

# Improving landscape Characteristics in Port Said's El Sallam Garden via Observational and Space Syntax Analysis

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**Abstract:** This paper provides a comprehensive examination of El Sallam Garden in Port Said City, concentrating on its landscape characteristics and potential for design enhancement. This study looks at how space syntax can be used to assess the impact of a tree planting design's spatial configuration on an urban park's visual fields. Trees play an important role in determining the spatial characteristics of an outdoor space. According to space syntax theory, an urban area is a collection of connected spaces that can be represented by a matrix of quantitative properties known as syntactic measures. Computer simulations can be used to measure the quantitative properties of these matrices. This study uses space syntax techniques to assess how tree configurations and garden area which can affect the social structures of small-scale gardens in Port Said. It also looks at how these techniques can be used to predict the social structures of four garden zones in El Sallam Garden. The study includes an observational and space syntax study through comparative analysis of four garden zones in El Sallam garden. The results of the study show that the area and planting configurations of the garden had a significant effect on the syntactic social and visual measures of the urban garden. The conclusions and recommendations can be a useful tool for landscape architects, urban planners, and legislators who want to enhance public areas and encourage social interaction in urban settings.

**Key words:** VGA (visibility graph analysis), agent simulation, space syntax, minimal paths, garden landscape, design, behavioral mapping, gate count.

## 1. Introduction

However, urban gardens can have a positive impact on urban design in several ways through environmental concern, biodiversity, decrease UHI (urban heat island), social opportunities, cross-cultural interactions, and social cohesion, as well as recreational and educational opportunities for the neighbourhood. Some gardens have low impact on these issues due to its design constraints, which can lead to social problems such as presence of drug abuse, smuggling and vandalism.

To solve these potential problems, the gardens should consist of a number of social activities that attract diversity of people, increase access points,

increase visibility in the gardens and increase walkable areas in the garden. In this research, it focuses on study of visibility through movement and changing behaviour of users in El Sallam garden in Port Said.

## 2. Context

Port Said itself was established in 1859 during the construction of the Suez Canal. The city has a rich history, including its role in the Suez Crisis in 1956 and the wars of 1967 and 1973 [1]. The city has grown with influences from the Egyptians, French and English. Port Said is known for its unique accent and is a popular summer resort and tourist attraction due to its beaches, museums, and duty-free port [2].

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Fig. 1 Location of El Sallam Garden and surrounding landmarks in El Sharq district, Port Said.

The city's history is relatively young compared to other Egyptian cities, affording researchers a wide range of historical documents, photos, maps, memoirs, and family collections [3].

The garden is situated at the meeting point of main city

boulevards and offers a unique vantage point, overlooking the Suez Canal. It is a historic site situated near the Italian House, El Sallam Mosque and Port Said Hotel as shown in Fig. 1. The garden consists of 4 fixed pergolas and 12 fixed benches.



**Fig. 2** El Sallam Garden surrounding roads and fixed furniture.

El Sallam Garden in Port Said, Egypt is a popular tourist attraction and recreational area. It is located in the Mansheya neighborhood of the city, near the Suez Canal. The garden offers a serene and green escape from the bustling city life. It features beautiful landscaped gardens, lush vegetation, and a variety of trees, plants, and flowers. Visitors can enjoy leisurely walks, picnics, and relaxation in this peaceful oasis. The garden also has a small museum where visitors can view captured US tanks and other war artifacts. The garden also has four shaded pergolas and a number of fixed furniture as shown in Fig. 2. Overall, El Sallam Garden provides a tranquil retreat for both locals and tourists in Port Said.

