerinnen und Hausbesorger, die jeweils für zwei Stiegen zuständig sind, sowie einen selbstorganisierten Mieterinnen- und Mieterverein. Eine Erhebung der Bevölkerungsstruktur im Bestand zeigt, dass im Wohnungsbestand noch viele Mieterinnen und Mieter leben, deren Verträge bereits bei Erstbezug der Anlage abgeschlossen wurden: insgesamt 200 Mietverträge (47%) entfallen auf Erstmieterinnen und Erstmieter, nur rund 28% der Verträge wurden vor weniger als 10 Jahren abgeschlossen. Durch die altersbedingte Entwicklung bestehen in der Bewohnerinnen- und Bewohnerschaft nun neue Bedürfnisse hinsichtlich Leben, Wohnen und Bewegung (Barrierefreiheit), die von den baulichen Strukturen im Bestand und dem Umfeld nicht abgedeckt werden können.

Im Rahmen des Projekts „Smartes Wohnen für Generationen" (2018-2021) wird die Erweiterung der Wohnanlage um zwei weitere Gebäude auf dem bestehenden Grundstück begleitet. Dabei werden konkret folgende Maßnahmenbündel umgesetzt und in Hinblick auf ihren sozialen Impact und ihren Klima- und Energie-Impact begleitend evaluiert:

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3.2 Maßnahmenbündel #1: Smartes generationengerechtes Wohnen

- Entwicklung und Implementierung von generationengerechten Wohnformen, die unter Einbeziehung von älteren Bewohnerinnen und Bewohnern und deren Bedürfnissen entwickelt werden
- Entwicklung von Angeboten für soziale Betreuung und Ambient Assisted Living (AAL), die je nach Bedarf ausgewählt werden können
- Konzeption und Umsetzung eines sensiblen Umzugsmanagements, das ältere Menschen aus dem Bestand dabei unterstützen soll, in eine neue barrierefreie, alternsgerechte, kleinere und energieeffizientere Wohnung zu ziehen
- Initiierung von Aktivitäten gemeinsam mit den Seniorinnen und Senioren und für das Quartier

Sozialer Impact

- Unterstützung von selbstbestimmtem Älterwerden
- Bedarfsorientierter Einsatz von AAL Technologien und Betreuungsangeboten
- Niederschwellige Information und sensible Umzugsbegleitung
- Gemeinsame Aktivitäten und Kompetenzstelle für das Quartier

Klima- und Energie-Impact

- Umzug in den Neubau als Energiespar-Chance
- CO_2-Einsparung durch Umzug in eine kleinere und energieeffizientere Wohnung
- CO_2-Einsparung durch gemeinschaftliches Wohnen in Seniorinnen- und Senioren-WGs

3.3 Maßnahmenbündel #2: Smarte Freiräume und Mobilität

- Partizipative und bedarfsorientierte Umgestaltung der Freiräume zur Erhöhung des Grünflächenanteils auf dem Grundstück und der Nutzungsqualität für verschiedene Generationen, unter Einbeziehung der Bewohnerinnen und Bewohner
- Implementierung von Urban Gardening als intergenerative Aktivität und Durchführung von Gartenworkshops zur Vermittlung von Gartentipps und als Ausgangspunkt für Bewusstseinsbildung für lokale Nahrungsmittelproduktion und bewussten Konsum
- Integrative Betrachtungsweise der Freiraumgestaltung der Wohnsiedlung gemeinsam mit der angrenzenden öffentlichen Parkfläche, die in den kommenden Jahren durch die Stadt ebenfalls partizipativ umgestaltet werden soll
- Entwicklung und Implementierung von alternativen Mobilitätsangeboten, die es bisher in der Wohnanlage nicht gab, unter Einbeziehung interessierter Bewohnerinnen und Bewohner und mit Mehrwert für das gesamte Quartier
- Information und Bewusstseinsbildung zu klimaschonenden Mobilitätsangeboten und zu Sharing-Möglichkeiten im Rahmen von Aktionstagen, die zum Kennenlernen und Ausprobieren der Angebote einladen

Sozialer Impact

- Ermöglichung sozialer Treffpunkte auf den Freiflächen
- Bedürfnisorientiert gestaltete Ausstattung für verschiedene Generationen
- Vielfältigere Mobilitätsangebote und Förderung selbst bestimmter Mobilität
- Stärkung nachbarschaftlicher Beziehungen durch Teilen und Tauschen

Klima- und Energie-Impact

- Erhöhung des Grünflächenanteils auf der Oberfläche des Grundstücks
- Förderung von bewusstem Konsum
- Implementierung von klimaschonenden Mobilitätsangeboten und Sharing-Modellen

- CO2-Einsparung durch alternative, klimaschonende Mobilität

3.4 Maßnahmenbündel #3: Smarte Energie im Haushalt

- Bedarfsorientierte Entwicklung und Implementierung von Smart-Home-Paketen, die zum Energiemanagement im Haushalt beitragen
- Durchführung von Workshops mit Bewohnerinnen und Bewohnern, die bei der Auswahl und Anwendung von Smart Home Lösungen unterstützen
- Durchführung von niederschwelligen Energiesparworkshops für die Bewohnerinnen und Bewohner, die bei der Auslotung von Energiesparpotenzialen im Haushalt und in Hinblick auf energieeffizientes Nutzerinnen- und Nutzerverhalten unterstützen und wichtiges Alltagswissen anschaulich vermitteln

Sozialer Impact

- Bedarfsorientierung und Unterstützung in der Anwendung von Smart Home
- Bessere Kontrolle über Energieverbrauch und Kosten

Klima- und Energie-Impact

- Smart Home und Energiemanagement
- Wissensvermittlung und Bewusstseinsbildung zu Energieeffizienz im Haushalt
- CO_2-Einsparung durch smarte Geräte und Bewusstseinsbildung

3.5 Maßnahmenbündel #4: Smarte Gemeinschaftsprozesse

- Aufbau und Begleitung einer Mehr-Generationen-Wohngruppe, die gemeinschaftlich plant und wohnt und dadurch auch Ressourcen spart
- Aufbau und Begleitung von Wohngemeinschaften für Seniorinnen und Senioren, die gerne in Gemeinschaft leben möchten
- Partizipative Planung und Gestaltung von Gemeinschaftsräumen, die bestehenden und neuen Bewohnerinnen und Bewohnern zur Verfügung stehen sollen (da es in der bestehenden Anlage praktisch keine Gemeinschaftsräume gibt) und damit auch neue Möglichkeiten der Aktivität und Begegnung im Wohnquartier ermöglichen
- Begleitung der Besiedelung der neuen Wohnhäuser und der Vernetzung zwischen bestehenden und neuen Mieterinnen und Mietern, Förderung von Wohnhaus- und generationenübergreifenden nachbarschaftlichen Beziehungen

Sozialer Impact

- Stärkung der Wohnzufriedenheit durch Möglichkeiten der Partizipation
- Entwicklung von Formen des gemeinschaftlichen Wohnens
- Neue Angebote an Gemeinschaftsräumen
- Nachbarschaftliche Beziehungen und Nachbarschaftshilfe
- Vernetzung bestehender und neuer Bewohnerinnen und Bewohner

Klima- und Energie-Impact

- Ressourcen- und Energiesparen durch gemeinschaftliches Wohnen
- Ressourcen- und Energiesparen durch Gemeinschaftsräume
- CO_2-Einsparung durch gemeinsames Nutzen von Geräten

3.6 Maßnahmenbündel #5: Smarte Kommunikation

- Einrichtung einer Projekt-Website und laufende Kommunikation zum Prozess und zum Projektfortschritt an alle Bewohnerinnen und Bewohner, analog und digital (Website www.meissauergasse.at; InfoPoint vor Ort, Flyer, Aushänge, digitale Infoscreens)

- Etablierung eines InfoPoints vor Ort mit regelmäßigen Sprechstunden, wo sich Bewohnerinnen und Bewohner persönlich informieren und mit ihren Themen und Ideen einbringen können
- Pilotimplementierung von digitalen Kommunikationsboards, die bisher noch in keiner Anlage des Wohnbauträgers Anwendung fanden und tagesaktuelle Informationen für die Bewohnerinnen und Bewohner ermöglichen
- Stärkung von Hausbesorgerinnen und Hausbesorgern und engagierten Bewohnerinnen und Bewohnern als Multiplikatorinnen und Muliplikatoren, die Aktivitäten und Initiativen in der Wohnanlage auch in Zukunft aktiv mittragen sollen

Sozialer Impact

- Transparente Information und Kommunikation
- Niederschwellige Kommunikation mittels verschiedener Kanäle
- Förderung eines konstruktiven Kommunikationsklimas
- Stärkung der Hausbesorgerinnen und Hausbesorger als kompetente Ansprechpersonen vor Ort
- Empowerment von Bewohnerinnen und Bewohnern

4 ERKENNTNISSE ZU POTENZIALEN UND HERAUSFORDERUNGEN VON NACHVERDICHTUNG WEITERGEBEN

Obgleich Nachverdichtungen zunehmend an Bedeutung gewinnen, fehlt bis dato eine genaue Untersuchung der sozialen und klima- und energierelevanten Aspekte in diesen Prozessen. Das Projekt „Smartes Wohnen für Generationen“ lotet die Potenziale von Nachverdichtungen von Wohnanlagen der 1950er- bis 1970er-Jahre in einer beispielhaften Umsetzung in einer Wiener Wohnanlage aus. Dabei wird insbesondere auf die Kommunikation und Partizipation von bestehenden und neuen Mieterinnen und Mietern gesetzt und speziell auf die Bedürfnisse von älteren Bewohnerinnen und Bewohnern eingegangen. Die eingesetzten Methoden und Instrumente werden explorativ erprobt und begleitend evaluiert. Für die sozialen Aktivitäten und die Maßnahmen mit Klima- und Energiewirksamkeit erfolgt eine sozialwissenschaftliche Begleitforschung sowie die Konzeption und teilweise Umsetzung eines begleitenden technischen Monitorings mit klima- und energierelevanten Kennzahlen.

Im Rahmen des Projekts sollen sowohl die bestehenden als auch die neuen Bewohnerinnen und Bewohner in ihren Bedürfnissen ernst genommen und in ihren Kompetenzen gestärkt werden. Nachverdichtung ist dabei ein komplexer Prozess, der verschiedene inhaltliche Dimensionen beinhaltet und daher eine multi- und transdisziplinäre Herangehensweise erfordert. Zudem stellt ein solcher Prozess, insbesondere die bestehenden Bewohnerinnen und Bewohner, die mit Veränderungen ihres unmittelbaren Lebensumfelds konfrontiert sind, auch vor Herausforderungen und ist für sie häufig mit gemischten Gefühlen verbunden. In der Prozessbegleitung ist daher ein besonders sensibler Umgang mit Anliegen und Bedürfnissen, die artikuliert werden, sehr wesentlich. Im vorliegenden Projekt wurden viele persönliche Gespräche geführt, um den Menschen zuzuhören und ein offenes Ohr für ihre Anliegen, Sorgen und Ideen zu haben. Ausgehend von konkreten Bedarfslagen und Initiativen wurden Aktivitäten teilweise auch adaptiert, um auf Bedarfe zu reagieren.

Die gewonnen Erkenntnisse werden an relevante Stakeholder weitergeben – u.a. im Rahmen von Stakeholder Workshops. Zum Abschluss des Smart Cities Projekts entstehen Publikationen, die das gesammelte Wissen bspw. in Hinblick auf „Nachverdichtung und Generationengerechtes Wohnen“ oder „Nachverdichtung und Klimaresilienz“ weitergeben, sowie ein Prozessleitfaden, der Lernerfahrungen in Hinblick auf die Prozess-begleitung weitergibt und andere Projektvorhaben bei der Durchführung unterstützen soll. Auf diese Weise sollen die Kompetenzen von Bauträgern und Prozessbegleiterinnen und Prozessbegleitern im Bereich der generationengerechten und klima- und energierelevanten Nachverdichtung und Modernisierung ausgebaut werden.

Stakeholder-supported Research on the Food-Water-Energy Nexus with three International Case Studies

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1 ABSTRACT

The projected increasing population in cities and metropolitan regions results in higher demands of resources, i.e., food, water, and energy (FAO 2018), that are essential for human well-being, poverty reduction, and sustainable development(Hülsmann and Ardakanian 2018).There are clear interactions between water, food, and energy that may result in synergies or trade-offs between different sectors or interest groups. To address the issue,the international project IN-SOURCE models and analyses the Food-Water-Energy Nexus (FWE Nexus) in three case study regions of Germany, Austria and the United States of America. Due to the complexity of the nexus issue, stakeholders have been involved actively in the research process, whose valuable output would strongly support the decision-making processes. This paper gives an overview of the methods, case studies, and stakeholder involvement of the whole project. With the novel methods, stakeholder-oriented process, and case studies' representativity, IN-SOURCE serves as a benchmark for future FWE researches.

Keywords: Urban Simulation Platform, CityGML, Stakeholder Engagement, Food Water Energy Nexus, Planning Tools

2 INTRODUCTION

Cities and metropolitan regions are deemed to face major urban management challenges in the future: 55 percent of the world's population already lives in urban areas, and according to a United Nations report(United Nations, Department of Economic and Social Affairs, Population Division 2019), it will be more than two-thirds by 2050. Such a high population density in a limited space requires even better planning of public infrastructure services, especially the secure and stable supply of food, water and energy. However, the growth of cities also opens up synergetic opportunities. With the expansion and reconstruction of sustainable infrastructures, cities can take comparatively large energy-efficient transformation steps to fulfil their climate protection goals.

In this context, the international project "INtegrated analysis and modelling for the management of Sustainable urban food, water, and energy resOURCEs" (IN-SOURCE) is aimed to model and analyse the Food-Water-Energy Nexus (FWE Nexus) in three case study regions of Germany, Austria and the United States of America. A common goal is to develop tools that support sustainable FWE strategies in collaboration with local stakeholders. The main focus is a shared open urban data and modelling framework, integrating 3D visualisation tools to assess FWE nexus impacts and support decision-making processes quantitatively.

The proposed modelling framework is based on the Open Geospatial Consortium (OGC) standardised open data model of CityGML and a newly proposed CityGML FWE Application Domain Extension (FWE ADE)[1] (Padsala et al., 2021). To date, this model, by finding its interfaces to urban simulation platforms such as UD_InfraSim[2] and SimStadt[3], can simulate energy, water and food potentials in decentralised supply infrastructures under boundary conditions such as climate change, population growth, and land use change in the timeframe to 2050 (Padsala et al., 2021). Nexus relations and further development of the FWE ADE to extend its support to the open source 3D City Database (3DCityDB) are currently being worked upon.

[1] https://transfer.hft-stuttgart.de/pages/in-source/in-source/FWEADE/
[2] https://www.ait.ac.at/en/research-topics/digital-resilient-cities/projects/ud-infrasim
[3] https://www.hft-stuttgart.de/forschung/projekte/aktuell/simstadt-20

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Additionally, environmental footprint indicators are being analysed forfood supply and demand (Kaufmann et al., 2021) andwastewater treatment plant (WWTP) analyses, for which the FWE data model integration is currently being investigated.

To facilitate public authorities' engagement,co-creative stakeholder processes are aimed to configure alternative urban and regional scenarios for integrated carbon-neutral and sustainable infrastructure. The goal is to understand the interlinkages between food, water and energy demand and analyse the feasibility of a decentralised and increasingly autonomous FWE supply. This encompasses efficient wastewater treatment with sewage sludge to energy projects, treated effluent reuse for irrigation in agriculture or a high regional food production ratio including food, green and forest waste to energy concepts. Prototype solutions will be analysed for their scalability and transferability to other cities and regions.

This paper tries to 1) consolidate major outcomes and lessons learnt during the development of the FWE urban data and modelling framework and discuss 2) results derived from the past co-creative stakeholder processes in the three international case study regions of Germany, Austria and the United States of America for larger public awareness and scientific community reach.

The IN-SOURCE project (May/June 2018 – September 2021) is part of the Sustainable Urbanisation Global Initiative (SUGI), established by the Belmont Forum and the Joint Programming Initiative Urban Europe. The project is funded by the EU Horizon 2020 programme and national funders, the Federal Ministry of Education and Research in Germany, the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology in Austria and the National Science Foundation in the USA.

3 SHARED MODELING FRAMEWORK

3.1 Nexus relations

The workflows for food, water and energy productionpotentials and demand have now been elaborated. Recently, the team has been working on local food security and the sustainable food system, adding the food component to the existing energy-water simulation platform and thus finalising it. Food demand, productive potential and self-sufficiency can be analysed in the context of the food-water-energy nexus at community, sub-regional and regional levels. Currently, the nexus interrelations are being explored, which is intrinsically important for estimating future needs and potentials under changing boundary conditions. Lastly, visualisations of different FWE nexus related scenarios shall give decision support to stakeholders.

