Spatial complexity; identifying critical zones in the Egyptian underground reciprocal stations

22nd international conference on urban planning and regional development in the information society

Egypt Map
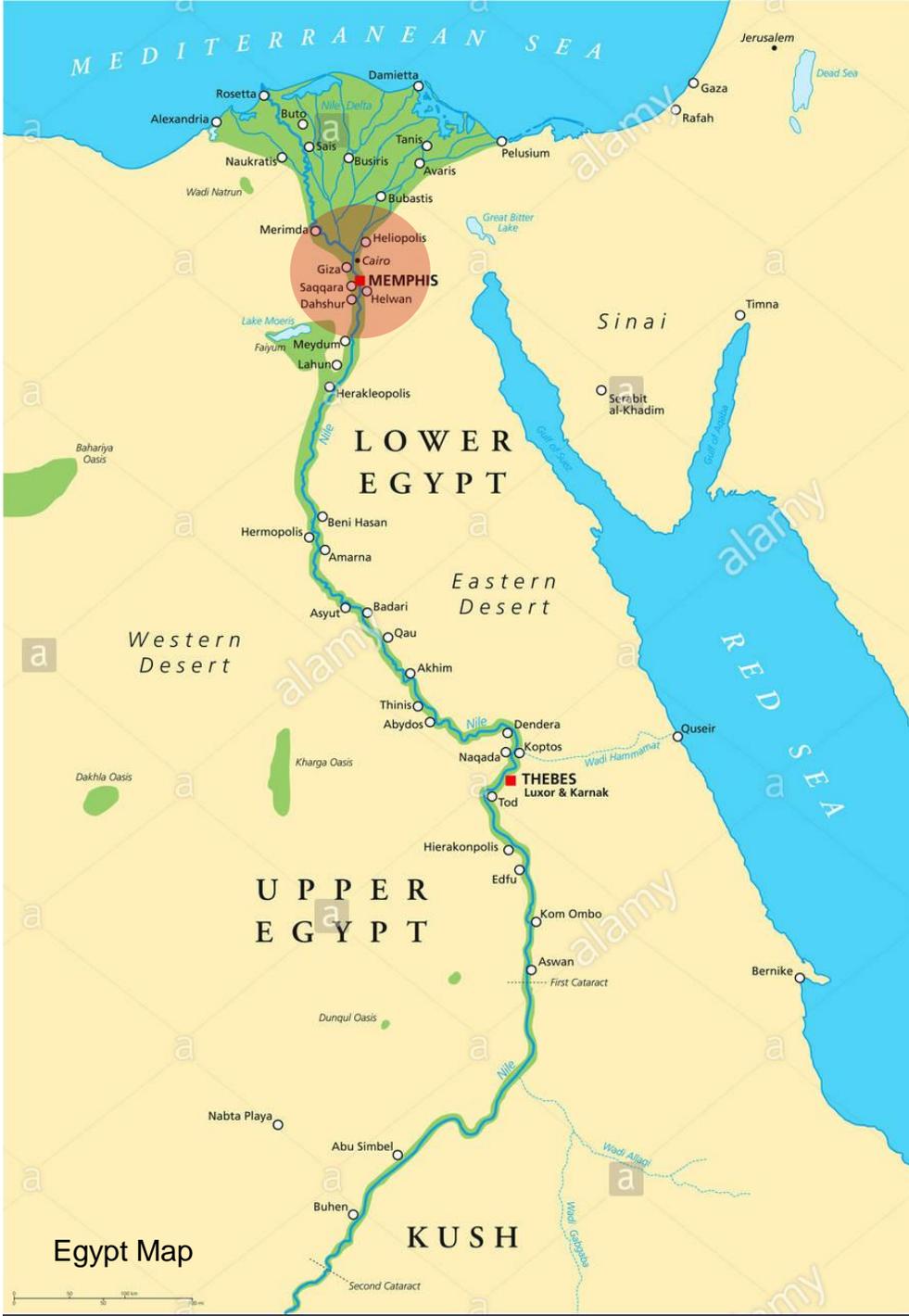
# Everything in Cairo is faster than in other parts of Egypt Egypt the desert city

- Area of Egypt: 1.002.000 km2.
- Populated area: 78990 km2.
- in the rate of 7.8%.

According to the 2017 census, Egypt Population is approximately 93 million.

Cairo is the capital of Egypt: 528 km2.
Population is 10 million.

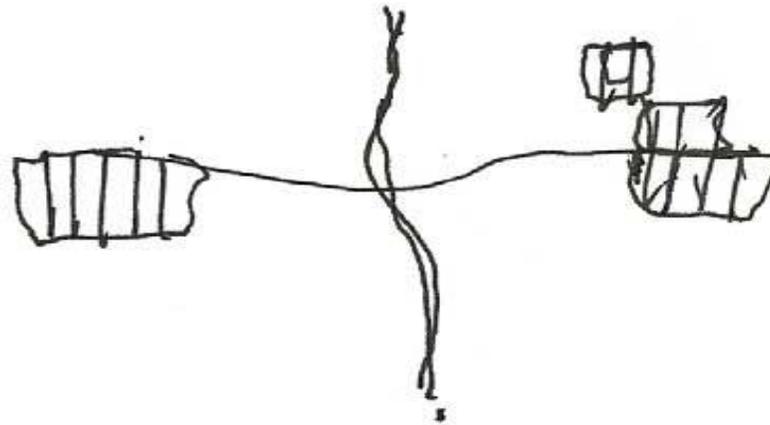# Cairo's desert development is the Greater Cairo

like all global-megacities, is entrenched in processes of globalization where flows of labor, capital and information are re-shaping its physical boundaries as well as the structure of the city. The city has quadrupled in size in the last 50 years.
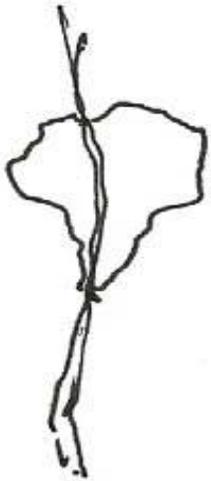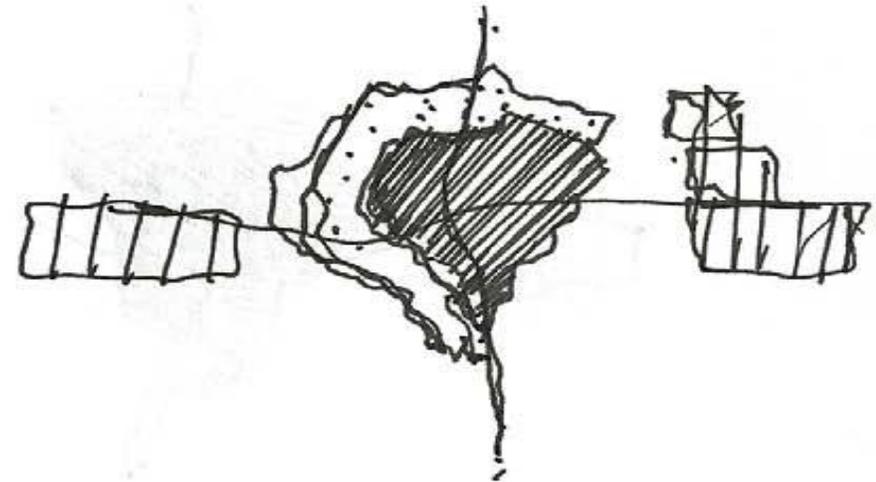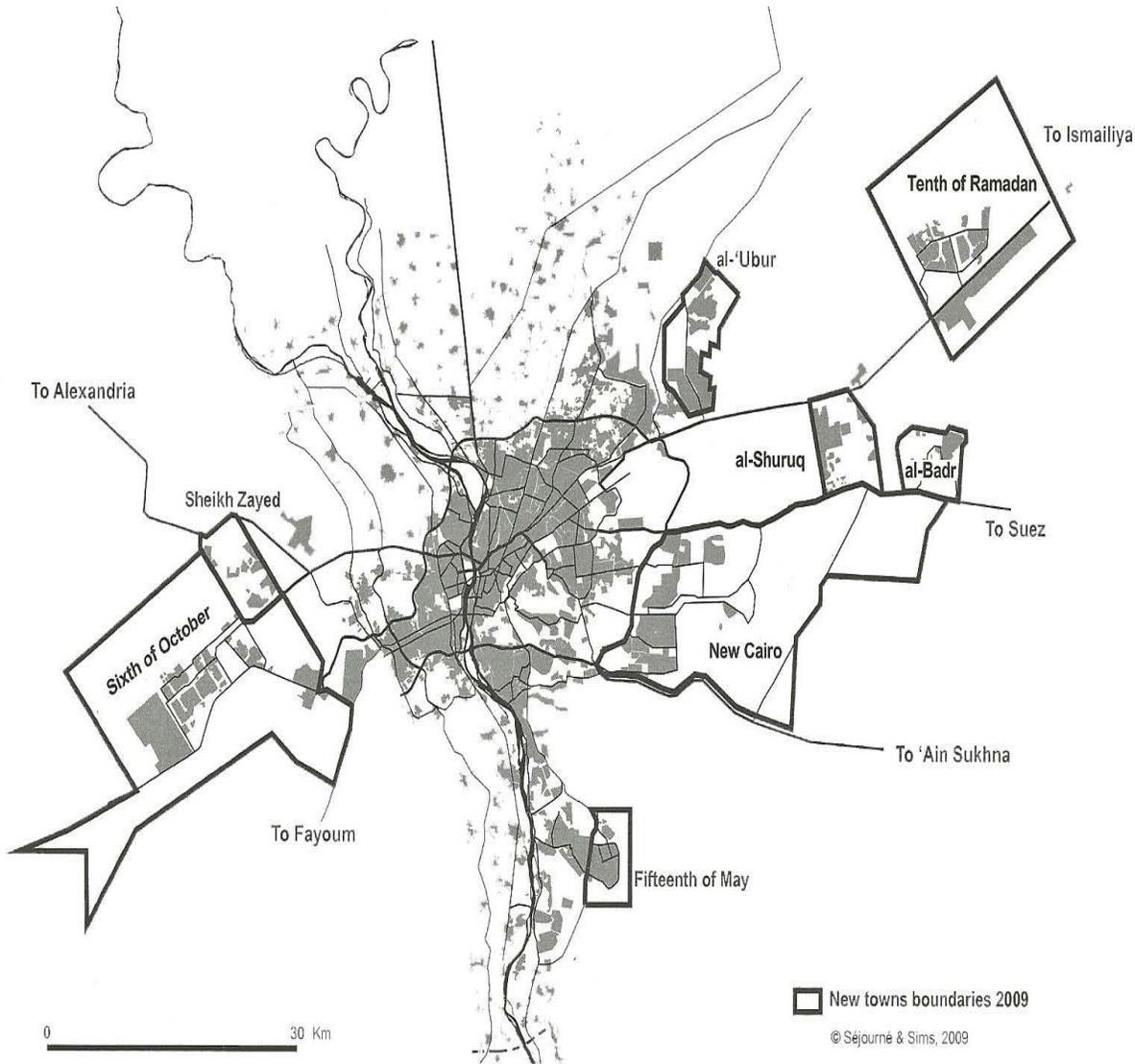

