Usage of Space Syntax techniques in architecture Case study: Farahzad neighborhood in Tehran

Sahar khodabakhshi[1]*, Amir samiei [2], Mina ganji[3]

[1]Sama technical and vocational training college,Islamic Azad University,Kermanshah Branch, Kermanshah,Iran. Email: sahar.khodabakhshi@hotmail.com

[2]Young Researchers Club, khomein Branch, Islamic Azad University. khomein, Iran

[3]Boroujerd Islamic Azad university, Boroujerd, Iran.

Abstract: *Space Syntax techniques, is a Series of theories and methods that refers to the space phenomenology. And we can name it as one of the most important contemporary methods of space morphology. In the modern era,various methods has been used to Analysis of architectural spaces. Visual method (formal), historical and continental are some of them. Space Syntax method that is used in this research, has a close meaning tocategorizing method phrase in literature. Using of this method become widespread sinceearly seventies in Bartlett school of England. With the effort of Steadman, Bill Hillier and Julian Hanson, whom first introduced this method, a new chapter of morphology in architecture has been opened. This method is technically growing that brighten the importance of using this method. The aim of this present study is an applied research, and the modality and method of this research is descriptive-analytical. Some parts of the theoretical information collected by library research and using of documents and reports. The main goal of the researches involved with this issue is the understanding of relations in space like creating zone boarders, gradating private and public spaces. This technique is one of the useful methods for understanding the space complexity and its transformation due to the design intervention. To achieve this goals briefing charts has been used. In this research, first, the method has been described. And then, usage of space syntax in architecture. At the end, with this method, regional context of Farahzad area in Tehran will be analyzed. with The result of this research,there are someobtained suggestions that at the end, the best suggested solutionwill be offered.*

***Keywords**: Space syntax, Convex space, Syntax space in architecture, Briefing chart, Space stracture.*

INTRODUCTION

Space syntax technique was presented in 1970s and its development was during 1980s and 1990s. This method was invented by Professor Bill with Julianne Hansen in University of London which was formalized since World War II at University of Cambridge and byworks of Leslie Martin and Lionel March as the founders of urban centerand usableland studies. Now it is used in the design process of many countries for analyzing the city fabric and large buildings. Architects and city-builders who used this technique in their works include Richard Rogers and Norman Foster. This technique should be considered in studies of morphological-space. In fact, space-morphological studies should be seen because of coming the social sciences on the planning and design sceneas a part of a wider process of creating interest in inter-disciplinary works which is the result of systematic attitude of the military forces during World War II. As a result of the modernization influence and systemic approach in the Uk, schools of architecture in the country divided into two groups of "modernism" and "Lulin" adopted an interdisciplinary approach for designing. Many years later, Lionel March moved from Oxford University to Bartlett, University of London and became the Head of the Department and thus, one in Bartlett and the other one at the University of Oxford, by works of Martin and March concentrated on the space, urban and user forms. Hillier in this study, while seeking the place time to communicate with social systems, studied

the two social and geometry dimensions of space. Focus of attentions was the space-morphology studies of Oxford with UCLA architecture and later in the same center, Bill Hillier transferred his fundamental researches concerning Bartlett and initiated the base productive elements. The approach of this phase should be seen as the beginning of space syntax theory, "social logic of space". Studies of Hillier are in the book of theoretical framework of space syntax, named "Space is machine". Hillier formulated and extended his next studies in this book.Geographical space, is an extensive space beyond the human understanding and cannot be viewed from one point of view. A way of understanding the geographical space, is the space syntax solution which is very important in predicting the spatialbehavior of human in urban settings. Space syntax is based on the fact that the urban environment is a connected and joined space in which each point is linked to another. Thus, space syntax is a method for describing and analyzing the relations between the urban spaces and the solution of displaying the buildings' morphology presents an image of the city through lookingat the public and open spaces. Spaces in the "space syntax" method are defined and understood as holes (streets, squares, etc.) among walls, fences and other obstacles that limit the walkers' traffic and/or the visual field.

This technique is rapidly developing in different countries. Since in our countrywe mainly use artistic techniques or traffic engineering methods for designing the urban development or improving the existing condition, it is necessary to use scientific methods that could clearly and scientifically explain the relationship between city fabricswith various events happening in the urban space. In this study, first the mentioned method is described and then using this method, the fabric of Farahzad region in Tehran is analyzed; and finally in addition to presenting the study results, some suggestions are achieved that finally the best recommended solution is also given.

