

Analyzing the Relationship between High-Rise Buildings and Citizens' Environmental Perception Using Space Syntax Method; Case Study: District 22 of Tehran

Hamed Behzadipour^a - Zohreh Davoodpour^{b*} - Hossein Zabihi^c

^a Ph.D. Candidate of Urban Planning, Faculty of Art and Architecture, South Tehran Branch, Islamic Azad University, Tehran, Iran.

^b Associate Professor of Urban Planning, Faculty of Art and Architecture, Qazvin Branch, Islamic Azad University, Qazvin, Iran (Corresponding Author).

^c Associate Professor of Urban Planning, Faculty of Art and Architecture, Science and Research Branch, Islamic Azad University, Tehran, Iran.

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ABSTRACT

Currently, some views about the influence of buildings and the built environment on people have become common in architecture and urbanism. In the meantime, high-rise buildings significantly influence the citizens' mental image of their urban environment because they act as a sign due to their physical form. The current study tries to analyze the spatial configuration of District 22 of Tehran and examine the location of high-rise buildings to determine how changes in the physical forms of the buildings in the main urban arteries affect citizens' mentality and environmental perception. The present study is applied research, regarding its purpose, a combination of quantitative and qualitative methods is used. To analyze the spatial configuration of and topological relationships between paths, the Space Syntax technique is used, and using the Depthmap software, three categories of maps of integration, connectivity, and intelligibility indices are prepared. After drawing the maps of the space syntax factors related to high-rise buildings, the type of integration is determined, and the final maps of factors are extracted, and spatially analyzed and interpreted. Findings designate that those high-rise buildings in spaces and paths have a higher intelligibility that those high-rise buildings in spaces and paths have higher intelligibility: 1) Along which there are signs of appropriate scale. 2) Around which there is a more continuous network of paths. 3) That there are appropriate changes in the length and width of the spaces, and 4) There are mid-rise buildings around the paths. Likewise, high-rise buildings are not individual elements but the relationships between spaces and their relative arrangement affect citizens' mentality and environmental perception.

Keywords: High-Rise Buildings, Perception, Space Syntax, District 22 of Tehran.

* E_mail: zdavoudpour@yahoo.com

1. INTRODUCTION AND STATEMENT OF THE PROBLEM

By analyzing the spatial configuration of District 22 of Tehran as a case study and examining the locations of high-rise buildings in it, this study aims to determine how changes in the physical form of high-rise buildings in the main arteries of the city affect the mentality and environmental perception of citizens. Consequently, to make the study system purposeful, this study tries to answer the research question of whether there is a significant relationship between high-rise buildings in the main urban arteries and their formal and visual features and the environmental perception of citizens? In this regard, to attain the research objectives, it is required to apply a comprehensive method that can precisely inspect the relationship between the physical texture of the city and the behavior of citizens. So, in the present study, the Space Syntax theory is applied. It is one of the useful tools applied in this field to understand the spatial complexity and its transformation due to urban interventions. Nowadays, this method is used to analyze urban textures and huge buildings and structures and is highly developing (Hillier & Vaughan, 2007). This method is not a tool merely for simple modeling but it is a method for understanding urban complexities, morphological logic, and behavior patterns (Hillier et al., 1993). If we adopt this method, our perception of cities will change, and this theory tells us that we must design and plan cities using a new method (Hillier & Stonor, 2010).

Reviewing the research background and the related literature in Iran and the world and various perspectives shows that researchers pay attention to the issue of citizens' perception of high-rise buildings. For instance, Faizi and Asadpour (2013), in their article entitled "Residence Perception of Urban High Rise Buildings' Scape, Case Study: Shiraz Chamran Hotel", have disclosed that regarding Chamran Hotel, the height factor has played an important role in the attention and pleasant feeling of residents and this was more related to the sensory dimension of perception and after a while, its effect disappears. In their article, Madani et al. (2017) have stated that density affects how the environment is perceived. Pashmforoosh et al. (2016), in an article entitled "Study of the effects of high-rise buildings on the city landscape with an emphasis on legibility", have indicated that the construction of these buildings is currently expanding in most major cities and they are a one of the main factors affecting urban landscape. Among international studies, Wener et al. (2015), in an article entitled "environmental psychology and sustainability in high-rise structures," have psychologically studied the behavior of people living in high-rise buildings and stated that these buildings have psychologically destructive effects on users and improving the health of users is possible by providing more natural environments and improving