The Formal City   The Informal City   The Desert City   The three parallel cities of Cairo

Greater Cairo map

Greater Cairo as a population bomb

Area of Greater Cairo represent 1.73% of Egypt Area

around a quarter of Egypt's inhabitants live in Greater Cairo, about 23 million, in addition to millions of commuters who came every day to work.

The capacity of Cairo's public transport infrastructure

In 1990 a study was conducted for the transportation future needs of the city, and estimated that:

there was a need for about 8.4 million journeys by public transport and 2.7 million journeys by other modes.

The actual public transport capacity is 4.9 million journeys/day, 3.5 million short of the actual requirement.

This has led to a 50% increase in the number of taxis with subsequent increases in traffic congestion.

The subway is the efficient solution

The capacity of Cairo's public transport infrastructure will increase from **20,000** ⟶ **60,000**.

finding way is so easy
&
Route is so clear in addition to the existence of signage system

Wayfinding is a **DISASTER**
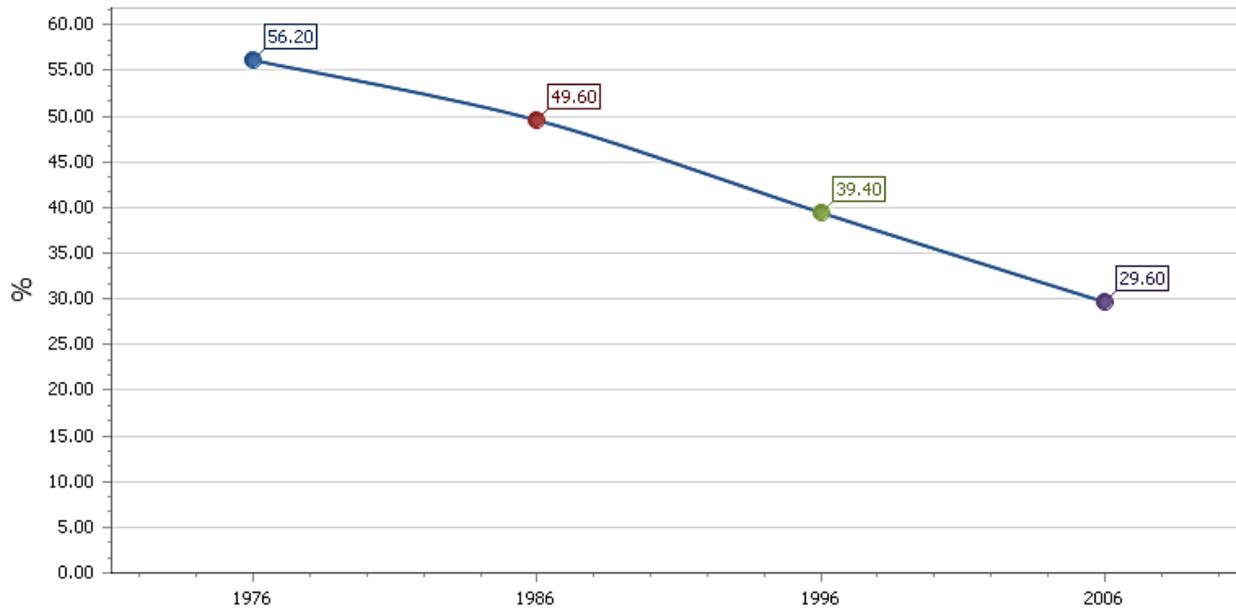
Perspective of Designers & Operational team

Users Perspective
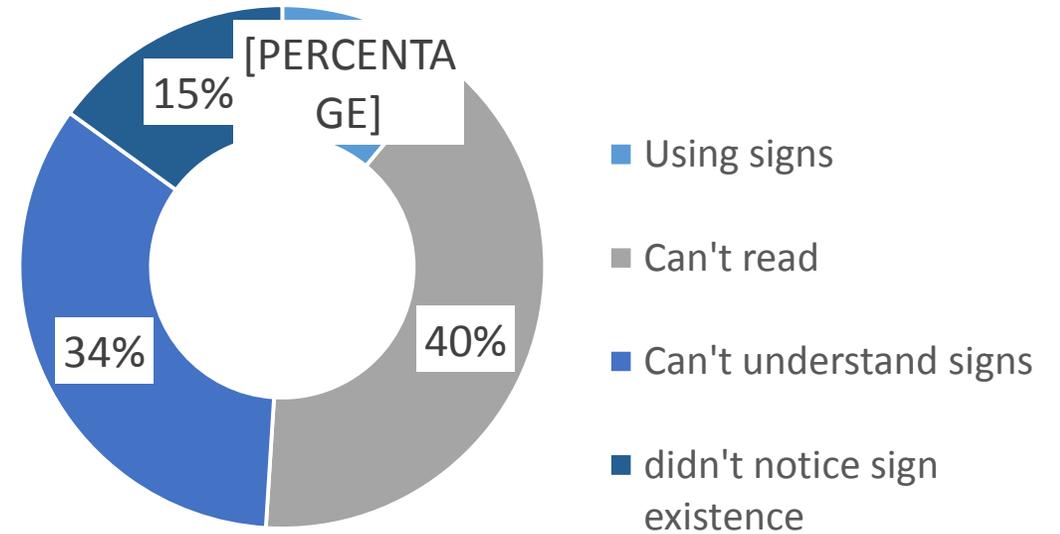
Who should we believe?

Does the signage system useful?

According to the Egyptian context that witnesses a high degree of illiteracy.
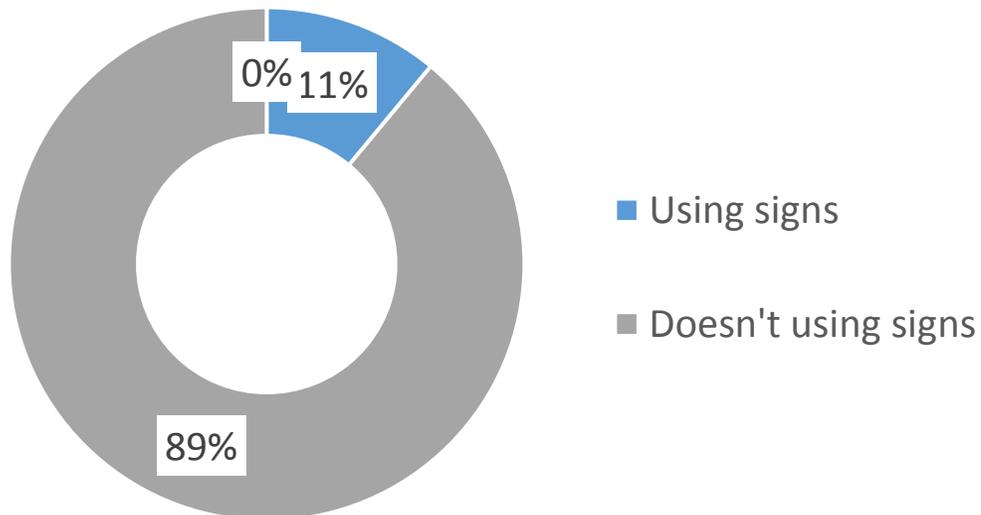
the presence of signage is not enough.

illiteracy of the Egyptian inhabitants is estimated at 20.9%.