Theoretical essentials

The method of space syntax analysis mainly benefits the four theories in the areas of philosophy, human geography, linguistics and mathematics:
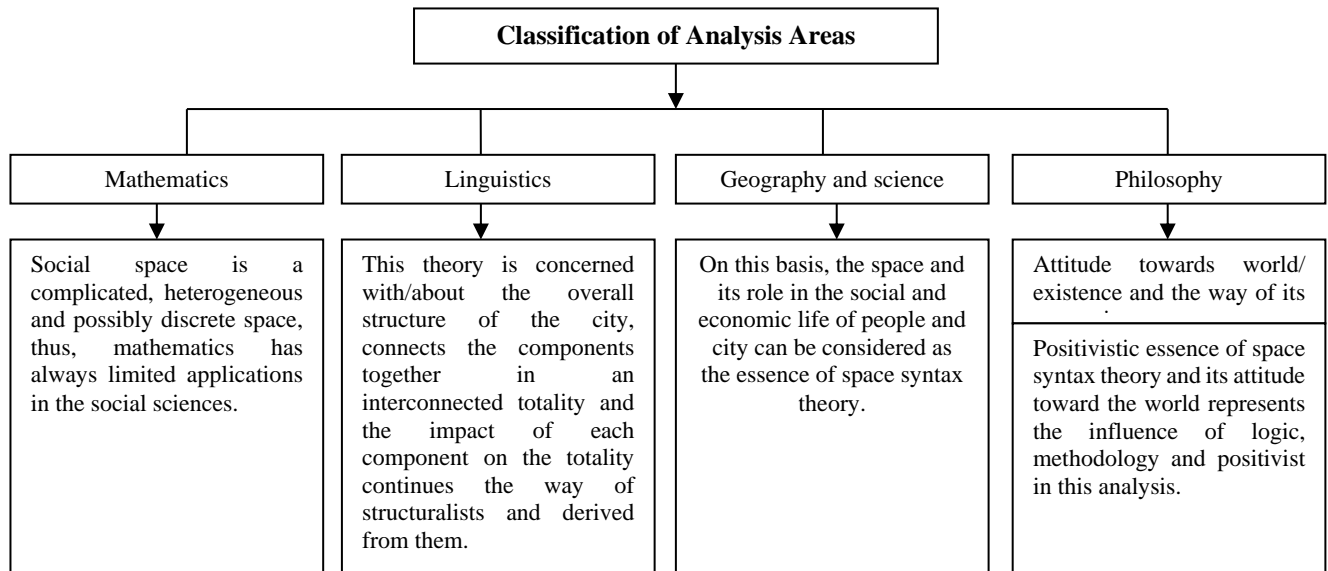
Figure1. Classification of areas of space syntax analysis (Sources: authors)

Defining the street as an urban space
Urban Street

Street as a communicating artery is considered as the most fundamental element in the Skeletonstructure of each living set. Street as one of the major components of urban fabric has the special image of the city which is affected by its linear Skeletonand transmission performance (Zekavat 1992:68). Street is one of social living spaces that is lost amidst the Skeletonattitude toward the city and this is while it is considered as the main element of city perception. Street is a public road paved in a built environment. It is a general part of the ground and connects the buildings in an urban area where people can freely gather on it, interact and move. Street can be simply a surface patched on the ground but often paved with a resistant and durable surface such as concrete,

rubble and brick. A part of itoriginally means the Street, can be leveled with asphalt, track layered or provided for pedestrians' transition. It is a word-building.

## Application and performance of street as a public space since past so far

Probably the concept of street was first used byVitruvius, Ancient Roman architecture. Describing the street scenes with three categories of tragic, intimate and legendarystreets on the scene, has left big effects on the mental image of European citizens even in the contemporary age. The differences between these three streets is reflected in their arrangement and organizing such that tragic streets distinct from other streets by elements such as column, paving, sculptures and all elements based on monarchical power (streets without human scale). Another kind of street named as the intimate street is organized from combination and placement of personal homes near each other. In these streets, balconies and connected rows of windows organize the appearance of street (streets with human scale).Finally, we can mention the legendary street. This type of street is ordered based on natural factors such as tree, mountain and the elements relevant to perspective layout. Later, by other authors and architects, such streets were considered as the origin and main source of street in the new concept. Tragic street as the origin of classic Renaissance street, intimate street as the origin of medieval Gothic streets and the legendary streets as the root of streets embedded in the nature outside the cities, labeled as new perceptions of ancient concepts (Moughtin,2004, 127- 128).

In today's image, street is a straight and cars' passage which its surface is asphalted (Tavasoli, 1378). Street is the result of decentralized formation of the houses and a structure for land distribution that allows the accessing to individual parts. Street has a deeper functional features than the square. Architecture behind the street, is seen just while passing and this street is rare in Iran. Concept of street against the desert was probably born during the Safavid era: it acts as an independent and separate space (Carrier, 2004). Streets such as Chahar Bagh in Isfahan at that time display the new concepts of public areas of the city which whether connects to the main square of city or it is parallel to it. The street has numerous trees on the sides due to the climatic conditions that is called "Chahar Bagh" or "Chenarestab" based on the type of placement in the external environment. In this period, mainly during the Qajar period, street for the first time not only has the concept as a resort but also as a business place (Habibi, 93: 2004). Trade also plays a role. Street, in its new concept, follows the two patterns:

The first pattern takes its form and spatial organization from "Maktab" street in Isfahan; axis with planted trees on both sides, water streams on both sides and single buildings that sit back toward the street and have gardens in their surroundings (such as "Darb Andarun" street, Ala al-Dowle) and the second pattern is the streets with build skeleton on the sides facing the street and form a continues Skeleton-spatial organization.These streets succeed to interfere the traditional network of market as the urban backbone of and then introduce themselves as the key element of urban network. These streets provide the residents with all kinds of urban services and facilities based on its main pattern- streets of Europe and especially France, the industrial age in the nineteenth century. "Marizkhane", "Cheragh gaz", "Naserie" streets, etc. Both patterns have either recreational function like "Maktab" street in Isfahan nor have merely roadway role like the streets of next periods. Street in this period and in the style of Tehran, display itself as an urban space with identity and live. In the contemporary ages especially Pahlavi regime, in line with global developments and reflection of modernity around the world (Habibi, 2004), uurbanization of our country is not deprived from the votes and for the first time, constructing cross streets is included in the government agenda and the old fabricof many cities are ruptured following this approach. Creating streets as a symbol of modernity, is the first reflection of Haussmann urbanization is such that has become international by the theories of European modernists in 1920s and it is heard in Iran and the idea of building broad and wide streets is realized (Habibi, 2004: 162-164).

