

USAGE OF SPACE SYNTAX METHODOLOGY IN URBAN PLANNING AND DESIGN: CASE OF MASHHAD, IRAN

Mohammad Rahim Rahnama and Alireza Bidkhori*

Associate Professor of Geography Department, Ferdowsi University of Mashhad(FUM)
PhD Student of Urban Geography, Ferdowsi University of Mashhad(FUM), International Campus

Corresponding author: Alireza Bidkhori

ABSTRACT: This paper, first, briefly explained the usage of method in urban design process .then, configurative specifications of mashhad's -one of the oldest and religious city of Iran- spaces are analyzed by space syntax methodology during three historical stages of its development (first stage, mashhad within the defensive wall limit; second stage, development of the city beyond defensive wall and construction of market, and the third stage, after street forming in 1940s), and the following results are to be used in the process of urban design.

- The urban spaces have shaped based on the structural logic.
- Manipulating or Intervening in space syntax method transforms the spatial structure of city.
- The analysis of urban space configuration, using the "space syntax method", enables the skillful society of urban designers to make the model which can predict the behavior in urban spaces.

Keywords: Mashhad city, space syntax method, urban design, urban planning, urban space.

INTRODUCTION

Urban spaces play a very important role in supplying peoples' demand in a face to face relationship with each other.

Face to face relationship is an important requirement of social man and lack of such a relationship may result in many negative effects on people's mental and psychological health. Traditionally, open urban spaces were places for such relationships. With the rapid improvement of communication in recent decades, need for face to face relationship as a "practical" factor in lessened, but social-cultural and psychological demand for such a relationship has still remained (and will remain) in its high status, and many attempts have been made to scientifically predict manner and communication in open urban spaces.

To investigate the relationship between urban fabrics and its events, also many methods are sued. These methods profit from various professions in theoretical fundamentals. Among them, artistic viewpoints based on personal interpretation, presupposition and experiences, had the biggest share in the analysis of the relationship between urban physical fabric and its events. Urban planning artist and artist urban planners predict specific events and activities for their designed city based on their experience and imagination.

Rapid over population and developments of urbanism during the late century, and needs for vast buildings, remarkably added to the number of urban planners who were developing cities and buildings new one. Complexity of urban relationship and not enough familiarity with social structure, which was rapidly changing, made the prediction of urban events in urban spaces at least very difficult. Making mistakes in designing and none-existence of right prediction have a powerful relationship with abnormality. Vandalism in urban space, improper use of spaces and contradiction in the way of using space are some of them. To explain and predict people's behavior and their relationship with urban physical fabric, many attempts have been made in various sciences like environmental psychology, sociology and different artistic professions. Despite many successes that these sciences – especially

environmental psychology – achieved, none of them were a comprehensive method to explain direct relationship between urban physical fabric and behavior (Arman, 2009).

Here, demand for comprehensive method lead to invention of “space syntax” method in the late 1970s, and its development in 1980s and 1990s.

It originated some twenty years ago in the work of Hillier and Hanson, (1984) and has since been developed at the space syntax laboratory at university college London, and at its various affiliates throughout the world(Ratti, 2004).

This technique is developing in different countries. As our country mostly uses artistic or traffic engineering methods for urban development design or the existing condition improvement, it is necessary to apply scientific methods which can scientifically and clearly explain the relationship between urban physical fabric and various events which happen in urban spaces. These events consist of urban people and various groups, pedestrians and drivers way to use urban spaces and its effect on land's price, rate of crime and such like. In this article the method is described at first and then three stages of physical changes of Mashhad's historical fabric are analyzed by using this method; and finally moreover to presenting the result of this study, some suggestions are also provided.

Space syntax method

Space syntax method defined by Hillier et al. as follow:

“Space syntax... is a set of techniques for the representation, quantification, and interpretation of special configuration in buildings and settlements. Configuration is defined in general as, at least, the relation between two spaces taking into account the third, and, at most, as the relations among spaces in a complex taking into account all other spaces in the complex. Special configuration is thus a more complex idea than special relation, which need invoke no more than a pair of related spaces”(Hillier et al., 1987).