Does the route clear?

11% Using signs, but the other 89% depends on luck or asking others users untill they could gain their own experience.

There is a gap to be bridged between the design process and architectural design disciplines, Architects have difficulty with perceiving the outcomes of a design in terms of the spatial configuration and user cognition.

0% 11%

■ Using signs

■ Doesn't using signs

89%

wayfinding and wayfinder

Wayfinding is an interaction between the environment and wayfinder

Verbal aid

Legibility

Signage (incl maps)
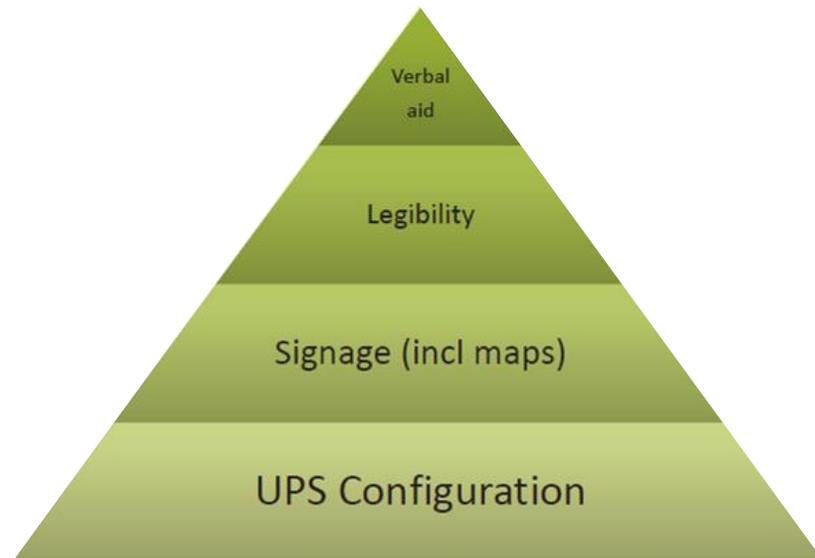
UPS Configuration

According to studies, the spatial configuration is the most important factor. Which mainly controlling pedestrian movements, to its ability to deal with different culture, level of cognition and literacy.
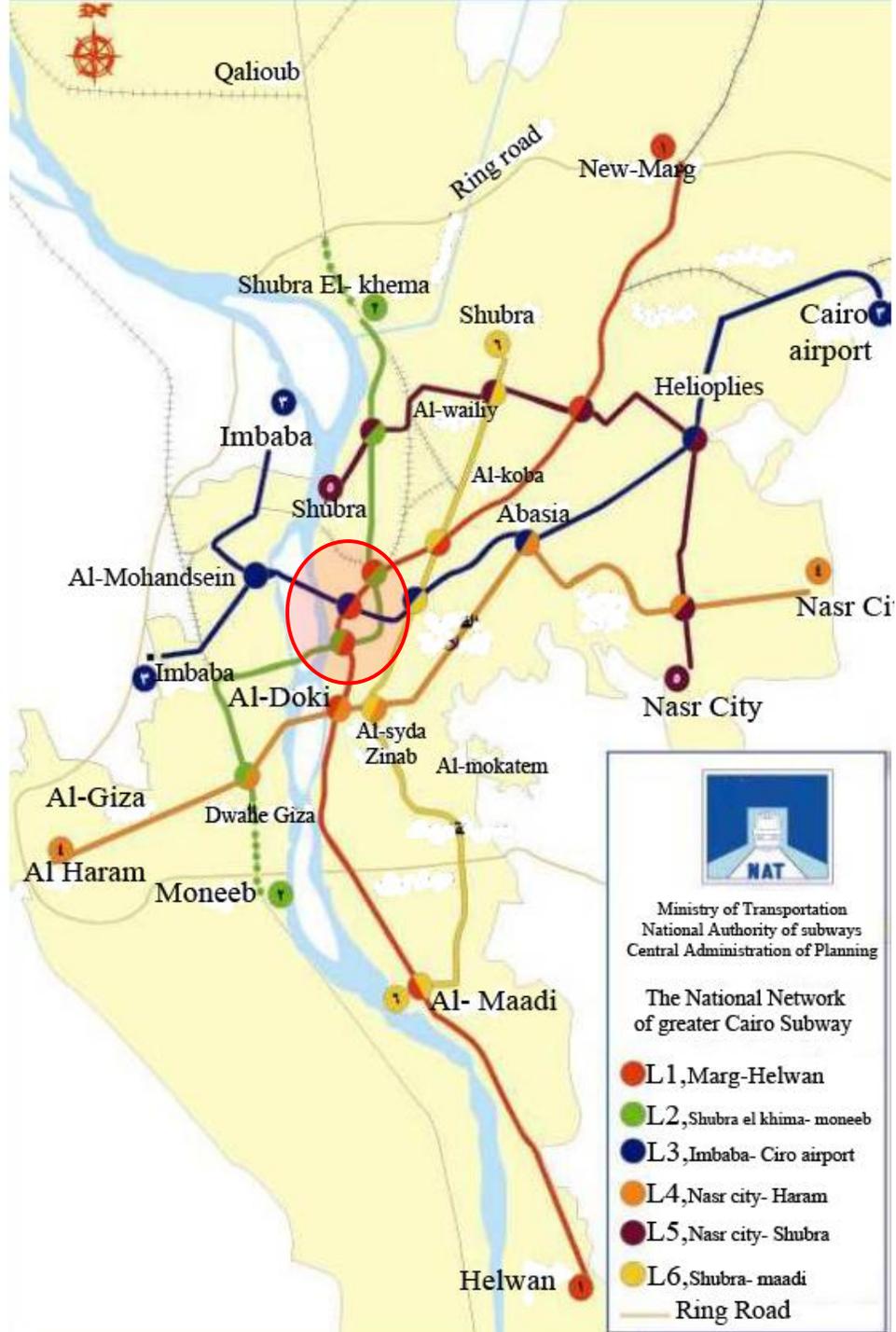
The Egyptian Receiprocal Stations

Foucsing on the egyptian subway, we have 3 lines with 5 million daily users, the three lines intersected in 3 reciprocal stations.

The 3 are located underground at downtown to target the most crowded contexts of greater Cairo.

Attaba station combines lines **2**&**3**,
Ramsis and **Tahrir** stations combines lines **1**&**2**.

Cairo's future development include 3 more lines, number of reciprocal stations will upgrade to 14.

Mathematical approaches for eligible Configuration

J- Graph technique

features of configuration could be uncover, through determining **depth degree**, **space integration** and **losing way possibilities.**

Decision point density

Determining **the relation between pauses & walking distance the highest gathering zones**.

Identifying **degree of intelligibility**, **critical zones** and **their features.**

Space syntax technique

Attaba station

- The Structure like a tree, with many possible routes.

- Long routes, as an indicator for deepth, but according to its mandatory, it supporting users flow.

- The station has high symetrical degree, so could be divided to 4 similar sets, which enhance mental map representation.
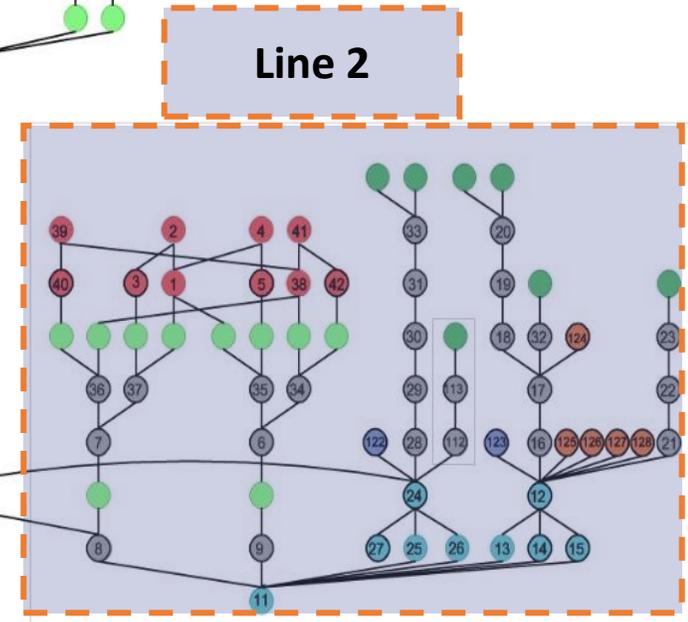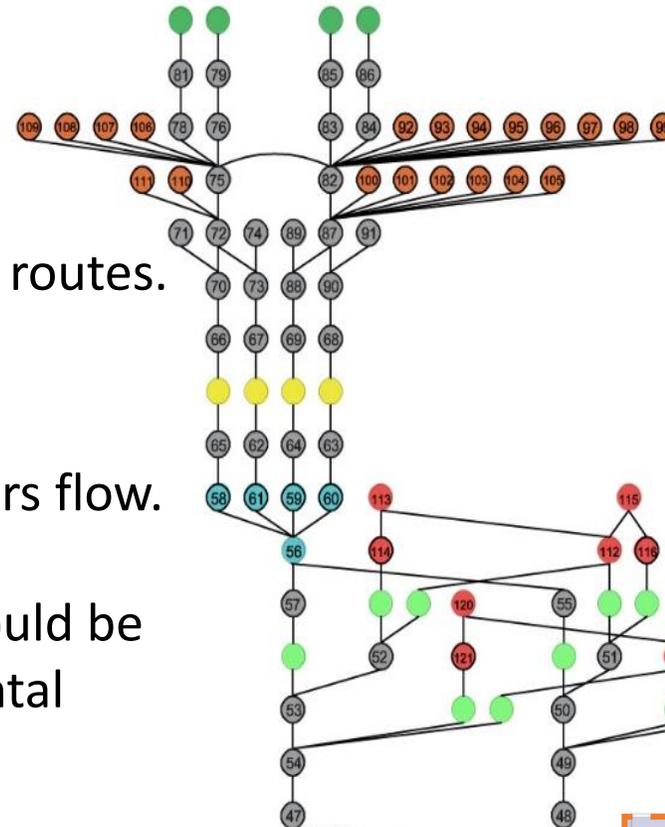
J- Graph technique


