Persian translation of this paper entitled:

تدوین مدل کاربردی تبیین ساختار ذهنی نقشه‌های شناختی مردم
از طریق تحلیل‌های ریخت‌شناختی–فضایی بافت‌های شهری موجود
نمونه موردی : بافت تاریخی شهر کرمان

is also published in this issue of journal.

Developing an Applied Model for Explaining the Mental Structure of Cognitive Maps of People through Spatial-Morphological Analysis of Existing Urban Textures, Case Study: Historical Texture of Kerman

Neda Ghoraba*
Manouchehr Tabibian**

Abstract

Theories of urban development have mentioned many advantages for using a structural approach. However, intuitive (and not objective) methods have been used to determine the main structure, which is essentially considered equivalent to the main passage network and public utilities. Since the mental conceptual structure is considered in a way that its components are combined to gether as a whole, the present study aims to develop an objective mechanism for extracting the mental structure of people about texture. Accordingly, this research seeks to answer the question that which elements and objective analysis have a greater impact on the explanation of the existing structures in the cognitive maps. In this regard, cognitive maps of people were collected through drawings and interviews, and the structure was extracted in three physical, functional and semantic dimensions. The analysis of the spatial values associated with the network of passages and land use in the geographic information system as well as the spatial qualities and relationships were carried out using spatial analysis. Spatial integration between the mental structures of cognitive maps, on the one hand, and the objective analysis of passages, land uses and spatial layout, on the other hand, showed that "axial depth" analysis explains the physical dimension of mental structure (Correlation = 0.72361, Sig. <0.001), "mean depth of convex space" analysis explains the functional dimension (Correlation = 0.66973, Sig. <0.001) and "Convex Space Integration1" analysis explains the semantic dimension (Correlation = 0.44744, Sig. <0.001). Accordingly, it is concluded that objective analyses of the existing urban textures can be used to explore people's cognitive maps. Contrary to existing theories, this paper showed that the segmentation and land use models could not significantly explain the structure of cognitive maps while spatial analysis has the highest degree of explanation of the structure of cognitive maps. The main network of passages, in accordance with the existing theory, is still an appropriate explanation for all three dimensions of mental structures of the cognitive maps.

*. Ph. D. Student in Department of urban planning and design, Qazvin branch, Islamic Azad University, Qazvin, Iran. Nedaghoraba@yahoo.com

**. Faculty Member of Tehran University, Tehran (corresponding author). matabibian@yahoo.com.au

The Scientific Journal of NAZAR research center (Nrc) for Art, Architecture & Urbanism

Introduction

There is a strong consensus on the usefulness of applying the concept of structure in urban projects. Regarding the expansion of cities and the impossibility of controlling all of their components within the framework of the deliberate and concentrated urban design and planning, the use of the concept of structure and the main structure is inevitable (Bahraini, 2011: 36). According to existing views, the main factors of the main structure consists of major communication routes, major open spaces, major centers of activity, major elements of the city and public buildings (Karrholm, Nylund& Fuente, 2014; Liu, Kang & Gong, 2016). As the urban neighborhoods and the other areas of a city shape the non-essential parts, such division of labor has many advantages and benefits. In this regard, it is possible to achieve conflicting goals such as geometric order and organic order, stability and change, coherence and diversity, control and freedom. From the economic point of view, the pressure on the public budget for designing the whole city has been reduced, and the people's participation in the formation of their residence and work is finally provided. The city structure creates an opportunity for all urban functions and types of human communication to be interconnected in an integrated network so that a strong bond is established between the most important urban elements and spaces (Peponis& Ross, 2014).

The clarity and readability of the structure is a city advantage because it will organize the main urban identity (especially in relation to its old texture) (Zhong, Schlapfer& Muller, 2015). Despite the importance of a clear and integrated structure, urban master plans not only encouraged low-density growth along with the imposition of zoning regulations and the segmentation of the main urban functions, but also have caused further disintegration in the structure of cities. Accordingly the structuralism methodology has also been adopted in the study. This method is historically a response to the reductionist thinking that ignored structures and spatial relationships (Lichfield, 2011).

While determining the main structure and its separation from other parts of the site (especially in the structural processes) is the basis for the next steps of the process (Andrade, Remolina & Wiesner, 2013), the consultants do not use a specified theorization mechanism to determine it. Like a small number of contemporary researchers (for example, see Karrholm, Nylund & Fuente, 2014), this article tries to present an objective and well-documented method for explaining the main structure of the historical texture, so that there is no need to use intuitive and mental methods to determine it. For this purpose, using a variety of texture analyses, the objective analysis of the status quo of the historical area of Kerman has been made. Finally, the adaptation between objective analysis and cognitive maps of citizens det e rmined which analysis was more capable of explaining the physical, functional and semantic structu r es of the environment. This research, like some o ther researches (for example, see Zhong, Arisona& H uang, 2014), attempts to extract the spatial structure from the mental map and the perceptual system of users.

Theoretical Framework
● Structure

In the humanities, the structure is defined as a framework of the rules and the relation between the elements. Gritching (1984), for example, describes the structure as a set of internal processes and relationships, or a network of relationships between elements that are represented in the outer appearance of the object (here, the shape of the city). For Levi-Strauss, structuralism is nothing but "trying to find an unchangeable element in surface differentiation" (Levi-Strauss, 2014). Moreover, a gestalt and holistic concept has been considered for structure, in which the elements (here, spaces and places) are not determined by the intrinsic and subjective features, but by their position in the whole and the roles they play (Sadowsky, 1982: 244).

