

Investigation of Presence In-Between Spaces of Public Arenas by Using the Space Syntax Technique (Case Study: Traditional Shiraz Bazar)

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Abstract

It is imperative to be present in the intermediate space of public arenas such as Bazaar. Important components effectively raise the desired quality of presence in these spaces. This research aims to investigate the factor of presence in Shiraz Bazaar. In cities, these public areas are arranged without considering the important components. Various factors affect attendance in the intermediate spaces, the aim of this research, considering the psychological aspects and increasing the quality level of the mentioned spaces, is to find the spatial elements and characteristics that are effective on attendance in the Bazaar space. The main question is: how can the components of presence in public arenas such as Bazaar be identified using the spatial layout technique? In this research, by using the methods of testing the audience's visual perception in a case study of Shiraz Bazaar, with specialized software, the measurement of effective visual factors in the interstitial space, such as Depthmap has been investigated. In this research, Visibility Graph Analysis (VGA) analysis has been used as the main analysis to investigate the spatial relationships of the collection. VGA analysis shows the visual continuity in the collection. This analysis has five indicators; Visual integration, control, continuity, entropy, and visual depth have been investigated. The result showed that the most important factor is the visibility and accessibility of the spaces to check the attendance rate in the public space of the Bazar or other words the spaces in between (including the Bazar and the public space of caravanserais). Examining this index is responsible for the level of cohesion and integration of spaces, privacy and privacy, and physical and visual accessibility, and is directly related to the degree of legibility and the way of hierarchy of spaces.

Keywords: Presence, Public Space, In-Between Spaces, Space Syntax, Shiraz Bazar

Introduction

Urban public spaces are among the most important areas in cities due to having interactions and relationships between individuals (Tibbalds, 2004 quoted from Rafieian et al., 2022). These arenas indeed are some parts of open and public spaces in cities where communal life exists (Pakzad, 2004). Publicness of arenas means the presence of people from different walks of society and age ranges, as well as available social and service activities in these areas (Tibbalds, 2004). In the opinion of Hall (2008), the environment is divided into two sociable and antisocial categories. The arenas are named based on the qualities that bring people together or keep them apart (Hall, 2008). Jane Jacobs (2009) describes the vitality index as the most important factor for attendance and permanent sociability of individuals in the environment (Jacobs, 2008). Public spaces serve as a space for people meetings (Gehl, 2008). The main function of public arenas is to provide the field for people's presence, so has a valuable position (Rafieian, 2009). Individuals need an appropriate urban field to be present in society. Physical settings and public areas are required in urban communities to meet the mentioned need (Daneshpour, 2007).

Loss of these arenas would decrease attendability and subsequently the urban social relationships. Public arenas are related to public activities. Public arenas are incomplete spaces that are completed with human presence. These spaces are indeed used for interactions and attendability.

The collective spaces' success secret is hidden in the sociability and active presence of citizens in these areas. The creation of communications networks of arenas is the factor that increases individuals' quality of presence. In this case, Nader Ardalan (2001) believes that Iranian architecture passes humans through an unobstructed space (vacuum), not through a solid mass (filled), and therefore, no fault continuous or barrier is created in the passageway of man. Human always moves in a wavey and extensive space that is continuously unique (Ardalan, 2001). Stierlin (1998) believes that passing from one to another arena is always repeated in the architecture of Iranian urban planning without any interruption in continuity. The reason is that buildings are synthesized in a continuous and dense texture. The building does not appear as a separate and single structure. It is not a wondering piece placed on a surface, rather is included in an urban fabric. It is a fabric that determines the dominant and important lines, such as the location, route, mosques, bazaars, and passages, as well as the major dominant situations and rituals (Golestani et al.,

2017). The important point in Iranian architecture and urban planning is the connection between components. In addition to physical and body distinctions between adjacent spaces, in-between spaces provide many functional and conceptual features and make the spatial dimensions meaningful. Ultimately, the connection between them results in the definition and limitation of a third space. It means that in-between space is a space that:

- A) Is limited based on the physical and form elements that imply the determination of borders and boundaries.
- B) Becomes meaningful in that focal point.
- C) Become a place for interactions (Balilan Asl et al., 2011).

Thus, physical characteristics of in-between space require using some words that represent multiple forms, semantic, and communicational aspects of this space. Hence, it is called the systems of in-between spaces in this research. These spaces play an effective role in presence perception and encourage users to search in the space due to creating value in the connection between inside and outside spaces (Grutter, 2004). In-betweenness in the closed traditional bazaars appears in different forms depending on the design of urban neighborhoods. In general concept, it consists of all entries, courtyards, portals, corridors, etc., and in more particular concept, connections between spaces are known with in-between systems that provide users with pause and authority for choice. These systems include rooms with four corners, halls, portals, etc. (Balilan Asl, 2011).

This topic must be examined because many indicators respective to space reading unfortunately have not been considered by designers in the design of many uses, including commercial uses. This issue leads to lower space efficiency and sometimes to intangibly less satisfaction and attendability of space.

In-between spaces of Iranian Bazar have been examined as a case study in terms of social-architectural aspects. In the first step, a pattern is prepared for in-between spaces at the theoretical level by using and identifying the physical features of architectural space, and then this model is examined based on the criteria adopted from architecture-associated attendability.

VGA analyses have been used in this research as the main analysis for examining spatial connections of the collection. The VGA analysis indicates the visual continuity in the collection. Visual integration means the number of visual steps required to go from one to another point in a system. Therefore, visual integration analysis indicates the rate of interaction between individuals and space. In general, VGA analyses can describe sophisticated spatial relationships but are limited to two dimensions, and the initial idea for the 2D nature of Depthmap is that humans do not fly in space. VGA analysis (visual integration analysis) has been done in this research to examine attendability in bazar. This analysis has investigated five indicators of visual integration, control, connectivity, entropy, and visual depth.

Background

The background of the case study expresses the research topic and approach of many researchers who have conducted studies in the same field. These studies include Iranian and foreign papers, books, and dissertations (Table 1).