At first, we investigate to identify the public areas with low Skeleton permeability in the depth of "Farahzadi" region and also permeability in three locations of this region including "Imamzade", "Hoseinie" and "Roodkhane".

Row	Building's name	Depth	Permeability

			Low intelligibilityand bad access
1	Imamzade	Deep	
2	Hoseinie	shallow	Low permeability
3	Roodkhane	Shallow (Low permeability)	Low permeability
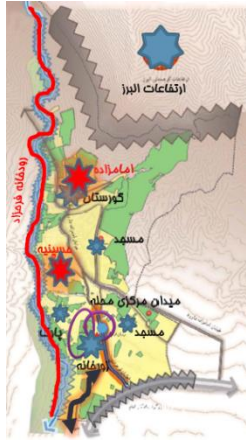
Aerial map of Farahzad area

General concepts in space syntax technique

The cases which considered as the basic and main concepts of this technique can be depicted as the following diagram:
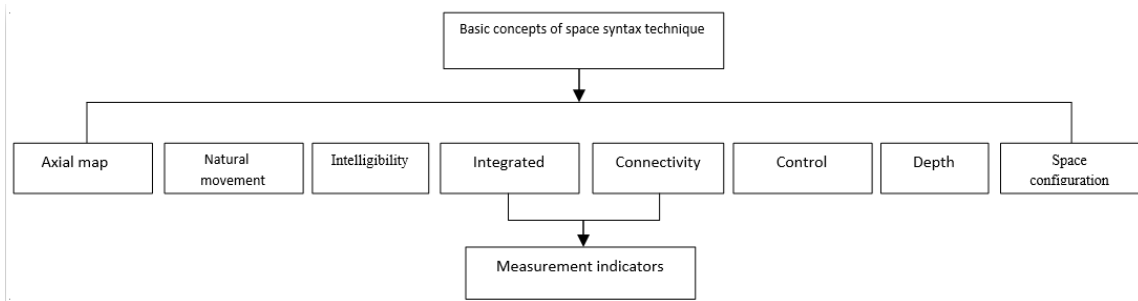
**Diagram2**: Classification of the basic concepts of space syntax technique (source: authors)

1. Space configuration

Space configuration means the arrangement way of spaces alongside each other and their interaction. As indicated in the diagram below, three different types of syntax configuration can be seen. Two cubes on the left side have no connectivity, the connectivity is symmetric and equivalent in the middle and the right side connectivity is asymmetric.
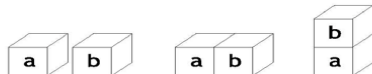
Diagram3. Explanatory graph of space syntax (source: Hillier,B1996)

Now, the connectivity with the third thing can also be investigated. In the Figure4 on the left, each of the cubes separately connected to the lower cube. All three cubes are connected in the middle and on the right side, the middle cubes should be passed in order to reach each of the end cubes. The explanatory depicted diagrams explain this better. Using these diagrams the concept of depth can be also defined.
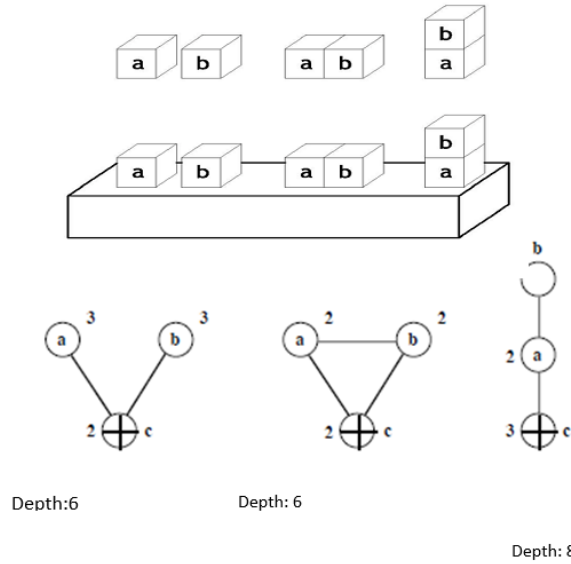

Figure4. Explanatory diagram of space syntax (Source: Hillier, B1996)

Approaching from each cube to another one, we must pass one or more objects. The number of objects to pass is that cube's depth to the origin cube. By changing the cube arrangement, whole space configurations will change. This phenomenon can be seen in the city as such by transforming the buildings and streets or creating new streets, the whole spatial relations of the city will change. And these changes will affect the citizen's perception of city and consequently its behavior in space (Iman Raisi, Abolfazl Habibi, 2008, *Quarterly*Journal of Abadi).