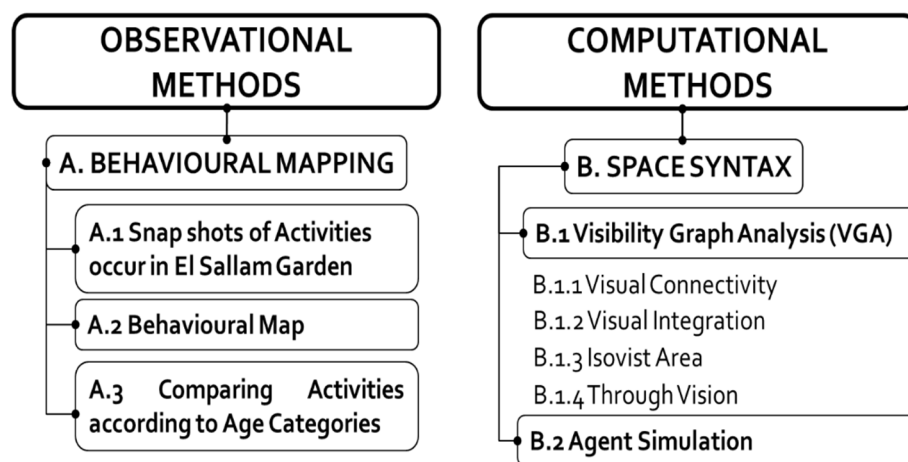
### 3. Methods

The study is based on hybrid method of observational and computational methods. Observational method is based on capturing data through the observation of a behavior or activity in real time, using behavioural mapping as naturalistic accurate depiction of behavior [4]. While space syntax as computational method was used to examine the relationship between human societies and space, this examination is conducted from the perspective of the general theory of the structure of populated space, encompassing various manifestations such as buildings, settlements, cities, and landscapes [5-9]. As space syntax built on two main concepts that

reflect both the objectivity of space and engagement in such space [10]. First concept is that space should be seen as integral to human activity, not just a backdrop like objects. Human actions in space have natural spatial geometries: linear movement, convex interaction spaces, and varied visual fields from different points. Second concept that human space involves the relationships between different spaces within a building or city. The configuration of space refers to the existing relations among the parts that make up the whole. Language has terms for spatial configurations, mostly describing relations between three entities. English prepositions like between, beyond, or inside demonstrate this. Understanding complex spatial patterns is a skill people possess at an unconscious level, similar to how language is structured. Precise terms for intricate spatial patterns are lacking [10]. These two concepts are to think of a space as visual, structural and movement entity and as spatial configuration which means that each space not

seen as individual space but as a result of interactions between different spaces as part of a system of spaces.

The study endeavors to explore the impact of the spatial arrangement of trees on the formulation of El Sallam Garden. As shown in Fig. 3, behavioural mapping is used as observational method which consists of three studies: (1) First taking snapshots of the activities that occurred in the garden; (2) Creating the behaviour map according to the distribution of activities in the garden map; (3) Comparing these activities according to age categories. On the other side, space syntax method is using VGA (visibility graph analysis) through local and global measures of four main visual measures which are: visual connectivity, visual integration, Isovist area and through vision. Other space syntax analysis is related to the simulation of movement and presence of agents in the garden which is agent simulation through gate counts. These visual and movement studies defined in the following.



**Fig. 3** Observational and computational methods.

### 3.1 VGA

This analysis is developed by Turner et al. [11, 12]; it is a computation of multiple points in a system of spatial relations, a method of analyzing the inter-visibility connections within buildings or urban networks, developed from the architectural theory of space syntax [11, 12]. It investigates the properties of a visibility

graph derived from a spatial environment, which can be applied to two levels: eye level for what people can see, and knee level for how people can move, which is critical to understand spatial layouts. This approach features a quantitative analysis of visual properties in the built environment, offering modeling and understanding of how the space may be used and perceived by its occupants [13].

### 3.1.1 Visual Connectivity

This analysis refers to the degree of visual access between different locations in a space or a number of spaces form a spatial system and can be defined as the visual relation between each location with its adjacent location. This concept is measured by the number of visible locations from a given point, which can be used to identify areas of high or low visual connectivity within a space [14-16].

### 3.1.2 Visual Integration

This analysis can be described as the chance for visual spatial exploration. As how much space can be visible from all visual points within the system [14].

### 3.1.3 Isovist Area

This analysis is used in space syntax and architectural analysis to describe the area visible from a given point in space [17].

The shape and size of an isovist can change with position, and it is typically represented as a shaded polygon on a plan in architecture and design [18, 19].

### 3.1.4 Through Vision

This analysis refers to the analysis of the degree of through visions for a neighborhood or public space, depicting the longest possible continuous view from a specific point [20]. It is a measure of the visibility lines for each location on a visibility graph grid and correlates well with pedestrian behavior in urban areas [21].