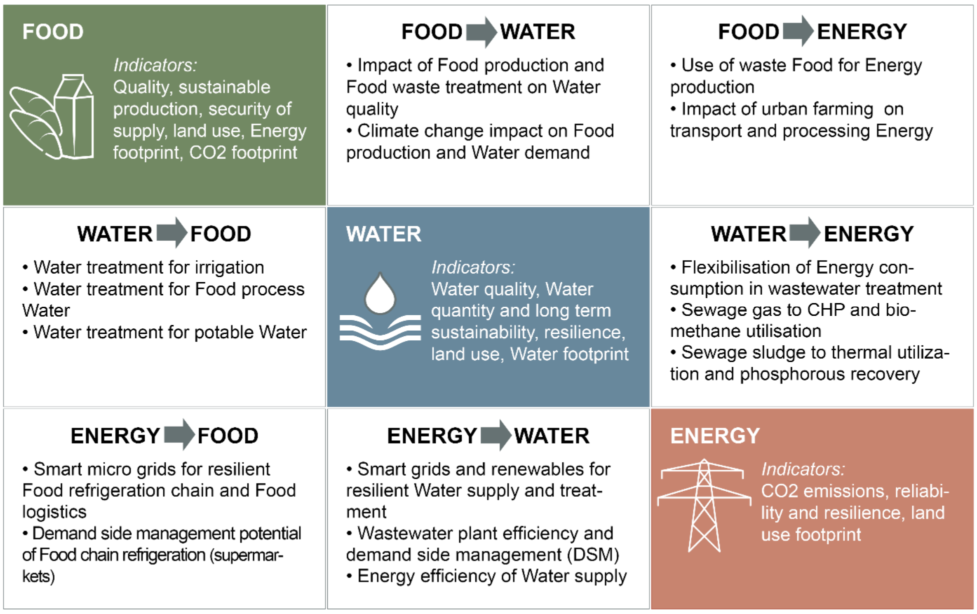

Fig. 1: The main indicators and FWE nexus questions addressed in IN-SOURCE (source: HFT Stuttgart)

3.2 Shared data model: developing a CityGML based Food-Water-Energy ADE

The development of the shared modelling framework is based on a 3D CityGML model depicting the county of Ludwigsburg in Germany, one of the three case study regions. The HFT research team set it up to model

FWE related scenarios, develop measures and work with the regional government to speed up implementing sustainable infrastructure for the whole region with 39 communities.

IN-SOURCE aims to model the impact of land use change and renewable energy transition on urban infrastructure using3D city models. The CityGML data model was extended for the food and water using CityGML's extension mechanism of the application domain extension (ADE). All national teams intensively worked on the definition of parameters according to their respective case study regions. The CityGML FWE ADE acted as a standard data exchange platformfor connecting domain specific tools to simulate FWE related scenarios. For example, to calculate biomass potential using SimStadt for a land use scenario simulated using UD_InfraSim based on Vienna's future population growth, climatic conditions and city development plan or simulating building stock energy demand using SimStadt for the neighbourhood development scenarios from the Gowanus case study of New York modelled initially using Rhinoceros3D (Padsala et al., 2020).

3.3 Simulation tools covering aspects of the FWE nexus

3.3.1 SimStadt: A comprehensive bottom-up tool to simulate potentials and demands of FWE nexus

Depending on the defined nexus relations, corresponding tools were applied and further developed to solve the nexus issue. To the author's knowledge, an assessment of biomass potentials along with other energetic potential and demand at the regional level based on a consistent set of geographical input has not been performed yet. The research question of this work will be: What are the local biomass resource potentials, their dependency on other resources, mainly water, their conflicts with other usages, i.e., food, competition with other energy technologies, i.e., wind and open land PV, and their contribution to renewable energy supply at the regional level?

To address this gap, work has been done to introduce a new workflow in SimStadt, the regional energy simulation platform developed at HFT Stuttgart (Nouvel et al., 2015). It evaluates the local biomass potential and irrigation demandon arable and forestry landsand its transformation to different forms of secondary energy, i.e., solid fuels, biogas, or bioethanol, based on geographical inputs. Based on the intermediate results of the above-mentioned biomass workflow, each land use field's vegetal and animal feed potentialsare simulated (Bao et al. 2020a).

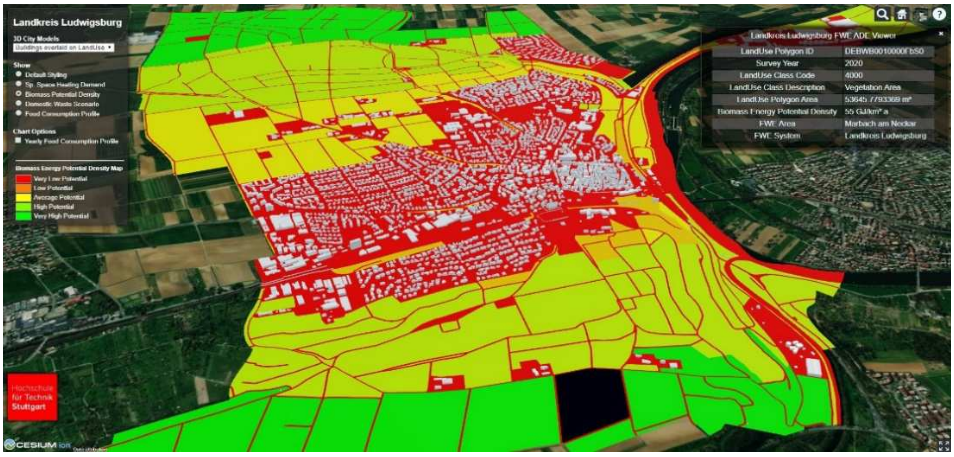

Fig.2: Biomass potential visualisation of Marbach,County of Ludwigsburg, Germany using CityGML 3D City Models (source: HFT Stuttgart, Bao/Padsala)

Since urban areas are the main consumers of resources, urban food[4] and water demand workflows (Bao et al. 2020b) were developed in SimStadt, including socio-economic factors, i.e., income, age, human development index, etc. While biomass in urban areas might not provide substantial amounts of bioenergy to local consumers, the example of green roof with PV modules is used to assess exemplarily the energetic impact and economic feasibility of urban biomass on the roof PV yield and heating demand (Weiler et al.

[4] Not published yet.

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2019), which are simulated by existing and well-validated workflows in SimStadt, using the same geoinformatics input data.[5]

3.3.2 FWE Land Use Simulator: A tool to simulate urban growth induced land use change and impacts to Food, Water and Energy

The FWE Land Use Simulator was built usingUD_InfraSim. This simulation platform enables urban planners to estimate the impact of urban development, urban growth, infrastructure costs, for example, for road and water networks, in relation to changes in land use (growth patterns) in the urban region (Gebetsroither-Geringer et al., 2015). It is built upon earlier 'urban development simulation tools' (Gebetsroither-Geringer and Loibl, 2007; Gebetsroither, 2009; Gebetsroither and Loibl, 2014). Within the IN-SOURCE project, the simulation platform was used, adapted and extended to build the FWE Land Use Simulator. This FWE Land Use Simulator enables, e.g., to explore the impact of urban growth scenarios on arable land and biomass production, the water demand and roughly estimate the renewable energy production potential from rooftop PV production.

3.3.3 HANPP and eHANPP environmental footprint indicator: visualisation of urban food production and global impacts of food consumption

We quantify urban land use intensities using HANPP (Human Appropriation of Net Primary Production) as environmental footprint indicator. HANPP measures the depth of human interventions into the biological productivity of ecosystems. Human appropriation of NPP occurs through land cover/use change (e.g., from forest to cropland, HANPPluc) which alters ecological patterns and processes and through agricultural and forestry harvest, where biomass is removed from ecosystems (HANPPharv). In IN-SOURCE HANPP was calculated for the city of Vienna and its food demand. The interactive website called “HANPP Explorer”showsa visualization of the urban food production and the global impacts of food consumption as well as the simulated impacts of dietary changes (Kaufmann et al., 2021).

4 THE CASE STUDY REGIONS

4.1 Low-density metropolitan region: County of Ludwigsburg

The administrative district of Ludwigsburg – County of Ludwigsburg – is a Southern German region of 687 square kilometres with 39 small to medium-sized cities. 540.000 inhabitants (786 per square kilometre) live in that district. The county stands for a growing metropolitan region adjacent to the Baden-Württemberg state capital of Stuttgart, including agricultural land.

The county governance seeks to speed up implementation of sustainable infrastructure such as maximum renewable supply, efficient wastewater treatment with sewage sludge to energy projects, treated effluent reuse for irrigation in agriculture, or a high regional food production ratio including food, green and forest waste to energy concepts. IN-SOURCE took up the ambitious climate protection plan of the county to support its implementation and demonstrate synergies in the food-water-energy sector. For this purpose, the potential of sustainable energies that can be used locally was analysed, e.g. the county-wide biomass utilisation potential, taking into account a good energy-food balance. In the area of wastewater, waste2power plays a role. By switching to CHP, the self-supply of electricity in waste water treatment plants can be increased to over 90%.

Further potentials lie in co-digestion and the decoupling of upgraded biogas as biomethane. In Ludwigsburg County, agricultural food production (still) plays a role and can cover the local food demand to a certain extent. Increased direct marketing and water reuse for irrigation in agriculture are other relevant topics.

4.2 Medium-density urban area: Vienna

Vienna represents a rapidly growing European capital with currently just under 2 million inhabitants. The city is pursuing an urban development plan (STEP), a climate protection plan and a smart city initiative. Urban planning faces the challenge of creating infrastructure and housing in a sustainable manner while maintaining a high quality of life. Economic and population growth induce changes in land use as well as

[5] The workflows of roof PV potential and heating/electricity demand are developed in the project SimStadt 2.0 (03ET1459A) funded by BMWi.

energy, water and food consumption; in this context, the city government has a strong planning and regulatory role regarding water and energy supply and was therefore included in the stakeholder process. There are still a number of farms within the city limits, and initiatives to promote urban and vertical farming and food production are emerging and gaining public attention, therefore we invited stakeholders from NGOs as well.

The city of Vienna is a medium dense European city, where also a 3D CityGML model is available that was already in use for energy-related analyses (Skarbal et al., 2017). Within IN-SOURCE, the CityGML model,together with the CityGML FWE ADE and the FWE Land Use simulator,will analyse the consequences of land use change for biomass generation rooftop PV potential climate change adaptation and population growth (Padsala et al., 2021).Urban food production and biomass potentials (HANPP) and current food demand are analysed as well as global, international and national impacts of changes in dietary patterns (eHANPP) (Kaufmann et al.,2021).

4.3 High density urban area: New York City/Gowanus

The expanding and very dense city of New York faces challenges of a limited capacity urban infrastructure, particularly the electricity grid, and increasing needs to provide a resilient infrastructure for water and food supply. New York committed itself to reduce GHG emissions by 80% by 2050. This should be reached by transforming the energy system into a sustainable energy system with a reduced carbon footprint.

In New York, the district of Gowanus/Brooklyn was examined. The common data model based on the CityGML standard was used for modelling as in the European case studies.

Urban transformative change requires substantial changes in the supply system and affects the FWE system widely. Gowanus is to be restructured in a climate-neutral manner and is an example of a very densely populated urban district. The current industrial district will be rezoned to a combined residential and industrial area, increasing population. Due to the lack of arable land in the densely built area to grow food within the city, land cultivation will be limited, and the focus lies on the import of food and urban agriculture. In order to reduce the carbon footprint, NYC is investing in more efficient public transportation systems, other means of electric vehicles (scooters, bikes), ride sharing and vision zero NYC (safe streets for pedestrians). Efforts on improving the energy efficiency of large electricity consumers (subway systems, wastewater treatment plants, etc.) have been taken by the city.

5 STAKEHOLDER ENGAGEMENT

An important goal of the IN-SOURCE project was the involvement of stakeholders throughout the process. This meant first and foremost identifying the relevant stakeholders in each case study region, for example, administration/municipality representatives, urban planners, energy and water utilities, food producers and logistics companies, supermarket associations, food promoters, citizens and NGOs. A stakeholder mapping table was produced in order to get an overview. In addition, potential contact persons were evaluated in terms of their professional affiliation with the respective nexus elements and their possible influence on the project.

Fig.3: US and international experts at a cross-sectoral workshop held in December 2019 at the Center for Architecture in New York

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A joint workshop design for all three case study regions, as initially foreseen, soon turned out to be not practicable. Each national team had to find asuitable form of co-operation. In the New York Gowanus district, a participation process was already initiated and mainly involved citizens, architects and urban planners (the Net Zero Neighborhoods project and Gowanus by Design, (http://gowanusbydesign.org/). Another stakeholder co-creation process running in parallel focused on optimising wastewater treatment plants throughout the city and involved, among others, NYC Agencies and the Mayor's Office.

In Vienna, a stakeholder process was started with identifying relevant stakeholders from the city administration and planning offices, civilly society organisations and NGOs. These were invited to a series of three half-day workshops (Smetschka 2020). The Vienna team developed a Causal Loop Diagram to discuss the FWE nexus and stimulatingco-operation. After elaborating a set of challenges and visions, keyfactors were identified, and available data analysed. Scenarios for sustainable urban development addressing food, water and energy production and demand were developed in the second workshop. In the final third workshop, results from modelling, visualisations of these results and the tools employed during the research will be presented, and their usability for city administration will be evaluated.

In the German case study, stakeholder engagement suffered from the Covid pandemic However, several consultation meetings were held to exchange mutual knowledge in wastewater treatment to enable the modelling of a wastewater treatment plant to identify flexibilities for the grid-serving operation of the power grid. In addition, virtual meetings are still planned to initiate stakeholder engagementin the County of Ludwigsburg, focusing on co-identifying and co-producing knowledge on varied elements of the urban FWE systems, which scenario simulations can now support.

Thus, in each local case study, stakeholders cooperate in developing a vision of how urban space and infrastructures should be designed, how FWE synergies can be optimised, renewables can best be integrated, and how population growth, land use changes and climate change challenges can be envisaged for future developments. Strategies and goals can be defined by converting these considerations into scenarios with key performance indicators (KPI), such as CO2emissions.

6 CONCLUSION

IN-SOURCE managed to develop a shared urban simulation toolbox and a single shared data framework for all three case study regions, which has a good replication potential for other cities and regions. Furthermore, the transferability of the shared urban modelling framework has been proved.

The stakeholder involvement helped to consider common urban and technological challenges in the three very different case studies. A joint workshop design was not feasible given the different stakeholder groups involved. However, a network of individuals with diverse professional backgrounds has been established, their visions and strategic planning skills pooled. With IN-SOURCE, an interesting learning process for stakeholders and researchers has begun.

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The Effect of the Pandemic of the Use of Public Spaces in Hungary

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1 ABSTRACT

The first wave of the coronavirus epidemic in Hungary held in 2020 from March until April. During this period the restrictions not only to the shops opening hours came into force but also for the use of public spaces. The most settlements in Hungary had closed their public spaces and parks from the local population, thus preventing the mass spread of the epidemic. However the experiences have showed that most people against the restrictions has used in the same way actively the local public spaces as before. Therefore the research presents how the people has used the public spaces before and after the coronaviros epidemic in Hungary. And when will they use them again and how often after the pass of the epidemic. Besides that what they expect from the public spaces after the pass of the coronavirus epidemic.

Keywords: survey, hungary, parks, public spaces, coronavirus

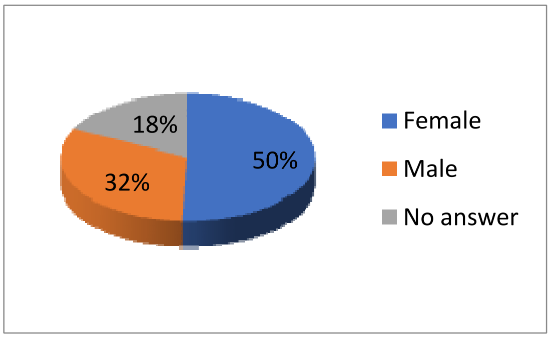
2 INTRODUCTION

The first wave of the coronavirus epidemic (COVID-19) in Hungary lasted from March to April in 2020, which, as in all countries, had a serious impact on all areas of life, including the use of public spaces. Since the virus appeared in Hungary, fewer and fewer people have visited the city's public spaces and parks, which was then officially restricted by a government decree in March. Namely the 5th paragraphs of the 71/2020. (III. 27.) government decree from the curfew following its publication has pointed out that "Individual recreational sports activities, recreational pedestrian traffic on the outskirts and in the interior of settlements – preferably in green areas – can be carried out alone or together with people living in the same household, with a distance of at least 1.5 meters from others." Then in most settlements, local governments closed public spaces and parks to the public, thus preventing the mass spread of the coronavirus epidemic. However, based on experience and news, many have actively used the local public spaces in most municipalities despite their limitations. But it was also possible to hear that families from other parts of the city or settlements moved to the given park or square to relax and have fun. Therefore the aim of the study was to explore how the use of public spaces in Hungary has changed since the outbreak of COVID-19 epidemic. And on the other hand, how can public spaces and parks be made attractive again to those who have not visited them at all because of the coronavirus after the epidemic has passed. Because national and international researches has proved that public spaces, which are especially true for cities and towns, play a significant role in keeping settlements livable for the local population. (Madden, 2008; Thompson, 2002). It is no coincidence that in many Western European countries recognizing this, they embarked on a serious public space development program, which in most cases was coupled with green space development. (Ghel, 2014) Because green areas, similar to the squares and parks, have the same impact on the livability and sustainability of a given settlement. (Anguluri–Narayanan, 2017) Therefore, in addition to the changes in the use of public spaces and parks in Hungary, it was also studied what the population would like to see in these public spaces. What kind of tools, street furniture, should they have and how important is the size of the green spaces.