Mathematical parameters can be used in creation of a model which predicts performance and the way of behavior in urban spaces. Graphic data of space syntax analysis is an effective tool in urban design process; in a way that the effects of physical intervening on urban fabric is seem graphically. Many of the researchers concluded that space syntax method is successful in prediction of pedestrians' and drivers' movement and also space use level. Regarding this studies, using this method, a model is achievable to predict the impacts of designing decisions in physical spaces on user's behavior in the urban design process.

Here, it is necessary to briefly mention some basic concepts. These concepts are as follow:

Space Configuration

As space syntax method is based on the analysis of the inter relationship between all urban spaces, space configuration can also be analyzed through this method.

Space configuration means the way that spaces are arranged beside each other and their mutual relationship.

Accordingly, it is concluded that a single change in space syntax method will result in some changes in total level of space configuration (khalatbari, 2008). In a sense, any kind of alteration in urban map at the level of city (addition or deletion of a space like a street, open space and such like) will create some changes in space configuration relationships of whole city.

It is obvious that configuration of spaces sets some urban behaviors in very specific order. This type of the space configuration, either in a building or a city, imposes some force to the space users. Nonetheless, how to percept artificial environment (building or city), in addition to other elements, also depends on the space syntax method (Arman, 2009).

Axial Map

A simple graph of urban streets and open spaces can be the base of the city's space configuration analysis. This graphic graph is called “axial map” and contains axial lines. “Axial map” is the longest access and view line of the urban environment, thus “axial map” includes the structure of the urban open space complex which is created based on the longest access and view line. This complex includes all urban public spaces. “Convex” is a space in which lines passing through each of its two areas would not get out of it. On other side, “convex” is a space, you can draw a line between two of its area getting out of it. It is necessary to say that urban users observe the entire city during the movement; thus person moving in the space observes different spaces in any moment of the movement.

Obviously, in this way all the observed spaces are seen. Therefore, such spaces are convexes where the observer can see all their aspects.

Drawing an axial map, it is possible to calculate urban configuration and also its peculiarities calculated quantitatively and graphically be shown from computer software. In other words, all urban spaces' depth from each other and from all urban spaces can be calculated and represented in this way (Khalatbari, 2008).

Integration

An axial map is a picture of the city's space configuration. This picture can be measured by the "integration" scale.

Integration is the main concept of space syntax. Integration can be defined as:

Each line's (space) Integration rate value, average number of lines(spaces) is a factor through which we can reach all the urban spaces; or in other word, it is the average number of direction alterations through which we can reach all urban spaces. Therefore, Integration in space syntax methodology has a relative meaning not an interval or metric one. Thus, in space configuration analysis, the concept "depth" is more meaningful than the concept "interval" (Arman, 2009).

In space syntax method the concept depth should be used to define distance among spaces. Depth in a space means that to reach the space we should pass some other spaces; or in a sense, depth indicates the number of direction alterations that is necessary to reach space through the other. Each axial line (space) has determined depth of other lines (spaces).

Integration value of a space (an axial line), is a mathematic parameter representing that line's depth from other ones in the city. In fact integration of an urban space indicates the extent it is integrated (merged) with the whole city. Integration map of city is an important tool to percept the behavior of its components, because several studies indicated that the state of integration value at the level of city correlates with the state of pedestrians' movement inside it.

Intelligibility

Principally, city is experienced from the low heights close to the earth surface, not from the high lands where the whole city is observable. From heights near earth surface, we cannot experience(observe) all urban spaces related to each other, but the observer must move on the surface and make a picture of whole city by putting together piece by piece taken pictures. Based on it, Hillier declares that intelligibility of city has direct relation with the concept of whole city reconstruction in mind and putting together these pieces. Therefore, intelligibility of a city is a relationship between local and comprehensive specifications of urban space (Kamran, 2012).

Experience has shown that Iranian cities with traditional fabric, have a very low intelligibility and cities with modern fabric have higher intelligibility. Low intelligibility of traditional cities is a part of their specification which controls the strangers' entrance to the depth of its residential part and in fact creates a kind of social control. Low intelligibility of traditional fabrics makes strangers achieve less perception of whole fabric and so there is a low probability to enter private places (khalatbari, 2008).

On the other hand, the move urban intelligibility, the weaker hierarchical structure of realms and more prospectus for strangers to enter inside fabrics and private places (residential parts). Such a phenomenon is seen in modern cities and plaid fabric.