Table 1. Research background (Source: Authors)

The changing nature of in-between spaces in the process of urban evolution	Rambza and Sasbjarska, 2022	Security, physical safety of space	The results indicate that the evolution process of in-betweens in public spaces may change the nature of cities, improve the compactness of cities, and increase the quality of life.
City interconnectedness: achieving urban convergence by examining in-between spaces in the city of Caracas	Garcia Alcaraz, 2022	Social interactions, identity, convergence, social distance	The results imply that in-between spaces can shape the coherence, convergence, and political power of a land that is created by confirming social interactions.
Modeling in-between spaces in native houses in East Gilan	Malek Fazli, 2022	Porches and stairs	Porches and stairs are the most used types of spaces in the houses of these areas.
Change and allocation of in-between spaces in Cairo	Abu Ali et al., 2022	Spatial quality, Life	People can revive the in-between spaces in the dynamic and creative ways. In-between spaces can be developed for better realization of

			functional and symbolic values.
There is a ripple effect: A social identity perspective on the role of in-between spaces	Fang and Haslam, 2021	Identity, wellbeing, social spaces, attend ability	In-between spaces can support positive social identities, being in the in-between spaces facilitates a sense of well-being, and in-between spaces are potential interfaces for broadening the community.
In-between spaces in the global age	Lazzarini, 2021	Communication and individual-collective identity, social dynamics	The urban public space is a place where continuous experiences are formed, and the differences between experiences are revealed concerning the “in-between space” or an in-between dimension.
Evaluation of the impact of spatial structure of the in-between spaces among dense houses on the social interaction of users	Zeruti and Bella, 2020	Social interactions, permeability	Social activities in mass residential areas depend on the permeability of the intervening spaces, which can increase interaction and social activities if appropriate.
Promoting attendability through the planning of in-between spaces: a theory-based framework	Goossen and Glyers, 2020	Civic identity, quality of life, social capital, and revival of society manifest	The attendability of spaces has become increasingly influential in the field of urban planning. The in-between spaces have served as a facilitator in strengthening public life. They also have direct (economic) and indirect (environmental and social) advantages.
Knowing how to use the in-between spaces to be present during crises	Vox and Essie, 2019	Attendability, sociability, security, body, crisis	The results show that in-between spaces during crises such as war, coercive incidents, etc. are the best places for the attendance of prominent people. People’s awareness of using these places can be improved by creating coffee shops, and commercial and exhibition spaces.
Discourse change in the in-between spaces” ideological concepts	Weksber and Aberlander, 2017	Social, business, and digital (virtual)	The in-between spaces provide a space for people to make a balance between the emotional attachments of home and family and the challenge of striving for competence and reward in the commercial space.

Theoretical foundations

Attendable spaces

Appleyard (1979) defines attendable spaces as spaces that develop a sense of comfort and boost communications. The comfort results from contacts that are joyful and bring pleasure. The contacts confirm individuals as some people of society (Appleyard, quoted from Shojaee & Partovi, 2015). In such places, individuals talk to each other for hours and experience long goodbyes. A place where, people spend their time and say you are welcome, thank you, etc. to their neighbors and strangers. It is a place where social life exists. These arenas encourage social interactions (Hall, 1982). It is a place for discovering facts or is the area for various amenities and being face-to-face. A place where, people share their ideas and feelings (Scholtz, 2005).

It is a space where, we can see our fellow citizens face-to-face and directly, and achieve experience through our senses (Gehl,

1987).

Sociable

This term means smoothing the social connections and is used when it provides space features and a way for creating social relationships. Sociable points to the quality of space designed based on the criteria of creating social interaction, vitality, etc., so that people find their outside environment and space with favorable and desirable conditions (Golkar, 2000). A sociable space brings people together and smooths social communications (Pakzad, 2007). In another definition, a sociable space includes some environmental capabilities that their promotion increased human interactions and communications. A sociable space is defined as a lively space that people always attend voluntarily and willingly (Jacobs, 2008 quoted from Shojaee & Partovi, 2015).

According to the definitions expressed by the researchers and theorists, it can be explained that space is attendable or sociable and can provide a public community during all hours of the day and night within long hours. In other words, it is an inviting space. Such space firstly provides social contact in the first step and subsequently social communications and interactions. Meetings, dialogue, etc. appear in such relationships. This space provides the field to achieve experience, share feelings, ideas, etc. (Shojaee & Partovi, 2015).

Collective arenas (public spaces)

Public space is defined as an open and accessible place or location that improves suitable behavioral patterns (Mardomi and Ghamari, 2011). Sociability in public spaces is based on the people's need for a sense of social belonging and interaction with each other, and this need is met in a supportive social space where, physiological comfort (Lang, 1994), territory claim, sense of ownership, and receiving justice in the space are provided.

Streets, squares, public passages, open spaces, parks, recreational spaces, street bazaars, etc. are among collective arenas where all people have easy access to them within different times and seasons of the year regarding their age and gender characteristics. Such spaces must be suitable for doing diverse activities (based on the culture of society, including holding celebrations or mourning ceremonies). Various mixed uses that citizens need must be established in these spaces. These places must provide the field for social interactions and relationships, and public organizations should be able to manage them to meet public interests. These spaces must include some criteria such as legibility (spatial and visual perception), human scale, security, human-centeredness, urban equipment and amenities matched with space performance, and finally must follow the common rules and norms available in the society (Partovi, 2012).

Space Syntax

Space syntax is a set of techniques used to introduce and describe spatial patterns. These techniques can provide spatial patterns in the acquired 2D structures (Hillier & Hanson, 1984). It includes theories and techniques for analysis of spaces' configuration that were introduced in the late 1970s by Bill Hillier, Julienne Hanson, and their colleagues at the Bartlett, University College London after many years of studies and finding affective factors and hidden patterns behind the forms of indigenous residence spaces (Hillier, B., Hanson, J., & Peponis, J. (1984)).

The rate of access to each part of the building would directly affect the quality of space. For instance, access through several entries to one space would decrease control over that space and increase the movement rate in that place. Thus, it increases the permeability rate of space. On the other hand, it limits the access and single connection between spaces and increases their control limit. Hence, it seems that the assessment of spatial patterns or genotypes of inequality or space syntax theory graphs in the indoor space of houses seems the most efficient solution for analyzing the relationship between spatial organization and social meanings regarding the social logic of space syntax theory.