Depth

Depth is the number of spaces to be passed in order to approach from one space to another one. In other words, the depth is the number of passed ways to reach a specific urban axis or node. The depth indicator shows the separation of one space from urban spaces. In other words, greater depth of a space means that to achieve that space, more intermediate space should be passed so that space is more separated.
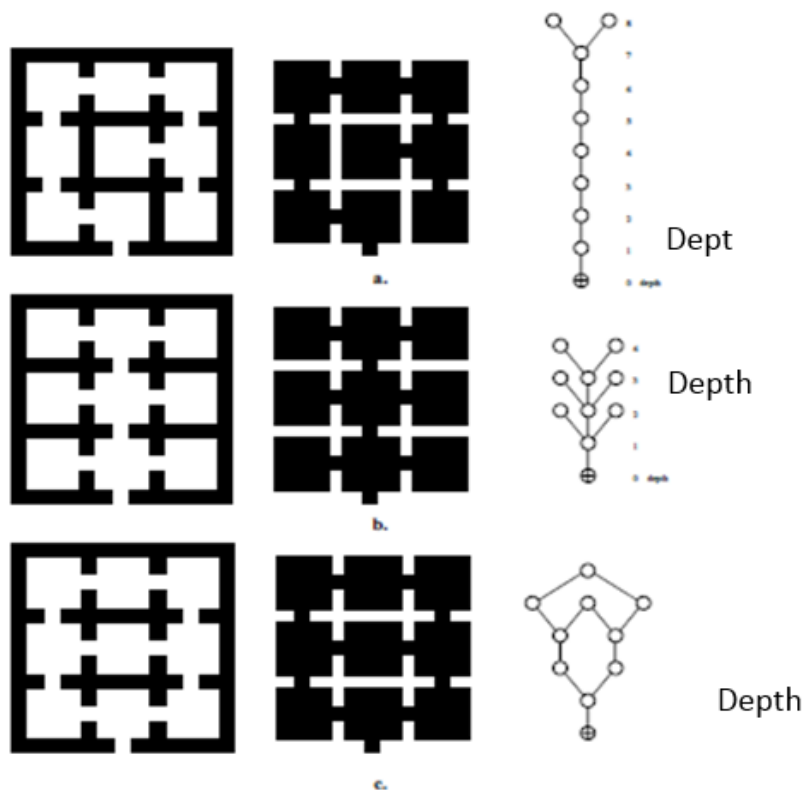
Figure5. Concept of Depth (source: Hillier, 2007,21)

Control

The possibility of selecting an axis or a node to its surroundings is called probability. The amount of control can define the amount of relative strength of the axial line in absorbing the potential from its neighbors and it is calculated in the following way where "k" is the number of node connections that are directly connected to a node and "ci" is directly related to the ith node connection (Yazdanfar, 2009: 66).
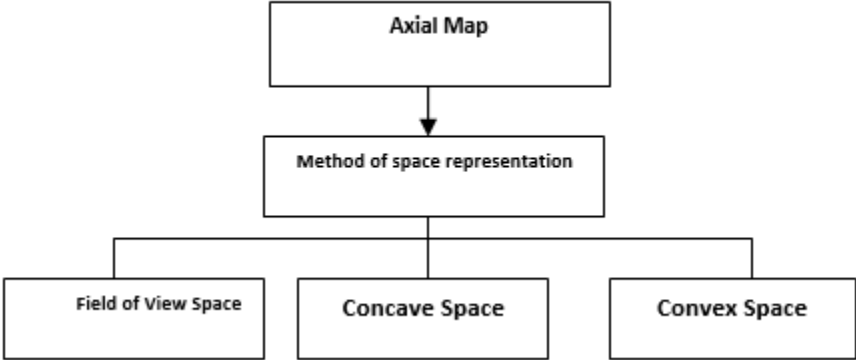
Axial map

Axial map is a graphical diagram which is obtained by decomposing the city spaces and open spaces. This diagram was prepared by special software and the basis of work is space syntax. In the axial map, we exhibit the highest sight and access lines that can be seen. This map will help us to divide the urban spaces into convex spaces where in all of them both sight and access principles can be tangible (Iman Raisi, Abolfazl Habibi, 2008, Quarterly Journal of Abadi).
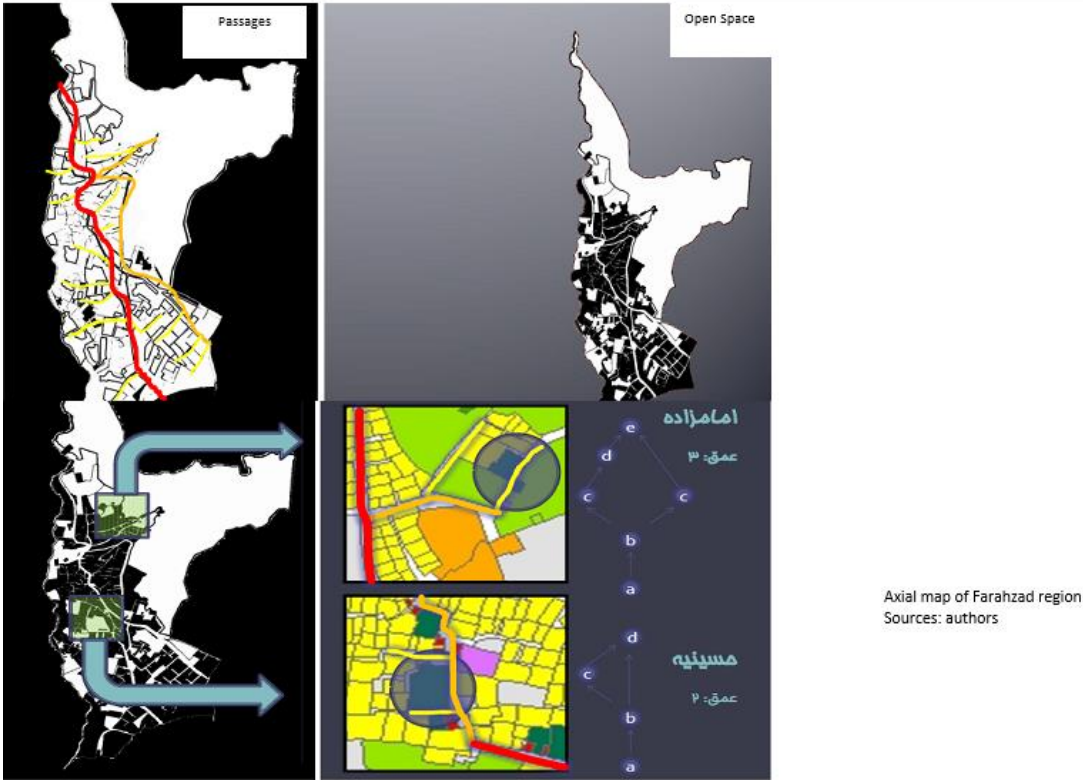
4.1. Method of space representation