Line 2

Horizontal routes	●	Horizontal connections between line 2&3	●	Platform	●
Ticket Window	●	Vertical connections, public zone	●	Ticket Hall	●
Stores	●	Vertical connections, private	●	Exits	●

J- Graph technique

Tahrir station

- The Structure combines tree and ring type.

- Low symmetrical degre, but colsed exists had converted movement to madonatry one

Closed exits

Horizontal routes — Horizontal connections between line 2&3 — Platform

Ticket Window — Vertical connections, public zone — Ticket Hall

Stores — Vertical connections, private — Exits

Ramsis station

- The Structure combines tree and ring type.

- Low similarity degree, leds to difficulities in mental map representation.
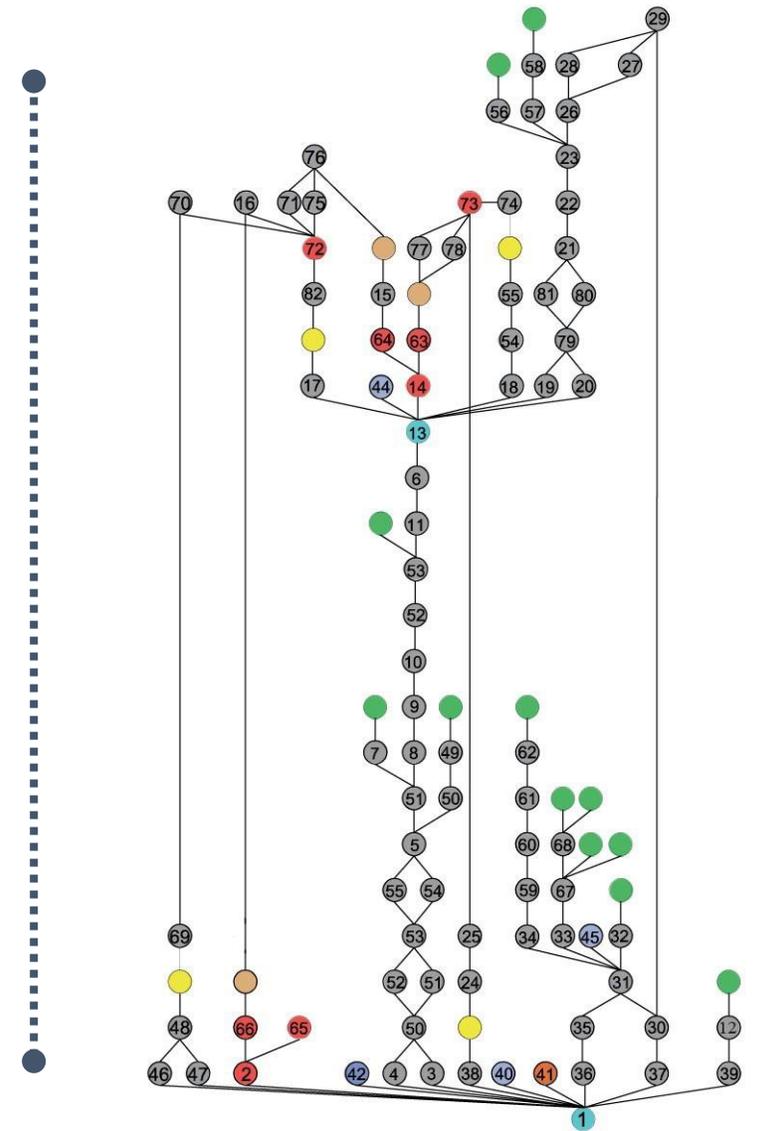
- Long routes with many decision points.

Horizontal routes — Horizontal connections between line 2&3 — Platform

Ticket Window — Vertical connections, public zone — Ticket Hall

Stores — Vertical connections, private — Exits
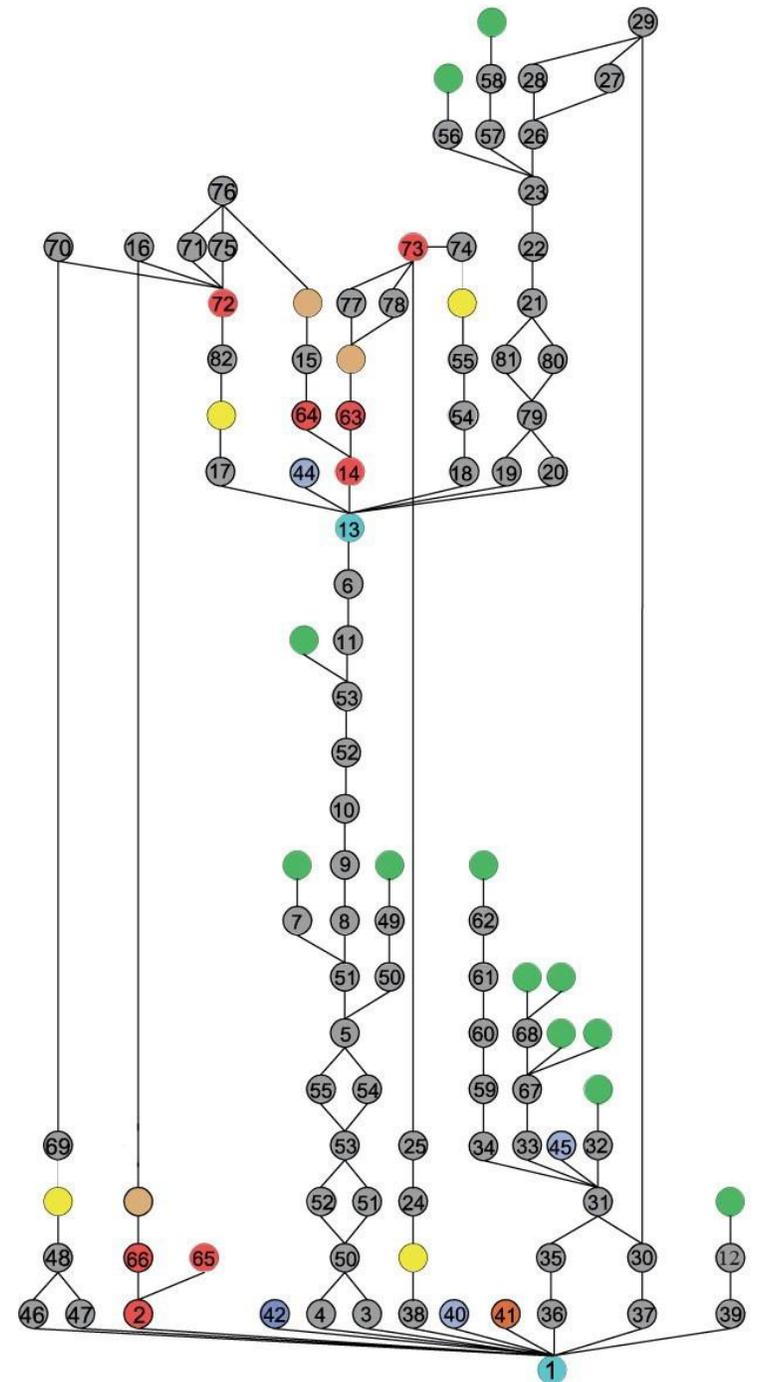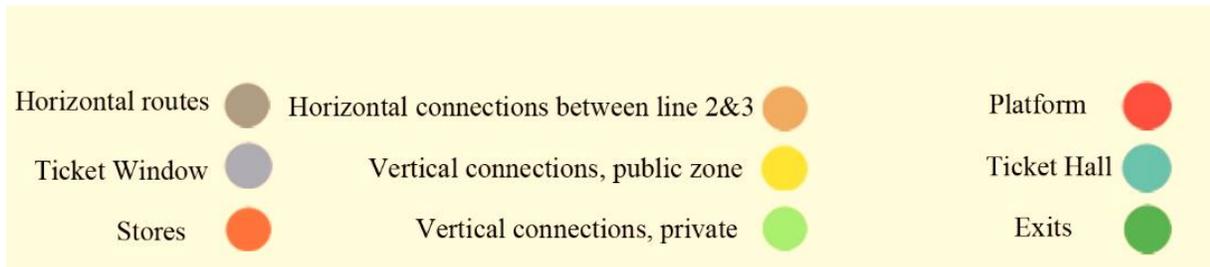
Ramsis station count as the most complex case
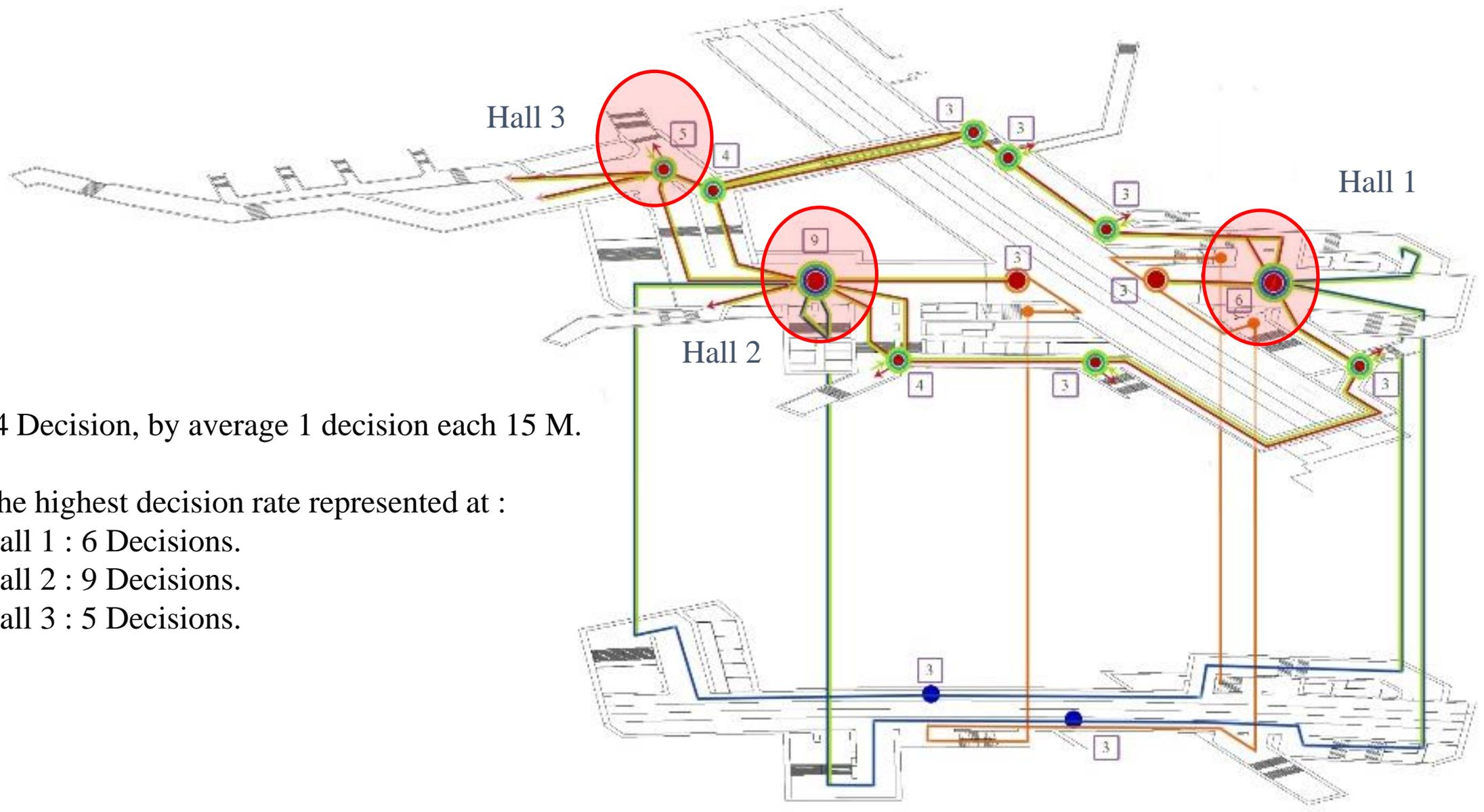
Line 2