According to the above, the structure has two aspects: one is the constituent elements, and the other

is the constant relations that connect the structural elements (Azadarmaki, 2004: 144). Therefore, the city's structure is not only composed of elements, spaces, land uses, activities and accesses, but also the way in which these elements interact with each other, and the attempt to adapt to the general form is important (Luchinger, 2013). If these elements are not related to one another, one cannot speak of a definite structure. In this case, one can only mention the individual components located next to each other in a geographic neighborhood (Dehghani and Aliakayi, 2013). Another group of theorists (see Mansoori, 2007) argues that the order and the relationship between the elements are not enough for making the main structure. They believe that the goal (which is the supply of personal and social amenities for human beings) is also a necessary factor.

In urban planning, the concept of the main structure includes some advantages such as regulation of the form (body and shape of the city) and the organization and consolidation of urban functions. It is so important that Moughtin defines urban design as "a discipline dealing with the structure and order of potential disruptions and disturbances between components in the city" (Moughtin, 1999: 30).

The main focus of this research is making the city more understandable by organizing the citizens' mental map which is another function brought by the concept of main structure. By the way, the term "time structure" came into the urban development literature when the cities were suffering from incomprehensiveness due to their complexity (because of physical development and the intense growth of population). Thus, the structure was understood as a concept in front of this complexity and tried to simplify it (Bazarger, 2003: 55).

The relationship between structure and mental maps is not limited to the function of the structure in clarifying the mental maps, but also a number of theorists have essentially considered the structure as a subject, not object, outside the world. Levi-Strauss believes that "the structures must be recognized in the patterns that the human mind imposes on reality."

From his point of view, the structure is not an object outside world, but rather a subjective and mental one" (Levi-Strauss, 2014). In other words, the structure is created in the human mind, which then transcends the shape of the city. This group of researchers seeks first to discover unconscious mental structures that are common to all users of space, and secondly, finds the relationships and rules that have been effective in the formation of these structures (Tavallaei, 2007: 19-20). It highlights the relationship between city structure and mental maps.

Subjective image (cognitive maps)

The city is a space where human experiences its perceptions of the world (Mansouri, 2007). The subjective image (cognitive maps) has been interpreted as brief data that individuals, groups, organizations, and societies have created in their minds and used to observe, understand and represent the phenomena on perceived in the real world (Zeile et al. 2015, b). Cognitive maps have such a link with psychological processes that each person records, encodes, stores, calls and retrieves the environmental information (Neacsu&Negut, 2012).

The ability to perceive and preserve the clean and accurate environment is a critical part of every responsive and successful city that results in emotional satisfaction with life in the city. The perceptual clarity of urban spaces is not only important in cognitive aspects but also includes emotional, functional and social issues (Kaplan, 2016).

In terms of emotional aspects, environments with a clear image in people's cognitive maps are perceived as safer and more relaxing spaces. On the other hand, the lack of clear perception of space reduces the sense of control over the environment and thus reduces the sense of autonomy (Wilson, Takahashi &Schoenbaum, 2014). Space perceiveability is also discussed regarding the quality of sense of place (as one of the main concepts of space phenomenology) because one of the prerequisites for the "sense of place" is the memorability of the environment (Panther, 2001).

Another function of mental maps is to induce and clarify the environmental meanings because people in the city create meaning by distinguishing between different sensory effects, and feel urban phenomena. The city is a complex arena of perception and memory, but the meaning of the city's space is limited to personal and cultural memory (Benjamin quoted from Tannicus, 185: 2011). The importance of subjective image can be investigated by adopting linguistic literature and likening the city to "a text that it is not easy to read," or to take the city as a "way of speaking," and ultimately to consider the city as a reader. Residents are slowly learning to create city spaces to speak with them (Bart, 167: 1997). Those types of physical or visual elements on their basis people solve their imagination from the city (path, edge, node,etc.) are precisely the semiotic vocabulary that formulates the city as a language or speech (Tannicus, 213: 2011).

Based on the emotional, cognitive, behavioral, and semantic functions of the citizens' mental maps, they can be used as a valuable criterion in determining the city's structure; or conversely, used in a dialectical relationship of the city's structure for clarifying the cognitive maps. This is discussed in the next section.

Space layout

As stated earlier, this research is aimed at developing an objective method for the perception and extraction of the main structure. To this end, the theories of space layout have been used for addressing and explaining the qualities of space or technical analysis of spatial relations (see Al -Sayed, Turner & Hillier, 2014). However, it should be noted that the intuitive addressing of the relationship between spaces and the role of this relationship in the formation of the city's main structure has a long history. For example, Rappaport in 1977 acknowledged that "the city's structure is a coherent set of spaces, which realizes the concepts, values, meanings, and the like (Rapaport, 1977: 8). However, technical and mathematical addressing of spatial relationships should be sought in the literature on the spatial layout.

Space layout theory emerged in the late 1970s (and developed during the 1980s and 90s) by Bill Hiller at the University of London. First, Hiller et al. used the term layout (method, order, rules, etc.) in 1974 and 1976 to analyze the initial rules of spatial structure (Hillier, 1998: 21).

The application of space layout methodology is essential to evaluate the capability of proposed projects to meet the requirements of the plan, such as the creation, direction, and prediction of movement in the city and, consequently, the formation of mental map. In order to predict the city's structure, the method of space layout can be used to identify the most accessible and isolated routes, so that the city's structure, movement pattern and cognitive map of pedestrians can be managed optimally (Abubakar & Aina, 2006: 2).