The spatial structure of a design can be represented using three types of syntactic map:

A convex space is a space that the lines drawn between any two points does not go outside. In contrast, the concave space is a space that a line can be drawn between two points of it which is also reaches the outside of space. It should be noted that in this method the convex space is considered. The convex space is important because that by placing in any convex space, its integrity is observed and understood by pedestrians.

Figure6. Components of axial map (Sources: authors)

4. 1.1. Convex map
This map display the minimum convexspaces that cover the complete surface of a design and the relationship between those spaces.
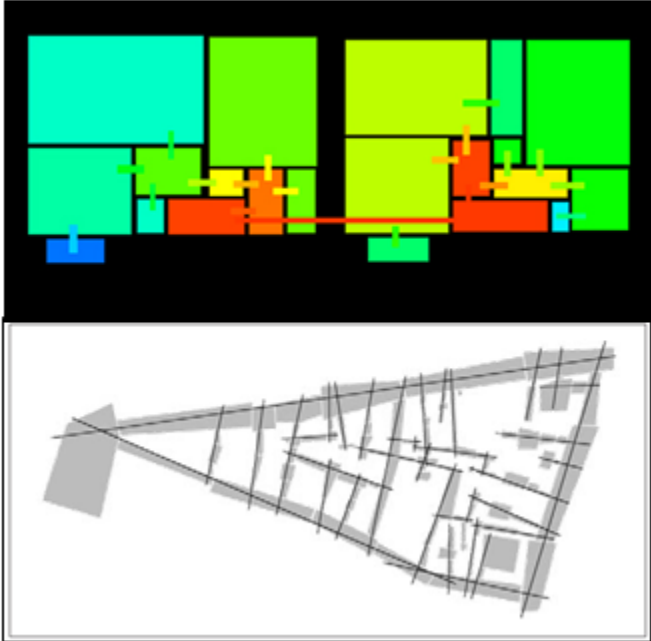

Figure 2: Map of two-dimensional structure and space from the area between Cornhill and Lombard street in 1677 (sources: 1996, Bill Hillier)
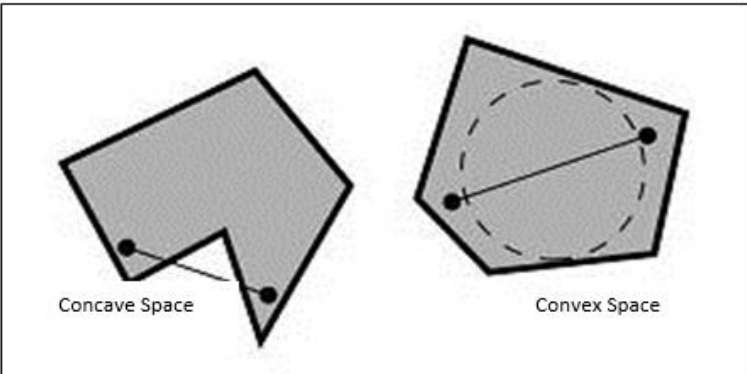

Figure3. Convex and concave map (source: 1996, Bill Hillier)

4 .1.2. Isovist Map: this map shows the areas that visible from convex or concave spaces.
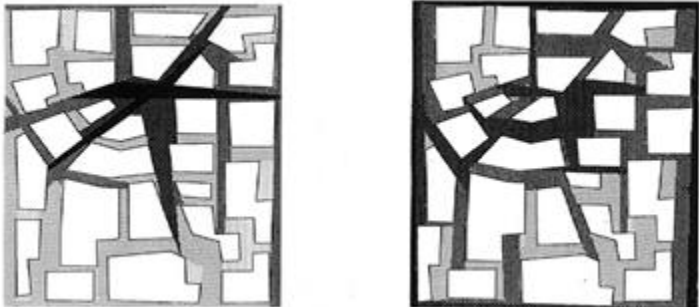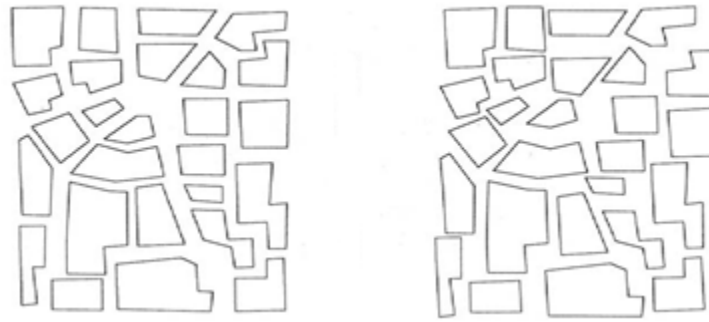

Figure4. Isovist map (Source: Bill Hillier, 2001)

Isovist space: Isovist is the whole arena that can be viewed from a certain point.