the quality of indoor spaces. In this regard, Bachelard (2017), in his book, states that high-rise buildings, except for the merits and values of verticality, are not in a natural environment and their relationship with space is an artificial relationship. Buildings that value themselves geometrically are indifferent to the simple issue of matching their true essence. Vicuna (2012), in an article entitled "The Forms of Residential Density in the Contemporary City: The Case of Santiago, Chile," has stated that the category of high-rise building construction has a quantitative-qualitative nature, and variables such as intensity, diversity, and variety are the determining factors in this regard. Kim and Sohn (2002) have shown a correlation between the density of buildings and the configuration of urban streets. Jenks et al. (2005), in a study entitled "The Language and Meaning of Density, Future Forms and Design for Sustainable Cities," have stated that one of the dimensions of density that can be measured is related to the level of people's perception as well as their mental perceptions and it is interpreted as perceived density.

Consequently, in conclusion, it can be assumed that since high-rise buildings have various physical, functional, and semantic dimensions, most research in the fields of architecture and urbanism has focused on the physical and functional dimensions of high-rise buildings. So, there is the gap of paying attention to the semantic level of a set of high-rise buildings in the urban space and its relationship with the citizens' mentality and environmental perception. While understanding people's thinking and attitudes about their environment is important and can be useful in better designing places.

2. RESEARCH LITERATURE

2.1. Definition and Concept of High-Rise Building

The construction of high-rise buildings has always been of interest to humans from the beginning of human civilizations to the present day, and most of the tallest buildings in the world were initially used to make better use of urban land in major cities of developed countries. After a few decades, the big cities of developing countries also used high-rise buildings to imitate them and, if necessary (Azimi, 2017, p. 14). In the definition of high-rise buildings, it should be stated that it is a relative matter, and it is not possible to formally provide a single and precise definition on which there is a consensus between all national and international official authorities (Golabchi, 2013). This category has a quantitative-qualitative nature, and variables such as intensity, diversity, and variety are the determining factors in this regard (Vicuna, 2012). In the following, Table 1 present the definition of high-rise buildings from different perspectives presented in the texts studied in this research.

Table 1. Definition of High-Rise Building from Different Perspectives

Different Perspectives	Definition of Tall Buildings
Geometry	If the ratio of height to diameter of the tower is 1.5π , it is called a very tall building If the ratio of height to diameter of the tower is π , it is called a tall building If the ratio of height to diameter of the tower is half π , it is called a medium building If the ratio of height to diameter of the tower is one-third π , it is called a short building
Structural Engineering	Its height causes the lateral forces induced by earthquakes and wind to impact its design significantly.
Fire Protection	Buildings with a height of more than 23 meters
Urban Landscape	Buildings that have a major impact on the skyline due to their heights
Urban Planning and Design	Buildings with more than 12 stories
The Supreme Council of Urban Planning and Architecture of Iran, 1998	Buildings with more than six stories
The Main Document of Tehran's Master Plan, 2007	Height of more than 12 stories, which can be considered an urban landmark. Having a noticeable effect on the skyline, vision corridors, or the meaning of the environment due to the its prominent height.
The View of the Supreme Council of Urban Planning and Architecture of Iran, Approved General Criteria for High-Rise Construction, 2019	buildings with a height of 27 meters and more or a building with a height of eight stories and more or the height of the highest usable floor is more than 23 meters from the ground level
Council on Tall Buildings and Urban Habitat (CTBUH)	Buildings with 14 stories and more or a height of above 50 meters are high-rise. Buildings with a height of 300 m or 600 m and taller are among the tallest buildings and super-high buildings, respectively.
The Emporis Standards	Buildings with 12 floors or a height of above 35 meters and buildings with a height of above 100 m high are classified as high-rise buildings and skyscrapers, respectively.