The space layout method, with the help of the concept of integration radius, is able to predict the passage rate and thus the importance of space in the cognitive map. Thus, the higher the level of the integration inthe street, the greater the potential for pedestrian movement, and therefore the space for the users will be more favorable (Raford& Ragland, 2003; Hillier, 1996).

In addition to the concept of the potential of movement, there is another concept called "normal movement" which expresses the relationship between the city's structure and the way urban spaces are located together with pedestrian traffic congestion. Normal movement implies another concept called the "economy of movement"; the normal movement and, as a result, the urban network will affect the patterns of land-use through absorption of movement. Furthermore, the post-formation patterns of land-use will aggravate the normal movement. In this way, a cycle of aggravating effects is formed, and this cycle will shape the city's pattern (Hillier, 1996).

Another strength of the space layout method is the ability to describe syntax properties (Hillier, 1998) graphically. Lynch believes that if we want to develop a specific language for cities, this language will probably be visual (Lynch, 1981). It can be

said that the space layout can pave the way for the achievement of the urban visual language by presenting the visual results of the analyses. On the other hand, it is hoped that space layout modeling can be understood by all (non-experts) due to the presentation of graphics, and thereby increases the participation of citizens in the urban design process and minimizes the difference between the specialized language and the public language (Hillier, 1999).

Conceptual framework

As it was mentioned, the relationship between the city's structure and the subjective image is dialectical. By adopting a phenomenological approach, it can be shown that the relation between these two concepts is so interconnected that some researchers (Levi-Strauss, 2014) essentially consider the two as one (or consider one as part of the other). In this regard, the structure is considered not as a perceptible object in the outside world, but as a mental and subjective matter or as a model that the human mind imposes on reality. In this approach, one can speak of a 'subjective structure' or 'cognitive map structure.' With regard to the relational nature of the concept of structure, one can consider the organization and the combination of elements in cognitive maps as a structure (in this interpretation, the structure is a part of the cognitive map). In other words, the city's order is subjective and inferential that indicates a relationship between its elements (Mansouri, 2007).

The relationship between structure and subjective image can also be explained more simply. In a pragmatic approach, the city's structure is intended to emphasize the elements with a special place in the cognitive map of the people. In other words, it is appropriate for the urban planner to highlight the objectivity in the minds of residents (Oranje, 2014). It can also be said differently. According to the Gestalt, the human mind is unable to comprehend the details of a city due to the high volume of environmental information. However, the main condition of mental life in a modern city is the ability to refine these stimuli and eliminate additional information. City planners can try to organize, simplify and comprehend the environmental information, and also provide an integrated picture of the whole city using the main structure as a concept and instrument against the complexity of today's cities (Sheriff, 2014).

In other words, the subjective image in this approach has been used as a valuable criterion for determining the main structure, because the ability to perceive and preserve the clean and accurate environment is a critical part of every responsive and successful city. The perceptual clarity of urban spaces is not only important in cognitive aspects but also includes emotional, functional and social issues and affects the emotions of space users (Nold, 2009; Gartner, 2010), their pathways (Roth, Kang & Batty, 2011) and urban activities (Daggitt, Noulas& Shaw, 2016). The research also aims to objectively identify the elements of the city's structure that describe the cognitive maps or their structures, so that emphasizing these elements would highlight these elements in cognitive maps and, consequently, ensure the clarity of subjective images.

Research Methodology

This research is both fundamental and applied study. It is fundamental due to the discovery of the nature of the city's structure in the perceptual system of citizens and the relationships between its variables and the objective variables of the texture. As well, it is an applied study because it aims to improve the method and means of identifying the mental structures of people about existing urban textures in Iran.

Typically, research methods are divided into quantitative and qualitative categories. Quantitative methods generally deal with counting and measurement, while qualitative methods are intended to discover subjective descriptions and environmental meanings and also interpret mental concepts (Hafeznia, 15: 2006). Accordingly, the present research method is divided into qualitative and quantitative sections. The qualitative research method has been used in drawing and defining the

perceptual organization and cognitive maps. The quantitative research method has been used in the section of physical, functional and spatial analyses and their adaptation to cognitive maps.

The first section that identifies and extracts cognitive maps of people has a phenomenological approach. The phenomenological approach that has been accepted in architecture and urban studies since the late 1970s is a descriptive approach based on observation and interpretation by observers and users of the space. In this approach, the phenomenon is examined in its own conditions. This empirical approach doesn't aim to provide quantitative descriptions and information gathering on its basis laws can be developed to predict behaviors but to understand the essence of human being (in relation to space and place) (Ahari, 34: 2012).

In the phenomenological approach, the city is considered as a physical-spatial phenomenon whose issues are examined by its own conditions. Such attitude forms the subject of environmental phenomenology. In environmental phenomenology, the goal is to understand the nature of the environment, i.e. what the environment means to the people. The phenomenologist relates to emotional engagement with the environment, and thus reaches qualitative descriptions (Pour Jafar, 2008). Following the above method and using information gathering tools (interviewing, observing and drawing a map), the present research has tried to improve the structure of the city's historical texture by studying the subjective image of people.

However, this article simply does not suffice to extract the cognitive map of people but also seeks to discover the objective factors that influence these cognitive maps. In this section, the article is a quantitative analysis. This part of the research should be considered as part of a positivistic research that aims to test hypotheses with objective methods (GIS) and statistical analyses.