Natural movement

The relation between space syntax structure and the traffic in its spaces is called "natural movement". From the Hillier's point of view "natural movement" is a part of movement that is determined with city space syntax structure, and not the attractions existed in it. The observations have shown that most of the traffic in city (in each space) is not because of origins or destinations in them but because of their existence in a part of the way. It is necessary to explain that even the purposeful movement (from origin to destination) should pass some related path ways.

The specification of space syntax in traffic (as a natural movement) is very important. Because space syntax method shapes the structure traffic and if people pass that space the specifications of space and specifications of designing, encourage people to stop in those spaces for a longer time and utilize those specifications. When people pass a space because of the space configuration specifications with a heavier traffic, organizations needing this population will gather in these spaces and this causes an increase in traffic.

They call this case Movement Economy that means the influence of traffic on the way of using the contiguous spaces. In addition, usually having traffic increases the value of contiguous properties, especially commercial properties. The result of many researches has proved that the space configuration of a city has a strong correlation link with the way of using spaces, traffic, type of functions and the value of contiguous properties.

The practical usage of space syntax method in the process of urban design

Physical models like architecture miniatures, and virtual models like three dimensional computer shapes are important equipments, that the environment designers use them as a visual experience of their proposed plans before their performance, almost these models are presented the final production of planning and do not play a role in the

design process. Urban fabric's space syntax method analysis proposes a model of city that enables the designers and the decisions makers to see the consequences of their performance on the probable manners in suggested urban spaces before giving the final solution and performing the plan in the process of designing.

In other words the analyzing space syntax method helps to know the consequences of cities' physical alteration; especially the road networks on the way of citizens' thinking and behavior. For this reason, using space syntax method, the syntax of urban method, the syntax of all urban space one after another (original structure of spaces) is analyzed.

This analysis with the help of computer, calculates the space specifications like the integration value of all urban public spaces (like squares and path ways) and presents them graphically and digitally (as a chart).

Then the urban researcher regarding the research requirement can observe and record the variety of behaviors in urban space. The meaning of behavior is how to use the urban spaces that can include things like, moving, standing, sitting, talking, buying and other things. In addition, recording the price of lands, the rate of vandalism and crime, and the study of their relation with the specification of space syntax can be the topic of research.

After this stage with calculating the amount of static consolidation of achieved space specification from space analysis and the information gathered from observations we can make a model that explains and predicts the relations between the city physic and behaviors and events. So the urban designer can predict consequences of his manipulation in the city. If the plan doesn't save the aimed behavioral results, the designer can change the plan, and reanalyzing space syntax method again and can evaluated the new plan and repeat it until he gets the desirable result.

Regarding this process we can evaluate the space syntax method as a model that has correlation link with the designer in urban design process.

Space analysis PACE ANALYSIS OF MASHHAD'S OLD FABRIC

Mashhad, the capital of Khorasan province, is the holiest city in Iran and a sacred place for pilgrims (Zabeth, 1999). Mashhad is located at 36.20° North latitude and 59.35° East longitude, in the valley of the Kashaf River near Turkmenistan, between the two mountain ranges of Binalood and Hezar-masjed (saeedi, 2012). The city benefits from the proximity of the mountains, having cool winters, pleasant springs, mild summers, and beautiful autumns, and has population of over 2 million. The name means the burial place of a martyr. Back in the 9th century A.D., Imam Reza was poisoned and martyred in the city. He was the eighth Imam (head spiritual leader) of Shi'ate Islam. His holy position made his tomb a sacred place for pilgrims to worship. There are plenty of priceless objects and unique manuscripts in the shrine's library. Mashhad is a tourist city with many hotels of various categories as well as a great number of guesthouses for the tourists and pilgrims who come to this city everyday by tens of flights, trains and buses. Before Imam Reza died, the city was known as Sanabad, a small village in the north of Persia. After his death, pilgrims came and ended up staying in Mashhad. The village grew into a small city because of his shrine. In the 16th century, The shrine and city restructured and enlarged (Saeedi, 2012). Mashhad is the hometown of some of the most significant Iranian literary figures and artists like as Ferdowsi, the Iranian poet of Shahnameh, which is considered to be the national epic of Iran (Zabeth, 1999). In this research three stages of Mashhad development with using the space syntax method were studied. This research made it obvious that how development of city changed the space specification from the space syntax perspective and in conclusion the functional role of its spaces have been transformed.