2.2. Effective Criteria in the Analysis of High-Rise Buildings

Generally, the three components of the urban environment and space include form, function, and meaning (Pakzad & Bozorg, 2015, p. 96). Sin the form of high-rise buildings is outstanding, they play an important role in creating a connection between the observer and the building. Though there are diverse types of forms that can be desirable or even annoying, in high-rise buildings, the type of form is of great importance because their high height is an inherent part of them (Golabchi, 2013, p. 241). Likewise, their forms are directly related to the climatic conditions, cultural, social, economic, and psychological characteristics of nations and reflect the climatic, cultural, economic, and social contexts of any society (Sonne, 2017). The form can change in height; this inconsistency in the form must be inspired by the interior plan of the building and the features of the exterior that are com-

patible with the characteristics of the environment (Wood, 2011).

Despite all the similarities, different people have different assessments of the same subject. Individuals differ in their level of awareness, culture, and life experiences, all of which are intertwined with the physical characteristics of the built environment and individuals' evaluations (Steg, 2017, p. 45). The citizens' amount of previous information and personal experiences will greatly influence their semiotic perception. Iconic signs are easier to understand than symbolic signs because of the more objective connection of the sign with the signified. In addition to the semiotic aspect, the meanings of the buildings for citizens can also be emotional and affective (Faizi & Asadpour, 2013, p. 112).

2.3. Definition and Concept of Space Syntax

The space syntax is a way to understand the spatial

configuration better so that the logic of social factors creating them can also be discerned (Hillier & Vaughan, 2007). In other words, the space syntax includes a set of computer techniques applied for modeling buildings and cities so that the resulting model consists of a system including interconnected geometric elements, and this system is analyzed to understand how the constituent elements are connected (Hillier, 2007). This method helps to know the consequences of changes in the physical form of cities, particularly the road network, on the mentality and consequently on the behavior of citizens (Abbaszadegan et al., 2012).

In this theory, the city is first divided into a system of the longest movement-visual channels through which the audiences move and understand the structure of the city. Then, each of these channels is displayed with a line for more advanced analyses, and in the next step, based on mathematical and graph analyses, the intersections of these lines are reexamined (Rismanchian & Bell, 2011, p. 74).

2.4. The Main Theories of the Space Syntax Method

The method of space syntax is based on two ideas. First, we should not look at space only as the background of human activities but as an immediate aspect of all that human beings do. The second idea is that human space is not just a matter of the properties of individual spaces but of the interrelationships between many spaces making up the spatial structure of a building or city (Hillier & Vaughan, 2007). Consequently, it can be said that the space syntax method is based on the following two basic theories:

A. Spatial configuration theory: Hillier believes that spatial and social forms follow a close relationship that spatial configuration alone can define many social patterns such as land use distribution pattern, movement, urban crime, location of immigrants, so on. Consequently, in analyzing the space and the audience's behavior in it, the important point is to consider

the relationship between spaces in a larger system, which is, here, referred to configuration (Hillier, 2007). Spatial configuration in architectural and urbanism studies, in addition to the characteristics of spaces individually, studies the relationships between them.

B. Theory of natural movement: In his theory of natural movement, Hillier discusses the effect of spatial configuration on the movement of pedestrians in the city. He states that spatial configuration alone is the most important factor in guiding pedestrian movement in the city, and in this regard, local and micro-scale factors such as attractions and land uses are less important (Toker et al., 2005).

3. RESEARCH METHOD

The choice of any particular research design is a function of the researcher's assumptions about the nature of the facts and how they are understood (Groat and Wang, 2015, p. 21). The current study is applied research that has used quantitative and qualitative methods according to its purpose. Consequently, the theoretical framework has been developed using a descriptive method, and the case analysis method has been used to analyze the case study to extract the findings. In this regard, the theory of space syntax has been used to analyze the structure and understand the spatial complexity of District 22 of the Tehran metropolis and study the location of high-rise buildings. First, using the available documents, including images and maps, the axialmap has been drawn in AutoCAD software. Next, the Depthmap software, which is based on the theory of space syntax, has been used to draw the maps of integration, connectivity, and intelligibility indices. After drawing the maps of space syntax factors related to high-rise buildings, its integration type was determined, and the final maps of factors were extracted, and spatially analyzed and interpreted.