3 BACKGROUND OF ONLINE SURVEY RESPONDENTS

The online survey ran from April 26 to May 16, 2020, and was shared via email outside of a popular social site. A total of 287 people started filling in the questionnaire, which was eventually completed by 170 people, so only the fully completed 170 questionnaires were included in the current processing.

In terms of gender, 50% of respondents were women 32% men and 18% did not answer this question (Fig.1.)



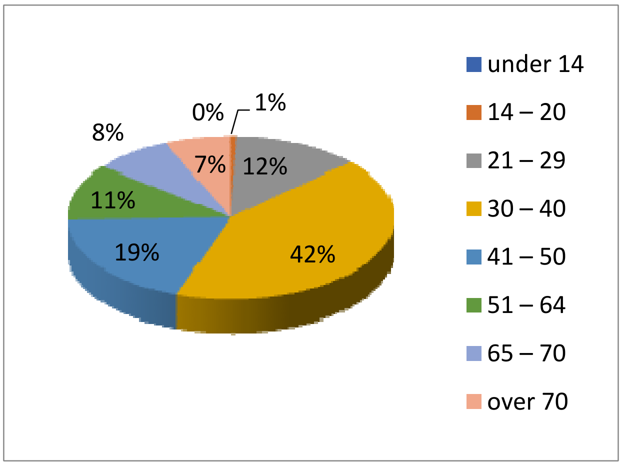


Fig. 1 (left): Gender of survey participants. Fig. 2 (right): Distribution of respondents by age group

In terms of age distribution, most people completed the questionnaire between the ages of 30 and 40 (42%), followed by those between the ages of 41 and 50 (19%). The other age groups represented less than 15% in the survey. Between the age 21 and 29 13%, between the age 51 and 64 11%, between the age 65 and 70 8% and finally the age over 70 7% completed the questionnaire. Between the age 14 and 20 only 1 person completed the questionnaire and there were no respondents under the age 14 (Fig. 2.).

In terms of the highest educational attainment, almost half of the respondents (46%) had a university degree (MA, MSc) and almost a quarter (24%) had a college degree (BA, BSc). High school degree had 20%, and vocational training or vocational school 4% of the questionnaire respondents. The other category was marked by a total of 9 people (5%) where almost without exception the doctoral degree (PhD) has been specified (Fig. 3.)

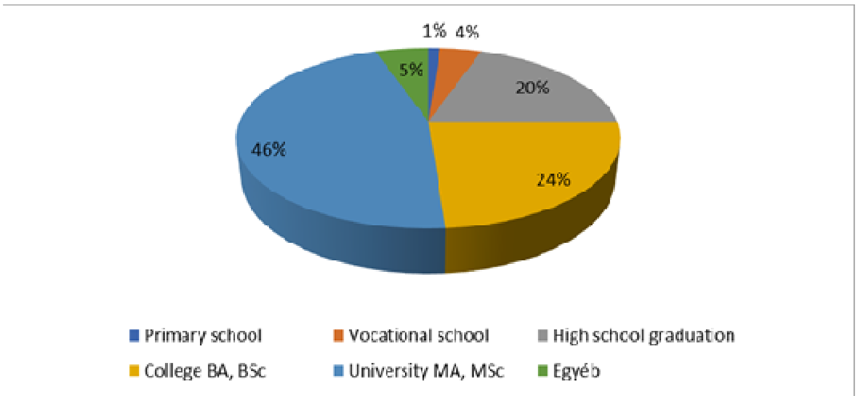


Fig. 3.: The highest educational attainment rate of respondents

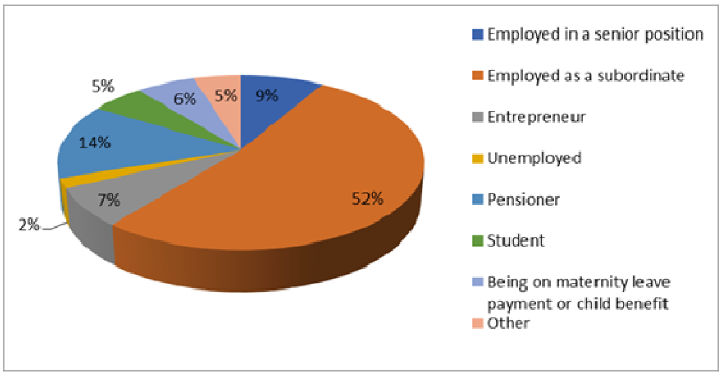


Fig.4.: Occupation of respondents

Slightly more than half (52%) of the respondents were employed as subordinates and 14% were retired (Fig. 4). The other categories were selected by less than 10% of the respondents, so 9% were employed in senior positions, 7% were entrepreneurs, 6% were in maternity leave payment or child benefit, 5% were students and 2% were unemployed. The other category was marked by a total of 8 people, where several gave their profession (eg. settlement planner), two wrote that they were students and two were both students and entrepreneurs.

4 USE OF PUBLIC SPACES BEFORE THE OUTBREAK OF COVID-19 EPIDEMIC

From the answers it turned out clearly that most people (77%) live within 10 minutes from the park or square they visit most often. Within this, primarily less than 5 minutes 37%, 5 minutes 19%, and 6-10 minutes 21%. Only 11% marked a distance of 11 and 15 minutes, and only 6% marked a distance of 16-20 minutes. More than 21 minutes distance were marked by 5 of respondents (Fig. 5.). All of this has confirmed previous research that people primarily like to visit the public space closest to where they live. (Jóna, 2016)

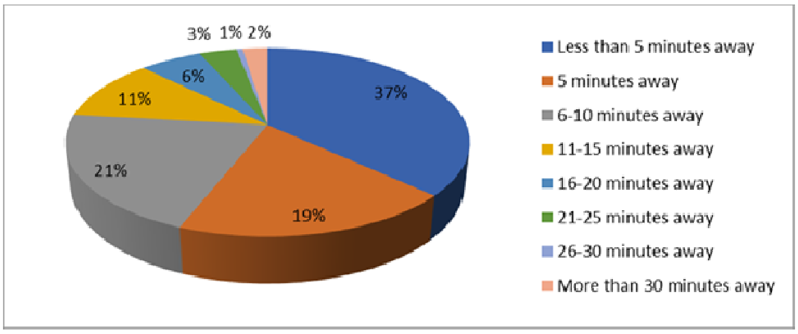
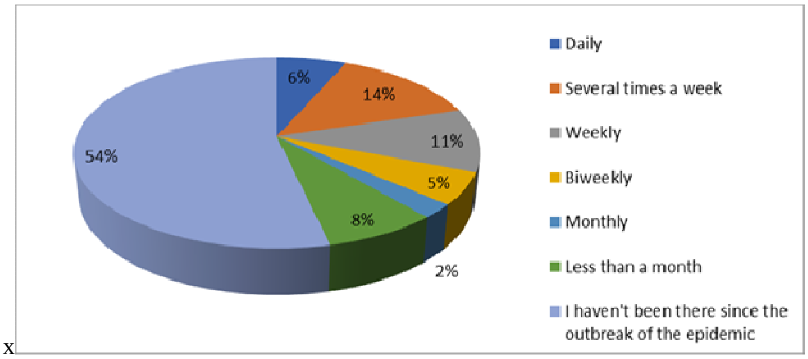


Fig. 5.: Time availability of the most visited public space



x

Fig. 6.: Frequency of visits to public spaces

In the period before the outbreak of the epidemic, the number of visitors to the squares and parks can be said that more than a quarter of the respondents (30%) visited the nearest one several times a week (Fig. 6). Daily 12% and weekly 19% has visited its favourite public space. However, it is important to highlight that 22% of the respondents of the questionnaire has moved out for less than a month. The rates of the biweekly (9%) and monthly (8%) visitor rates didn't even reach 10%.

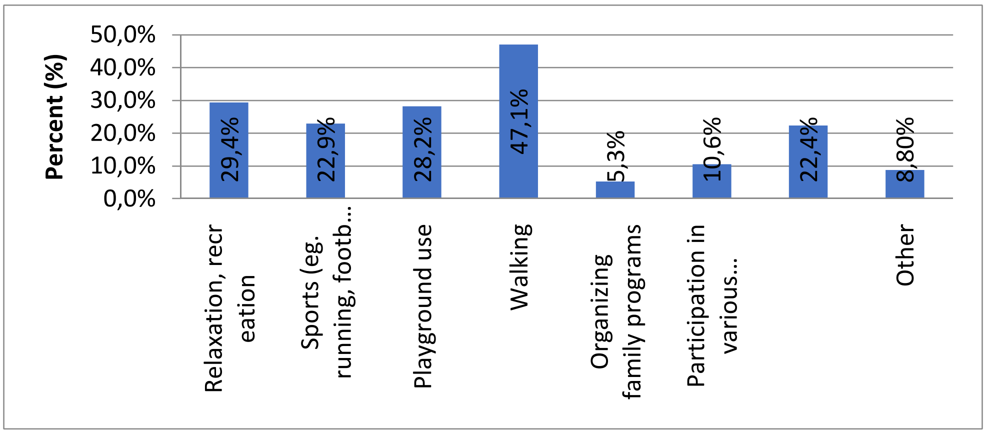


Fig. 7.: The purpose of the use of squares and parks before the coronavirus outbreak

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To the question what purpose the respondents used the space or park they visited most often, most indicated walking (47.1%), followed by relaxtion, recreation (29.4%) (Fig. 7). Playground use (28.2%) received the third highest number of markings, which was followed by sports (eg. running, football, basketball, etc.) (22.9%) and social relations (eg. meeting, chatting with friends, acquaintances, etc.) (22.4%). Participation in various programs (eg events, sports days, etc.) was supported by just over 10%, while the organization of family programs was supported by only 5.3%. The other category was chosen by 8.8%, where more people wrote that they visited the nearby community space for dog walking. But many also wrote that they had just passed through it or that they hadn't been visited for any purpose.

5 USE OF PUBLIC SPACES SINCE THE OUTBREAK OF COVID-19

One of the key questions of the survey was to explore how the outbreak of the coronavirus epidemic and the restrictions imposed affected the willingness to visit public spaces. Form the answers it turned out clearly that 54% of the respondents did not visit their favorite square or park since the virus appeared, but 46% still visited it with varying frequency (Fig.8). Within this, 14% several times a week, 11% weekly, 6% daily, 5% biweekly, 2% monthly, and 8% less than 1 month.

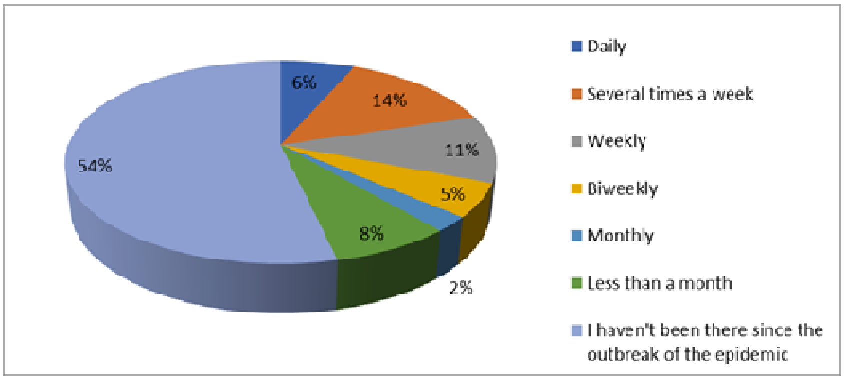


Fig. 8.: Visits to squares and parks after the outbreak of the coronavirus epidemic

The purpose of visiting and using parks and squares among those who stated in the previous question that they continued to visit the one closest to them (46%) was done primarily for walking (29.4%) (Fig. 9). This was followed by sports (eg. running, football, basketball, etc.) (11.8%) and then, with a slight difference, relaxation, recreation (10.6%). From the other aspects, apart from the other (5.9%) category, none even reached 2%. The most spectacular decline was the use of the playground (1.2%), social contacts (eg. meeting, talking to friends, acquaintances, etc.) (1.8%) and participation in various programs (eg. events, sports day, etc.) (0%). In the case of the latter, of course, the fact that mass events have been banned for a limited time plays a significant role, and in the case of the former two, the fear of the virus and the measures restricting its spread linked to group activities are in the background. In the other category, several wrote that they "not using" the public spaces, or they using only to walking through it. But besides of that such aspects as dog walking, work, and cycling also appeared.

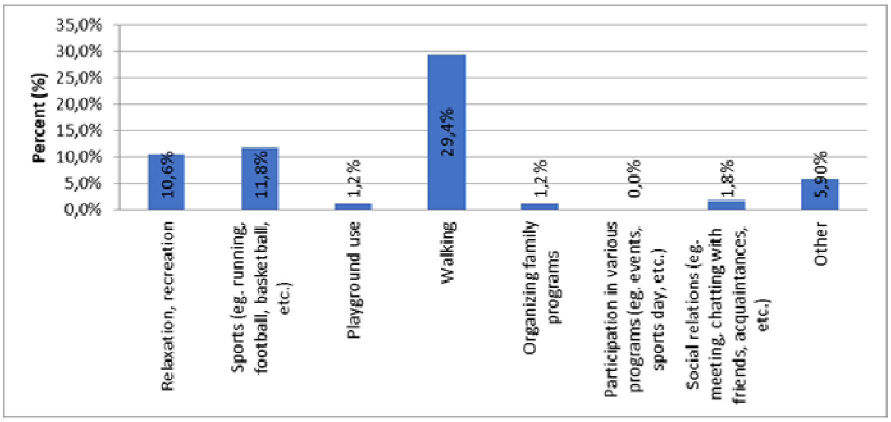


Fig 9.: The purpose of the use of squares and parks after the coronavirus outbreak

To the question, how the respondents as a whole perceive the change in visiting their favourite public space, 55% answered that they have not visited it at all since the outbreak of the coronavirus epidemic. Only 14%

visit it in the same way as before, 13% less often and 8% more often. Looking at of both extremes 5% stated that they visit a nearby square or park very rarely and much more often (Fig. 10.).

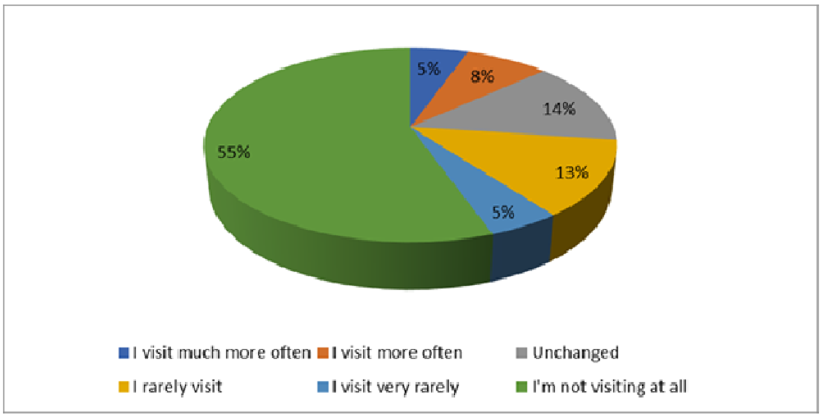


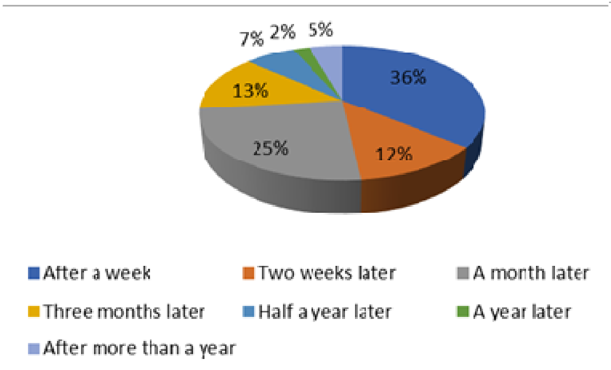
Fig. 10.: Changes in the number of visitors to squares and parks after the outbreak of the coronavirus epidemic

In the next question, those who answered in the previous case that they visit nearby squares or parks more often had to justify why. There were very different responses, but overall, the majority of people did so because of their daily movement needs. Because several people wrote, since almost everything was closed due to the danger of the virus, only the parks and squares provided them opportunities for sports and movement. And some people has also mentioned that they had more free time to move away from home more often during their work from home.

But those, on the other hand, who visited the nearby parks less frequently or not at all, primarily mentioned two main reasons: the curfew, and the fear of the coronavirus. Most people clearly complied with the “stay at home” call, but some also mentioned that they could stay at home because they had their own garden. What is definitely worth mentioning is the use of playgrounds, because some did not visit nearby parks due to the closure of playgrounds.

6 USE OF PUBLIC SPACES AFTER THE END OF THE COVID-19 EPIDEMIC

The last part of the survey looked for the answer to the fact that after the coronavirus epidemic is over, how will people use the public spaces. So therefore, the respondents first had to answer what they think, how soon they will revisit the square or park closest to them after the epidemic has passed. Based on the answers received, there was an interesting duality, because 36% would like to take back their favorite community space a week after the virus threat passed, while 25% would rather wait another month. The 12% of respondents would expect two weeks, 13% would indicate three months, half a year 7% and one year only 2%. Interestingly, however, there were also those (5%) who thought it would take them more than a year to walk safely back to their favorite square or park (Fig. 11).