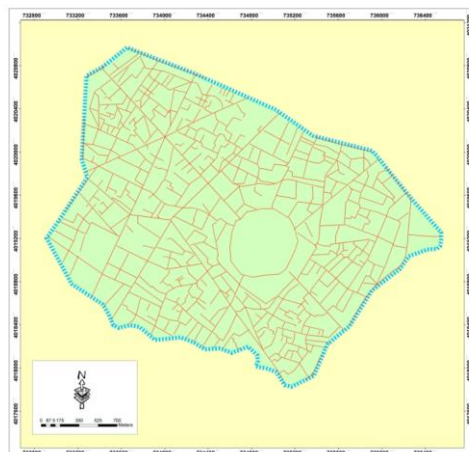


Figure 1. City of Mashhad with defensive wall integration map. Source: (khanikof, 1980)

Figures 1, 2 and 3 also show a comprehensive integration in the city of Mashhad during three periods. at first period the city of Mashhad was protected by a defensive wall around it; at the second period the development of Mashhad and construction of market happened beyond the defensive wall and older parts of city; finally at the third period: the old city of Mashhad has changed after imposition of new street formation (as we can see now). It is necessary to say that these plans have been analyzed by the computer using space syntax method and can be investigated by colorful codes. In these plans the color red shows the highest comprehensive integration value and the color green shows the lowest comprehensive integration value. In other words the color red shows the lowest depth and the color green shows the highest depth of all urban spaces.

In this study it is also hypothesized that space syntax method in a city depends a lot on the way of using the spaces (this hypothesis has been supported in many studies). It is necessary to say that if we support this hypothesis we can made a predictive model of movement in space of cities. In computer analysis of urban space syntax a chart will be made attached to this plans that show the value of each axial line (space) and in fact each color shows the quantitative value of each space in city.

Figure 1 shows the city of Mashhad in defensive wall limit. This map shows some specifications of the city as follow:

A: the main axle of city, are the main pathways that have the highest integration values, which lead to the city gates and link its important parts. The main axles of the city are shown with the red color.

B: The residential parts of the city have less comprehensive integration and are placed in city's "depth". these spaces are shown with the green color.

C: All parts in the Mashhad at the first stage have less depth than the main axles. It is necessary to say that this kind of morphology structure is a part of Iranian –Islamic cities specifications. This means that however the residential places are in quiet positions of city; they are not very far from the urban daily life and in fact are not the solitude. Being in solitude from the urban daily life can have physical- psychological- social consequences.

The space syntax analysis of Mashhad's second development stage can be seen in figure 2. As we can understand from this map, spaces with the highest comprehensive integration value are moved to the north-west that contains the market and new urban centers. In fact the functional hearth of city as we expect has the highest degree of the comprehensive integration. If the hypothesis in this article that " the highest integration degree has the highest amount of activity" in proved, in this part the city center has the highest amount of activity and the highest integration and so the functional heart of city is there. Traditionally market should be easily accessible from all parts of the city. The space syntax analysis also explains that the market of Mashhad has a very low depth and its users can access this important part of city from all city spaces with the least direction alteration.

Regarding space syntax method accessing the market is very "easy". In figure 2 the market that has highest integration value in all parts of city is shown by the color red.

Choosing the Market place in city is very important, to the fact that each wrong decisions for the trade units place in the city causes loss and damage. The shopkeepers' talent and their recognition cause them to place their trade unit in the lines that have high comprehensive integration; in the pathways where are the people's "natural movement" roads and the movement pressure is high.

Hillier and Cooperator, (1993) have represented evidence which show stores and people are placed in some lines with the high comprehensive integration value in London city.