The space syntax software or Depthmap is used in new studies due to some problems and limitations in graph analysis techniques. Evaluation of physical access in the case studies is also done through the capabilities of Depthmap Software. To do so, visibility analysis and depth step or step depth are used without considering the metric distance and only by changing the space (and metric depth by considering the metric distance). Analyses related to physical access can be done by using these two techniques. Varoudis et al. tested this problem in a paper and described the effect of different kinds of visual and physical accesses on the space structure and quality and social relations ruling it (Varoudis and Penn, 2015: 155-152).

The term “in-between” space is the most common definition presented for the space existing between inside and outside. This escape is a “semi-private and semi-public” arena that is not fully public or private. This intermediate space does not have an independent form, character, and place but is a place between some spaces with several characters and identities, so is a space used to improve connections between spaces. In other words, this space does not have its specific borders and is determined and defined by the spaces around it. When this space is opened then it provides social, cultural, and normal interaction, so that various covert potentials and abilities appear in this place (Grosz, 2001: 93). These places mainly play the role of threshold spaces. They are border crossings and places in which, citizens with different viewpoints meet each other (Hajer& Reijndrop, 2001: 128).

Studied Area

Shiraz Bazaar

This bazaar is part of a large area, which was constructed under the order of Karim Khan Zand after the Shiraz was chosen as the Capital. This bazaar was constructed in a large area between the Citadel and indoor space with the cooperation of some popular architects, industrialists, and masters of that time from 1804 to 1808. It is said that Karim Khan ordered to building of this bazaar after he saw Qeysarieh Bazaar in Lar (Proshani, 2019). A pleasant description exists about Shah Square and its bazaars, considering this bazaar a factor for the reputation of Shiraz, and introducing it as the most active bazaar of Iran that represents the eastern and Iranian bazaars. By describing this bazaar, Pierre Loti introduces Sarajan Aisle as the most beautiful part of this market. In the present place of Vakil Bazaar, some buildings possibly existed that their background goes back to Safavid era. In 1936 after Karim Khan Zand Street- as one of the main routes in Shiraz was extended, 8 arches of this bazaar and some part of Ghavami and Roghani Caravanserais that blocked the street were destroyed, so a part of the north side of this bazaar was separated from the rest area, and located in other side of street. Vakil Bazaar was constructed on a route that reached Allah Akbar Tang to the former Isfahan Gate near the gate and inside the fence. This Bazaar is Chalipa-shaped and made of four aisles. The main branch made of two north-facing and south-facing aisles is around 500m (Porshani, 2019). The north-facing aisle to Chaharsoo that has 48 arches is called Kolahdoozan Bazaar, the north-facing aisle with 40 arches is called Bazazan Bazaar, the east-facing aisle with 19 arches is called Alaghebandan Bazaar, and the west-facing aisle with 11 arches is called Tarkeshdoozan Bazaar. On the west side of the southern aisle and its middle area, another bazaar called Shamshirgaran Bazaar exists that was a place to make swords and had 11 arches, which its end is connected to a large northern-southern aisle. The entrance opening of this bazaar is located in front of Vakil Mosque's portal linking this mosque to the whole area of the bazaar.

The width of the aisles in Vakil Bazaar is greater than the area of all bazaars in Iran. There are some stone-made platforms with Toranj motifs in the front of each chamber (store). The roof of the aisles is made of a row of brick domed arches, bent arches, simple architectural works, and twill brickworks that have created a highly beautiful view of the bazaar space. Air conditioning and lighting of the bazaar are provided on the top of each chamber through the pores worked on the domes or through windows deployed on the ceilings. In the past, the floor of this bazaar was around 1m lower than the current surface, and it was paved with gray-colored slate stone with a beautiful marble pond located in the middle of Charsoo, which was buried under the soil after the bazaar floor raised. In the past, the bazaar had five big doors that were used to protect the bazaar at night. In the construction of the bazaar, stone was used in the foundation and base of platforms and forecourt, brick in the walls and arches, and wood in the construction of doors and gates of the chambers. Chaharsoo or the intersection place of aisles is a space with eight corners with two chambers in each corner of it.

Vakil Bazaar has five large caravanserais connected to the aisles where warehouses and chambers of merchants and industrialist workers exist. Of them, four caravanserais are located in the north-facing aisle three of them (i.e., Roghani, Ahmadi, and Gomrokkhaneh Caravanserais) are located in the east front that were constructed at the same time with bazaar construction, and the fourth one is located in west side. The fifth caravanserai called Fil Caravanserai is located on the north side of Shamshirgaran Bazaar, which is a complex of commercial chambers. The main gate of Roghani Caravanserai is decorated with beautiful Muqarnas and the entrance corridor and dado are coated with red-colored stones. The main wooden door of this caravanserai still exists.



Fig 1. A view of Shiraz Bazaar

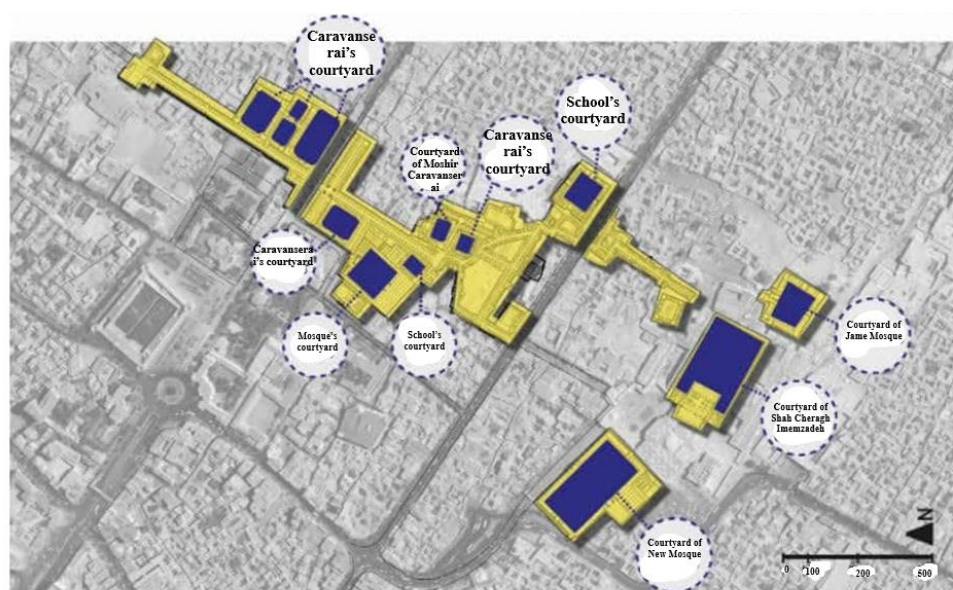


Fig 2. Various sequences in the aisle of Shiraz Bazaar (Source: Hakimian, 2019)