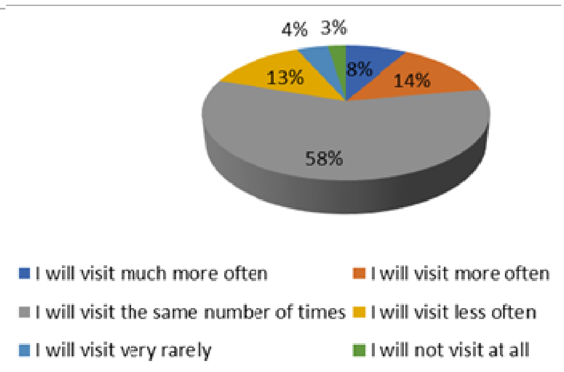


Fig. 11 (left): Time to revisit public spaces after the coronavirus epidemic has passed. Fig. 12 (right): Changes in the number of visitors to squares and parks after the epidemic has passed.

To the question how the frequency of visits to public spaces will change after the epidemic has passed, more than half of the respondents (58%) answered that they will visit the same number of times as before (Fig. 12). Slightly less than a quarter (22%) will catch more often, including 8% much more often, 17% will catch

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less often, within which only 4% answered that they will very rare. Finally, only 3% thought they would not visit the nearby public space at all.

In the next question, those who had previously answered that they would go to public spaces more often after the epidemic had passed had to justify why. Based on the responses received, three groups could be distinguished, where in the first, families wrote that they wanted to take their children back to their favorite playground, and if possible more often than before. The second group included those who wanted to spend as much time outdoors as possible after the virus threat is over, especially in nearby parks or green areas. The third group included those who, due to the lack of social relations, would like to visit nearby parks and squares as often as possible for this purpose. For those who responded that they would visit less frequently, three groups could also be distinguished. The first group included those who, due to fear of the coronavirus, preferred to visit or revisit other places that had been closed in recent months after the epidemic had passed (e.g., gyms). And those in the third group will visit the squares and parks less often because with the end of working from home they will be able spend less time outdoors.

In the last block of the online survey, similarly to the previous chapters, the respondents had to answer the question of the purpose for which they will primarily use the squares and parks closest to them after the coronavirus epidemic has passed. Comparing the received answers with the answers before the period of the epidemic outbreak (Fig. 7.) walking was still the most popular activity. However, sports (e.g. running, football, basketball, etc.) (28.2%) were marked by 6% more than earlier (Fig. 13). So, after the passing of the epidemic, more people plan to play sports in the public spaces, and the social contacts (eg meeting, talking with friends, acquaintances, etc.) (24.7%) also showed a slight increase. The recreation, relaxation (28.8%), playground use (27.6%) and participation in various programs (eg events, sports day, etc.) decreased slightly. The other category (5.9%) was also less chosen, where dog walking and passing through the public space were still written by most people.

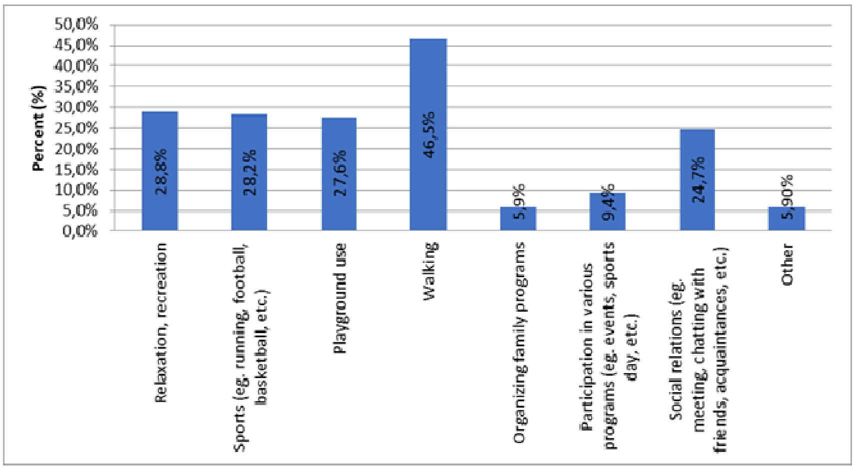

Fig. 13.: The purpose of the use of squares and parks after the end of the coronavirus epidemic

However, the respondents had to answer not only how they will use the squares and parks after the epidemic has passed, but also in their opinion what kind of tools, street furniture, etc. must they have. Therefore, in the case of the parks they had to specify these objects, where most people have marked the plants (trees, bushes, flowers) (82.4%), followed by the trash (80%) and then the benches (78.8%) (Fig. 14). The other aspects were not mentioned by half of the respondents either, only the public lavatory (47.1%) could approached this rate. The 44.7% of the respondents would like have drinking fountains in the parks and 37.1% would like bicycle storage. The rate of playground creation (27.6%) is the same as the rate of playground use in the period before (Fig. 7.) and after (Fig. 13.) of the coronavirus epidemic. The dog toilet (22.4%) was marked by more people as the tables (18.2%) or the sports field (12.9%). The least popular were the placement of the dog runner (8.8%), the public statue (5.9%), and the fountain (4.7%). The other category was marked by only 9 people, where additional aspects such as shading, hand washing, hand disinfection, wifi, changing facilities and “smart” devices (eg. smart bench, e-roller, e-bike, electric charger). were given.

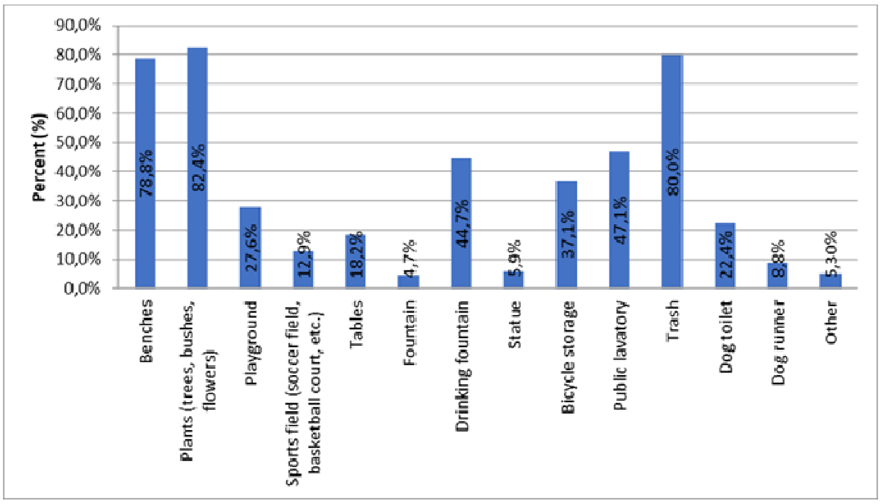

Fig. 14: Equipment tools and objects of parks after the end of the coronavirus epidemic

In public spaces, in contrast to parks, most people had marked that they want enough trash can (80%) after the coronavirus epidemic had passed (Fig. 15). This was followed only by the placement of benches (76.5%) and the planting of plants (trees, bushes, flowers) (67.6%). The respondents, similar to parks, would like to have public lavatory (40%), bicycle storage (37.6%) and drinking fountains (35.9%). Interestingly, the fountain was marked by only 9.4% of respondents to the questionnaire, although previous research has shown that people specifically require fountains in public spaces to improve their microclimate and well-being. To the public space placed tables was chosen by 17,6% and statues by 12,9%. In the other category, 8 people had added such additional aspects as the placement of individual street furniture instead of benches, the placement of an eye-catching or "cult" work of art, a public clock, the creation of appropriate walking routes in the square and similar to the parks provision of hand washing and hand disinfection opportunity.

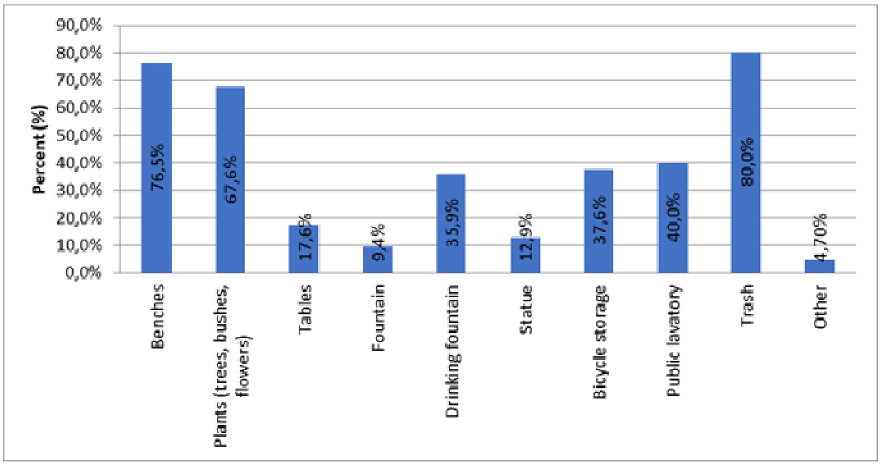

Fig. 15: Equipment tools and objects of public spaces after the end of the coronavirus epidemic

In the penultimate question of the survey the respondents had to provide a written answer to the question that in their opinion after the coronavirus epidemic has passed how could be made attractive again the squares and parks to become as popular as they were before. A significant prat of the respondents thought that no action would be needed because the squares and parks would be as popular as before after the virus has passed. A few people even pointed out, that probably with the unlocking of the prohibition will be even more people on the public spaces than before, because people couldn't go anywhere at the time of the restrictions.

However, the other part of the respondents believes that the regular maintenance and cleaning of squares and parks, the care for vegetation, placing the right number of trash can help the most of the public spaces to become popular again. Many people wrote more vegetation and the increase of green spaces as the disinfection and the possibility of hand washing too. There were those who said that with the right community programs could make parks and spaces more attractive. There were those who said that with the right community programs could be achieved that the parks and squares become attractive again. But several people have also written about the placing of benches at the right distance, to ensure a safety distance in the event of an epidemic. The last question of the survey was what the local governments will have to pay attention after the epidemic is over, during the creation of squares and parks and their development in the future. In a significant number of the answers, the cleanness, the hygiene, the regular maintenance, the development of toilets, and the plant care were highlighted by the respondents. But many have also written on this question to have a sufficient amount of trash can in public spaces, as well as the shading which would be especially important in parks. More people have indicated also to clearly separate the functions in the parks, for example, athletes on the sports field should not disturb children and parents who use the playground. There were those who complained that there was no proper dialogue between local governments and the residents during the creation and development of a square or park, therefore community planning has been suggested by several people in such cases. Many have written about security, the placement of public cameras, and making these spaces attractive to all ages. The planting of more vegetation were also mentioned as well as the segregation of dog areas and the provision of “dog bags”.

7 CONCLUSION

From the results of the online survey clearly turned out that a significant part of the population in Hungary complied with the curfew and didn’t visit the nearby squares or parks. However, it was also found that 46% of the respondents, although with varying intensity, but continued to visit public spaces despite the restrictions. This was mainly due to the fact that because of the closure of sports facilities, these spaces were the best alternative to sports, daily movement. And it’s also important to highlight that many people, with the introduction of working from home, have been able to shape their daily routine in such a way that they could more often to visit the nearby parks or squares. In terms of purpose of use, everyone primarily likes to walk in these places, which was true for the period before the outbreak of the epidemic, during it, and it will be also in the future period. This was followed by the relaxation, recreation, as well as the use of the playground, sports, and finally the social relations. Of course, in the post-epidemic period, the popularity of these activities declined, which was especially true of the use of playgrounds and social relations.

Based on the results of the survey it can be pointed out that for the Hungarian population are especially important in their environment can be found squares and parks. And these public spaces after the passing of the coronavirus epidemic will playing also an important role on the keeping of the Hungarian settlements liveability. Nothing proves this better that in both case the increase of the green areas, the disposal of trash cans and the cleanness were highlighted. Therefore, in the future during the development of the settlements public spaces these aspects must be taken into account.

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The Possibility of Qualifying the Courtyards of Religious Buildings as Open Public Spaces: a Case Study of the City of Brčko

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1 ABSTRACT

Open public spaces are those parts of an urban morphology that make the city whole. These spaces essentially represent integral parts of the city's urban structure, and as such, they are always in the process of change and transformation. With the rapid expansion of cities in recent years, the planning and development of open public spaces in many cities and states have been neglected. At the same time, more and more attention is on the construction of new residential and commercial buildings. Therefore, it is important to find an open space in an already built urban space that has the potential to become a new open public space, such as inner courtyards of residential buildings or courtyards of religious complexes. Although they are open spaces, the courtyards of religious complexes are not considered public space. Religion, and therefore the religious complexes, has a significant role in people's lives, and their role has changed during the turbulent era of war and afterwards. Nowadays, religious communities mostly use the courtyards for their own needs, without users' ability to satisfy their needs for socializing, creating new social relationships, and recreational activities. Due to the characteristics of other public spaces, these courtyards potentially represent ideal parts of the urban structure that can become a new open public space in the city. Also, the advantage of these open spaces around religious complexes is that they already have urban landscape elements. Using the criteria for determining the quality of open public spaces, equipment, availability, and other spatial characteristics it is possible to decide whether the courtyards of religious complexes can meet users' needs. The territory of the city of Brčko was chosen for the case study because there is a large number of religious complexes that belong to different religious communities and which differ from each other in their internal structure. By analyzing the courtyards of religious complexes, with the help of the criteria for determining the quality of open spaces, it is possible to assess the potential of these courtyards to become new open public spaces.

Keywords: public space, criteria, quality, courtyards of religious buildings, Brcko

2 INTRODUCTION

The structure of the city and urban settlements and the quality of life of the inhabitants in the urban environment is greatly influenced by open public spaces, i.e. their existence, position, equipment and other attributes. Open public spaces are places where people from a particular settlement gather, perform recreational and other sports activities, spend their free time, and create new social relations. In other words, open public spaces allow for informal gatherings and therefore encourage interaction between a broader range of society (Oldenburg, 1999). Also, open public spaces are places where the population of a particular community interrupts the daily routine due to physical and mental rest (Đukić, Vlastos & Joklova, 2019). On the other hand, open public spaces represent the connections between the built urban units within the city, i.e. these spaces essentially make the city a whole. Spatial configuration and urban forms, which depend on open public space and layout and the number of buildings around it, have the most significant impact on the quality of urban life and human relations in the urban environment (Moughtin & Mertens, 2003). Due to the considerable importance that open public spaces have for the urban structure and the population's quality of life, their existence in urban areas is no longer a luxury but a necessity. In recent years, due to the increase in the number of inhabitants in cities and the growing need for new residential and business premises, the concept of development and preservation of open public spaces has been endangered. For this reason, it is crucial to find open spaces in already built urban areas, where this problem is present, which can and must become new public spaces that will be accessible to all residents regardless of their demographic characteristics.

Before finding areas within a settlement that could become new open public spaces in the future, it is necessary to list those spaces that already are open public spaces. The category of open public spaces consists of a more significant number of available spaces due to different interpretations of the terms "public" and "open". The term "public" can mean a space owned by the state or city. Still, it can also mean a space owned by a particular company or private person, but which, regardless of the ownership structure, can be used publicly, i.e. which is available to all categories of the population. Also, the term "open" can mean an unfenced, open space, and it can also mean a space that is open for public access or public recreation (Kollarou, Lantitsou & Athanasopoulou, 2014). Open public spaces are easiest to describe as parts of the built or natural environment to which citizens have free access (Carmona, De Magalhaes & Hammond, 2008). Based on the above, open public spaces include parks, playgrounds, markets, areas around memorials, unfenced schoolyards, plateaus, common public gardens, promenades, and sections of roads intended for pedestrians (Carr, Francis, Rivlin, & Stone, 1992). Schoolyards we can classify as open public space, but they can also be closed, i.e. spaces intended exclusively for scholars. In the category of spaces that can become open public spaces under special conditions, schoolyards can include the inner yards of apartment blocks. This paper will examine the possibility of classifying the courtyards of religious complexes as open public spaces. Let's consider those religious complexes are present in all urban areas. All these buildings have certain courtyards in which there are elements of the urban landscape; thus, they can become new open public spaces, which is why they are an ideal subject of research.

Religious complexes have always played an essential role in people's lives because religious beliefs and attitudes that influenced people and their behaviour were presented within them (Kulagina - Stadnichenko, 2016). Also, within these complexes, people performed religious rituals that evoked different feelings, from hatred to complete devotion (Teller, 2016). Religious buildings had such an impact on people, especially during or after the war. In such difficult times, people express the need to visit religious complexes to a much greater extent because it creates a sense of calm. Religious buildings during the war in Bosnia and Herzegovina in the 1990s were of great importance in the lives of all inhabitants of the country. Yet religious complexes had, and still have, far greater significance after the war. This significance is reflected in the fact that these complexes, due to their role in people's lives, can and must become the main actors in the peace-building process (Preljević, 2017).

On the example of the urban structure of the city of Brčko, with the help of criteria for determining the quality of open public spaces, we will research the possibility of treating the courtyards of religious complexes as open public spaces. A unique advantage for this research is that in the city of Brčko, the facilities of different religions are close to each other. Thus, we will conclude whether the courtyards of religious complexes can become spaces for connecting people and creating new social relations between the inhabitants who during certain historical events clashed with each other, as was the case in Bosnia and Herzegovina. Essentially this is the aim of this research. The paper will research the possibility of courtyards of religious complexes becoming new open public spaces in those cities facing the disappearance of other types of open public spaces. Courtyards of religious complexes can be places where the inhabitants of certain areas create new social relations without endangering religious complexes and the needs of the religious community.