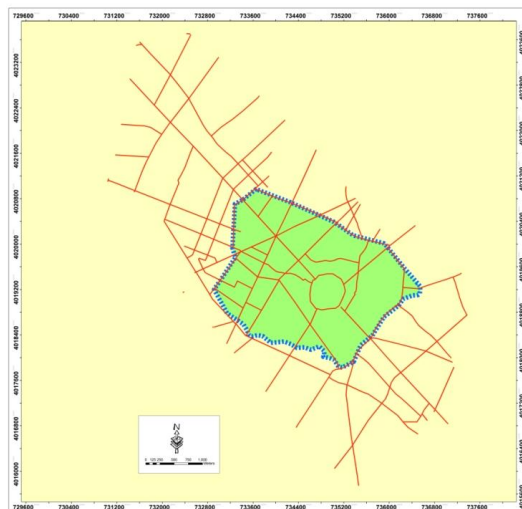


Figure 2. City of Mashhad integration map in second development stage. Source: authors study

Stores act as attraction poles but cannot change the space integration value, because the integration is related to the space specifications and in fact depends on the entire system of city. So we can conclude that Mashhad's market development in its north-west part which is the heart of the city (with high comprehensive integration) is a suitable place where its physical specifications attract the pedestrians and change the sore places.

As we can see in figure 2 the marginal spaces of Mashhad in the second stage of development have a high depth; meaning that the space centralization with low integration around the city and also some spaces with these specifications are in the middles of the city (Hakim,1986:190). These spaces are residential parts which regarding social structure should have been placed in special and private places. This is a specification of the Islamic cities. In the second stage of the city development, the main path ways have lost their importance in comparison to the market and have also lower integration regarding space syntax.

In the second level of Mashhad's development, these space specifications are obvious:

A: the heart of the city has been transformed to the north-west part where in markets with highest integration is made (color red).

B: residential parts around the city and some residential spaces in the middle of the city have been turned into the deepest urban spaces (color green).

After streets formations of 1940s in Mashhad, the construction of traditional city fabric was totally destructed. In this street formations there haven't been paid any attention to the past space logic.

Figure 3 shows the third stage of development in the city of Mashhad, in this age a new phenomenon appeared that was unfamiliar with the city space structure. The purpose is modern streets that were imposed to the fabric. These pathways were a lot wider and longer than the street is, its depth for space syntax is less and the conclusion has a higher comprehensive integration. new streets of Mashhad had these specifications that were imposed to the city without respect of structural and spatial specifications. One of these streets has destroyed the market lengthwise and has destructed its valuable ingredients. As we can understand from figure 3 the highest integration value belongs to these streets. These streets have attracted the integration value of other internal traditional spaces of fabric and in conclusion internal space of city and its ingredients have placed in depth and solitude from other parts of the city.

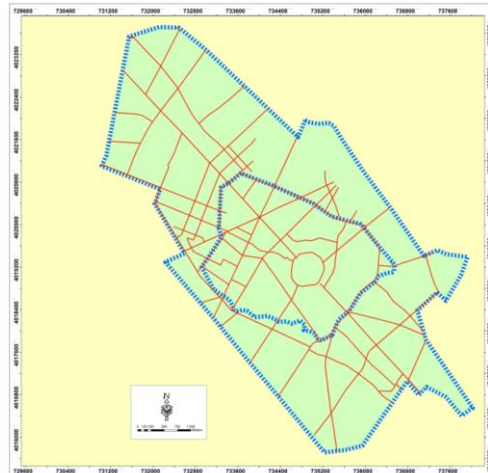


Figure 3. City of the Mashhad integration map in third development stage (after imposition of streets)
Source: (Municipality of Mashhad's, 2012: pp.120-138)

Historical original pathways, the remaining of traditional spaces have high depth and low legibility and formed as isolated spaces. In contrary, the main street has been known as the heart of city and has attracted most of the activities. So these modern spaces have the most active implications- like trade and official units- where as other spaces do not have enough attractions. When internal spaces lose the space integration, many of its traditional functions disappeared and a kind of historical annihilation happened. It is necessary to say that there is a strong relation between depth and building damageability (Abbaszadegan, 2001).

The city center (market, Imam Reza holy shrine and mosque) has the highest amount of activity and highest integration and so the functional heart of city is there, and its users can access this important part of city from all city spaces with the least direction alteration.

After formation of new streets the average value of integration increased more than the other development levels of city but the distance between the most and the least space integration value in the modern city of Mashhad become very much. This means that some part of the city (almost most streets) have a high integration and some of the spaces (almost the internal fabrics) are in very high depth (very low integration) from all urban spaces and in conclusion they are in a kind of solitude from other city spaces. In other words in the second level of development the spaces around the city that had a high depth are now in the city and so central parts are in solitude and the city begins to rot.