3.1. Case Study

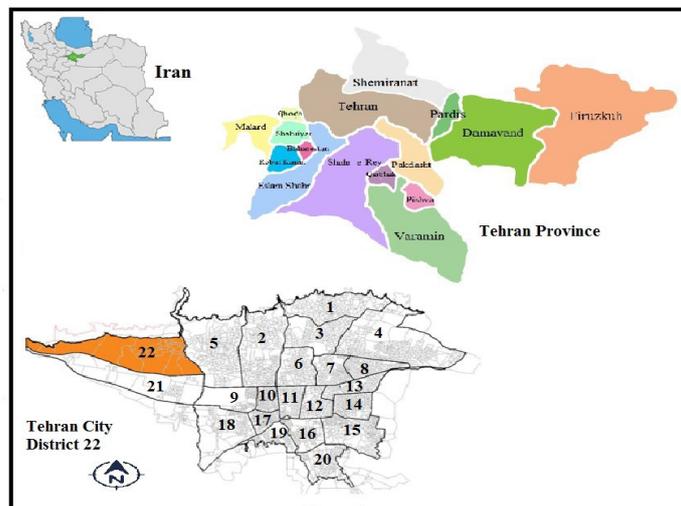


Fig. 1. Geographical Location of the Case Study

In this study, the district 22 of Tehran metropolis has been selected as the case study due to the growing trend of high-rise construction, general tendency to mass construction, large-scale construction, and the existence of different and diverse forms of distribution and arrangement of high-rise buildings. As shown in Figure 1, this area is located in the west of Tehran, which is bounded on the north by the foothills of Alborz, on the south by the Tehran-Karaj freeway, on the east by Kan watercourse, and on the west by Alborz province. The population of District 22 was equal to 176,000 people in 2016, its area was 5800 hectares, and its population density was 30 people per hectare (Salari, 2017, p. 10). Since the main volume of construction in the region is carried out in the form of residential and commercial complexes by various cooperatives and institutions, the prominent construction rules followed in the region are complex construction rules. Generally, the most common type of housing is mass construction (in two more common forms: residential complexes and high-rise towers) (Tehran's Center for Studies and Planning, 2017, p. 121).

The notable points are the physical growth of high-rise buildings along the main and important Highways of Hemmat and Resalat, and the major effect of the highways on the structure of the area is quite evident. Due to the better visibility of high-rise buildings from these arteries, in response to the research question, the formal and visual characteristics of high-rise buildings in the main arteries are significantly considered. Likewise,

the separation of mass-building zones from other residential zones in the region makes it possible to evaluate the intended effects of high-rise buildings in comparison to other zones through field studies. On the other hand, considering the experiences of high-rise building construction in this area, this zone can be considered a suitable example for other areas of Tehran.

4. DISCUSSION, ANALYSIS, AND RESEARCH FINDINGS

To analyze the research subject, i.e. the spatial configuration and topological relationships of paths and especially the main structure of space, it is necessary to examine the formal and visual characteristics of high-rise buildings and the topological structure of paths using the space syntax method. The analysis method generally consists of two parts: first, the axial map was drawn, and then the maps of the space syntax factors in the area study were analyzed. In this regard, first, an area with an approximate radius of three kilometers from the center of the district 22 of Tehran, i.e. the case study, was selected. This area, shown in Figure 2, includes buildings, roads, and in general, the total physical-spatial structure of the area. Then, to prepare the map of axes, using AutoCAD software, the axial lines of all the roads in the area were drawn in a way so that all the lines were connected in an integrated manner.