3 BACKGROUND RESEARCH

As already mentioned in the introductory part of this paper, open public spaces are those parts of an urban morphology that make the city whole, i.e. represent the city's urban connective tissue; therefore, the existence of these spaces is essential for the city structure. The visitors of open public spaces can view these as outdoor living rooms or as entertainment and recreation centres (Kaftangui, Welling, Masalmeh & Anbar, 2019). With the rapid expansion of cities, open public spaces have been neglected in recent years in that development, i.e. in cities and countries around the world, the planning and development of these spaces are ignored. On the other hand, the focus is on the construction of new residential and commercial buildings. For that reason, researchers in the built-up urban space are looking for new types of open public spaces, such as the inner courtyards of residential buildings (Jona, 2018) or schoolyards to provide citizens with open public space. The citizens need these spaces to be able to perform the activities already mentioned in the introductory part of this paper.

In addition to the above mentioned, another type of courtyard within settlements and cities represents an ideal space that we can potentially classify as a new open public space in the built urban fabric. These are courtyards of religious complexes that are open spaces but not public at the same time because religious communities mostly use them for their own needs. For that reason, the possibility for citizens to satisfy their needs for socializing, creating new social relations and performing recreational activities has been reduced. The fact is that the courtyards of almost all religious complexes, regardless of which religious community they belong to, are equipped with some urban landscape elements that visitors to these areas can use. One example is the monastery courtyards in Iceland and Norway, described by Per Arvid Åsen (2021) in his research. In his work, Åsen states that some of the essential elements of these courtyards are fountains, garden ownership, green areas, etc. We can find similar examples in India, where architects and urban planners are trying to create a theme park in a Hindu temple courtyard that would simultaneously satisfy religious needs and enable other cultural activities. (Ghose, 2012).

Courtyards of religious complexes and school and inner block courtyards can be intended only for certain citizens. If we consider that public spaces are those to which all categories of residents and users have free access, we cannot observe these spaces as open public spaces. On the other hand, courtyards of religious complexes can be intended for all residents, regardless of their affiliation to a specific demographic category. We can conclude this by observing the various religious complexes that today, together with the surrounding area, represent tourist attractions such as the Hagia Sophia in Istanbul or the Notre Dame Cathedral in Paris. These two mentioned religious complexes and the spiritual and tourist significance for the social community also connect visitors with different demographic characteristics. It is clear that religious complexes, i.e. their courtyards, can have a much broader application than the usual religious activities if they are classified as open public spaces. These courtyards can become places of reconciliation and reunification in territories where there have been conflicts between the inhabitants of the social community.

The conclusion is that no matter what religious community the buildings belong to, there is almost always a fenced or unfenced open space around them representing the courtyard of that building. This open space and its use are under the control of the religious community to which it belongs. Since the courtyards of religious complexes almost always cover a larger area, these courtyards tend to become new open public spaces in urban settlements and the city. Based on the analysis of previous research on open public spaces and religious complexes, we can conclude that so far, these complexes have not been sufficiently researched, i.e. the possibility of treating these complexes as open public spaces has not been explored. For the courtyards of religious complexes to be classified as open public spaces, their possibilities must first be analyzed, which would ensure quality spending of citizens' free time, but which at the same time would not conflict with the needs of religious communities.

Due to their characteristics, which are the same or similar to those of other open public spaces, courtyards of religious complexes potentially represent ideal parts of the urban structure that can become new open public spaces in the city. Also, the advantage of these areas around religious complexes is that there are elements of the urban landscape on their surface, which can affect the excellent attendance of these areas and allow the qualification of these areas as public. This paper aims to determine the quality of courtyards of religious complexes with the help of criteria intended to assess the quality of open public spaces and determine the possibility of qualifying courtyards of religious complexes as open public spaces.

We must emphasize that the population's attitude towards religious complexes in Bosnia and Herzegovina has changed over the past few decades. Before the war in Bosnia and Herzegovina in the 1990s, the population visited religious complexes to a lesser extent due to political beliefs that differed from those prevailing today. During the war, and even after it, the attitude of the population towards religion, and thus towards religious complexes, changed. Today, the situation is such that religious complexes and their courtyards are visited much more by citizens than thirty years ago. Many different things influenced that situation, but the most significant influence is the greater accessibility of the church to the population and the people's approach to religion. Precisely because of the better attendance of the courtyards of religious complexes, they gain the opportunity to become public places that will connect citizens of different demographic characteristics.

4 METHODOLOGY

In this part of the paper, we will present the criteria used in the multi-criteria analysis to examine the possibility of classifying courtyards of religious complexes as open public spaces. Before presenting the criteria, it is crucial to explain why we chose the city of Brčko for the case study. The city of Brčko is located in the northeastern part of Bosnia and Herzegovina along the Sava River. It is one of the cities in

Bosnia and Herzegovina in which the structure of the population has changed several times throughout history. Changes in the city's population structure were influenced by various factors, including the conquest of the city by the Ottoman and later the Austro-Hungarian Empire. After that, the population structure changed with immigration and emigration from the area of today's city due to the formation of new state communities in this area, but unfortunately also due to the war in the XX century. Changes in the population structure have created a multiethnic environment that has led to the construction of many religious complexes of different religious communities. Today, within walking distance of the city centre, there are buildings of the Orthodox, Catholic, and Islamic religious communities. All these mentioned facilities have open spaces that are around them and that represent their courtyards. These courtyards can have a significant impact on the city of Brčko and its inhabitants, because if we are based on the fact that in this city the basic structure of the population consists of three nations that conflicted in the late 1990s, then we can conclude that classifying courtyards of religious complexes as open public spaces can help reconcile and bring these peoples closer together. An analysis of the quality of these courtyards should answer whether these courtyards can become new open public spaces. Also, a crucial fact for this research is that near the mentioned religious complexes, an ethnically heterogeneous population potentially represents the users of these open spaces.

4.1 Criteria for determining the quality of open public spaces

Determining the quality of open public spaces cannot be done before the criteria for analyzing and evaluating these spaces are selected. In recent decades, many researchers have written about this issue. From their research, we can conclude that almost everyone used some general criteria to analyze the quality of open public spaces. Jan Gehl uses three basic criteria to determine the quality of open public spaces whose evaluation depends on the answers to certain questions (Gehl, 1987). These three criteria are safety, comfort, and enjoyment.

Determining the safety of open public space, i.e. the degree of protection when using that space, is carried out by answering questions aimed at the safety of space users at any time of day and questions about the level of protection that open public space provides for the users. We can analyze the degree of user protection by assessing the user's vulnerability to traffic activities, noise, wind, etc., while using the space.

Comfort, i.e. the degree of comfort, is determined based on the possibility of using open public spaces by users for different needs. It is crucial for the quality of the open public space that the users can stand undisturbed while using that space. They must be allowed to sit in an open public space and lead each other without compromising conversations. Users must be able to enjoy the view without interruption while in an open public space to feel comfortable. Different sports and recreational facilities can significantly impact comfort if they are present within the area of open public space.

Users' enjoyment while using open public spaces is an essential criterion because it directly affects the quality and improves public space attendance. The facilities near that space can affect the enjoyment of visitors staying in an open public space. Objects surrounding an open public space can evoke different feelings in users, i.e. users may admire the environment or be frightened by the facilities appearance, colour, or dimensions. Also, the facilities surrounding the open public space affect the lighting, airiness, and other fundamental characteristics of the space.

In addition to safety, comfort, and enjoyment, many other criteria can help determine the quality of open public spaces. Some of these criteria were analyzed and presented by Mark Francis (Francis, 1987). He believes that a vital indicator of the quality of open public spaces is the use of space by different age groups. Citizens of varying age groups must want to use the space, regardless of whether they are children, teenagers, adults, or retirees. The equipment of the space indeed affects this criterion because open public space must have specific contents to be interesting for all age groups.

Open public space will be much more visited and used by residents of a particular community if those residents are allowed to participate in creating and arranging the space. Therefore, participation and control by users are considered an essential quality criterion. Small urban gardens are one example of user participation in space management, resulting in high daily attendance (Francis, Cashdan & Paxon, 1984).

Another crucial quality criterion is the representation of green areas within the boundaries of open public space. Green areas, tree lines, landscaped flower spaces are a vital part of open spaces. The representation of green spaces significantly impacts attracting visitors and the overall quality of urban design of open public spaces (Lewis, 1979).

The accessibility of open public space can directly affect the greater or lesser attendance of open public space. The location of buildings, distance from promenades and roads, and connect with other open public spaces significantly impact the quality of a particular open public space. Also, access to space must be provided to all users, including the elderly, people with disabilities, pregnant women, etc. (Jacobs, 1995).

Privatization can also have an impact on the quality of a specific open public space. Suppose an individual or a company privatizes an open public space or part of it. In that case, it may result in several detrimental effects, such as a change in the primary purpose of the land, or it may prohibit certain visitors from using the space. The quality of the surrounding open space can also be impaired if privatization results in the construction of new facilities (Korosec - Serfaty, 1982).

The equipment of the space, as mentioned, dramatically influences the higher attendance of the space. A space with elements of an urban landscape such as benches, lighting, promenades or bike paths, etc., has a more significant potential to be visited, which affects the better quality of the space. The equipment of the playgrounds is essential, and the presence of additional facilities such as certain types of art, monuments, or fountains can undoubtedly affect the much higher quality of open public spaces.

CRITERIA		DESCRIPTION OF CRITERIA
GENERAL	Accessibility	Evaluating the possibility of access to the courtyard of the religious complexes
	Equipment	Equip the courtyard of the religious complexes with urban landscape elements such as benches, playgrounds, etc.
	Comfort	Valorization of the possibility of using the courtyard of the religious complexes for different purposes (sitting, walking, sightseeing, etc.)
	Enjoyment	The position of religious and other buildings in the courtyard of the religious complexes, i.e. the impact of buildings on courtyard characteristics
	Adaptation to different groups	Possibility to use the space for different groups of residents (children and the elderly, residents of different nationalities, genders, etc.)
SPECIFIC	Space design	Participation of users in the space arranging, i.e. the possibility of adapting the courtyard space of the religious complexes to different needs
	Overgrowth of green areas	Are the green areas in the courtyard of the religious complexes represented, and to what extent?
	Location improvement	Evaluating the possibility of adding new, different elements of the urban landscape to the courtyard of religious complexes

Table 1: Description of criteria for determining the possibility of classifying courtyards of the religious complexes as open public spaces

We can use many other criteria to determine the quality of the space. It is also possible to use the instructions given by the Urban Design Compendium from 2000, which Milena Vukmirović analyzes in her doctoral dissertation (Vukmirović, 2013). Based on the instructions, Vukmirović singled out aspects that could create new open public spaces regardless of the urban fabric within which these spaces are located. On the other hand, based on those aspects, it is possible to create new criteria for determining the quality of existing open public spaces. Aspects that Vukmirović singles out include places for people, improvement of existing locations, a mix of content and form, harmonization with the landscape, establishing connections, investment management, and design that accepts change. Based on these aspects, it is possible to create new quality criteria, such as improving existing locations. This criterion would determine the possibility of creating new open public spaces based on existing contents and activities in a particular area. Also, by analyzing the design of the space, it is possible to determine how much the open space can be adapted to different contents and adapt to the requirements of other groups of users. Another criterion that could evaluate the quality of

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open public spaces is a mix of content and forms that would help select new content based on existing architectural and landscape structures. The stated criteria, of course, cannot be used without the general, already stated criteria because they could not be evaluated independently.

5 RESULTS

With the help of the presented and selected criteria, we will determine the possibility of classifying the courtyards of religious complexes as open public spaces. We will use the criteria to assess the quality of selected courtyards of religious complexes, which generally have similar characteristics as courtyards of religious complexes in many other cities. Before conducting a multi-criteria analysis, first, we will present the courtyards of religious buildings selected for this research.

5.1 Case study - Identification of potential open public spaces in the city of Brčko

As already mentioned in the paper, on the example of the courtyards of religious complexes located in the city of Brčko, will be examined the possibility of classifying these courtyards as open public spaces. Based on the fact that according to the 2013 census, there are about 40,000 inhabitants on the city's territory (Agency for Statistics of Bosnia and Herzegovina, May 18, 2021), it is clear that there are a large number of religious complexes and their courtyards. After the war events from the 1990s, the national divisions in Bosnia and Herzegovina, as well as in Brčko, are enormous in all spheres of society (Clarke – Habibi, 2018). Therefore, the role of religious communities and open spaces around religious complexes could be in connecting different groups of residents. This research will analyze the potential of three courtyards of religious complexes to become new open public spaces.

According to the data from the Urban Plan of the Brčko District, which was valid for the period 2007-2017, the Catholic Church in Brčko was built in 1883. Next to the church in the same courtyard is a building intended for a monastery. The other area that belongs to this religious building is its courtyard, which consists of green spaces and pedestrian paths in the most significant percentage. In the courtyard of the Orthodox Church in Brčko, in addition to the church and cultural centre, there are three other buildings, while the spaces that connect these buildings are green areas and pedestrian paths. There is also a children's playground in the courtyard of this church. The open space around the church is enriched with benches. The mosque in Brčko is located in the western part of the city at the exact location of the old mosque that was demolished during the 1990s. There are green areas around the mosque through which there are pedestrian paths to the mosque, and next to these pedestrian paths, there are benches for the visitors to this area.

Fig. 1: Position of selected courtyards of religious complexes on the territory of the city of Brčko


Fig. 2 (left): Orthodox Church courtyard. Fig. 3 (right): Orthodox Church courtyard (children's playground)


Fig. 4 (left): Catholic Church courtyard. Fig. 5 (right): Mosque courtyard

Fig. 1 shows the location of three courtyards of religious complexes in the inner city, and the figures below fig. 1 show the courtyards of the Orthodox Church (Fig. 2 and Fig. 3), the Catholic Church (Fig. 4), and the mosque (Fig. 5).

5.2 Possibility of classifying courtyards of religious buildings as open public spaces

To determine the possibility of classifying the courtyards of religious complexes into open public spaces, we will analyze selected courtyards of religious complexes from the territory of Brčko, based on the selected and described criteria in table no. 1. The criteria presented in this table are divided into general and specific because the general criteria answer whether the courtyards of religious complexes can become new open public spaces. Many researchers consider these criteria general because these criteria apply to any other open space that we want to classify as the open public. On the other hand, special criteria from table no. 1 can help explore the possibility of courtyards of religious complexes to adapt as potential open public spaces to different population groups and different community requirements. In other words, these criteria may answer the possibility of combining different elements that are characteristic of open public spaces with the existing courtyard structure.

From the analysis of the courtyards of religious complexes located on the territory of the city of Brčko, we can conclude that these courtyards have the required quality and become new open public spaces. The advantage of these spaces is undoubtedly in the equipment and access. However, the great advantage is that religious communities do not limit the use of the courtyard to those residents who do not belong to that religious community. Basically, it is one of the primary and main characteristics of all open public spaces.

Using specific criteria for determining the quality of courtyards of religious complexes in Brčko, we can conclude that these courtyards generally have certain green areas or tree lines or other elements of green infrastructure. Even if there were no green areas in these courtyards, it would be possible to add them. In the courtyards of religious complexes, it is not a practice for visitors to participate in creating and arranging space, which could be their only negative characteristic.

Criteria	Courtyards of religious complexes
Accessibility	Religious facilities always have secured access from the street, promenade, or other POS
Equipment	Around religious buildings, there are primary elements of the urban landscape such as benches, buckets, and in some cases, even children's playgrounds
Comfort	In the courtyards of religious complexes, in addition to meeting spiritual needs, it is possible to perform other activities
Enjoyment	Religious buildings are positioned mainly in the centre of the courtyard and generally have a positive and pleasant impact on the users of the space
Adaptation to different groups	Courtyards belonging to religious buildings can generally be used by all residents of a particular community, regardless of their demographic characteristics

Table 2: Courtyard analysis of religious complexes based on general criteria

6 DISCUSSION AND CONCLUSION

As already mentioned in the paper, open public spaces significantly impact the quality of the urban structure of settlements and cities and the quality of life of the city's inhabitants. Creating new open public spaces in an already built urban form will be a real art in the future. Suppose we know that open spaces have always been important places of cultural, political, and economic life from the earliest civilizations until today (Stanley, Stark, Johnston & Smith, 2012). In that case, the existence of these spaces in the urban structure must be imperative. Therefore, finding open spaces in the city and classifying them as new public spaces is one possibility in creating new open public spaces so that urban settlements would not become traditional dormitories. The main target of this paper was to explore the possibility of classifying courtyards of religious complexes as new open public spaces. The classification of a particular open space as an open public space is impossible without determining its quality. For that reason, we used the criteria for assessing the quality of open public spaces in this paper.

Courtyards of religious complexes are spaces that exist in almost all urban areas. These courtyards belong to religious communities and are therefore minimally endangered by constructing new buildings, dramatically affecting the non-existence of other types of open public spaces. The advantage of preserving this space is that these courtyards in urban areas are mostly fenced, but this can also be a disadvantage because open public spaces with no isolation boundaries are far more appreciated because they actively communicate with the surrounding space (Dormidontova & Belkin, 2019). Also, the advantages of these courtyards are that their location in the city and urban settlements is perfect, which ensures their accessibility and connection with other areas. Also, the advantage of religious complexes is that they generally do not cover a large area within the courtyard that belongs to them, allowing locating other facilities in the courtyard and ensuring good lighting and airiness of the open space.