From another perspective, a part of this study is a case study. In the case study, unlike experimental research, the researcher does not manipulate the independent variable and its effect on the dependent variable, but rather selects a case and examines it from important aspects. The case chosen in this thesis is the historical texture of Kerman.

Data Collection Method

As described in the conceptual model section, this research consists of two categories of perceptual and objective variables. The review of the subject literature suggests that various methods including visual survey, operational instruments such as logging, tracing and tracking of space users, review of the labeled space data (Zhu &Ghahramani, 2002), group review of cognitive maps, and investigation of sensory stimuli in space (Quercia, Schifanella& Aiello, 2015) are used to collect perceptual data. In this research, data collection has been done in the section of developing the structure of citizens' cognitive maps by two methods of drawing and interviewing. For this purpose, 98 people from Kerman were asked to draw a map based on their mentality of Kerman's historical texture. The section was carried out by the following questions:

Please draw the historical texture of Kerman city on this paper.

Add the most important elements of historical texture.

Figure 1 presents a sample of people's drawings for Kerman's historical texture.

Three methods of the audit, perceived, and objective can be used to collect man-built environment data (see Bahrainy&Khosravi, 2013). In this research, in the field of physical, land use, and spatial analysis using the GIS, an objective method has been used for data collection (Fig. 1).

Data analysis method

Regarding the residents' mental data about the historical texture of Kerman and the development of their cognitive maps, considering the qualitative nature of the subject, the data obtained from the maps were analyzed using the AHP analysis method (see Ghoraba and Tabibian, under judgment). Then,
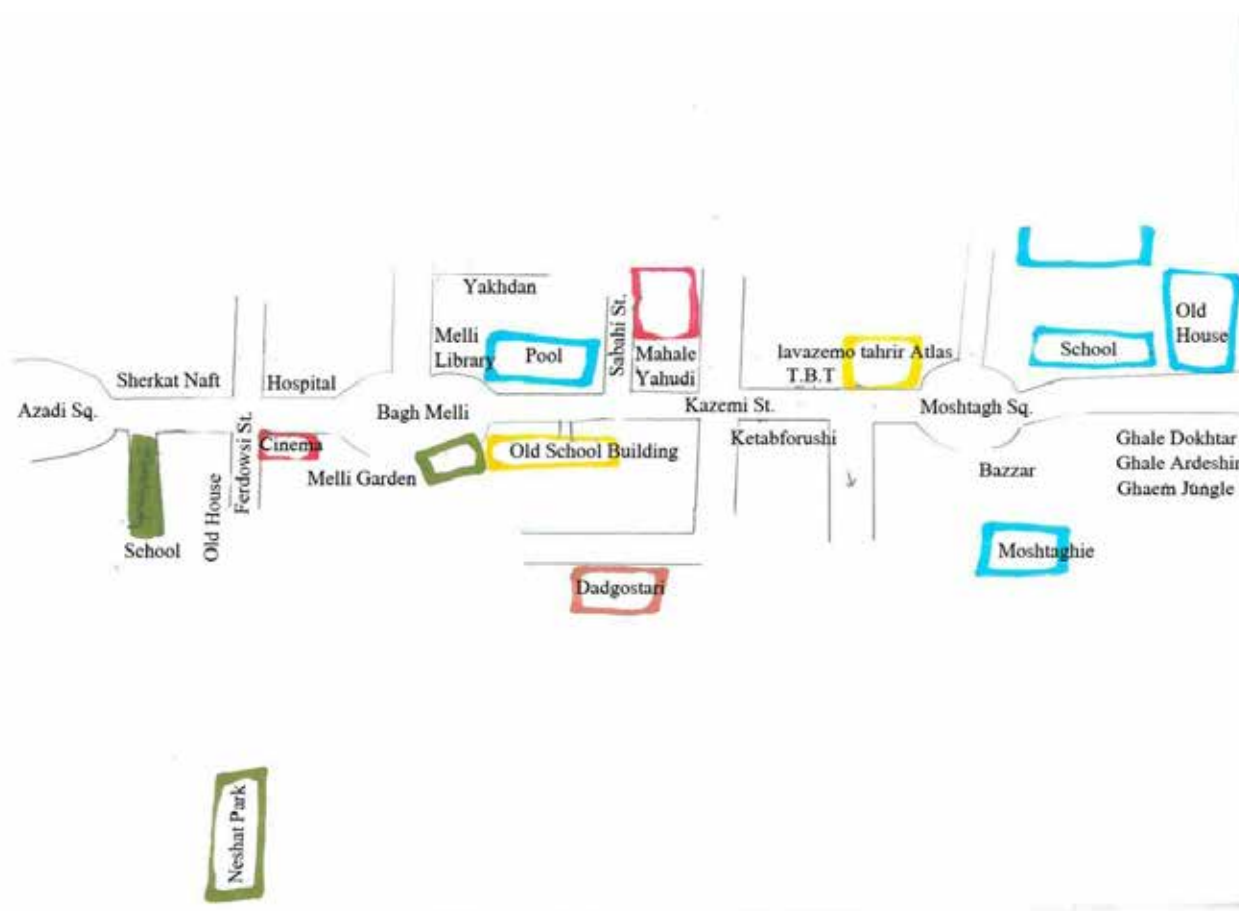
Fig. 1. A sample of people's drawings for Kerman's historical texture. Source: authors.

the maps of the mental structure of people from the historical texture were expressed in three dimensions: physical, functional and semantic (Fig. 2).