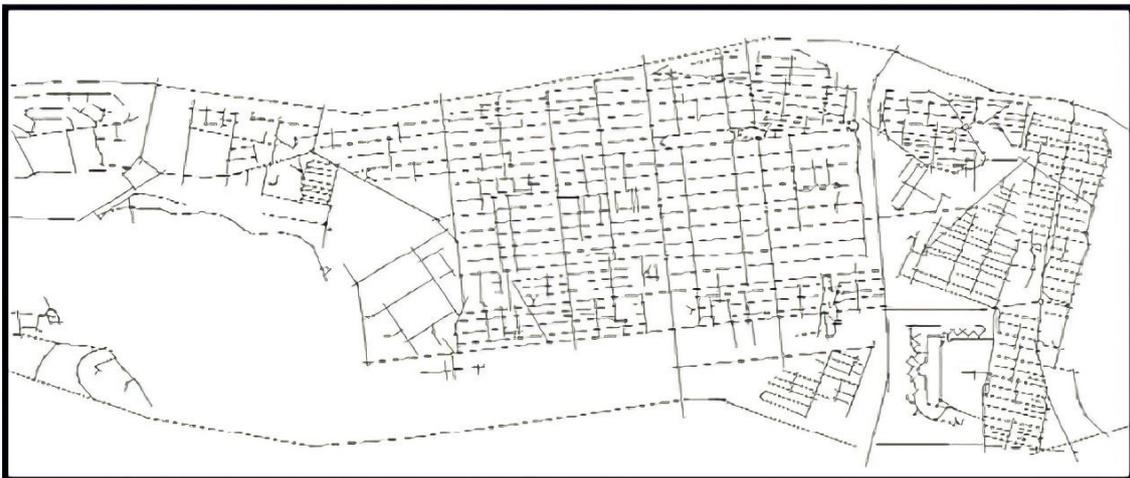


Fig. 2. Axial Map of District 22 of Tehran in D-X-F Format

Then, using the Depthmap 10 software, three analyses have been performed on this district. These analyses include the study of integration index on two scales (i.e. global integration and local integration), connectivity index, and intelligibility index, which are discussed in the following:

4.1. Study of Integration Index on Two Global

and Local Scales

Two global and local scales have been used to measure the degree of integration of the paths, which greatly affects the legibility of the area. The integration value of each line is the average number of lines or spaces from which all the spaces of the city can be

reached. The higher the integration value of a line, the higher its accessibility in the system. In the current analysis, lines in warm colors indicate higher degrees of integration, and thereby their higher accessibility in the system, and cold colors indicate lower degrees of integration and thereby lower accessibility. As shown in Figure 3, the most integrated paths, or in

other words, the most accessible paths for navigation, are Azadegan Freeway, Golha, Kaj, and Hashemzadeh Boulevards, Hava Niroom (eastern side of Chitgar Lake), and Jozani (North side of Chitgar Lake) streets. Generally, it can be said that the global integration of paths is low.