The transformation of the perception of religious complexes that have taken place in recent years has provided a significant opportunity and accessibility for every user to engage in religious courtyards and other activities such as urban parks or different types of open public space. This transformation took place by placing elements of the urban landscape in the courtyards of religious complexes. Recently, special attention of younger users of those spaces has been attracted by children's playgrounds set up in the courtyards of religious complexes, as is the case with the courtyard of the Orthodox Church in Brčko. The far better attendance of these yards is also encouraged by the significant representation of green areas, but they are also inspired by the benches placed along with those areas.

Based on the analysis of the courtyards of religious complexes in Brčko conducted in this research, we can conclude that these courtyards have excellent quality and potential to become new open public spaces. It is certainly possible that in some urban areas, the courtyards of religious complexes may differ from those analyzed in this paper. Still, the possibility of classifying them as open public spaces almost certainly exists. Categorizing these courtyards as open public spaces would represent a new chance for a population that has conflicted during specific historical periods. It would be a chance to establish new connections between people and create a better living environment for all citizens regardless of nationality.

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Urban Living Labs as a Driver for Sustainable Food-Water-Energy Innovations

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1 ABSTRACT

The Food-Water-Energy (FWE) nexus provides a useful frame for considering sustainable urban development, due to the inevitably close linkages among demand for energy, freshwater and food by the growing urban population, and the availability of these resources.

To facilitate sustainable development on a global scale, local and regional solutions concerning food, water and energy challenges need to be established and tested. The exchange of best practices and their potential transfer and upscaling should be fostered.

The project GLOCULL (Globally and Locally-sustainable Food-Water-Energy Innovation in Urban Living Labs) has been initiated by an international consortium to address the above-mentioned needs: to create evidence of potential solutions with respect to FWE nexus in seven Urban Living Labs, to share results and experiences, and to provide methodological and practical guidelines and recommendations, with a local and global scale outlook.

Urban Living Labs (ULLs) represent an experimental approach of university involvement in a real-world setting, where academic and non-academic actors, including local administration and stakeholders, collaborate on various urban development challenges. Despite the recognition of ULLs as a promising form of urban governance on the EU level (EU 2011), their successful implementation requires further evidence-based elaboration (De Kraker et al. 2016).

Each of the GLOCULL partners (the consortium includes: Maastricht University / Netherlands, Leuphana University Luneburg / Germany, The University of Natural Resources and Life Sciences, / Austria, Arizona State University / United States, University of Sao Paulo / Brazil, Lund University / Sweden and Stellenbosch University / South Africa) has developed and implemented experiments focusing on local innovations in various aspects of the FWE nexus, within an ULL. The innovations have been co-created by universities and non-academic partners in each country, using transdisciplinary approaches, resulting in co-production of knowledge, shared with the international project partners. Moreover, flow- and causal-loop diagrams were used to integrate knowledge gathered through participatory, integrated assessments in each of the implemented experiments. The impacts of the project include: the academic impact through advancing knowledge on sustainability transitions through ULL in the FWE nexus and different economic and societal impacts. The latter provides evidence on the local and global sustainability of local food systems, the acceleration of the transition towards sustainable food system, the integration of the FWE nexus and related

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inputs into decision-making and the contribution to practice partners (local individuals and organisations) through facilitating closer collaborative relationships, network-building and solution orientated approaches to their FWE challenges. Furthermore, the project is also focusing on capacity building. Practice partners are developing technical and personal skills, as well as individual and collective agency, and are sharing their practice and lessons institutionally. This should help to strengthen scholars-local actors-collaboration and co-production of knowledge.

An evaluation and case study reporting framework is being developed by the partners to reflect on and assess the implementation of each ULL and compare the process and outcomes across the seven ULLs. Moreover, local and international partner experiences will be synthesised into an implementation guide for practitioners and a participatory assessment toolkit. Keywords: sustainable urban development, urban innovations, transdisciplinary research, urban living lab, food-water-energy nexus

2 INTRODUCTION

2.1 The Food-Water-Energy (FWE) nexus

Addressing sustainable development inevitably requires understanding close interlinkages among ecological, economic and social aspects, as well as among the different resources, sectors and disciplines, and the actors involved. This paradigm is embodied on the global level by the 2030 Agenda for Sustainable Development Goals (UN 2015). The Food-Water-Energy (FWE) nexus provides a useful frame for considering such synergies among energy, freshwater and food resources.

The concept of the FWE nexus emerged after the energy and food crisis in 2007–2008, and has since been growingly embraced by the academic and policy community. It underlines the integrated and interactive links among food, water and energy resources, as components of one system, in order to maximize synergies, and minimize trade-offs among these sectors (Hoff 2011in Wahl et al, 2021). Researchers to-date have identified several knowledge gaps with respect to implementing FWE nexus approaches, including the identification of real world solutions and pathways to action, considering different contexts and multiple scales (Leck et al. 2015 in Wahl et a. 2021). They have called for applying inter-and transdisciplinary approaches, engaging societal and non-academic actors (Scanlon et al. 2017; Simpson and Jewitt 2019) and addressing “innovation, social and political context, collaboration, and implementation in policy and practice” (Albrecht et al. 2018, p. 20, in Wahl et a. 2021). To facilitate sustainable development on a global scale, local and regional solutions concerning food, water and energy challenges need to be established and tested. The exchange of best practices and their potential transfer and upscaling should be fostered.

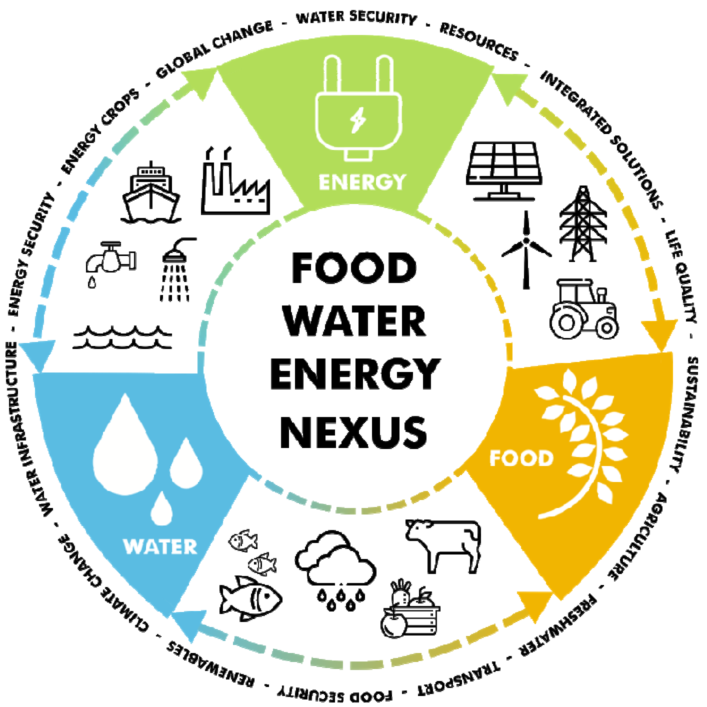

Fig. 1: Food Water Energy Nexus. Source : Own Illustration by Kim Ressar.

Application of FWE nexus on the urban level is particularly valuable in light of growing urban sustainability challenges. Along with increasing urbanization and resource consumption, cities are centers of economic activity, innovation and entrepreneruship (Fuenfschilling et al. 2019 in Wahl et a. 2021). Due to its increasing complexity, the urban context can help in understanding and managing the FWE nexus, while at the same time, application of the nexus approaches can serve to address urban sustainability challenges (Wahl et a. 2021).

2.2 The GLOCULL project

The project GLOCULL (Globally and Locally-sustainable Food-Water-Energy Innovation in Urban Living Labs) has been initiated by an international consortium to address the above-mentioned urban sustainability challenges . The consortium includes Maastricht University / Netherlands, Leuphana University Luneburg / Germany, The University of Natural Resources and Life Sciences, / Austria, Arizona State University / United States, University of Sao Paulo / Brazil, Lund University / Sweden and Stellenbosch University / South Africa. The partners were selected because of their expertise in transdisciplinary approaches. The partners aimed at: 1) creating evidence on potential urban sustainability innovations based on the framework of the FWE nexus and in the context of seven different cities, as well as 2) sharing results and experiences on the international level and, and 3) providing methodological and practical guidelines and recommendations, with a local and global scale outlook.

The project is organized into seven Work Packages (WPs), see Figure 2.

The given contribution presents the methodological approaches and results of the GLOCULL project to-date.

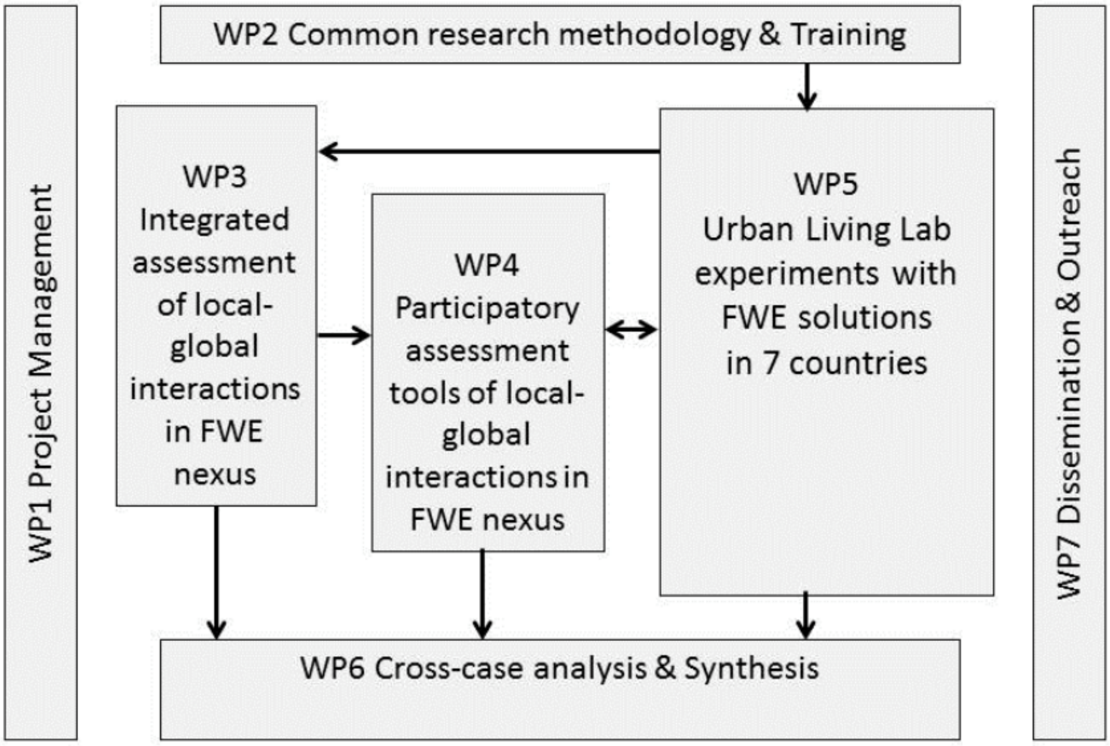

Fig. 2: GLOCULL project organization. Source:GLOCULL project.

3 MAIN APPROACHES AND METHODS

The GLOCULL partners agreed on the following approaches to implement the project:

(1) Setting up Urban Living Labs and co-creation of local urban FWE innovations in close collaboration with local stakeholders, and co-production of knowledge using transdisciplinary approaches;

(2) Participatory, integrated assessments, using flow- and causal loop diagrams to integrate knowledge gathered from implemented experiments. Synthesising local and international experience in implementation guidelines for practitioners and a participatory assessment tool kit;

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(3) Designing and using an evaluation framework to reflect on and evaluate implementation of each ULL and compare the process and results among the 7 countries.

3.1 Urban Living Labs

The GLOCULL partners chose to implement Urban Living Labs (ULLs) - an experimental approach of university involvement in a real-world setting, where academic and non-academic actors, including local administration and stakeholders, collaborate on various urban development challenges. Despite the recognition of ULLs as a promising form of urban governance on the EU level (EU 2011), their successful implementation requires further evidence-based elaboration (De Kraker et al. 2016).

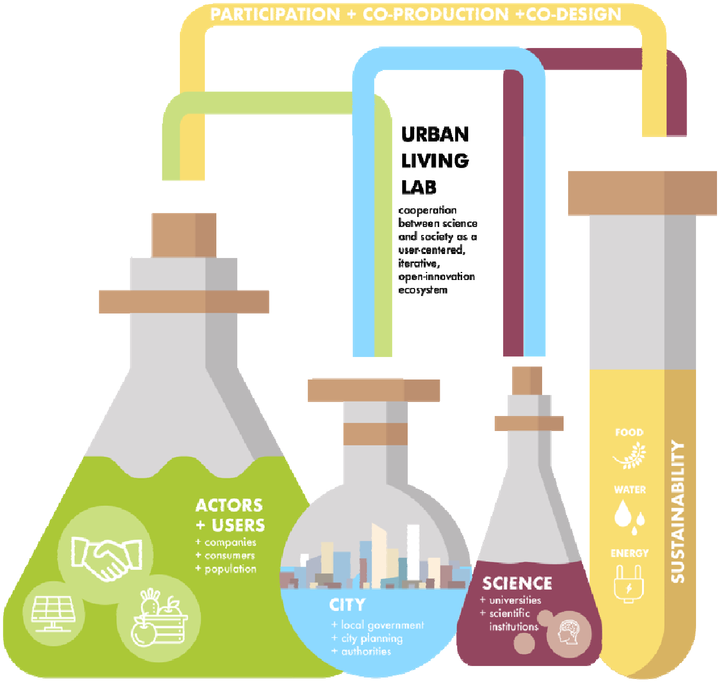

Fig. 3: Urban Living Labs Source: Own Illustration by Kim Ressar.

Each partner has set up an ULL and within these, developed and implemented experiments focusing on local innovations in various aspects of the FWE nexus. The innovations have been co-created by universities and non-academic partners in each country, using transdisciplinary approaches. The actors from outside academia have been involved from the design phase in each ULL, albeit in each case to a different extent, based on their level of availability. Flow-and causal-loop diagrams were used to integrate knowledge gathered through participatory, integrated assessments in each of the implemented experiments. The knowledge and results co-produced within each ULL have been regularly shared with the international project partners. Table 1 includes the name and brief description of each ULL.

3.2 Participatory Assessment Toolkit

Based on the partners' experience in using flow- and causal loop diagrams, to integrate what they have learned in collaboration with the stakeholders of each ULL, a Toolkit has been created, in order to help assess local and beyond-local-scale impacts of innovations on the FWE nexus.

The Toolkit combines the focus on local and beyond-local impacts. It enables its users to learn about the FWE nexus, to apply nexus-thinking to an innovation case of their choice and to jointly learn about the impacts of innovations on the nexus. Although it can be used by interested individuals, it is best suited to participatory (Living Lab) setting. The Toolkit has been designed in a way to facilitate evaluation of the impacts of innovations based on criteria and indicators that matter to the users, in order to emphasise joint learning and co-creation (and co-optimisation) of innovations.

After further testing the Toolkit in the seven GLOCULL Living Labs, it will be made freely available and accessible via the GLOCULL website (https://glocull.boku.ac.at), the Belmont Forum website and via Github, supplemented with a user manual.

Country	Partners	ULL Name	ULL Brief description
Austria	The University of Natural Resources and Life Sciences, Vienna (BOKU), NIKKO Photovoltaik (NP)	Agrivoltaics in urban / peri-urban areas	The ULL focuses on dual land use – coupling food and energy production. It tested potential for introducing Agrivoltaics to greenhouse vegetable production at the outskirts of Vienna, by mounting PV-panels on greenhouses of gardeners, members of the local vegetable producers' association, and initiated a multi-stakeholder discussion process about the issues of societal acceptance, governance challenges and technical solutions for Agrivoltaics in Austrian urban agricultural areas.
Brazil	University of Sao Paulo	Local solutions for FWE nexus in São Paulo	The ULL aims to conduct a sustainability assessment, in a participatory fashion, of ongoing actions in the rural south zone of São Paulo, with a particular focus on the interdependence of the nexus systems and local characteristics. The ULL worked with the goal of validating the sustainability of municipal actions to support local agriculture by developing a set of indicators that can capture FWE interactions, existing conflicts and potential responses. The ULL accompanies the project "Ligue os Pontos" (LoP – or "Connect the Dots"), which main goals are to: i) contain urban sprawl by maintaining the farmers in the south zone of São Paulo, ii) promote sustainable agriculture practices, and iii) preserve natural ecosystems.
Germany	Leuphana University Lüneburg	Urban Sustainability Transformation 2030+	The ULL builds upon previous collaborations of Leuphana University, the City of Lüneburg and other actors to establish a Sustainability Living Lab, funded by the German Ministry of Education and Research since 2014. The Lab is supporting implementation of Lüneburg's collaboratively developed vision of a sustainable community that meets its local and global responsibilities. This sustainability vision covers 25 topical areas, including food and energy in the local economy. A local food council as a novel governance body and a local-living economy that emphasizes local food production and consumption are among these measures. The ULL is supporting development of concrete measures to reach these visions.
The Netherlands	Maastricht University	Closing the FWE cycles at neighborhood level	The ULL is focused on the FWE nexus in the context of the SUPERLOCAL project in the Bleijerheide district in the City of Kerkrade, where a local housing corporation is working on replacing vacant high-rise buildings with high-quality but affordable low-rise housing in a sustainable manner. The ambition is to recycle and re-use all possible landscape elements, building materials, to introduce a close-loop water system, and to consider social sustainability with respect to the residents of the resulting neighbourhood.
South Africa	Stellenbosch University	Management of edible food waste in informal settlements	The ULL accompanies the establishment of a community garden and a fresh food market in a Khayelitsha township, located in the sorroundings of Cape Town. It addresses challenges, such as food safety and access to food, as well as opportunities to enhance the system, and aims to enable better governance by formal and informal actors that would help Cape Town to further develop its economic, social and environmental objectives.
Sweden	Lund University, Brygghuset Finn	Sustainable urban Craft Beer Production	The SustBeerLab ULL is focused on tangible measures to increase the sustainability of craft beer production in selected urban areas in southern Sweden. The aim of the lab is to develop, physically implement and test novel solutions to sustainability challenges associated with craft beer production in the region. Within the FWE-nexus, several potential targeted solutions that integrate knowledge have been proposed and are explored in a co-creative process with the stakeholders.
USA	Arizona State University, City of Tempe, City of Phoenix, Local First Arizona	Developing sustainable local food system	The ULL focuses on learning about and facilitating community-based entrepreneurship and innovation at the food, water, energy nexus among the local business owners in City of Tempe and City of Phoenix. It comprised efforts to: (i) Identify catalytic actions that can be taken by different stakeholders to spur innovation, entrepreneurship, and investment at the (FWE) nexus; (ii) Assess and prioritize catalytic actions for the impact on decarbonization efforts, broader sustainability objectives, and public support. (iii) Design, test and implement capacity building experiments, located in Phoenix and/or Tempe, aimed at enabling stakeholders to take high priority, high impact actions.