The route of the Vakil Bazaar allows the audience to have a long view of the indoor space of the bazaar at the longitudinal axis. This uniformity illustrates the quality in different sequences at the view axis with transverse divisions of space. Because the longitudinal axis is divided into rhythmic transverse axes and each axis ends in a chamber, it leads to dual physical movement in the bazaar's body. The audience passes the route sometimes longitudinally and sometimes transversely. This dual movement would create different perspectives of the space body in the mind. Also, movement sometimes can be visual. The visual image of space results in physical movement. The visual image is done through the eyes in the space and space perception.

The effective theory used in the research

Hillier's configuration theory (space syntax and visibility)

This theory was projected in London by Hillier and Hanson (1984) and is based on the study of the connection between social and spatial forms. This theory believes that space is the main and primary core of social and cultural incidents. However, because space is itself shaped by social, cultural, and economic processes, it is usually considered a platform for social and cultural activities so its form is not usually considered and is assumed invisibly (Rismanchian, 2010: 50). Space syntax includes a set of analytical techniques that describe the relationships between space and society (Hillier, Hanson Peponis, 1984).

This method formulates the characteristics of space configurations by using graph-based techniques and describes and analyzes the architectural space patterns in the building, city surface, and the method through which spatial patterns are shaped within buildings and cities (Hillier, B. 2005).

Visibility: The legibility of spaces is affected by the visual access rate. In the space syntax, visual information is described by anisovist which is a set of visible points from the proper point in the space (BENEDIKT, M. L. 1979). When doing spatial analysis, space syntax has the potential for assessing both accessibility and visibility situations (BECK, TURKIENICZ B. 2009).

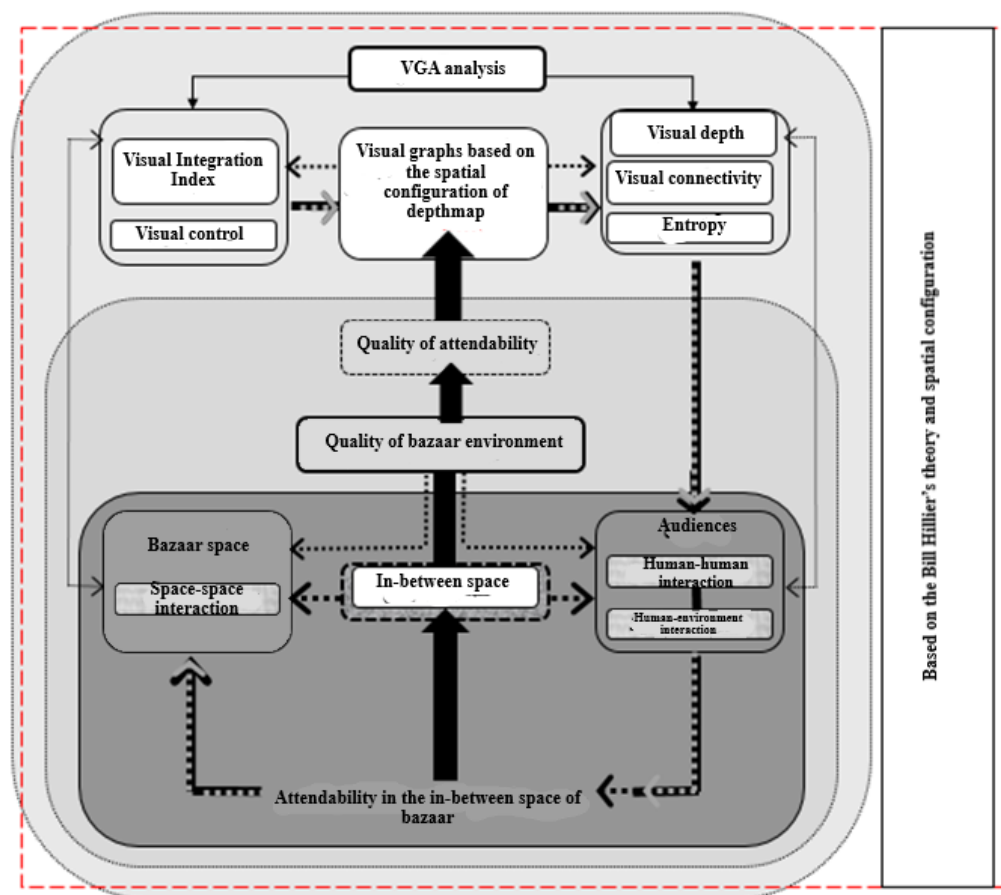


Fig 3. The final model of Bill Hillier's theory for achieving required indicators based on the visual perception in the in-between space of public spaces in the Bazaar (Source: Authors)

Method

This study tends to examine and compare the quality of various accesses, including physical access and visual access in the in-between spaces of traditional Shiraz Bazaar to find the audiences' attendability. Thus, aisles of Shiraz Bazaar, Haals, and Caravanserais in the historical fabric were chosen as the case study.

It is worth noting that the "percentage measurement" and "graph changes" (minimum and maximum) techniques are used for accurate comparison between the mentioned cases regarding the variable area of Halls and in-between space in the bazaar aisle. Therefore, the area differences do not affect the spatial analysis of case studies. To compare these qualities, a strategy must be used in this field that provides a powerful technique for the evaluation of acquired data. To do so, space syntax theory and its solutions for space interpretation were used regarding the nature of this theory.