Closed exits
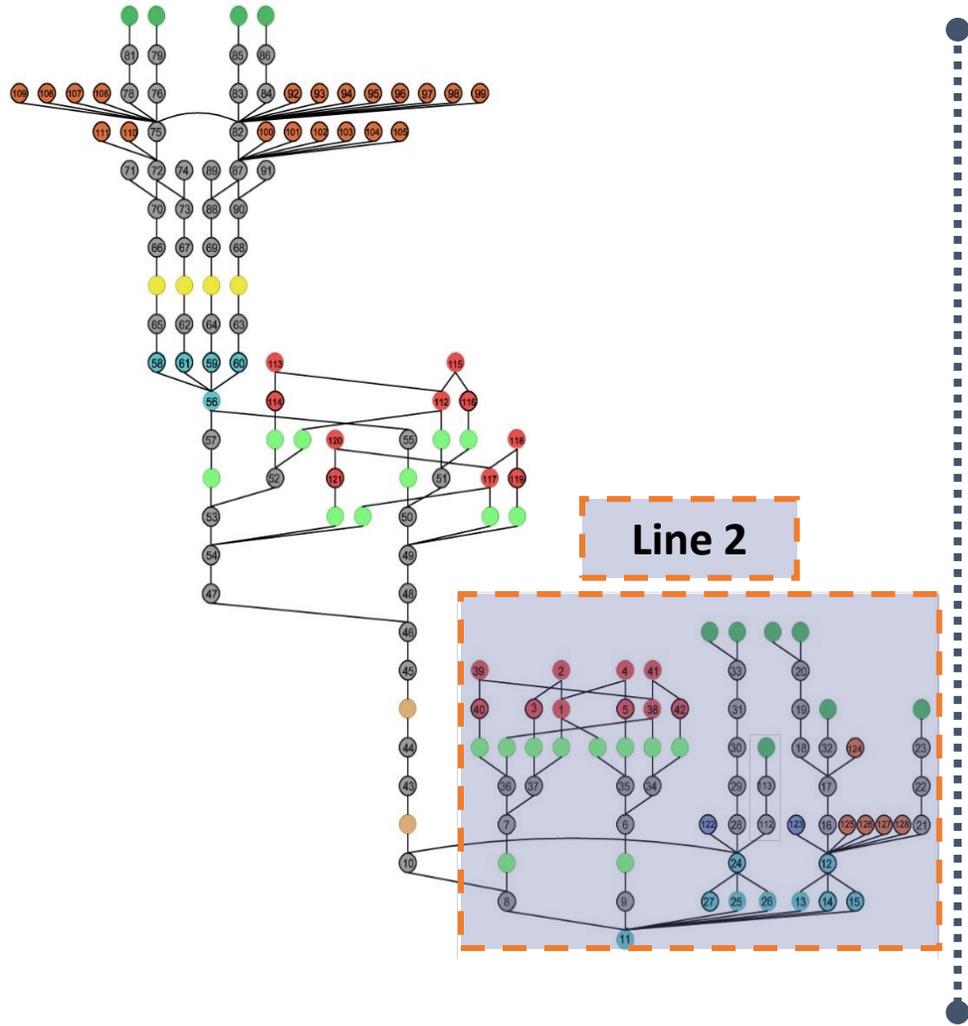
Attaba station
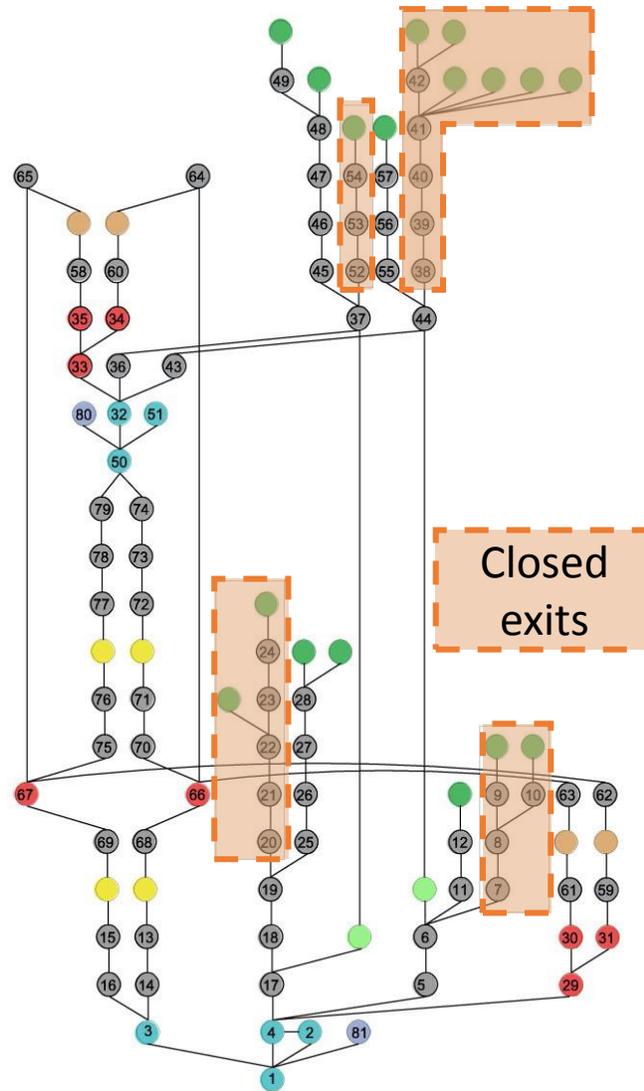
Tahrir station

Ramsis station

Hall 3

Hall 1

Hall 2

14 Decision, by average 1 decision each 15 M.

The highest decision rate represented at :
Hall 1 : 6 Decisions.
Hall 2 : 9 Decisions.
Hall 3 : 5 Decisions.