Objective analysis methods were used to analyze the physical, functional and spatial characteristics of the man-built environment of the historical texture of Kerman. Spatial layout analysis was used in connection with hierarchy, qualities, communication, and organization of urban spaces (as the variables influencing the mental structure of the people as experienced during urban travel [Balcan et al., 2009]). The above analyses were performed in the Depth Map software environment. Spatial layout analysis is a set of theories and techniques used to analyze the network configuration of the associated urban spaces (Jiang, 2008). The ontological roots of the spatial layout analysis that can be retrieved in Ludwig Wittgenstein's ideas and linguistic concepts

are closely related to the main structure concepts. From Wittgenstein's point of view, "basic units in speech are not words, but basic sentences." Here, the units of the city are not its spaces, but the relationships between the spaces (compare the definitions given for the structure). In other words, words alone do not mean, but the syntactic relationships and their relative positioning give meaning to the words (the relations between spaces determine the extent of their use and, consequently, the role of each space in the mental map). In this study, 23 spatial layout analyses were used to investigate the spatial relationships and qualities (5 analyses axial map, 10 analyses for the Isovist map, 8 analyses for the convex space map). Two of these maps are shown in Fig. 3.

However, another category of research has shown that walking and the amount of space used, as well as the cognitive map of citizens, depend on the land

Fig. 2. Maps of mental structure of people from historical texture in three dimensions: physical, functional and semantic. Source: authors.
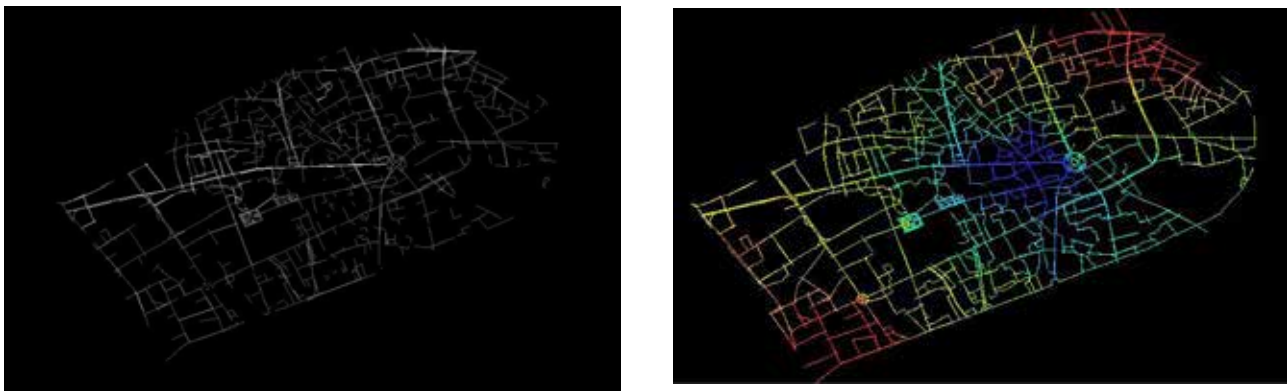

Fig. 3. Analysis maps a. Axial depth, b. Axial entropy. Source: authors.

use system. On this basis, the second part of the objective analysis of this study addresses the spatial analysis of land use index elements.

Dependency matrices (dependence between walkable areas and pedestrian attracting land uses) were used in the evaluation of the spatial values of the places in the historical texture of Kerman. We have presumed that, firstly, the walkable spaces are those spaces enclosed by appealing land-uses; secondly, the walkable and crowded spaces are important elements in the cognitive map of the people (a large number of studies show the direct relationship between the amount of encounter with urban spaces and the formation of a mental map; for example, see Marcu, Giusti&Barthel, 2016 and Dias &Ramadier 2015).

The map of the analysis of spatial values related to land-use was presented as Figure 4.

In this regard, by scoring the elements of the passage network, the score of each route depends on the two factors: its width and its intersection value. Accordingly, a map of the analysis of the spatial values related to the passage network was obtained as Figure 5.

In the final step, spatial integration analysis of Arc GIS software was used to investigate the degree of adaptation and interaction between the mental structure maps of people from the historical texture and the spatial analysis obtained from the previous section.

Fig. 4. The map of the analysis of spatial values related to the land-use. Source: authors.

Fig. 5. The map of the analysis of the spatial values related to the passage network. Source: authors.

Analysis Result

As it was said, the maps and interviews were categorized using AHP analysis, and then, three physical, functional and semantic structures were extracted from the mental maps of the residents using the Expert Choice software. 25 maps of the existing textures were obtained from the objective analyses. Eventually, a spatial integration was taken between the objective analyses and the three structures obtained. This section discusses which objective analysis better explains the citizen's mental map.

The research findings show that the strongest explanators in relation to the physical structure of citizens' mental maps are the "axial depth" and "texture passage network." In relation to the functional structure, the strongest explenantions are the "average depth of the convex space," "texture passage network," "total depth of the convex space," "convex space integration," and "convex space intensity." In terms of the semantic structure of the citizens' mental maps, the strongest explanators are the "convex space integration," "convex space intensity," "total depth of the convex space," "convex space control," and the "texture passage network," respectively.

Analyses show that the passage network explains the main structure of the historical texture well. It means that the network of passages alone can

simultaneously explain the physical, functional and semantic structure. Meanwhile, the attention to the degree of integration shows that the texture passage network determines the functional dimension of the mental structure of the citizens better than the physical and semantic dimensions. In addition, the passage network has a modest ability in explaining the semantic dimension of the mental structure of citizens. Therefore, it is necessary to use other objective analysis of texture for determining and predicting this dimension of texture structure (semantic dimension).