Table 1: GLOCULL Urban Living Labs. More information can be found on the GLOCULL project website: https://glocull.boku.ac.at/

The browser-based Toolkit (available at http://bramoosterbroek.nl/GLOCULL/toolkit.html) consists of three modules with various tools:

- Module 1 "Awareness and Opportunities" aims to acquaint users with the concept of the FWE nexus with the help of several multimedia items (e.g., videos, podcasts, and games). This module familiarizes users with thinking about FWE nexus as an integrated system, and identifying opportunities regarding saving resources, converting resources, gaining local sustainability benefits or gaining benefits on another spatial scale. The tool provides basic guidelines on the available multimedia, to enable a quick choice of most relevant itemps for each user.

- Module 2 “System Overview” aims to account for the potential resource savings, efficient resource conversions, beneficial social, environmental and economic effects, as well as beyond-local effects. The Module 2 tool supports the creation of a FWE system’s diagram that enables an overview of a regional and local system, into which the user’s Living Lab innovation is embedded. The Tool, in the form of a PDF template, guides the users through several steps to (graphically) represent the FWE system in which their project is embedded, as well as to to identify the beyond-local and sustainability impacts of their project. It also aids its users to pinpoint where innovation is possible, and identify direct and indirect beyond-local and sustainability impacts effects of a potential innovation. Last but not least, it facilitates comparison of system performance, such as the system with and without a set of interventions. A manual and examples, based on GLOCULL case studies, enable tool-users to develop their own FWE-system overview.
- Module 3 “Quantitative Assessment” aims to help users perform a quantitative Food-Water-Energy assessment and compare the current situation with a potential scenario in which an innovation is implemented. The Tool provides a Multi Criteria Analysis-based template (including scoring, standardisation, and weighting) for the quantitative assessment of two or more FWE scenarios, relevant to the user. It assists users in accounting for a comprehensive set of themes (for example food savings, impact on surroundings, social aspects) and indicators of an integrated FWE assessment. Moreover, it helps visualize the difference in how these themes are impacted between the situation prior to and after an innovation, using radar charts.

The quantitative assessment tool can both be fed with detailed data, but also with estimations (e.g. on a Likert-scale). The latter helps overcoming challenges in cases where quantitative data are hard to retrieve. Case study files based on the GLOCULL Living Labs are presented in the same file format as the tool, and can be downloaded from the toolkit.

Dimension	Level	General Description
Setting	Context	What are the general contextual factors that significantly influence the overall purpose of the lab or the specific design, outputs, or outcomes of the experiments the lab conducts?
Spatial and temporal scope	Lab	What is the spatial scope of the lab?
Process		What is the Lab’s procedural design?
Organization		How is the Lab organizationally structured?
Sustainability		What is the Lab’s general sustainability orientation?
Outputs	Experiment	What changes were generated, inside or outside the lab, as a direct result of the experiment?
Outcomes		How did the experiment contribute to sustainability of society, both within and beyond the immediate scope of the Lab?
Processes		How was the experiment designed and conducted?
Inputs		What are the enabling factors of the experiment?

Fig. 4: GLOCULL Case Reporting Scheme. Source: GLOCULL Project (based on Forrest et. al., 2019, Luederitz et. al. 2017, Schäpke et. al. 2018,)

3.3 Case study reporting scheme

A case study reporting scheme has been developed by the partners to reflect on and assess the implementation of each ULL and compare the process and outcomes across the seven ULLs. The aims of the reporting scheme include: 1) helping the partners capture the work conducted by the transdisciplinary teams within the ULL, 2) facilitating reflection on the implementation of the sustainability-oriented experiments conducted in the ULLs, 3) structuring the reporting on these collaborative activities and 4) providing more comprehensive understanding of the development and the impacts of sustainability solutions in such settings.

The partners are in the process of testing the scheme based on their respective ULLs, and will update the scheme based on this experience, in order to render it applicable beyond the GLOCULL project to 1) support researchers and practitioners to explore their own projects and 2) facilitate generating a growing knowledge base on sustainability-oriented experiments and transfer of knowledge between experiments conducted in different contexts. The reporting scheme is structured following a basic logic model of context, laboratory and experiment/s (see Figure 4).

4 MAIN RESULTS AND IMPACTS

The impacts achieved by the project include:

- Advancing academic knowledge on sustainability transitions through ULL in the FWE nexus.
- Capacity building of academic and practice partners, through development of technical and personal skills, individual and collective agency, and sharing practice and lessons institutionally.
  - The GLOCULL partners have achieved joint learning about, and increased interest in, the FWE nexus across stakeholders that were not so much interested in, or aware of, nexus issues before. More awareness is expected to lead to increased support for innovations that are sustainable across the nexus among politicians (e.g. by prioritizing nexus issues as is happening in the USA already), policy makers (in Brazil), and consumers (in South Africa, Austria, the Netherlands, Sweden and Germany).
  - The Tools created by the project can be used by stakeholders in Living Labs, in collaboration with researchers, beyond the GLOCULL project and after the finalization of the project, to help them learn about the FWE nexus plan and assess innovations, as well as optimize synergies in the FWE-nexus.
- Advancing sustainable solutions or innovations at the ULL level. Various economic and societal impacts in the individual ULLs, including:
  - Collecting evidence on the local and global sustainability of local food systems,
  - Acceleration of the transition towards sustainable food system,
  - Integration of the FWE nexus and related inputs into decision-making,
  - Contribution to practice partners (local individuals and organisations) through facilitating closer collaborative relationships, network-building and solution orientated approaches to their FWE challenges.

Table 2 outlines more specific impacts in each ULL.

Country	ULL Name	Impact
Austria	Agrivoltaics in urban / peri-urban areas	Providing the evidence base and fostering public discussion about the importance of agrivoltaics in urban / peri-urban areas; Making inputs into policy to support dual use of agricultural land
Brazil	Local solutions for FWE nexus in São Paulo	Application of sustainability indicators related to the FWE nexus on the digital platform of the city of São Paulo, Brazil
Germany	Urban Sustainability Transformation 2030+	Supporting local businesses to introduce changes in food (ex. local non-dairy milk) and clean energy supply to foster a sustainable local economy in Lüneburg, Germany
The Netherlands	Closing the FWE cycles at neighborhood level	Facilitating introduction and settlement of “re-cycled” and sustainable housing with a closed local water cycle in Kerkrade
South Africa	Management of edible food waste in informal settlements	Establishment of an urban garden in a school yard, and a fresh produce market in an informal settlement of Khayelitsha in Cape Town
Sweden	Sustainable urban Craft Beer Production	Garnering interest and feedback through experiment trials, especially from plant scientists, farmers, and craft beer brewers in Sweden
USA	Developing sustainable local food system	Building local capacity and establishment of a collaborative organization driving and supporting sustainable food economy development in Phoenix, Arizona

Table 2: GLOCULL Impacts.

5 CONCLUSION

Despite the differences between the innovations in the seven projects, the ULL has proven to be a useful approach to creating a space of interaction for multiple academic and non-academic actors. In this sense, the seven GLOCULL project ULLs have facilitated new and strengthened existing transdisciplinary collaborations. Moreover, we expect the project to have initiated long-lasting relationships between stakeholders, municipalities and scientists.

The tools developed in the project draw insights from the seven cases, thus being adaptable to different contexts, scenarios, kind of innovation and group of actors. The tools are not only meant to rise awareness about the FWE nexus and to support decision-making, but they also foster and monitor learning processes.

The project gave insights on how to conduct transdisciplinary research and on how the FWE nexus, and system thinking more generally, can contribute in developing solutions both in an urban context considering local and beyond-local impacts.

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The Monitoring Canvas: a Tool for Co-Creating Actions in Mission Oriented Innovation Policies

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1 ABSTRACT

Recent years have seen a surge of "missions" in innovation policy. The grand, and seemingly overwhelming challenges humanity faces at the beginning of the 21st century, are typically cited as the driver behind this shift. With mission-oriented innovation policies (MOIP), policymakers choose a top-down perspective, while at the same time granting "embedded autonomy" to all actors involved: A bold and well-defined challenge is set, that gives direction to the aspired transformation and bottom-up experimentation by a large field of actors will need to solve the myriad of tasks left open. Thus, successful MOIPs will need to spark activity in multiple sectors and disciplines and keep actors involved over a long period and throughout a demanding transformation process. We present a tool for co-designing concrete actions, the smallest parts of a MOIP. We argue that due to the long timeframe of MOIPs and – if successful – the constantly changing innovation landscape, it is essential that all actors involved have a clear perception of how their actions contribute to the tragets of the MOIP. By collecting the very basic information on the context for an action, the action itself, and indicators that show whether or not an action creates an output as desired, the Monitoring Canvas secures transparency for all parties involved and allows for the continuous modification of an action. Thus, the Monitoring Canvas is not a comprehensive monitoring and evaluation system, but rather its "front end" – designed for high usability.

Keywords: action, MOIP, innovation, challenges, monitoring canvas

2 INTRODUCTION

For many policymakers around the globe, the 21st century is characterized by a set of "grand challenges". They are "grand" or "wicked" because the challenges originate from ethical and moral dilemmas inherent in modern lifestyles (Ferraro et al. 2015, Keitsch 2018). Thus, to address these challenges is to transform (parts of) social systems. The challenges of today include (but are not limited to): fighting hunger as well as cancer, cleaning up the oceans, create gender equality, battling the climate crisis, and securing biodiversity (Mazzucato 2018, Lawson & Martin 2020). International organizations (e.g. United Nations: Sustainable Development Goals), transnational unions (e.g. European Union: EU-Missions of the Horizon Europe framework), government agencies (e.g. Austrian Federal Ministry for Climate Action: Mobility of the future), and cities (e.g. Amsterdam: Smart City Innovation Mission) have recently agreed on missions and have set targets to spark innovation, investments and a widespread engagement of the public (Janssen et al. 2021, Laurre 2021).

This shift in innovation policy requires new skills and tools by and for policymakers (Laurre 2021, Mazzucato et al. 2019). In this paper, we present a tool for co-creating actions and indicators (the smallest parts of MOIPs) in one integrated process. Section 3 briefly introduces mission-oriented innovation policies. In Section 4, we shows the larger process of implementing a MOIP based on the framework of policy roadmapping as proposed by Miedzinski, Mazzucato & Ekins (2019). In Section 5, we introduce the Monitoring Canvas as a participatory tool and show how it is embedded in the overall process policy roadmapping. Section 6 presents a fictional design created with the Monitoring Canvas and section 7 concludes and points at directions of further research.

3 MISSION-ORIENTED INNOVATION POLICY

The climb of MOIPs on all governmental levels has prompted researchers to warn both about overly optimistic hopes on what they can achieve and about the danger that stakeholders might feel overwhelmed by the ambition and complexity of a "mission" (Laurre 2021: 12). There are two possible sources for these pitfalls, inherent in the history of MOIP and innovation policy in general: First, there have been (although in many ways not comparable) tremendously successful missions in the past. Second, there is a large body of literature on how past innovation policies have failed. In this section, we introduce both threads, show which requirements have been formulated in response and their relevance to contemporary MOIPs.

3.1 Successful missions

Like many contemporary methods, terminologies, and planning approaches, missions have a strong connection to military applications and the dawn of the space age. Probably the best known of all "missions" are the Apollo Program and the Manhattan Project (Ergas, 1987, Leslie 1993, Mazzucato & Perrez 2015). However, these missions were different.

These "old type of MOIPs" were predominantly technological endeavors. Like in contemporary missions, the administration set the agenda and was willing to deploy large-scale investments. But contrary to "new" MOIPs, the number of actors was relatively small and homogenous (a large group of experts). The idea for a new understanding of missions is attributed to the nuclear physicist Alvin M. Weinberg. In his Reflections on Big Science Weinberg insisted, that science could go beyond mere technological ends and address "big problems". The big problems Weinberg had in mind in the mid-sixties of the past century, included the increasing environmental pollution and the difficult relationship between science and society (Weinberg 1994).

The diffusion of Weinberg's idea owes to a connection made in documents like the Maastricht Memorandum, in which the authors argued that using innovation and technology policy to solve "big problems" would – as a positive side effect – result in competitive advantages in a globalized world (Soete & Arundel 1993: 93-94). This idea of a "green economy" is constitutional to the reasoning behind the new type MOIPs (Kemp & Soete 1990).

Old: Defence, Nuclear and Aerospace	New: Environmental Technologies
The mission is defined in terms of the number of technical achievements with little regard to theireconomic feasibility.	The mission is defined in terms of economically feasible technical solutions to particular environmental problems.
- The goals and the direction of technological development are defined in advance by a small group of experts. - Centralized control within a government administration. - Diffusion of the results outside of the core of participants is of minor importance or activelydiscouraged. - Limited to a small group of firms that can participate owing to the emphasis on a small number ofradical technologies. - Self-contained projects with little need for complementary policies and scant attention paid to coherence.	- The direction of technical change is influenced by a wide range of actors including government, private firms and consumer groups. - Decentralized control with a large number of involved agents. - Diffusion of the results is a central goal and is actively encouraged. - An emphasis on the incrementalist development of both radical and incremental innovations in order to permit a large number of firms to participate. - Complementary policies vital for success and close attention paid

Table 1: Characteristics of Old and New "Mission-Oriented" Projects (Source: Soete & Arundel 1993: 51)

The transition (from technological missions to those that want to change parts of society) is not a self-evident one. As a result, many case studies on "new" MOIPs have been conducted in recent years (see the STIP database by the OECD[1]). Like a rocket capable of bringing a human being to our close astronomical neighbor, missions to change society are seen as very complex design problems. The design problem is opening an "ecosystem" that allows not just one, but many different paths toward a certain future, target or goal. In more detail, a new ecosystem creates and shapes new markets that have a certain "directionality" and inspires spending and enthusiasm by both public and private actors. Three essential dimensions have been defined for new MOIPs:

(1) Strategic orientation: Whatever the mission, it has to be such, that it engages a very large part of society. If the targets of the mission are accepted, then necessary resources can be attracted.

[1] https://stip-pp.oecd.org/stip/knowledge-transfer/case-studies

(2) Policy coordination: The efforts made toward the set goals have to be consistent. Public and private actors (how to accept the mission) have to coordinate so that their actions do not undermine the actions of other actors.

(3) Policy implementation: Across sectors, policies that have been implemented have to be constantly monitored and evaluated, if they work toward the desired direction.

These three points are very challenging indeed. Unlike purely technological or "old" MOIPs all these points will have to be co-defined by many (and an ever-increasing number, if the mission is successful) stakeholders (Foray et al. 2012).

3.2 A succession of failurs

In the light of these enormous challenges and looking back at past efforts, researchers and practitioners came to conclude, that past efforts in research, innovation, and/or industrial policy were largely a succession of different kinds of failures. Although it is acknowledged, that the public sector did play a role in shaping markets in the past, it is a point of discussion, what exactly this role has been (Edler & Georghiou, 2007). Preez (2013) concludes that policies supported the growth of suburbs and mass production that new missions want to challenge.

Failures have been connected to many origins. Free markets could not work as smoothly as expected (market-failures, Rodrik 2008). Governments, acting with the best of intentions, might produce positive effects, but at the risk of creating large-scale crises (government-failure, Rodrik 2008). Finally, aspired transformations could fail to materialize, due to the inner workings of the public sector and its connections to the society (transformational system-failure, Weber 2012).