## 3.2 Agent Simulation

It is possible to provide a definition for it as the imitation of the behavior of individual agents in terms of movement. Each agent is distributed throughout the spatial system and selects its movement pattern based on a visual field that is determined by the VGA. Consequently, the agents are computed in advance with regards to the range of visibility from any point in the system. This investigation permits social researchers to

simulate the movement patterns of individuals within specific spatial relationships [14, 22].

## 4. Findings

### 4.1 Observational Findings

Behavioral mapping encompasses the methodical observation and documentation of the actions exhibited by individuals or collectives within a designated space or setting [23]. In order to conduct this examination, scholars generate a visual representation or schematic of the area under scrutiny, carefully annotating both the location and conduct of the subjects at regular intervals. By employing this technique, valuable insights can be garnered regarding the tendencies of movement, social exchanges, and the utilization of distinct zones within the given environment. Consequently, this approach can be effectively employed in the examination of various locales such as in the case of gardens [24]. This study is combined with counting visitors who enter or exit the garden as gate count study [25].

As shown in Fig. 4, behavioural mapping as the main observational analysis in this study was associated with static snapshots which show users' behaviours through camera shots such as kids playing and people's social activities. The behaviour map show also that most activities were done at the central zone of the garden and in general there are less presence of users in the four surrounding zones in the garden. In table 1, it shows the total number of users through one hour from 10 pm to 11 pm in Fridays as weekend days and in Sundays as weekdays in summer and winter in 2021 and 2022. To sum up, it shows the number of youth users was dramatically decreased on Sunday at 7th of November in 2022. Also it shows high percentage of female users and kids in the garden which is an indicator of high level of safety in the garden.



Fig. 4 (a) static snapshots; (b) Behaviour map of El Sallam Garden.

Table 1 Four tables of number of visitors in October, November and May.

| At Friday as weekend (29/10/2021) |         |    |         |    |          |    |         | At Sunday (7/11/2021) |         |    |         |   |          |   |         |
|-----------------------------------|---------|----|---------|----|----------|----|---------|-----------------------|---------|----|---------|---|----------|---|---------|
| Time                              | Sitting |    | Walking |    | Standing |    | Playing | Time                  | Sitting |    | Walking |   | Standing |   | Playing |
| 10:00 pm                          | M       | F  | M       | F  | M        | F  |         | 10:00 pm              | M       | F  | M       | F | M        | F |         |
| 11:00 pm                          |         |    |         |    |          |    |         | 11:00 pm              |         |    |         |   |          |   |         |
| Older (over 50)                   | 15      | 23 | 18      | 17 | 9        | 4  | -       | Older (over 50)       | 10      | 11 | 7       | 5 | 3        | 3 | -       |
| Youth (18-50)                     | 19      | 24 | 30      | 19 | 31       | 10 | -       | Youth (18-50)         | 11      | 10 | 7       | 3 | 6        | 5 | -       |
| Child (under 18)                  | 20      | 8  | 15      | 21 | 10       | 4  | 11      | Child (under 18)      | 2       | 3  | 5       | 3 | 3        | - | 2       |

| At Friday as weekend (2015/2022) |         |    |         |    |          |   |         | At Sunday (29/5/2022) |         |    |         |    |          |   |         |
|----------------------------------|---------|----|---------|----|----------|---|---------|-----------------------|---------|----|---------|----|----------|---|---------|
| Time                             | Sitting |    | Walking |    | Standing |   | Playing | Time                  | Sitting |    | Walking |    | Standing |   | Playing |
| 10:00 pm                         | M       | F  | M       | F  | M        | F |         | 10:00 pm              | M       | F  | M       | F  | M        | F |         |
| 11:00 pm                         |         |    |         |    |          |   |         | 11:00 pm              |         |    |         |    |          |   |         |
| Older (over 50)                  | 19      | 26 | 23      | 21 | 11       | 2 | -       | Older (over 50)       | 12      | 14 | 9       | 7  | 4        | - | -       |
| Youth (18-50)                    | 22      | 27 | 31      | 22 | 32       | 8 | 4       | Youth (18-50)         | 14      | 15 | 21      | 23 | 25       | 9 | -       |
| Child (under 18)                 | 18      | 11 | 16      | 23 | 13       | 9 | 23      | Child (under 18)      | 12      | 7  | 8       | 12 | 5        | 1 | 21      |

M: Male; F: Female.