It should be noted that although the texture passage network is simultaneously the strongest explanations of the main structure dimensions, it does not mean that it is also the best explanator for different dimensions of the structure of the historical texture. In other words, other physical, functional and semantic structures of citizen's mental maps are explained more accurately by other spatial analyses (the physical dimension of the citizens' mental structure is most often explained by the "axial depth" analysis, the functional dimension by "mean depth of the convex space", and the semantic dimension by the analysis of "convex space integration").

Accordingly, the best explanators of cognitive map structures include depth, mean depth, and integration. In this way, the "axial depth" can be used to explain

the physical structure and the "convex space depth" to explain both functional and semantic structures. In conjunction with the three main concepts of spatial layout, namely, axial vision, convex space, and isowest, it should be said that only the axial vision and convex space relate to the mental structures of space users; in other words, different analyses of the isowest maps do not have a high predictability. Therefore, the use of such analyses is not necessary to explain the mental structure of the people.

The Comparison between the highest level of integration in each dimension showed that among the dimensions of the citizens' mental structure the least explainable is the semantic dimension. In other words, the semantic dimension can be predicted and explained by objective analysis of the texture less than other dimensions of the mental structure. The highest level of explanation for this dimension was made by the "Convex Space Integration Analysis" at the level of 0.447 (this is a moderate degree of

integration). It is while the physical and functional dimensions are explained by the integration level of 0.751 and 0.723, respectively (these values show strong integration). On this basis, it should be concluded that the semantic dimension forms the most intractable dimension of the mental structure of citizens that cannot easily be retrieved by objective analysis. Future research should focus on this dimension and take advantage of other objective analyses to explain it.

As a result, spatial layout analysis, in contrast to dispersion and distribution of land-use and access, has the ability to explain better, determine and predict different dimensions of the texture structure. The functional structure of the texture is most often explained by the "convex space mean depth analysis"; the physical structure of the texture is most often explained by "axial depth analysis, "and the semantic structure of the texture is most often explained by the "convex space integration analysis."

Conclusion

Based on what has been said, the perceivability and ease of drawing a cognitive map in the city are important from various aspects. While the urban planner can influence the objectivity created by this subjective image to promote and clarify the city's mental map of the citizens. In other words, the urban planner can, to a certain extent, strengthen the formation of the subjective image (perception, identification, remembrance, and re-readability) through the intervention and skillful manipulation of the objective elements of the city, and thus create a sense of place. In this regard, given the definitions are given for the structure, its concept and application the urban environment can be used as an important instrument for creating a consensus and increasing the level of sharing the citizens' subjective images. In that way, the clearer the elements of the spatial structure, the more similar the people's subjective images of urban spaces (the variance between subjective images will be less). On this basis, it is necessary to consider which of the objective elements have a greater impact on the explanation of the structures existing in the mental maps of the people.

The theoretical section of this research has shown that structure is a subjective matter developed from the perceptual frameworks of man to the environment. Accordingly, the structure should be searched in mental maps. The analytical sections also sought to discover objective methods for predicting and explaining the structure. After extracting the citizens' cognitive maps and its structures, we have superposed them and examined their integration. Finally, the research findings show that, unlike the prevailing opinion in the literature, the public land-uses and their distribution do not explain any of the dimensions of the subjective structure of the citizens significantly. Due to the insignificant integration of this objective analysis with the physical, functional and semantic structure, it can be concluded that the land-use map does not have the ability

to predict the main structure within the historical texture and cannot be used for this purpose. The "Isovist compression," "Isotope environment," "relative asymmetry of the convex space," "mean axial depth," "axial entropy" and "axial connection" are of moderate explanatory degree. It means that only one of the semantic, functional or physical structures is explained significantly. It is suggested not to use such analyses as advisors, especially when there are financial or time constraints.

The analysis of "axial depth", "convex space control", "moderate depth of convex space", "convex space integration", "convex space intensity", "relative asymmetry of convex space", "relative entropy of convex space" and "total depth of convex space" are of high degree of explanation. It means that each of these analyses significantly explains two of the semantic, functional or physical structures. It is suggested to use such analyses to determine the main structure when there are financial or time constraints.

The present research results showed that consistent with the theories in the subject literature, the strongest explanator of all dimensions of the main structure(simultaneously) is the passage network. Passage network is an appropriate explanator for all dimensions of the main structure of historical texture. However, three spatial layout analyses, namely, "axial depth," "mean depth of the convex space," and "convex space integration, "explain the physical, functional and semantic structures better than the passage network.

A higher explanation of spatial layout analysis compared with the analysis of the dispersion and distribution of passage network elements and land-uses indicate that spatial layout analysis is more capable of predicting the main structure. The present study showed that the spatial layout technique is used to predict pedestrian passages, land prices, and crime rates, as well as to predict and explain cognitive maps of citizens. The reason behind this issue, apart from the technical aspect, should be sought in theoretical and epistemological basis of the spatial layout (in which the city's units are not the spaces themselves, but the relations between them) and the main structure (in which the intrinsic features of the urban elements are not important, but the position of these elements and the roles they play are very important).