Having a computer simulation tool (Depthmap Software) for the assessment and evaluation of data, this technique can process many syntax features in the space configuration. The output of this technique helps to examine and discuss the quality of the environment.

After the case studies were analyzed through computer tools and quantitative data were obtained, a qualitative strategy was used to analyze the results. In this technique, authors investigated the reasons for research results relying on direct observations and their respective documents. Therefore, it is stated that the method used in this paper is a combination of quantitative (software analyses) and qualitative (logical reasoning) methods. Fig 4 depicts the research process and assessment of visual and physical quality in the Shiraz Bazaar.

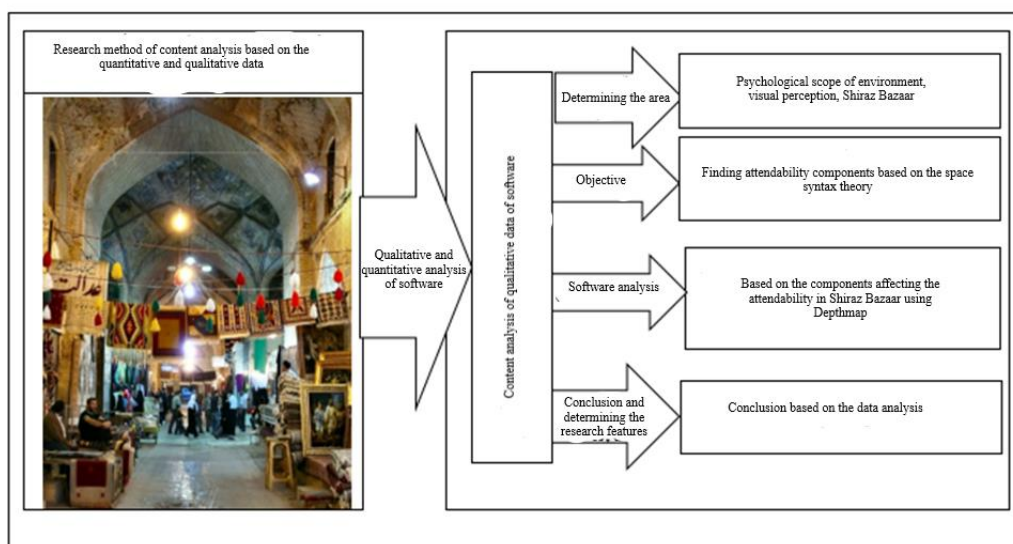


Fig 4. Research method model-Source: (Authors)

Data analysis

To analyze the data of the research, quantitative data is used through the space syntax technique Software. The following results are extracted from the conducted analyses.

Analysis process

In this research, VGA analyses are used as the main analysis for examining spatial relationships of the complex. VGA analysis indicates visual connectivity in the complex.

Visual integration means the number of visual steps required to go from one to another point within a system. Therefore, visual integration analysis indicates the rate of interaction between individuals and space. In general, all VGA analyses can describe complicated spatial relationships but are limited to two dimensions, and the initial idea for the 2D nature of Depthmap is that humans cannot fly in space.

VGA analysis is indeed a two-step process. In the first step, a set of suitable points is determined on the plan that these points form the graph nodes. In the second step, edges or lines of the graph are created between the points that are directly in visual connection with each other. It can be explained by these relationships that when point A has a view to point B point B also has a view to point A.

The VGA analysis assesses the depth of all points, indicating whether the depth of each area is greater or less than other areas. In this analysis, those points having the best collection with other spaces appear in red. It can be stated that these spaces have less depth. Those points with fewer connections to other areas appear in the color spectrum from cold-green to dark blue.

In general, it is stated that those points with more visibility and better connection to other areas appear in warm colors and those points with less visibility and fewer connection to other areas appear in cold colors.

VGA analysis (visual connectivity analysis) has been done in this study to examine the attendability rate in bazaars. This analysis examines five indicators: visual integration, control, connectivity, entropy, and visual depth.

Visibility and accessibility of spaces are the most significant factors used to examine attendability in the public space of the bazaar or other words, the in-between spaces (including the bazaar aisle and public space of caravanserais). Assessment of this index indicates coherence and integration rate of spaces, private space, privacy, physical and visual accessibility, and has a direct relationship with spaces' hierarchy. Therefore, VGA presents the best response to these indicators.

In addition to the bazaar aisle which is the main in-between space, the spaces discussed in this analysis are shown as secondary in-between areas in Fig 5. In this research, visual integration, control, connectivity, entropy, and visual depth are examined as the most important indicators affecting attendability.

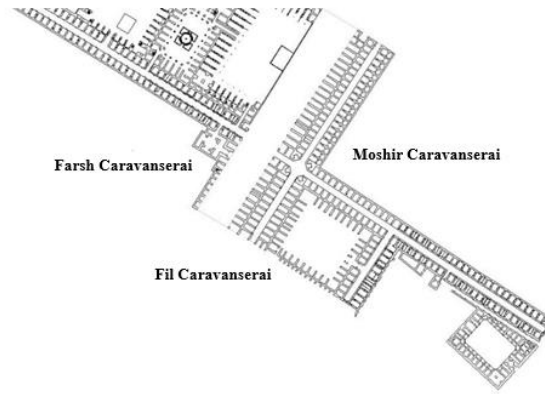


Fig 5. Spaces analyzed in the study (Source: Cultural Heritage Organization of Shiraz)

1.1.1.1. Visual integration analysis

According to visual integration analysis, it can be stated that the bazaar aisle- as the main in-between space- is more visible than other areas. The value of the visual integration index for the in-between space of the bazaar aisle varies between 7.48 and 8.48. This value has the maximum rate in the intersection between the bazaar aisle and the street and is shown in red color in the analysis. In this area, individuals have longer horizontal views so create better connections with other areas. This area appears in the spectrum of red, orange, and yellow colors in the analysis. This index shows different values in different spaces of the bazaar.