#### 4.2 Space Syntax Studies Findings

As shown in Fig. 5 and Table 2, El Sallam Garden consists of four small gardens divided by the shape of marine anchor as pedestrian path. The four small garden zones: zone A, zone B, zone C and zone D, have differences in area and number of trees. Zone B is the largest garden of about 1,587 m<sup>2</sup> with the largest number of trees of 26 trees, while zone C is the smallest garden of about 1,429 m<sup>2</sup> with the least number of trees of 3 trees. Zone A and zone D have area of 1,465 m<sup>2</sup> and 1,448 m<sup>2</sup> respectively and number of trees of 16 and 8 trees.

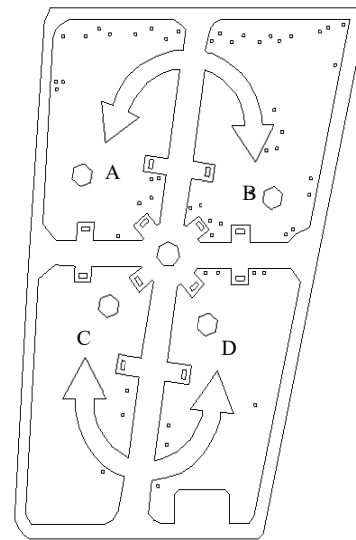
The hypothesis of this study is to examine the effect of area and number of trees on the visibility and movement of pedestrians through two hypothesis:

Hypothesis 1: As number of trees increased, the visibility and movement quality decreased and vice versa.

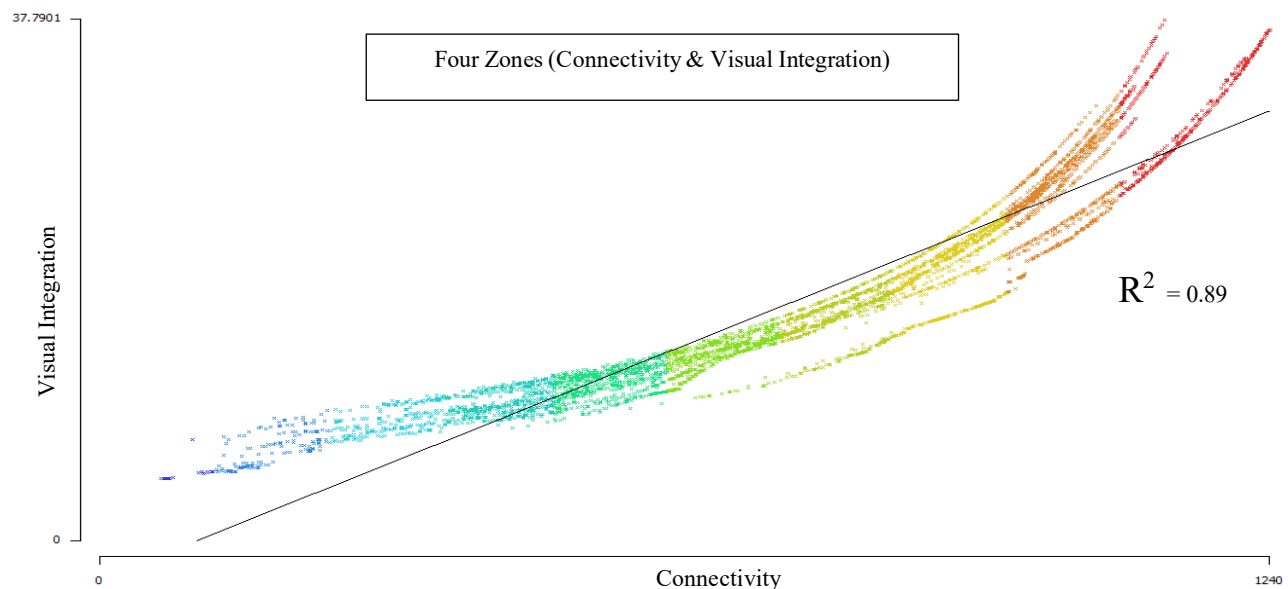
Hypothesis 2: As area increased, the visibility and movement quality decreased and vice versa.