4 MISSION-DRIVEN POLICY ROADMAPPING

The success of old MOIP sparked research on case studies of successful and failed missions (Mowery, 2010) and more recently led to the development of first tools and toolkits to the design the process of implementing an MOIP (Miedzinki et al. 2019, Larrue 2021; in more general tems see the OECD toolkit navigator[2]). We propose that the Monitoring Canvas can be integrated in the larger context of implanting an MOIP. It covers the smalles part of an MOIP – creating a single action and finding ways to monitor its performance – and it can be used, to co-create actions for the target(s) of the MOIP. We build on the MOIP policy roadmapping framework as proposed by Miedzinski et al. (2019) to show where and how the Monitoring Canvas can be useful. We deliberately chose not to connect the Monitoring Canvas to the Mission Design Canvas by the OECD (OECD 2021), because (1) of the different levels they address, (2) that it is in our view not possible to use them together in one workshop (although we want to encourage experimentation to combine them in a succession of workshops) and (3) the advantage of having one subject displayed on a single sheet would be lost. The Monitoring Coanvas covers the smallest parts of MOIPs, but they are important none the less: Successful MOIP consitst of a collage of actions by various actors (Vassolakou et al. 2021). Due to this inherent complexity, it is critical for all actors involed to understand exactly how their engangement is contributing to a new future. Thus, a tool that draws out this very basic realtion can by crutial.

4.1 Policy roadmapping for MOIP

Miedzinski et al. 2019 present a framework for implementing a MOIP based on the concept of "roadmapping" (Galvin 1998). Roadmaps allow planning into the (distant) future, by collecting knowledge from a large number of involved actors. Roadmaps are graphic representations that align certain targets on a timeline (Phaal et al. 2004). The process of designing a MOIP roadmap involves multiple stakeholders, involves knowledge about the current state of the (social) system where the transformation should take place, and runs over many months or years (Miedzinski et al. 2019: 24 - although Fastlane-processes have been presented to create a MOIP in 100 days). Once implemented, a constant process of policy learning has to start, to further develop the MOIP and adjust to the changing context. Table 2 connects the basic design principles of MOIP (see above) with the roadmapping framework and the process of creating an MOIP.

[2] https://oecd-opsi.org/toolkit-navigator/

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<table>
<tr><th colspan="2">MOIP design principles
(Laurre 2021: 17)</th><th colspan="2">MOIP roadmapping framework
(Miedzinski et al. 2019: 37)</th><th>Process of MOIP roadmapping
(Miedzinski et al. 2019: 37)</th></tr>
<tr><td>Staregic Orientation</td><td>Informing andselecting specific societal challenge(s) and strengthening legitimacy of focused policy intervention towards clear and precise objectives</td><td colspan="2">Grand challenge and mission</td><td rowspan="3">Scoping: The process of agreeing on the broad challenge that will be addressed by the roadmap. Key-partners need to be engaged in the mission and share to common agenda.
Baseline: To empirically ground the mission, data needs to be retrieved on the current state of the selected problem. This involves not only the data on the problem, but also on the social-technical system (the innovation- and policy landscape).
Vision and goals: At this stage, a common vision and distinct goals are created. They have to be inspirational and bold, but at the same time achievable. Interim targets are located on the roadmap and "hot spots" for the transformation identified.
Innovation pathways: For the "hot spots" selected, innovation pathways are developed. A mix of innovations is developed and are placed on the roadmap to visualize alternative innovation pathways.

Policy roadmap: Concrete targets (goals) are set and timelines for actions are developed. Public and private actors necessary for achieving the goals are identified. Finally, monitoring mechanisms are developed.

Policy learing: Governance mechanisms have to be established, so all parties involved have an overview of the current situation. Capacity building is required to allow for data-collection and analysis.</td></tr>
<tr><td>Policy co-ordination</td><td>Coordinating the strategies and activities of the different institutions involved in the policy</td><td>Innovation pathways</td><td>Innovation strategies

Enabling systems</td></tr>
<tr><td>Policy implemen-tation</td><td>Ensuring he consistency and effectiveness of the modes of intervention and resources of the public and private partners mobilised to achieve the policy objectives</td><td>Policy Roadmap</td><td>Policy action plan

Governance

Learning and capacity building</td></tr>
</table>

Table 2: Criteria, principles and process of MOIP roadmapping.

4.2 Using the Monitoring Canvas

The Monitoring Canvas can be used in Steps 5 and 6 (see table 2, right) in the roadmapping process. Miedzinki et al. 2019 suggested that workshops would be a fitting method. The idea behind the canvas is that it is essential for all partners involved to (1) have a shared understanding of how actions are measured and (2) their commitment does affect the transformation. Using the Monitoring Canvas, short and medium-term actions are developed together with ways to monitor their success. In step 6 (policy learning), the Monitoring Canvas can be used to re-align actions within a changed system or context.

5 CO-TREATING ACTIONS, TARGETS AND INDICATORS. THE MONITORING CANVAS

The Monitoring Canvas is a tool and temple for co-creating actions in the context of MOIP. It can be used to design new actions as well as for reviewing existing ones. On a single (virtual) page, it offers an overview of the action, embedded in its larger context and ways all collaborates can check if their commitment contributes to achieving the set target. The canvas consists of eight building blocks aligned in lines and columns (Fig. 1). Thus, the Monitoring Canvas is a tool for participatory engagement and extensively builds on successful existing templates like the Business Model Canvas as proposed by Oswalder et al. (2010) and especially its recent adaption for MOIP by the OECD (OECD 2021). However, unlike its predecessors, the Monitoring Canvas covers only a single action and not an entire mission (or business).

The Canvas connects one action with indicators that show if it is successful or not. However, the Canvas is not a sound monitoring system in itself, but only a first step toward it. Furthermore, because only a single action is covered by one Monitoring Canvas, it is not possible to study the consistency and coherence within the policy mix of a MOIP (Kemp & Pontoglio 2011, Reichardt & Rogge 2016).

In what follows, we present seven steps to work with the Monitoring Canvas. The steps work as a guideline for workshops. We encourage hosts to modify or rearrange these steps (together with the participants) to best suit their needs. This process of working with the Monitoring Canvas is the result of internal discussion and fictional designs by the authors and external collaborators. Figure 2 provides an overview of the steps, locates them on the Monitoring Canvas, and provides guiding questions for each step. The steps are detailed out below as an orientation for working with the canvas:

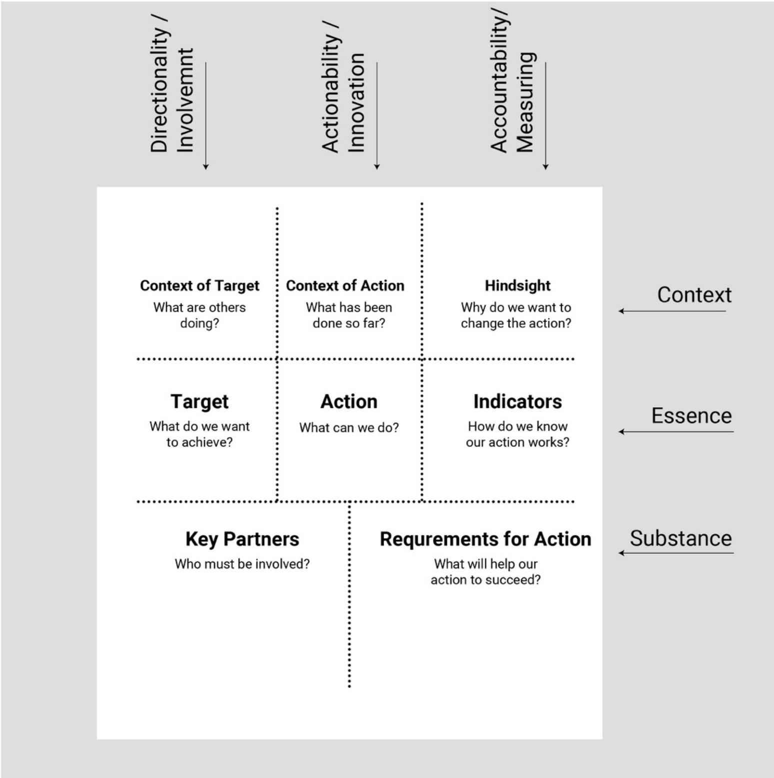


Fig. 1: The Monitoring Canvas (with labels for lines and cloumns).

5.1 Select a target (or goal) form policy roadmap (Step 1)

Considering the participants of the co-creation workshop, choose a mission or target from the MOIP best suited for the present group. It can be helpful to do this in advance: to make sure that the necessary partners are invited and participants can prepare for the workshop.

5.2 Discuss the context of the target (Step 2)

More often than not, you will encounter a situation where other actors are already working toward similar targets, or even your group or organization has done so in the past (Miedzinski et al. 2018). This can be a chance to align with other missions and/or to focus or adjust your action (this is especially true if you use the Monitoring Canvas for reviewing your roadmap). Discussing the context of your target is important to understand why prior actions did not work as desired and what you can do to inspire better results.

5.3 Discuss the context of actions and reflect on their success (Step 3)

Review past actions and discuss their success and reasons why they performed below initial expectations. Did they inspire enough partners? Was the direction of the transformation shared and clear to all parties involved? Were they too ambitious or not courageous enough?

5.4 Create an Action (Step 4)

The term action refers to the (policy) instrument or activities (or a combination of instruments/activities) that the co-creating group can use to contribute to the transformation toward the selected target. Actions work best, when they are open to multiple development paths and types of solutions (Mazzukato 2018: 812). Thus, they need to be easily understandable for all actors (some of them possibly present at the co-creation workshop) and, although ambitious, within their capabilities.

5.5 Build relationsships (Step 5)

Nobody is solving missions alone - the same is true for actions. A successful action requires the commitment and contribution of all partners involved. Consider both options: partners where established networks or relations exist and new ones (that need to be approached and informed about the MOIP, the concrete action, and their possible role). The bottom-up nature of MOIPs on this level implies that some adjustments will be necessary, once new perspectives join the process.

5.6 Understand requirements (Step 6)

Working on the requirements of the action is to detail your design – to make sure that it is not only a good idea but that it works in the present context and that the parts add up to a larger whole. At this stage, identify drivers, enabling factors, and the barriers to your action. You will find drivers and barriers across the spectrum of the desired change: from technological problems or missing links to the level of culture and values that do not align to the mission target (Miedzinski 2016). It is important to outline co-benefits for all partners associated with the alternative innovation pathways.

5.7 Set indicators (Step 7)

All partners have to understand the connection between the created action and the indicators to measure its success. They need to be able to see how their contribution advances the transformation process. Thus, designing indicators is providing ongoing guidance along a path that is largely unknown to all partners involved. Clear indicators will secure the engagement of the partners involved and can spark interest in new parties.

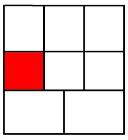
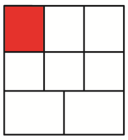
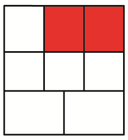
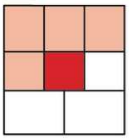
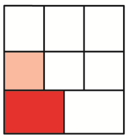
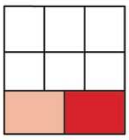
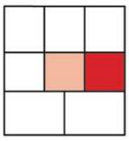
Design steps (work with iterations)	On Canvas	Key questions for discussion Considering the people involved (present at the workshop)
Step 1. Select a target from policy roadmap		Which target (goal) from the policy roadmap do we want to address? *Cross-check*: Can we realistically create an impact concerning the target?
Step 2. Discuss the context of the target		Are there other programs (in other sectors or policy levels) already working toward similar targets? *Preview*: Can we cooperate/align with other actors from other programs? (Step 5)
Step 3. Discuss context of past actions and reflect on their succes		Are there actions in the past (we have set)? *Review*: Why were they below initial expectations?
Step 4. Create Action		What can we do, to open multiple innovation pathways toward the target selected?
Step 5. Build relationsships		Who are the key partners across sectors and disciplines that need to be involved? *Cross-check*: Do key partners share our vision and especially the target selected?
Step 6. Understand requirenments		What is needed for the success of the action? *Reflect*: Are there co-benefits for the actors involved?
Step 7. Set indicators		How can we know our action works? *Detect*: Do we have the necessary data?

Fig. 2: Overview of the co-creative process working with the Monitoring Canvas

6 FICTIONAL DESIGN: AN EDUCATION ALLIANCE FOR CLIMATNEUTRAL MOBILITY

Below we present a fictional design for an action in the context of the circular economy. We chose the context of Vienna, Austria for this fictional design. We worked with experts on the reuse and recycling of building materials in a virtual workshop[3] The Canvas below (Fig. 3) is the result of this workshop.

[3] The authors would like to thank DI Stefan Bindreiter, DI Andreas Gassner, and Dr. Julia Forster for participating in the virtual workshop.

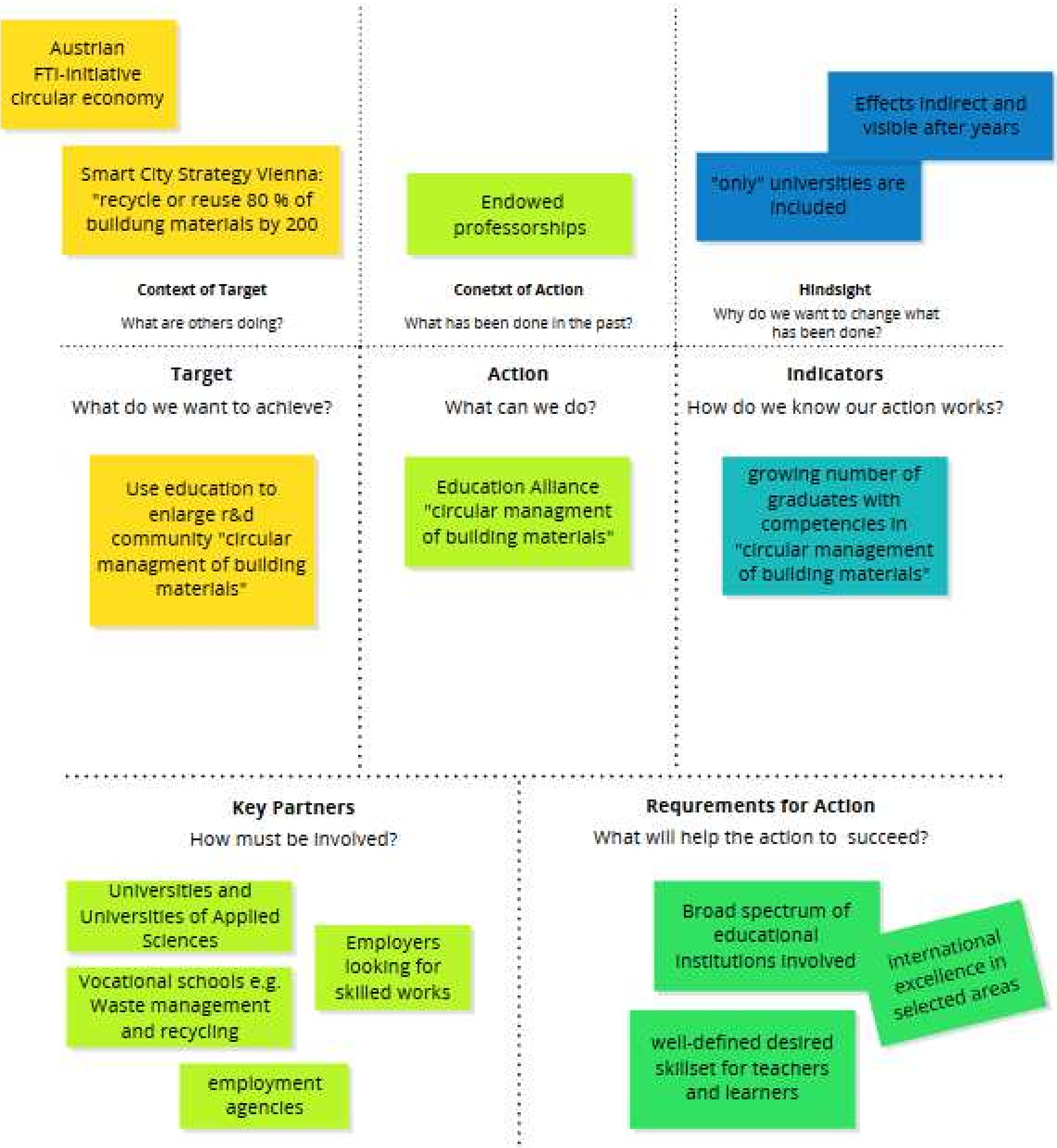


Fig. 3: Example of a completed Monitoring Canvas (fictional design co-produced with the support of experts in the field)

7 CONCLUSION

We have presented the Monitoring Canvas as a supplement to existing toolkits for the creation MOIP. As we have pointed out above, it covers the smallest parts of an MOIP, the single action, and although it shows ways to understand if the action is successful or not, it must not be mistaken for a comprehensive monitoring or evaluation system. The Monitoring Canvas is a participatory tool and as such, we hope, helpful to engage and bond the necessary large number of stakeholders. So far, the Monitoring Canvas has very little capabilities to check the consistency of one action with others in the same MOIP. Although perfect coherence and consistency are impossible to achieve (Carbone 2008; Reichardt & Rogge, 2016), this is certainly a point for further elaboration. The honest chance that a certain set of partners is capable of achieving a certain target, has been pointed out as important, not only to engage other actors but also for the overall success of the mission Bödeker & Rogge (2014). Currently, there is no way to check the Monitoring Canvas for the credibility of its results. Thus, we think that a very close relation to the second step (baseline)

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of the roadmapping framework has to be secured. Working with sound evidance is absolutly necessary use this participatory tool in the larger context of an MOIP.[4]

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