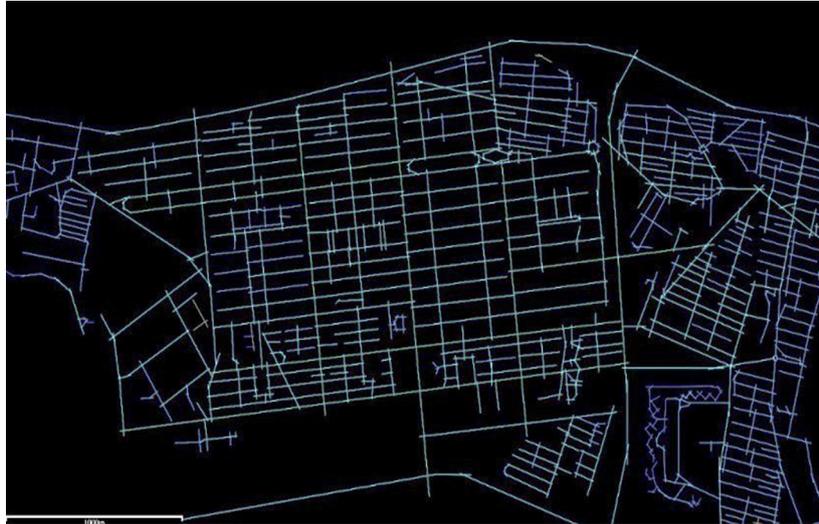


Fig. 3. Study of the Global Integration of Paths

The study of the global integration shows that the north-south paths of Kaj, Hashemzadeh, and Golha boulevards as well as the east-west paths of Hava Niroom, Amirkabir, Acacia, 8th and ninth Ghaem streets, and Olympic Village boulevard, have higher degrees of integration and accessibility than the whole area study. The buildings in these areas are mid-rise, and buildings with higher heights are seen as sign elements at specific points and intersections of important paths.

Comparison of local integration and global integration shows that Hava Niroom, Amirkabir, Kaj and

Golha Boulevards have high degrees of integration at both local and global scales and are considered the most accessible paths. Furthermore, the study of local integration indicates that, in general, the paths in the eastern and western parts of the area have a lower degree of integration than the central parts of the area, and these paths are more suitable for residential and local uses. The East Golestan area has the highest degrees of accessibility and integration, and therefore the paths in this part are more suitable for commercial and office uses (Fig. 4 & 5).



Fig. 4. Study of the Local Integration of Paths (R=3)



Fig. 5. Study of the Local Integration of Paths (R=3)

Table 1. Study of the Paths in the Case Study in Terms of Integration Index

Paths	Local Integration	Global Integration
Min.	0.21	0.21
Moderate	0.75	1.52
Max.	3.49	3.73

4.2. Study of Connectivity Index

Connectivity, or connection, means the number of direct links between each space and another (Young et al., 2015). Consequently, the higher the connectivity of each space to adjacent spaces, the more public that space can be, and the lower the connectivity, the more private that space can be. Regarding the surveys done in this study, it can be said that connectivity is a local

criterion because it only examines the relationship between neighboring spaces. Consequently, although the overall connectivity of the area studied is not high, the connectivity index is significantly high in some paths in the area (Fig. 6). Kaj Boulevard, Hashem-zadeh Boulevard, Hava Nirooz Street, and Amirkabir Boulevard have the highest connectivity, followed by Sarvestan, Ninth Ghaem, and Golha Boulevards.



Fig. 6. Study of the Connectivity of Paths

4.3. Study of Intelligibility Index

The strong synergy between global and local information makes it easy for people to visualize the overall spatial configuration in their minds. The concept of intelligibility of the city is directly related to environmental perception in mind. Also, examining and comparing the data of the two integration and connectivity

indices represent the extent to which the paths are perceived by the residents (i.e. intelligibility index). The higher the value of this index for a path, the residents better understand the general structure of that area and will not have trouble navigating that path, and in these paths, people can easily imagine the overall spatial configuration.