**Table 2** Number of trees and area of each zone.

| Zones  | No. of trees | Area                 |
|--------|--------------|----------------------|
| Zone A | 16           | 1,465 m <sup>2</sup> |
| Zone B | 26           | 1,587 m <sup>2</sup> |
| Zone C | 3            | 1,429 m <sup>2</sup> |
| Zone D | 8            | 1,448 m <sup>2</sup> |
| Sum    | 53           | 5,929 m <sup>2</sup> |



**Fig. 5** Four zones in El Sallam garden.



**Fig. 6** Scatter plot of connectivity and visual integration values for the four zones.

As shown in Fig. 6, the four studied zones show high correlation between connectivity and visual integration which are two main measurements for finding the level of visibility in each zone.

The four zones are simulated through depthmap X as space syntax tool. The contour simulation results of the five measurements for the four zones are shown in Fig. 7; their scatter plots are shown in Fig. 8.

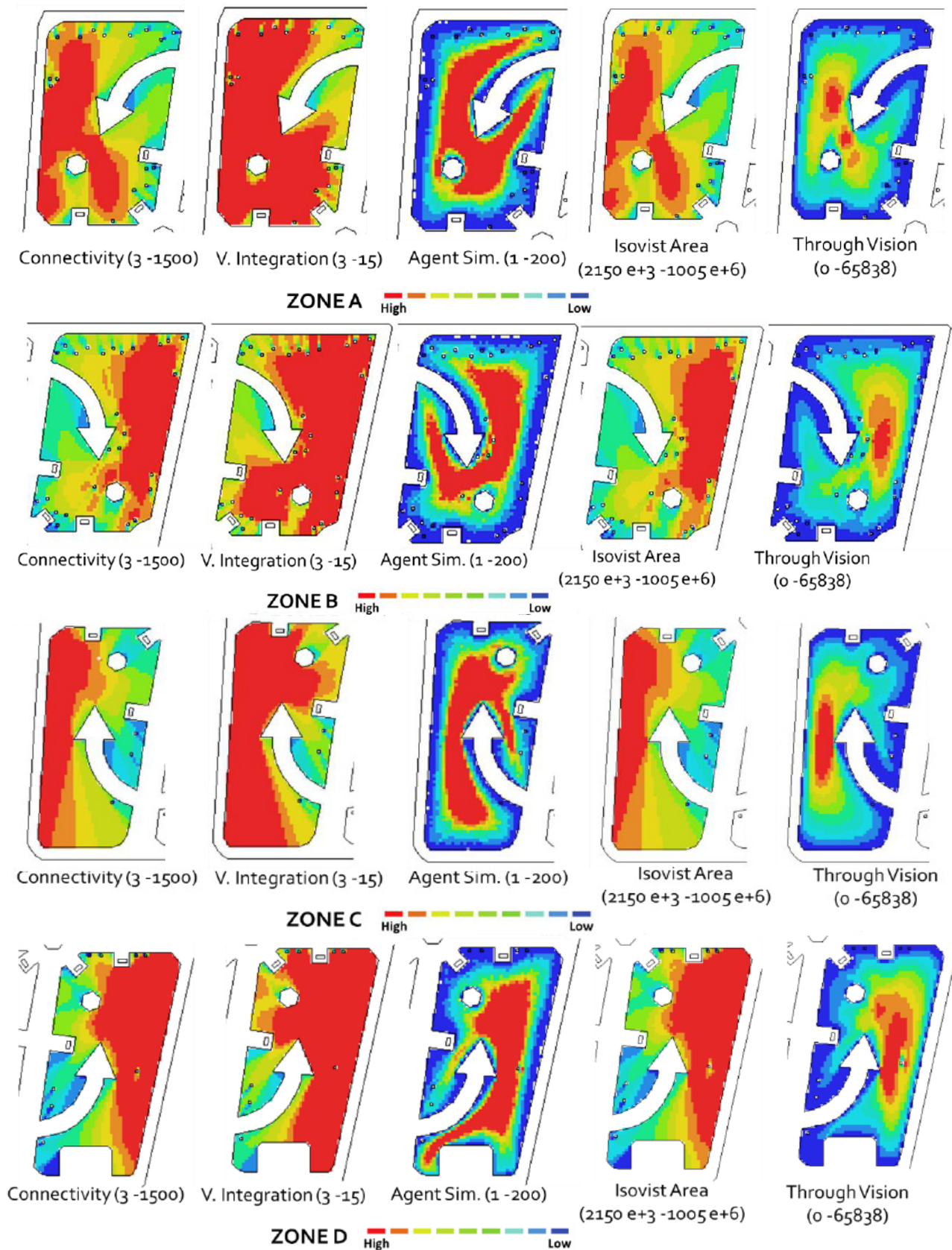


Fig. 7 Space syntax simulation of four zones in El Sallam garden.