Moreover, the distribution of warm and cold colors in the graph of various bazaar spaces indicates the privacy rate and the demarcation of that space from other areas. Among the spaces studied in this area of the bazaar, the lowest visual integration rate belongs to Fil Caravanserai, which appears in the color spectrum analysis from bright to dark blue. (this space has more privacy rather than other caravanserais). The entrance space of each caravanserai is more visible and accessible than other areas and also depicts the entry hierarchy. Farsh Caravanserai (Zarrabkhaneh) appears more in the green color spectrum, which indicates high accessibility and visibility and its better connection with the main aisle of the bazaar.

Moshir Caravanserai which is located in the main aisle of the bazaar has a high quality of visibility and accessibility and is placed in the communicational route. According to the conducted analysis, among considered spaces, the elements of furniture deployed in the space such as ponds and green spaces somewhat decrease the quality of visibility and accessibility in the courtyard of caravanserais (Fig 6.).

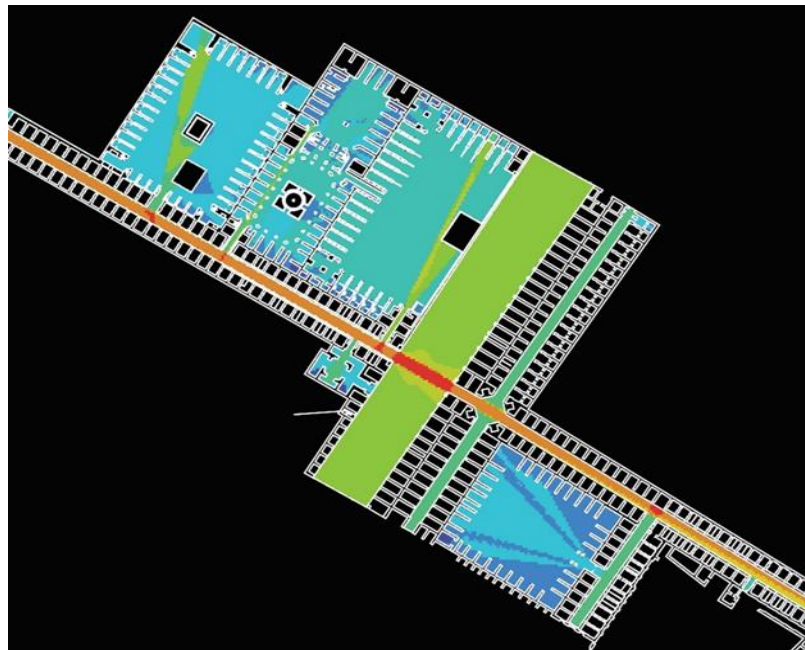


Fig 6. Visual integration analysis (green color spectrum has appeared that indicates high visibility and accessibility and its better connection with the main aisle of the bazaar)

The visual integration index has been measured roughly for different spaces by choosing one point of each space.

Table 2. Visual integration index

Fil Caravanserai	Moshir Hall	Farsh Hall	Roghani Caravanserai	Ahmadi Caravanserai	Gomrok Caravanserai	In-between space of bazaar aisle
3.88	7.67	4.65	4.41	4.13	3.88	8.48

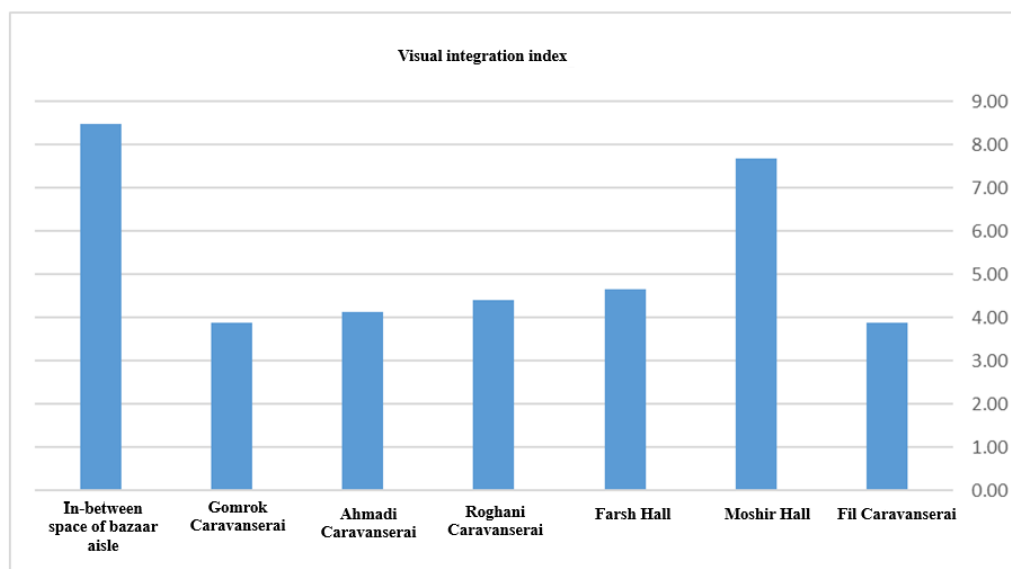


Diagram 1. Comparative graph of visual integration index

In the comparison of in-between spaces, the bazaar aisle serving as an in-between space indicates the highest visual integration index. According to the graph, the visual integration index indicates the highest value for Moshir Hall after the bazaar aisle. This hall is located in the main aisle of the bazaar and has the highest integration with surrounding spaces. Farsh Hall also indicates a relatively high visual integration index due to its better access to surrounding spaces (Table 2. & Diagram 1.).

Visual control analysis

In the visual control analysis, that space that has control over other spaces is highlighted. This space can be effective in providing security for other areas. In the space of a prison, the main aisles and central core space have control over the prison cells, for instance. This issue is also related to visibility and accessibility. Control index in the studied houses is closely related to spatial hierarchy and control over the space. It also holds the role of more private and public spaces. This case is also important for providing security of spaces.

In the assessment of the bazaar aisle as the main in-between space, the highest rate of relative control index is related to the intersection between the bazaar aisle and sub-routes that appear in the red color in the analysis. The value of the relative control index for these areas varies between 2 and 2.20.