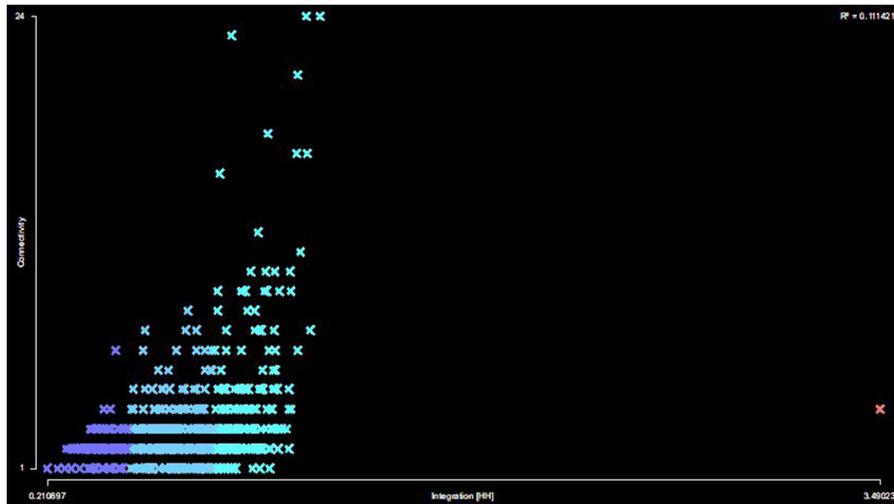


Fig. 7. Study of the Intelligibility of Paths

According to Figure 7, this index is derived from the correlation between the two integration and connectivity indices. R^2 is estimated to be 0.11. The closer this value is to 1, the higher the intelligibility of the area. The compaction of the points at the bottom of the graph indicates the multiplicity of paths with low intelligibility, and the scattering of paths at the top of the graph indicates the few paths with high intelligibility. Besides, since the graph shows no linear form,

the paths in the area have no high intelligibility. Then, according to Figure 8, it can be said that the paths with high intelligibility, where the residents can more easily imagine the spatial configuration, are North-South paths of Golha, Kaj, and Hashemzadeh Boulevards, East-west paths of Hava Nirooz, and 8th and 9th Qaem streets, the paths in the eastern part of the Olympic Village boulevard, and Cheshmeh Town Street.

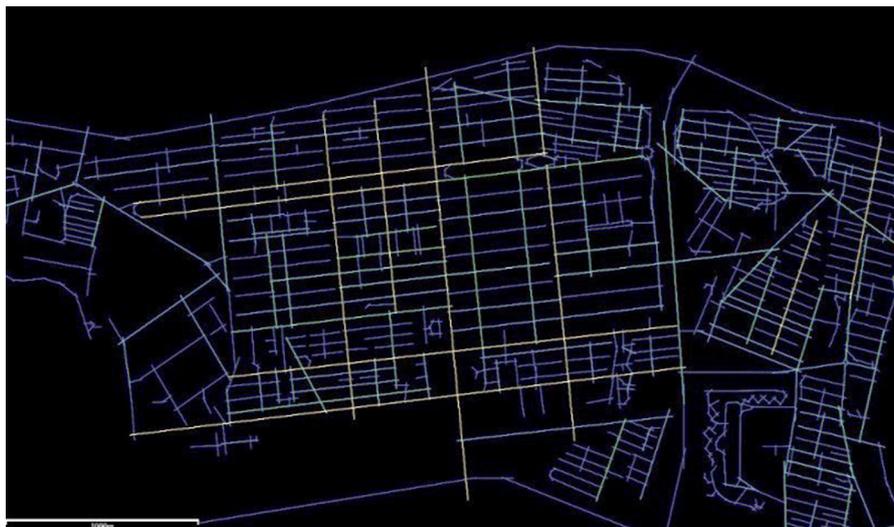


Fig. 8. Study of the Intelligibility of Paths - Paths with Higher Intelligibility

Likewise, the correlation between the two global and local integration indices has been calculated ($R^2=0.52$). It can be said that the graph is relatively well coherent and has a nearly linear form. Given this,

it can be said that the overall relationship between these two indices is relatively good (As stated earlier, most paths with high global integration are also integrated on the local scale).