Potential routes at each point

Road crossers

Arrivals users

Changing line or direction

Departing users of line 1

Departing users of line 2

Intelligibility degree

Space syntax - Axial analysis

the axial integration HH graph

the axial connectivity graph

Correlation (R²=0.25).

Low   High
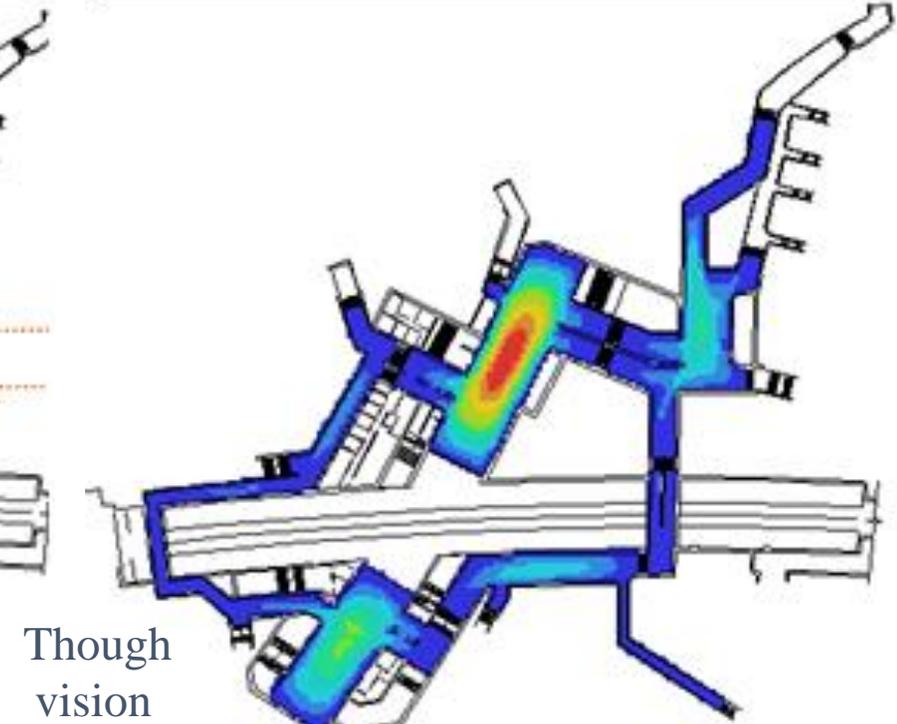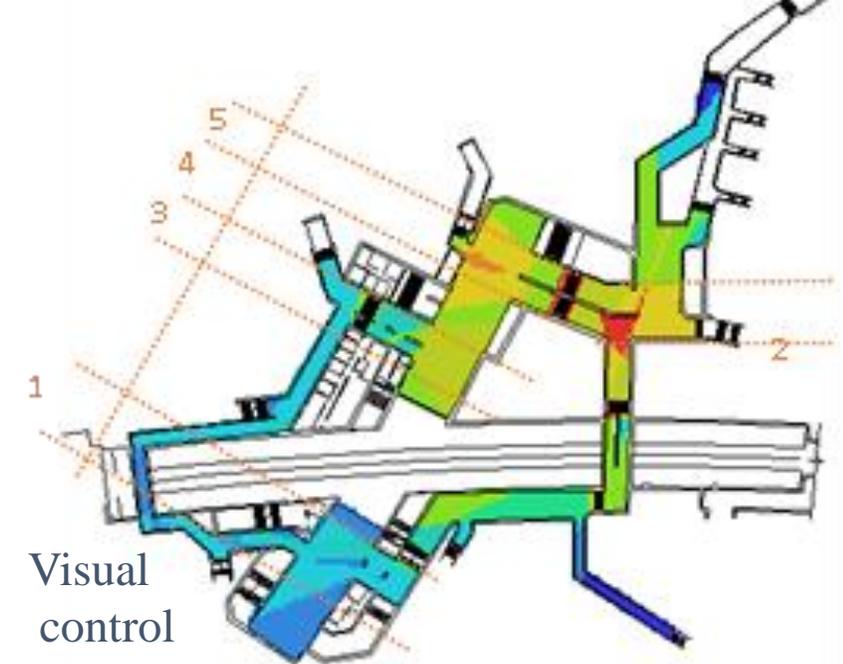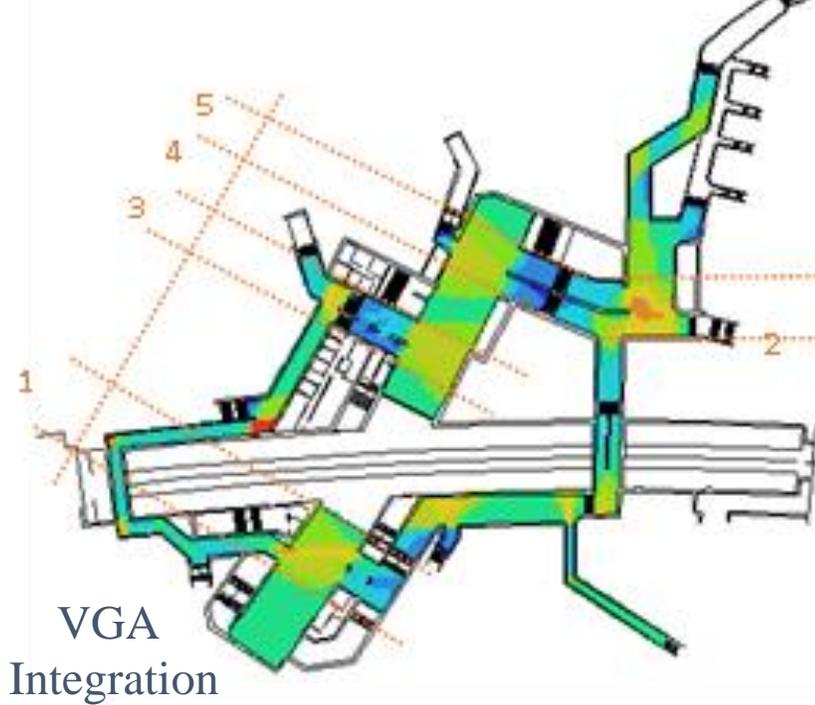
The VGA analysis give us the mean visible area in every position of the spatial system four patterns conclude :

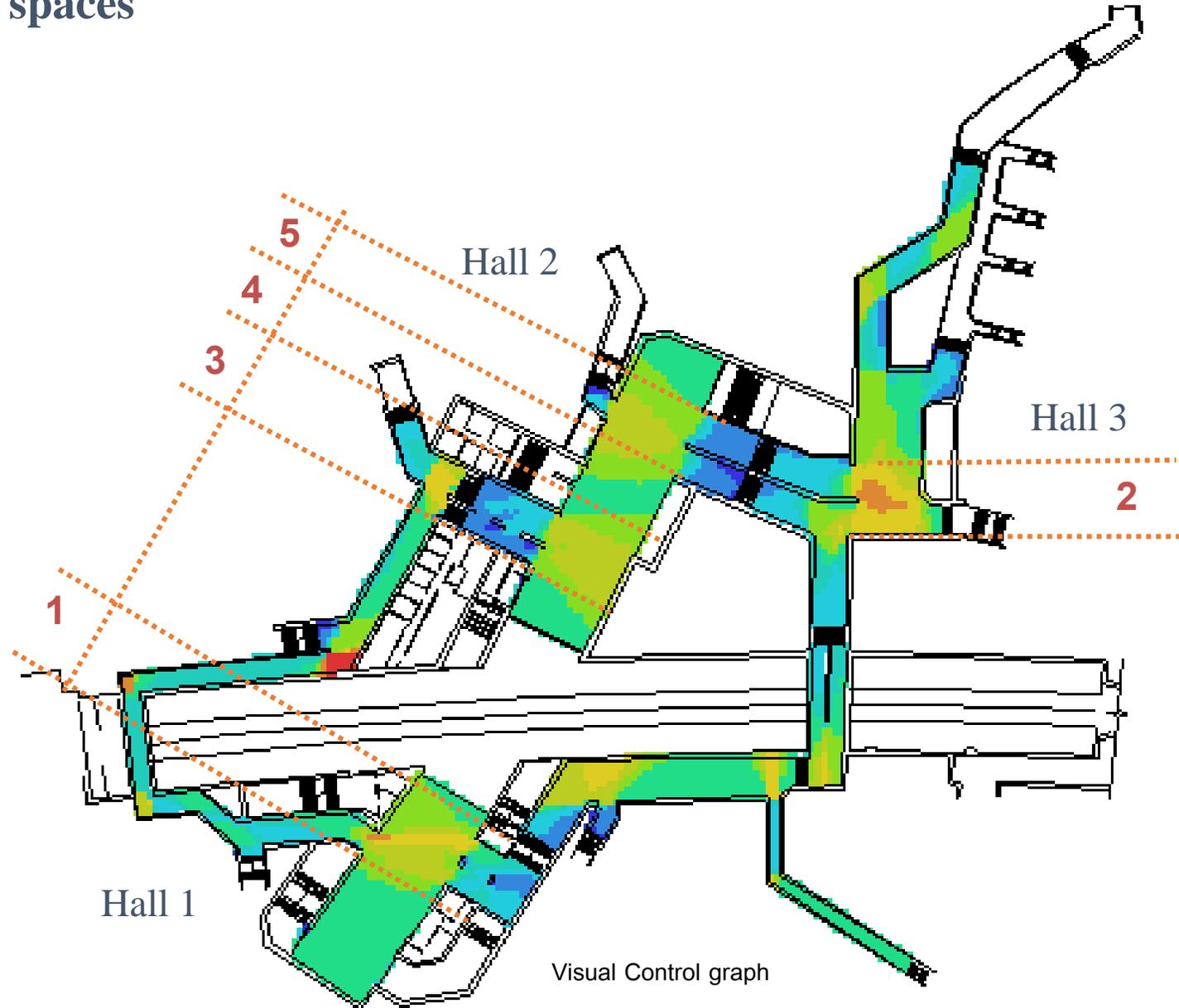**VGA integration**: where users pause to evaluate their navigation.