The space layout theory essentially describes the city as the spaces between the masses and not the masses themselves. Since the space order controls the nature, density, volume, approach, and direction of displacement, communication, and behavior, it forms the cognitive map of the people. The kind of behavior that a person expresses with whom, where, on what ground strongly affects the spatial order, social order, the amount of space used, and, finally, the importance of space in the citizen's mental map. Applying the ontological concepts and roots of spatial layout analysis, in which the basic units to understand the speech are not "words" but rather the "sentences," are highly relevant in the jargon of urbanization. The research showed that urban units in the cognitive maps are not the lot numbers and their land-uses or even individual spaces, but the relations between spaces make the city perceivable. In other words, words alone do not mean, but the syntactic relationships and their positioning relative to one another give meaning to the words. In the urban context, the relations between spaces determine the extent of their use and, consequently, the role of each space in the mental map. By adopting the philosophy of space layout in which the primacy of "syntax" on "components" is valid not only for the words of a sentence but also for all objects and phenomena in the world, to examine the structure of urban spaces, it is concluded that the relations between spaces are important, not the unique features of each space.

The research also showed that objective analysis could be used to determine the main structure. It is important in many aspects. First, the minimization of spatial relationships in a way that it is free of intuitive and subjective analysis, to explain and recognize the spatial structure is a low-cost, fast and free of individual tastes (and resulting human faults). Ultimately, as limitations, the semantic dimension of the subjective structure of people was explained less than two other dimensions by objective maps. Future research needs to be focused on a

different category of existing texture analysis so that it will be able to provide stronger explanation for this dimension of the mental structure. Finally, in order to investigate the generality of the findings of this study, it is necessary to re-examine the similar findings in other urban textures (such as new textures or intermediate textures) and analyze the results

Endnote

The spatial layout analysis is based on the following three spatial concepts:

1. Visual field or visual scope (the term used by Michael Benedict from University of Texas) refers to the visible polygonal field or a level that is seen from any point in space. In other words, the visual field is the entire range that can be seen from a specific point in space.

2. Axial space or axial line (the idea proposed by Bill Hiller from University of U.C.L) refers to the linear and straight visual field of an observer and the resulting path. In the definition of the axial space, it should be possible for the observer to go through the visible linear path and reach the observed point.

3. Convex space (the term used by John Peponys et al. in Georgia Tech) refers to empty spaces that do not cut the environment and leave it out, if we draw a line between the two points in the environment. In other words, it is said to be a polygon that all points within it are visible from all other points within the same polygon.

Integration: is one of the most important factors in spatial layout, which implies spatial cohesion. That is, the greater the degree of integration in one space, the more coherent the space is with other spaces and the overall space of a city. This feature also indicates the amount of access to the space, i.e. the more integration it has, the higher the access space.

Manipulate: This term is used by Gordon Cullen in his book "Urban Landscape", which means manipulating urban elements to ensure their impact on human senses.

Entropy: It analyzes the extent of space situations with their depths relative to space, rather than the depth of the spaces relative to their own. If there are a lot of situations close to the space, that space is asymmetric, which means that its entropy is low. If the depth is equally extensive, then the entropy value is higher. This index can express important cultural topological differences in spatial outputs.

Reference list
- Abubakar, I. R. & Aina, Y.A. (2006). GIS and space layout: An analysis of accessibility to urban green areas in Doha district of Dammam Metropolitan Area, Saudi Arabia. *Proceedings of Map Middle East Conference*, Dubai, UAE, March 26-29.
- Ahari, Z. (2012). *Isfahan School in Urbanism*. Tehran: Tehran Art University Publication.
- Azad Armaki, T. (2004). *Sociology Theories*. Tehran: Soroush Publication.
- Andrade, GI. Remolina, F. & Wiesner, D. (2013). *Assembling the pieces: a framework for the integration of multi-functional main structure in the emerging urban regions, Urban Ecosystems*. New York: Springer.
- Al-Sayed K., et al. (2014). *Space layout methodology, Architecture & Cities*. UCL, London: Bartlett School of Architecture.
- Bahrainy, H. & Khosravi, H. (2013). The impact of urban design features and qualities on walkability and health in under-structure environments: The case of Hashtgerd New Town in Iran. *Cities*, (2): 17-28.
- Badita, A. & Popescu, L. (2012). Urban image analysis through Visual Surveys. Craiova City (Romania) as a study case. *Forum geographic*, 4 (2): 223-228.
- Balcan D., et al. (2009). Multiscale mobility networks and the spatial spreading of infectious diseases. *Proceedings of the National Academy of Sciences,* (324): 1557–1561.