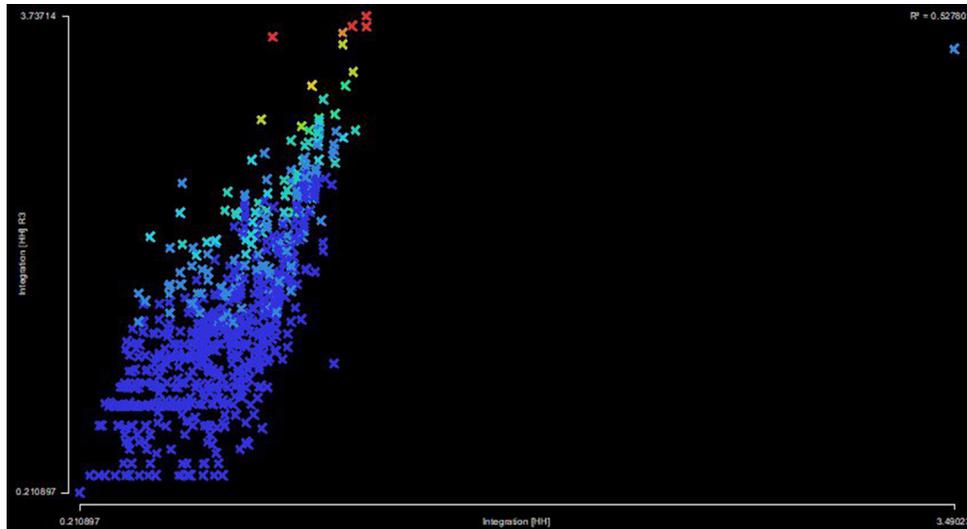


Fig. 9. Study of the Correlation between Global and Local Integration

Table 2. Study of Correlations between Indices

Scale	R2
Correlation between Local and Global Integration	0.52
Correlation between Connectivity and Global Integration (Intelligibility)	0.11

Figure 9 shows the paths that have the highest legibility in the area and are easier to navigate for residents. Accordingly, the paths in the study area can be classified into three categories:

- The main characteristics of paths Type I: Paths with a suitable position in terms of proximity to the main elements of the area structure such as highways, vegetation, and urban signs, mid-rise buildings, and also relatively high degrees of integration and visibility in terms of geometry and space syntax. In the area study, for example, one can refer to Kaj, Hashemzadeh, and Golha boulevards, as well as the east-west paths of Hava Nirooz Boulevard, Amirkabir, Acacia, the eighth and ninth Ghaem streets, and Olympic Village Boulevard.
- The main characteristics of paths Type II: Paths with outstanding signs on a local scale, med-rise buildings, and the highest degree of integration on a local scale. For example, one can refer to Hava Nirooz, Amirkabir, Kaj, and Golha Boulevards, and Cheshmeh Town Street.
- The main characteristics of paths Type III: Paths with a relatively low degree of integration compared to other paths. For example, one can refer to Allameh

Mohammad Qazvini Boulevard, Moj (north of Chitgar Lake), Golestan, Jihad, and Cheshmeh streets (in the eastern section of the district).

5. CONCLUSION

The space syntax method helps to understand the consequences of changes in the physical form of cities on the mentality and, thereby, the behavior of citizens. In response to the research question, i.e. whether there is a relationship between the formal characteristics of high-rise buildings in the main arteries of the city and the environmental perception of citizens, in the study area, it was found that those high-rise buildings in spaces and paths have higher intelligibility: 1) Along which there are signs of appropriate scale. 2) Around which there is a more continuous network of paths. 3) That there are appropriate changes in the length and width of the spaces, and 4) There are mid-rise buildings around the paths. This study also revealed that high-rise buildings are not individual elements but the relationships between spaces and their relative arrangement affect citizens' mentality and environmental perception.

Regarding the location of high-rise buildings and the most important identified signs, paths, and factors affecting the environmental perception of the area, the results obtained in the study area can be expressed as follows:

- In the central part of the area, most of the buildings are mid-rise, and this part has the highest degree of integration on a local scale. Some of the main paths in this area are also in better condition in global integration.
- Most high-rise buildings are located in the western part of the study area (northern area of Chitgar Lake), in which the integration index is lower than other parts in the area, on both local and global scales. The connectivity index is also low in this part.
- Increasing the height of buildings to the level of towers around the Chitgar Lake makes the overall legibility of the paths become low. The height and density observed in the central part of the area seem more desirable.
- The occasional use of high-rise buildings as a sign, such as the intersection of Kaj Boulevard with Hava Niroom and Amirkabir streets, where Tehran Mall buildings, Hana Towers, etc. are, has made this part of the path more legible and increased their intelligibility for residents.
- The eighth and ninth Qaem streets, which serve as local streets in the whole area, have a relatively high degree of integration on a local scale; these paths lead to Valiasr Mosque, Sanobar Park, and Otrish Square. The presence of vegetation and religious buildings, as urban signs, have been effective in enhancing the legibility of these paths.

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