visual control: where users pause to make route decision.

visual clustering coefficient: where users lose information when moveing.
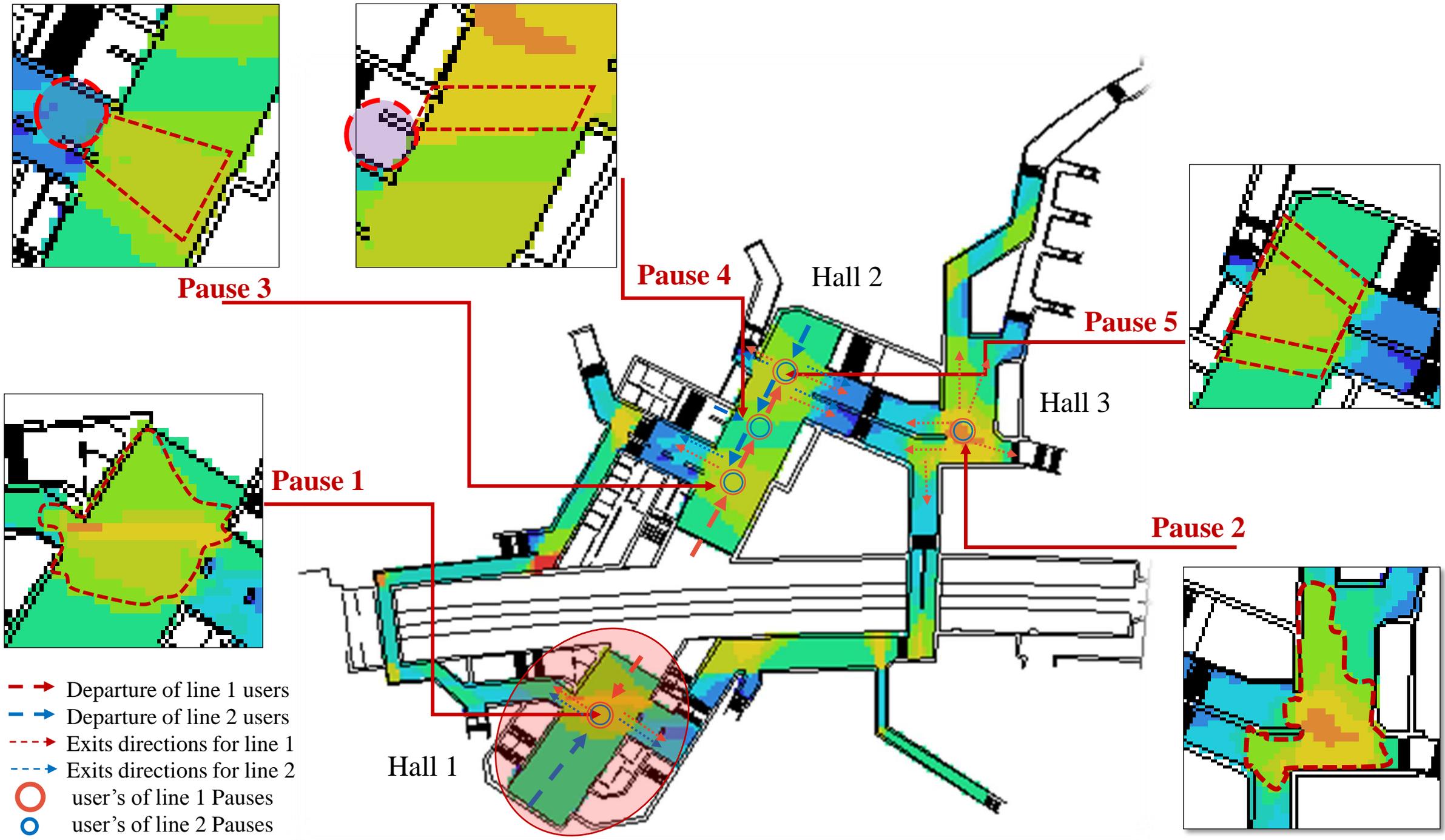
through vision graph: the longer lines of vision

VGA Integration

Visual control

V. C. C

Though vision

Determining critical spaces

Space syntax - VGA analysis

Hall 1

Hall 2

Hall 3

Visual Control graph

1 2 3 4 5

Features of critical space

Pause 3

Pause 4

Hall 2

Pause 5

Hall 3

Pause 1

Pause 2

Hall 1

- - → Departure of line 1 users
- - → Departure of line 2 users
- - → Exits directions for line 1
- - → Exits directions for line 2
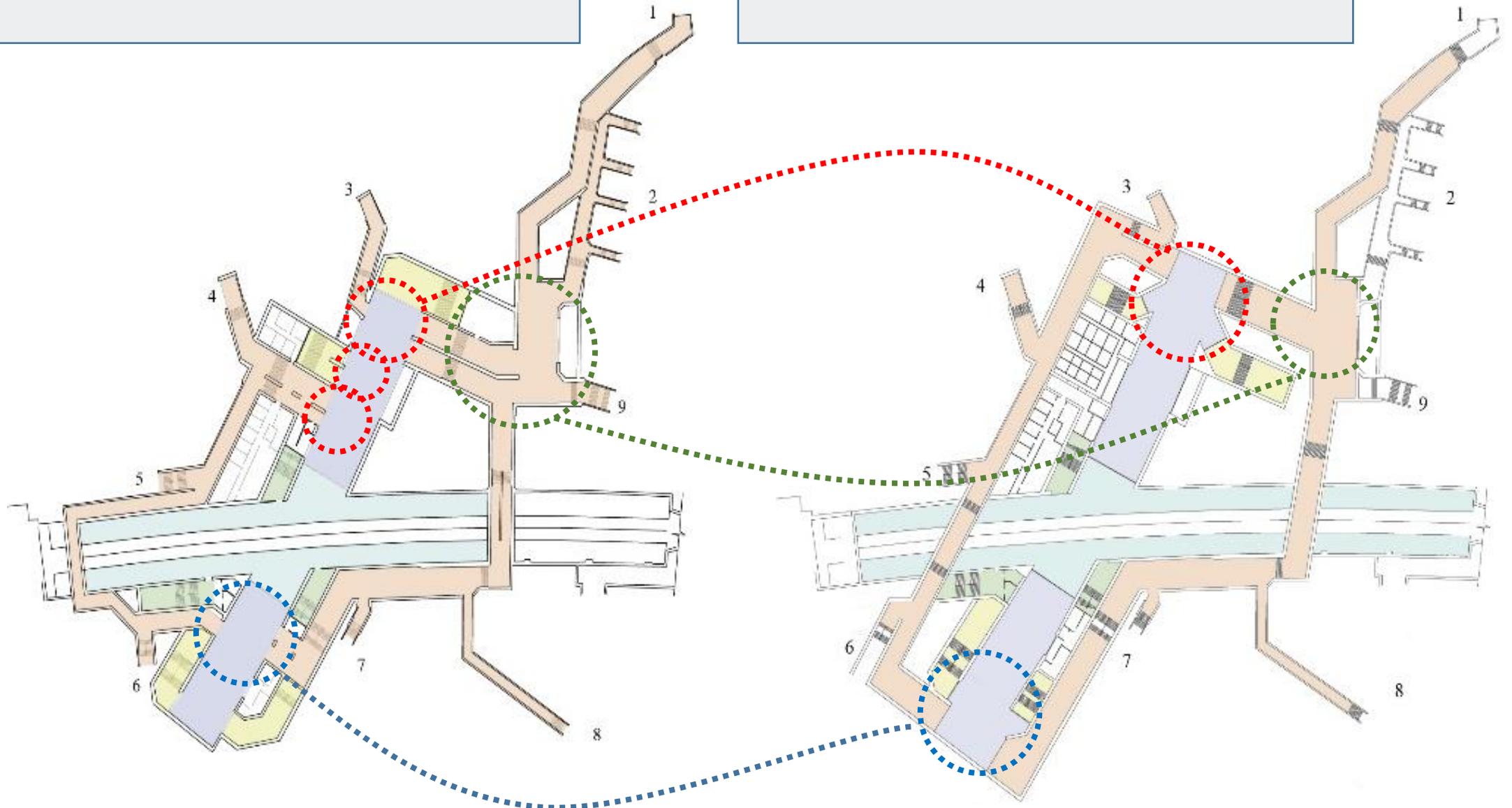○ user's of line 1 Pauses
○ user's of line 2 Pauses
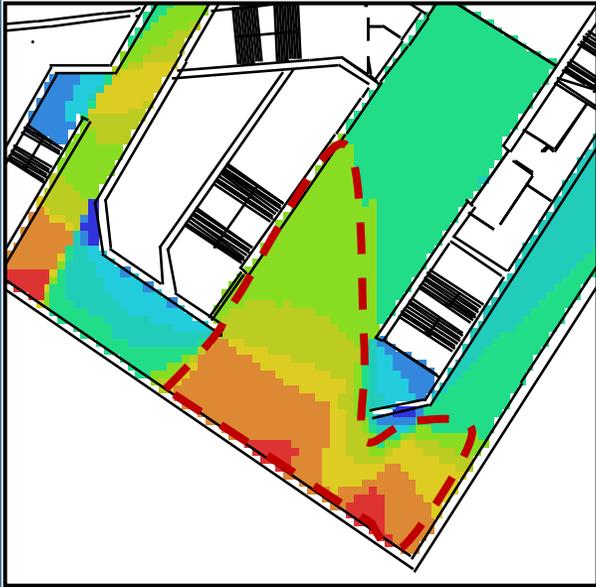
reducing : number of critical pauses, possible routes.