Briefly, historical fabric of Mashhad after street forming (third stage of development) has had the following space syntactic alterations:

- A: new streets have attracted the integration value of whole city – specially the heart of the city – so the traditional heart of city has lost its value and is isolated.
- B: whole historical fabric, has become segregated from whole city, however it is in the heart of city.
- C: streets have been turns into main axles of the city.

CONCLUSION

In urban design process the demand for a tool which adds to the individual ability and skill for designing and which makes the urban designer aware of the result, is obvious.

The longer the street, the less its depth as space syntax is and it has a high integration. The new streets of Mashhad have these specifications; these streets have been attracted the integration value of other internal traditional spaces of fabric and so the internal spaces of fabrics and their elements are placed in the depth and in a solitary state. When the spaces in the fabric lost their space integration, many of their traditional functions disappeared and a kind of historical annihilation happened.

Among various methods that can supply this demand, the space syntax method is a very secure method. The recent research shows the process of alteration can be explained by this method very well.

The knowledge and information of old city of Mashhad as a decisive, confirms the outcomes of these alterations analysis using the space syntax method. Such outcomes can be found in old fabrics of many other cities of Iran

(Abbaszadegan, 2000). Nonetheless, it is observed that the manner of different beneficiary groups in this fabric have a strong consolidation with the Mashhad old fabric's integration decisive (kamran, 2012).

These and other finding of researchers in other parts of the word show the trust of space syntax in city fabric explanation and also the relation between cities' space syntax with the way of the using city. From these results it is deduced that:

- The urban spaces have shaped based on the structural logic.
- Intervention in the space syntax method (changing the pathways, making new pathways in the city, or making new space) transforms the spatial structure of city.
- Urban structural alteration is followed by behavioral and functional changes.
- The Iran's traditional fabrics has low intelligibility and manipulating them like street forming can make them more intelligible, such an increase in intelligibility is opposite to these fabrics shaping logic.
- Structural alteration of traditional Iranian cities has happened without paying any attention to their shaping logic and highly correlates with fabric annihilation rate.
- Urban space configuration analysis, using the "space syntax method", enables the skillful society of urban designers to make the model which can predict the behaviors and relations in urban spaces.

Suggestion

Considering the presented result it is suggested that:

A: Before any intervention in the city fabrics especially valuable fabrics of the city (that their physic and function is valuable) is existing and suggested structure should be analyzed and its changes should be compared to the goals of design .

B: For all old fabrics, it is necessary to prepare a model which predicts the functions while intervening the fabric. This model should have the ability to explain the relation between physical fabric and the behavior in its spaces.

REFERENCES

- Abbaszadegan M. 1999. The relationship of urban spaces and users behavior. Sokhan, Iran.
- Abbaszadegan Mostafa. 2000. Urban fabric patterns recognition using the space syntax method, like: Old fabric of Semnan. Elm-o-Sanat University, Iran.
- Arman M. 2009. Space syntax method in east University of khoozestan, Iran.
- Hakim BS. 1986. Arabic-Islamic cities: building and planning principles. Amir Kabir, Tehran.
- Hillier B, Hanson J, Graham H. 1987. Ideas are in things: an application of space syntax method to discovering house Genotypes, Environmental and planning B: Planning and Design, 14, pp. 363-385 .
- Kamran M. 2012. An introduction to space syntax method. Ghadiani Publishing, Tehran, Iran.
- Khalatbari A. 2008. Graphic data bank of space syntax. Jahad Daneshgahi Press, Tehran, Iran.
- Khanikof I. 1980. visions of old Mashhad. Nashre-e Nima, Mashhad, Iran.
- Municipality of Mashhad. 2012. Statistics Book. Municipality Press, Mashhad, Iran.
- Ratti C. 2004. Urban texture and space syntax: some inconsistencies, Environment and planning B: planning and design, 31, p.1.
- Saeedi R. 2012. Mashhad Tourists Guide. sokhan publisher, Tehran, Iran.
- Zabeth HR. 1999. Landmarks of Mashhad. Islamic Research Foundation, Tehran, Iran.