This index is related to the spatial and plan structure of caravanserais, and in all considered spaces, the courtyard plays the role of controller space that has relative control over other spaces. In the intersection between the bazaar aisle and the street, the most relative control is seen in the route that appears in red within the analysis. Also, this quality is seen in all intersections between main and secondary routes, and the intersection between the route and entrance of caravanserais (Fig 7.).

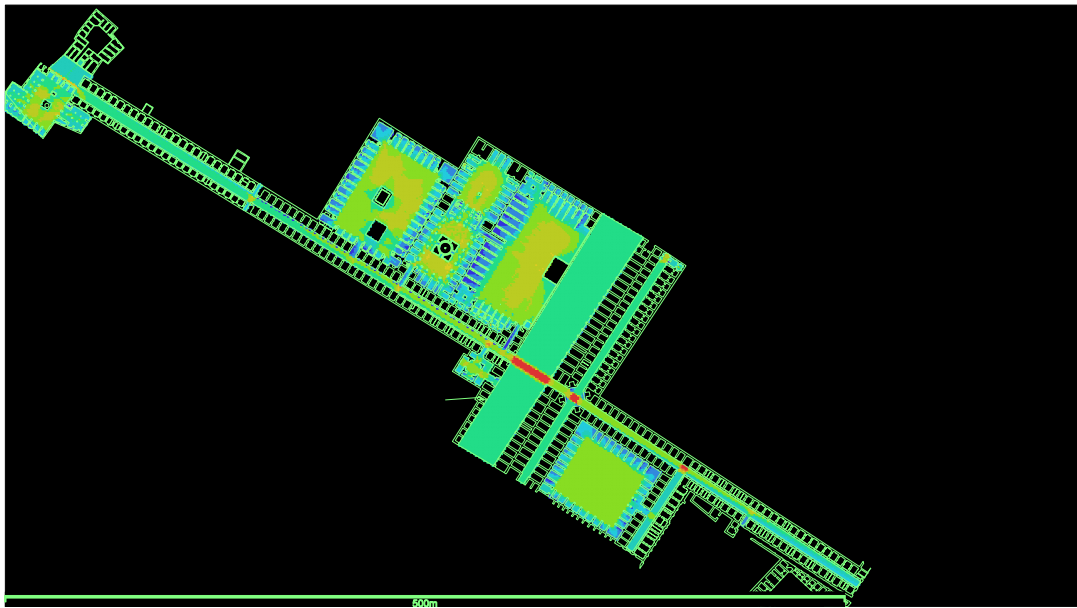


Fig 7. Visual control analysis (In the intersection between the bazaar aisle and the street, the most relative control is seen in the route that appears in red within the analysis)

Table 3. Visual control index

Fil Caravanserai	Moshir Hall	Farsh Hall	Roghani Caravanserai	Ahmadi Caravanserai	Gomrok Caravanserai	In-between space of bazaar aisle
1.30	2.20	1.33	1.42	1.38	1.35	2.20

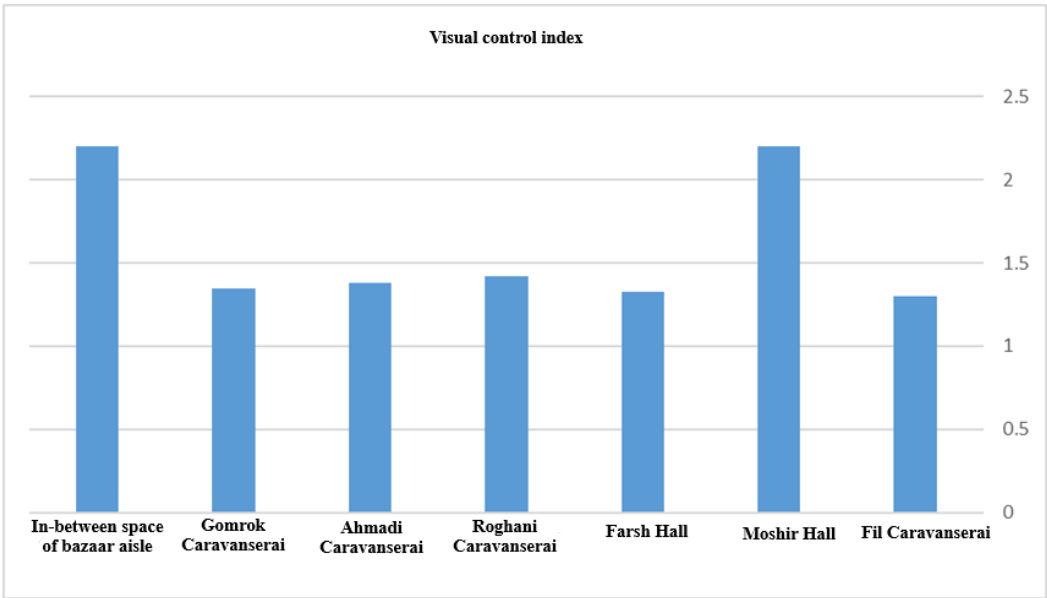


Diagram 2. Comparative graph of visual control index

In the case of the visual control index in the next rank after the in-between space of the bazaar aisle, Moshir Hall indicates the maximum rate because this chamber is located in a place that has control over the other spaces. However, the relative control indexes of the bazaar aisle as the main in-between space and Moshir Hall are highly close to each other. Moshir Hall is followed by Roghani Caravanserai which provides the highest control due to its location and connection with the main bazaar aisle (Table 3 and Diagram 2).

Entropy analysis

Entropy analysis means the distribution of points based on their visual depth from one point. Therefore, when many locations are visually close to a core then their visual depth from the core will be asymmetric and the entropy value will be lower. In other words, the entropy will be higher when visual depth is distributed more homogeneously. Entropy analysis indicates the accessibility rate of space. The higher the entropy index, the more difficult the access to other spaces will be and vice versa. Therefore, spaces with low entropy- that appeared in cold colors within this analysis- are the most accessible (Fig 8.).