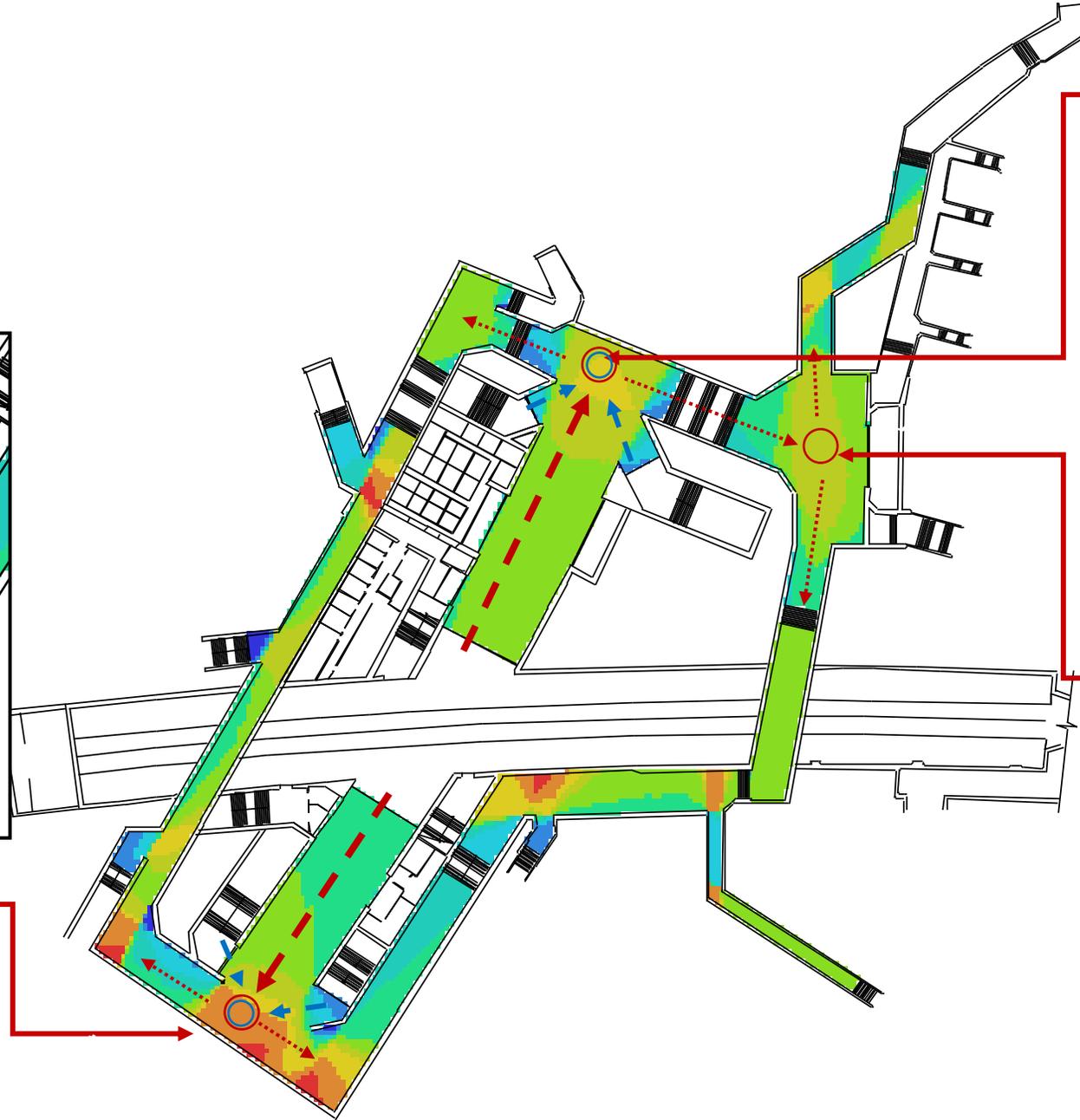**Increasing:** similarity degree and width of visual field to obtain all routes.
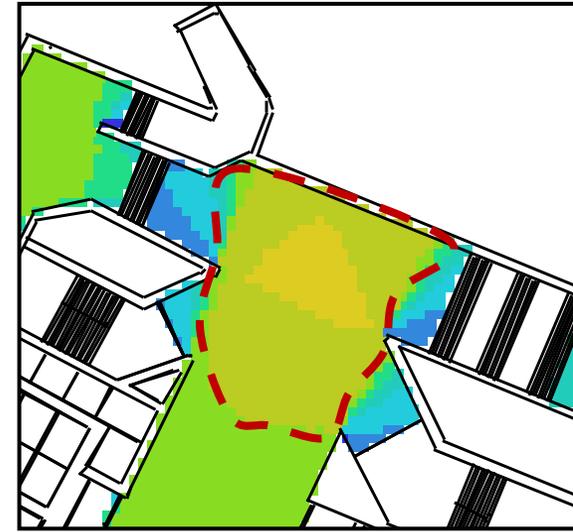
The original design

The Proposed design

Intelligibility degree

Space syntax - Axial analysis

the axial integration HH graph

the axial connectivity graph
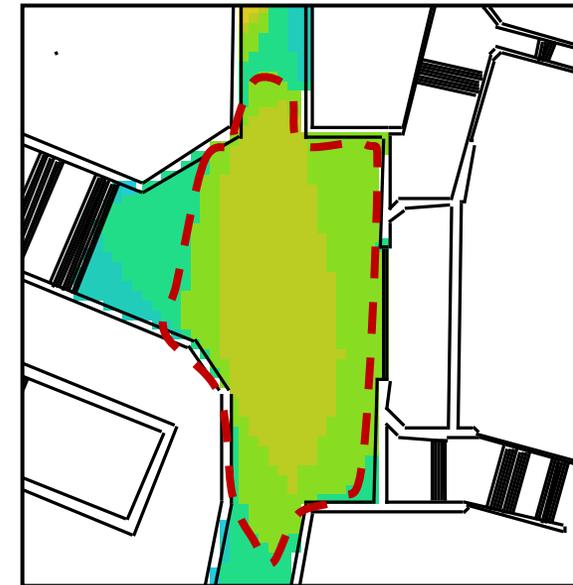
Correlation (R²=0.82).

Low | High

Pause 3

Pause 2

Pause 1

- Achieving extremely complicated or eligible circulation system, is mainly about how you control and design critical zones and horizontal routes.

- Critical zones could be identified as pauses that discontinues movement sequence, which normally present in case of increasing possible routes and creating difficulties in mental map representation.

- As proposed by this study two main types of paths could be identified, the sequential paths which could guide users flow, and multi possibilities paths which enhance space interactively. Thus, in such a functional buildings sequential paths have the priority on the multi possibilities paths.

- Structure elements should be designed with respect to spatial configuration to avoid production of additional routes. if its necessary, its preferred to be set in the middle.

- Spatial configuration and its role in directing movement affect users flow more than routes width.

- Signage system is not always the suitable solution, especially in case of illiteracy.

- Well connecting of urban context with indoor environments is a challenge, Providing various access is not the anchor, especially for departing, but it's mainly about the ease of reaching destinations by confirming the importance of increasing visual access and symmetry degree, and decreasing number of turns and distance to the target.

THANK YOU ...