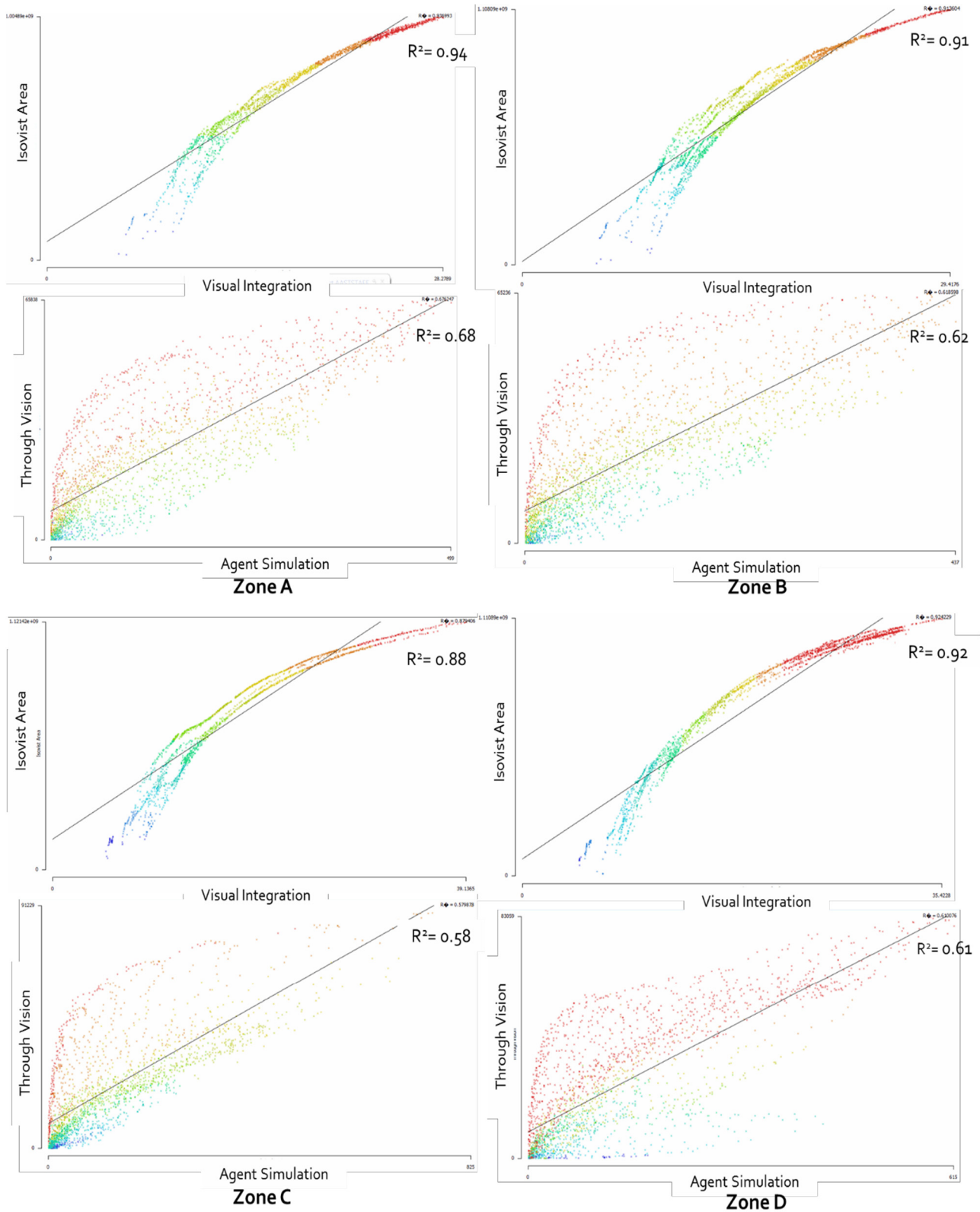


Fig. 8 Scatter plots between different measurements in the four zones.

**Table 3 Space syntax visibility and movement values for the four zones in El Sallam Garden.**

|        | Visibility values |       |       |                    |      |      |              |            |            | Visibility through movement values |        |        | Movement values  |      |     |
|--------|-------------------|-------|-------|--------------------|------|------|--------------|------------|------------|------------------------------------|--------|--------|------------------|------|-----|
|        | Connectivity      |       |       | Visual integration |      |      | Isovist Area |            |            | Through vision                     |        |        | Agent simulation |      |     |
|        | Min               | Mean  | Max   | Min                | Mean | Max  | Min          | Mean       | Max        | Min                                | Mean   | Max    | Min              | Mean | Max |
| Zone A | 34                | 1,123 | 1,568 | 5                  | 18   | 28   | 2.15<br>e+7  | 7.2<br>e+8 | 1<br>e+9   | 0                                  | 21,815 | 65,838 | 1                | 121  | 499 |
| Zone B | 9                 | 1,110 | 1,733 | 5                  | 16   | 29   | 5.6<br>e+6   | 7.1<br>e+8 | 1.1<br>e+9 | 0                                  | 21,306 | 65,236 | 1                | 102  | 437 |
| Zone C | 85                | 1,096 | 1,767 | 5                  | 17.7 | 39   | 5.1<br>e+7   | 6.9<br>e+8 | 1.1<br>e+9 | 0                                  | 22,537 | 91,229 | 1                | 124  | 825 |
| Zone D | 13                | 1,164 | 1,719 | 4.8                | 19.9 | 35.4 | 7.1<br>e+6   | 7.5<br>e+8 | 1.1<br>e+9 | 0                                  | 24,785 | 83,059 | 1                | 130. | 615 |

The scatter plots show moderate correlation between agent simulation and through vision it ranges from 0.58 to 0.68 and high correlation between visual integration and isovist area ranges from 0.88 to 0.94. To sum up, Fig. 7 also shows high presence of simulated steps of agents in the middle area in each zone while visibility values for connectivity, visual integration and isovist area show increase in values at the edges far from the central path.