Figure5. Map of Isovist space (source: Bill Hillier, 2001)

Measurement indicators
Connectivity: This indicator measures the number of immediate neighbors that are directly related to a space.
Integration: This indicator shows the average depth of a space to the other spaces of system. Spaces of a system can be ranked from the most integrated to the most separated one.
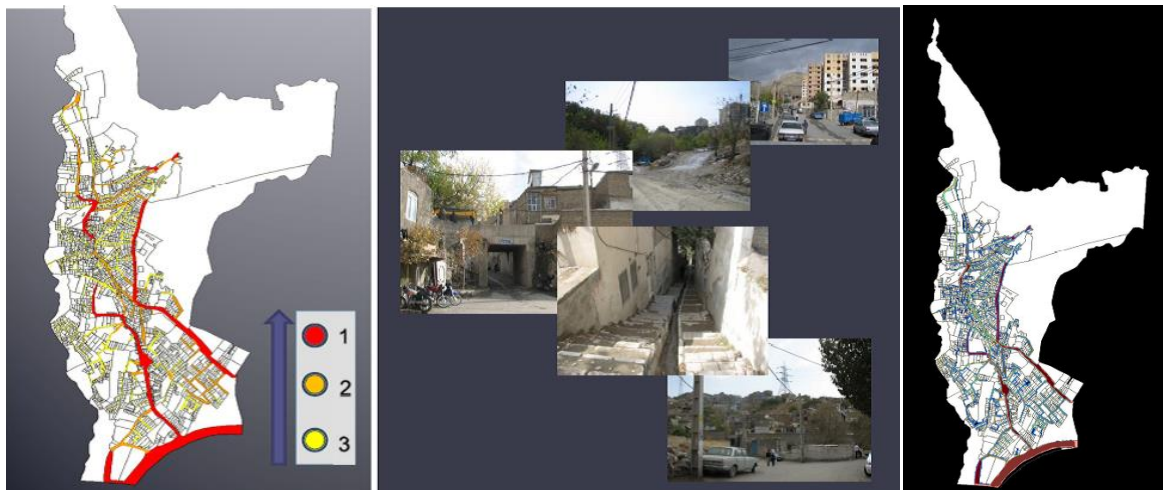

Integration value map of Farahzad region (source: authors)

Intelligibility
Perception of urban space for citizens is through moving in the city; the main factor that shape this perception is intelligibility of the city. Different parts of the city are formed in the minds of people and they visualize the whole city in their mind by putting them together. Understanding the whole urban system is formed through its spaces and also the amount of integration among them in the whole city system. Intelligibility indicator represents the amount of spatial information that can be obtained visually from an axial line (space). Experience has shown that the cities with a traditional fabricin Iran have very little intelligibility and cities with modern urban fabric have higher intelligibility. The lower intelligibility of traditional fabrics causes the strangers to understand the integrity of fabric less and thus it is less likely to penetrate the more private areas. On the other hand, when the city intelligibility increases, the hierarchical structure of the territories become weaker and the probability of penetration by strangers into the fabric increases. Such a phenomenon has been observed in modern cities and checkedfabric.
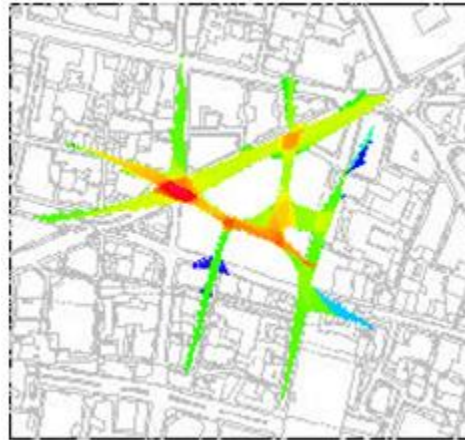
Figure6: Intelligibility map of space, red is the highest amount of intelligibility and the blue hsa the least amount (source: Bill Hillier, 2001).

Intelligibility map of Farahzad region (source: authors)
Overlapping of intelligibility map and integration value map of Farahzad area (source: authors)