- Bart, R. (1997). *Empire of Signs*. Translation by Fokohei, N. Tehran: Ney Publication.
- Bahraini, S. H. (2011). *Urban Design Process*. Tehran: University of Tehran.
- Daggitt, ML., Noulas, A. & Shaw, B. (2016). *Tracking urban activity growth globally with big location data.* Royal Society Open Science.
- Dehghani, M. & Alikaei, S. (2013). Analysis of the Effect of Levi Strauss Structuralism on Urban tructuralistTheories. *National Conference on Architecture, Culture and Urban Management*.
- Dias P. & Ramadier, T. (2015). Social trajectory and socio-spatial representation of urban space: the relation between social and cognitive structures. *Journal of Environmental Psychology*, (41): 135-144.
- Gartner, G. (2010). Emotional response to space as an additional concept of supporting way-finding in ubiquitous cartography. In *Mapping Different Geographies*, Springer Berlin Heidelberg, Germany.
- Ghoraba, N. & Tabibian, M. (2017). Recognition of the role of subjective perception in the definition of city structure. *Urban Management Publication,* No. 49, Winter 2013.
- Grichting, W. L. (1984). The meaning of social policy and social structure. *International Journal of Sociology and Social Policy*, 4 (4): 16-37.
- Hafez Nia, M. R. (2006). An Introduction to Research Methodology in Human Sciences. Tehran: SAMT.
- Hillier, B. (1996). *Space is the Machine: A Configurational Theory of Architecture*. Cambridge: Cambridge University Press.
- Hillier, B. (1999). The hidden geometry of deformed grids: or, why space layout works, when it looks as though it shouldn't, Environment and Planning B. *Planning and Design*, (26): 169-191.
- Jiang, B. (2008). A space layout approach to spatial cognition inurban environments, Position paper for NSF-funded researchworkshop Cognitive Models of Dynamic Phenomena and Their Representations. Pittsburgh: University Pittsburgh.
- Kaplan, S, (2016). *Cognitive maps, human needs and the designed environment.* Chicago: Aldine.
- Karrholm, M., Nylund, K. & Fuente, P. P. (2014). Spatial resilience and urban planning: Addressing the interdependence of urban structures. *Cities,* (36): 121-130.
- Levi-Strauss. (2014). *Structuralism and Sociological Theory*. London: Taylor & Francis.
- Liu X, Kang C. & Gong, L. (2016). Incorporating spatial interaction patterns in classifying and understanding urban land use, *International Journal of Geographical Information Science,* (30): 334-350
- Lichfield, N. (2011). *Settlement planning and development: a strategy for land policy*. Vancouver: The University of British Columbia.
- Luchsinger, A. (2013). Structuralism in Urban Architecture and Planning. Translated by Izadi, M. S. & Ghoraba, N. Tehran: Yadavaran Publication.
- Lynch, K. (1981). A Good City Form. Translated by Bahreini, S. H. Tehran: University of Tehran.
- Mansouri, S. A. (2007). Two periods of space organization in the Iranian city: before and after Islam, with the use of evidences of developments in Kerman city. *Bagh- e-Nazar*, (7): 49-60.
- Marcus, L. & Giusti, M. & Barthel, S. (2016). Cognitive affordances in sustainable urbanism: contributions of space layout and spatial cognition. *Journal of Urban Design,* (21): 439-452.
- Moughtin, C. (1999). *Urban Design: Method and Techniques*. London: Routledge.
- Neacsu, M. C. & Negut, S. (2012). City Image Operational Instrument in Urban Space Management. Romanian Sample, In: J. Burian (ed.) *Advances in Spatial Planning*, Rijeka: InTech. (13): 247-274.
- Nold, C. (2009). *Emotional Cartography- technologies of the self*. Available from: http://emotionalcartography.net/EmotionalCartography.pdf, 2009.
- Oranje, M. (2014). *The language game of South African urban and regional planning: A cognitive mapping from the past into the future*. institutional Repository. London: Routledge.

- Pakzad, J. (2011). *Articles on Urban Design*. Tehran: ShahidiPublication.
- Panther, J. (2001). Sense of Place, Authenticity and Character. *Journal of Urban Design*, 6(1): 73–86.
- Paz, A. (2016). Introduction to "Teleologies of Structuralism". *Journal of Ethnographic Theory*, (8): 29-31.
- Peponis, J., & Ross, C. & Rashid, M. (2014). The structure of urban space, movement and presence: The case of Atlanta. *Geoforum*, 28 (34): 341-358.
- Pour Jafar, M. R. (2008). Phenomenology of Urban Environment: A Reflection on The Promotion of Space to Urban Place. *Journal of Environmental Science and Technology*, 10 (4): 282-297.
- Quercia, D., Schifanella, R. & Aiello, L. M. (2015). Smelly maps: the digital life of urban smells capes. *Journal of Social and Information Networks,* (8): 39-50.
- Raford, N. & Ragland, D. (2003). *Space Layout: an innovative pedestrian volume modeling tool for pedestrian safety.* UC Berkeley: Safe Transportation Research.
- Roth, C., Kang, S. M. & Batty, M. (2011). Structure of urban movements: polycentric activity and entangled hierarchical flows. *PLOS One*, 6(1): 15923.
- Sadovsky, V. (1982). The methodology of science and system approach, Translation by Periani, K. *The scientific journal of Haddad.*
- Sheriff, JK. (2014). *The fate of meaning: Charles Peirce, structuralism, and literature*. Princeton: Princeton University Press.
- Tannis, F. (2011). *Space, City and Social Theory, Social Relationships and Urban Forms*. Translation: Parsi, H. R. & Aflatouni, A. Tehran: University of Tehran.
- Tavalayi, N. (2007). *Integrated City Form.* Tehran: Amir KabirPublication.
- Wilson, R. C. & Takahashi, Y. K. & Schoenbaum, G. (2014). Orbitofrontal cortex as a cognitive map of task space. *Neuron*, 81(2): 267-279.
- Zebardast, E. (2001). Application of Hierarchical Analytic Process (AHP) in Urban and Regional Planning. *Honar- ha- Ye- Ziba*, (10): 13-21.
- Zeile P., et al. (2015). Urban emotions: benefits and risks in using human sensory assessment for the extraction of contextual emotion information in urban planning. *Planning support systems and smart cities*, (12): 209-225.
- Zhong, C., et al. (2014). Detecting the dynamics of urban structure through spatial network analysis. *International Journal of Geographical Information Science,* 28 (11): 1-21.
- Zhu, X. & Ghahramani, Z. (2002). *Learning from labeled and unlabeled data with label propagation. Technical Report CMU-CALD 02-107*. Pittsburgh, USA: Carnegie Mellon University.