Table 3 summarized the visibility and movement values showing the minimum, mean and maximum for every measurement for the four zones.

Hypothesis 1: As number of trees increased, the visibility and movement quality decreased and vice versa.

Number of trees partially affected the visibility and movement quality. Zone B of 26 trees shows the less mean values of visual integration, through vision and agent simulation while Zone C of 3 trees shows less mean of connectivity and isovist area. This means that number of trees affected movement values more than visibility values.

Hypothesis 2: As area increased, the visibility and movement quality decreased and vice versa.

As area increased, it affected the visibility and movement quality. As Zone B is the largest area, it shows the less mean values of visual integration, through vision and agent simulation while Zone C which is the smallest area has less mean of connectivity and isovist area. This means that area of the zone affected movement values more than visibility values.

Zone D shows the best visibility and movement values, however it does not have the least number of trees and not the smallest area. This means that distribution of elements and the shape of the garden are more important factors affecting visibility and movement in gardens.

## 5. Recommendations for Future Work

This study is initial part of research to study the gardens in port said which recommended:

- A design guide for decision makers to create new regulations and laws for the design of gardens.
- More observational-based longitudinal observations to deeply understand social behavior in gardens.
- Help urban designers and architects to design and retrofit new gardens.

Applying machine learning methods on finding data of these studies to generate more socially effective garden designs.

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