Natural movement

The most important and effective factors of the movement in city are the origin and destination points. The study of movement production investigates these two important factors and addresses the way of distributing the movement size in the passages intermediating the origin to destination less. According to the space syntax theory, selecting an intermediate space to reach the destination has a direct relationship with the syntactic structure of urban spaces. The relationship between the structure of spatial syntax of city and density of traffic in its spaces is called natural movement (Iman raisi, Abolfazl Habibi, 2008, Quarterly journal of Abadi). This factor is widely used for analysis and designing buildings all around the world. Some of these places include Louvre museum in Paris, the Museum of Acropolis in Athens, Ufizzi Gallery in Florence and Britain Museum, the National photo gallery, and Natural History Gallery.
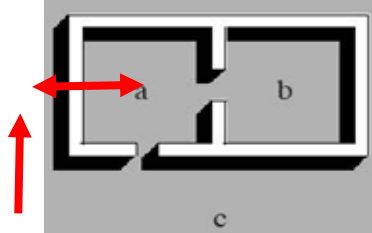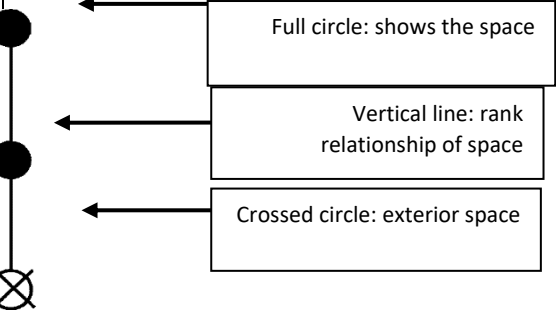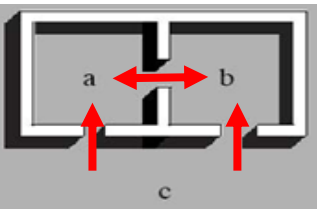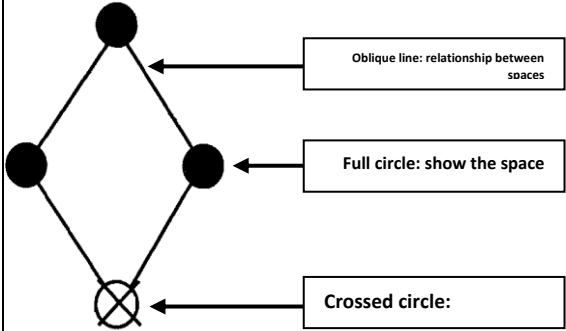
Explanatory Diagram

The connection between components of the diagram, or circles that each of them are diagram of a space, can be seen in different images. One kind of that is a linear pattern and one is a rotatory pattern. Linear pattern in a circle is connected to another circle with a vertical line. This means the placement of spaces as nested (Dr. Gholam-Hossein Memarian, 8: 2002). In other words, one space should be passed in order to reach another one. Rotatory pattern means the relation of at least three space. In other words, if two spaces can be accessed simultaneously, these two spaces are placed at a deeper level than the previous space. If the two room or space placed next to each other are connected by a door, it is shown with a horizontal line in the diagram. Linear and

rotatory patterns have also their own social meanings. Linear pattern tells us that to pass each space another space should be passed. Each deepening rank means the increase of privatization degree in deep spaces. All diagrams also introduced as two tree and distributed images. Each of these general diagrams that indicate the relation of all spaces in a building, have their special social meanings. One of the resulted obtained from the overall image of the diagrams is finding the degree of integration and differentiation of spaces in relation to the outdoor or the origin or, any space with another one. These diagrams can be plotted in the form of a computer program and the depth degrees of spaces can be calculated relative to the origin point (Dr. Gholam-Hossein Memarian, 8: 2002). When each space is placed deeper than its previous space and when a space has more survey relation with other spaces, the computer calculates it relative to the origin point and gives a number. A space with more connection to other spaces reflects thehigher integration degree and on the contrary, spaces with less connection have lower integration degree. By comparing the obtained numbers, we can achieve the degree of integration and differentiation of spaces. Designers of the diagram believe that higher degree of space differentiation represents the more private space and a space with higher integration degree means having relationship with other spaces which reflects the more generality of space. These rotatory diagrams give the audience a quick understanding of the relationship between spaces. By depicting such diagrams the rotatory movement in the building can be seen clearly.

Table1: Introduction of explanatory diagram components (source: authors)

Components of explanatory diagram		
Diagram of all spaces	Full and empty circle	1
Diagram of movement origin or outside	Circle with a cross or plus sign	2
Diagram of depth and rank relationship of spaces	Vertical line	3
Diagram of relationships between match spaces	Horizontal line	4
Reflects the relationship between spaces	Oblique lines and in some cases, curved lines	5
Reflect the depth of ranks near the checked plate, in other words, it shows the depth of each space relative to the outer space	Numbers	6

Kinds of explanatory diagrams		
Space outside the interior plan Shows the exterior space 	 Full circle: shows the space Vertical line: rank relationship of space Crossed circle: exterior space	Linear or tree rotatory diagram
If in the plan the relationship between the interior and exterior from two sides, both linear-rotatory and rotatory diagrams can be used. 	 Oblique line: relationship between spaces Full circle: show the space Crossed circle:	Periodical or rotatory diagram

Table2. Components of explanatory diagrams (reference: Abbaszadegan, source: authors)

CONCLUSION

Space syntax method, is a theory and an analytical tool in architecture and urbanism. In this paper, recognizing the spatial structure as the most important feature of spatial space was discussed. At the end, discussions of the paper can be summarized as follows:

The aim of space syntax is to investigate the social relations in the architectural space. It should be noted, however, this method has been also applied in the analysis of urban spaces.

1 .A pictorial tool called explanatory diagrams has been used for interpretation of these drawing patterns, which was fully addressed above.

2. Form and skeleton have no role in this method.

3. Effect of different factors on the movement and rotation, especially climate has been ignored in this method.

4. It seems that in this method, attitudes and social behaviors of people in an urban texture are analyzed based on above features such as intelligibility, integration, etc. Elements that have no considerable place in the texture design.

5. Converting the human qualitative features that unconsciously occur in the human mind and in dealing with urban spaces, has presented in this method and can be used.

6. The result follows by this method is the separation from theory-like qualities that may no efficiency, and utilizing the same quality components can be understood and used due to resulting in numbers.
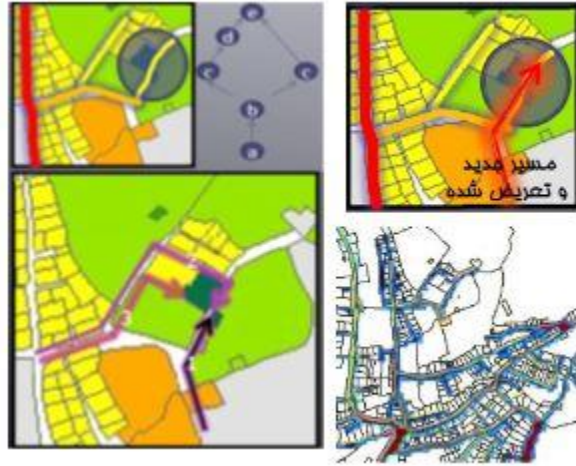
Providing alternative for Imamzadeh in "Farafzad" area
New access depth: high
Intelligibility: low
Road widening: low
Access to improve the access: appropriate

Diagram of the best proposed solution in Farahzad region (source: authors)
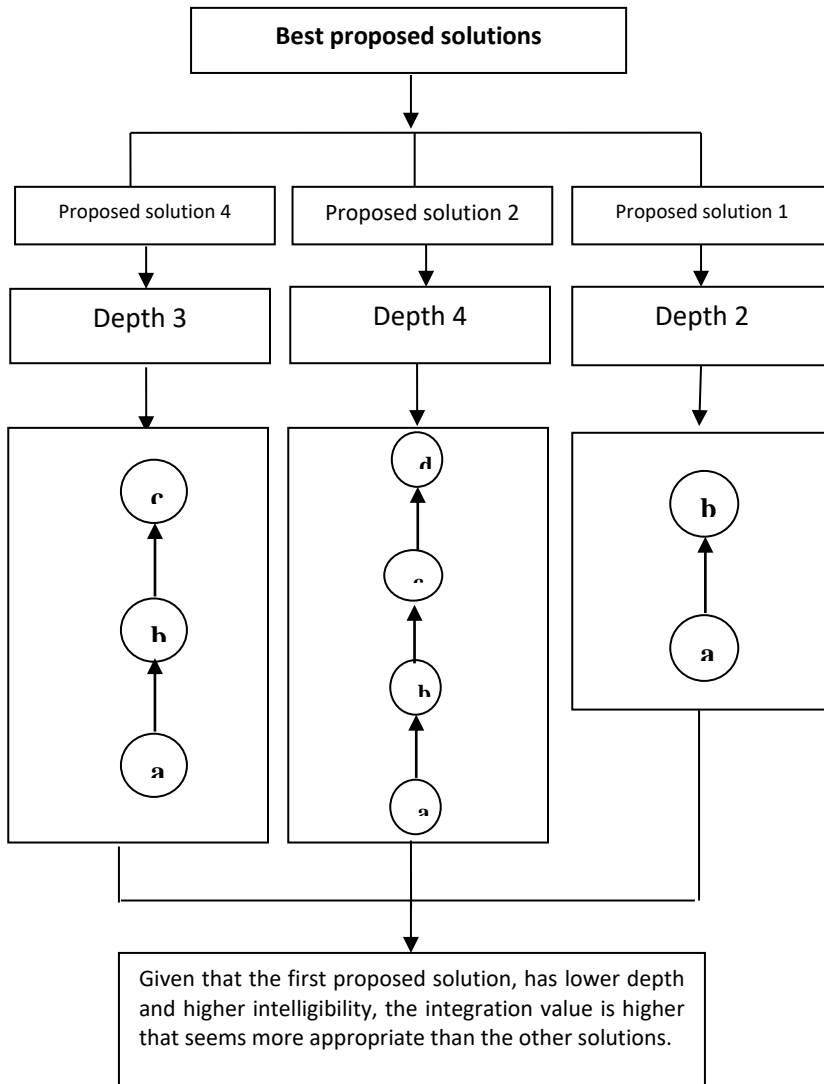
REFERENCES

1. Steadman, J. P. (2001) "Every built form has a number." Proceedings of the 3rd International Space Syntax Symposium, Georgia Institute of Technology, Atlanta, GA, 7-11 May 2001.

2. Hillier, B. (2007) "Studying cities to learn about minds: how geometric intuitions shape urban space and make it work." Environment and Planning B: Planning and Design (forthcoming).

3. Hillier, B., Turner, A., Yang, T., Park, H. T. (2007) "Metric and topo-geometric properties of urban street networks: some convergences, divergences and new results" Proceedings of the 6th International Space Syntax Symposium, ITU, Istanbul, Turkey, 12-15 June 2007.

4. Hillier, Bill, Hanson. Julliene, " the sociologic of space", Cambridge University press, 1984.

5. Hillier, B. "Space is the machine" , 1996

6. Hanson, J (1998) Decoding Homes and Houses, Cambridge: Cambridge University Press.

7. Hillier , B., & Hanson, J. (1984), The social logic of space, Cambridge University Press, New York.

8. Hillier, B. (2004), Designing safer streets: An evidence-based approach. Planning in London, 48, pp45-49.

9. Hillier, B. (2007), Space is the machine, A configurational theory of architecture Space Syntax.

10. Hillier, B. (2009), Spatial sustainability in cities organic patterns and sustainable forms. Proceedings of the 7th International Space Syntax Symposium, Stockholm. pp10-20.