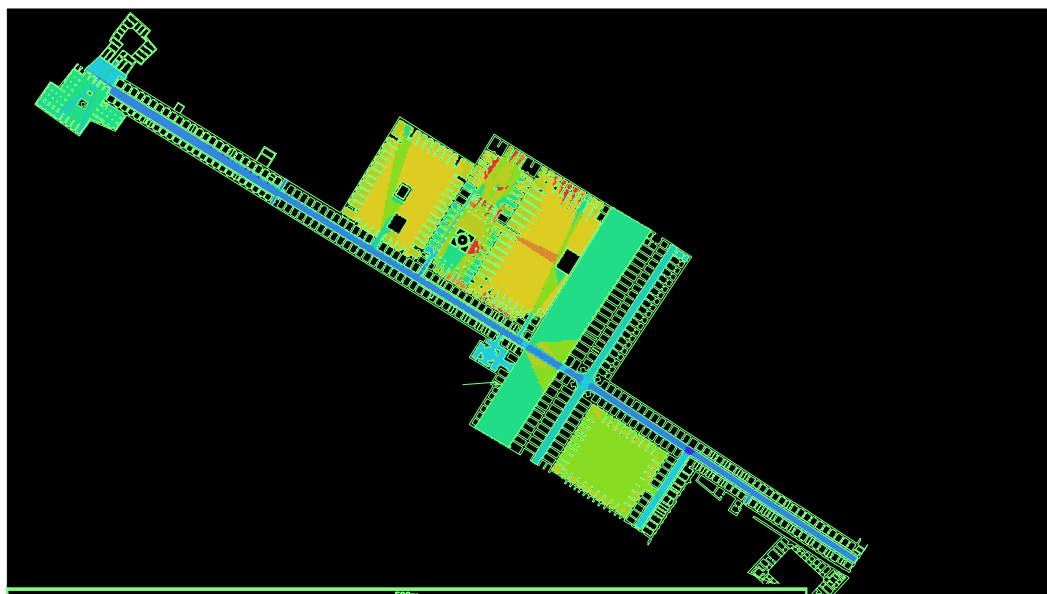


Fig 8. Entropy analysis on assessment of in-between spaces. The result of this analysis indicates that the entropy index has the lowest value in the bazaar aisle and appears from bright to dark blue within the analysis.

In the assessment of in-between spaces, the result of this analysis indicates that the entropy index has the lowest value in the bazaar aisle and appears bright to dark blue within the analysis. The entropy index of the bazaar aisle varies between 1.65 and 1.85. The entropy index indicates the highest value in Roghani, Ahmadi, and Gomrok Caravanserais, but shows the lowest amount in Farsh Hall (Zarabkhaneh). It means that Farsh Hall is the most accessible space among considered caravanserais. In the plan of Roghani and Ahmadi Caravanserais, courtyard furniture has led to a higher entropy index in some areas rather than the courtyard and access to these areas is more difficult.

Moreover, the entropy index indicates a hierarchy of access and privacy in the spaces. In Fil Caravanserai, for example, the entropy index in the central spaces of the courtyard is lower and is higher in the spaces around the caravanserai which indicates more privacy of spaces around the caravanserai rather than the central courtyard. In addition to the in-between space of the bazaar aisle that was mentioned before and has a considerable difference from other spaces so is considered the most accessible space, the entropy index has the lowest value in Moshir and Farsh Halls, which shows better access to these two spaces to the surrounding spaces (Table 4 and Diagram 3).

Table 4. Entropy index

Fil Caravanserai	Moshir Hall	Farsh Hall	Roghani Caravanserai	Ahmadi Caravanserai	Gomrok Caravanserai	In-between space of bazaar aisle
2.14	1.83	1.87	2.36	2.33	2.34	1.65

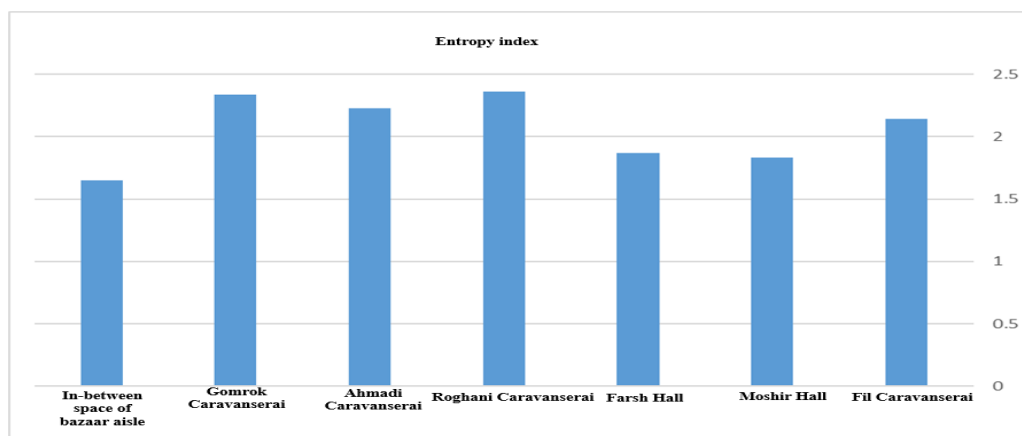


Diagram 3. Comparative graph of entropy index

Connectivity analysis

Connectivity analysis is about spatial integration and coherence. The results of this analysis confirm the previous analyses, indicating that the connectivity index is higher in public spaces. In the in-between space of the bazaar aisle, those areas crossed with the street appear in red and show the highest connectivity index with a value of 6627. This value is greater than 2050 in other areas (Fig 9).

Among studied caravanserais, Ahmadi Caravanserai indicates the lowest connectivity rate and Roghani Caravanserai shows the highest connectivity value. The value of the connectivity index is related to the form and area of the courtyard of each complex. In each caravanserai, the connectivity index is higher in the central courtyard compared to the spaces around the caravanserai, and central areas of the courtyard are more visible and accessible.

The entry area usually has a lower connectivity rate, which indicates its proper performance in demarcation and creating an entry hierarchy. In the case of the connectivity index, Ahmadi Caravanserai has the lowest value regarding the location and access to the main bazaar aisle through an intermediate space. Moreover, Moshir Hall and Roghani Caravanserai have the highest connectivity index. It seems that the connection with the bazaar main aisle is a suitable criterion for understanding various indicators especially the connectivity index (Table 5 and Diagram 4).

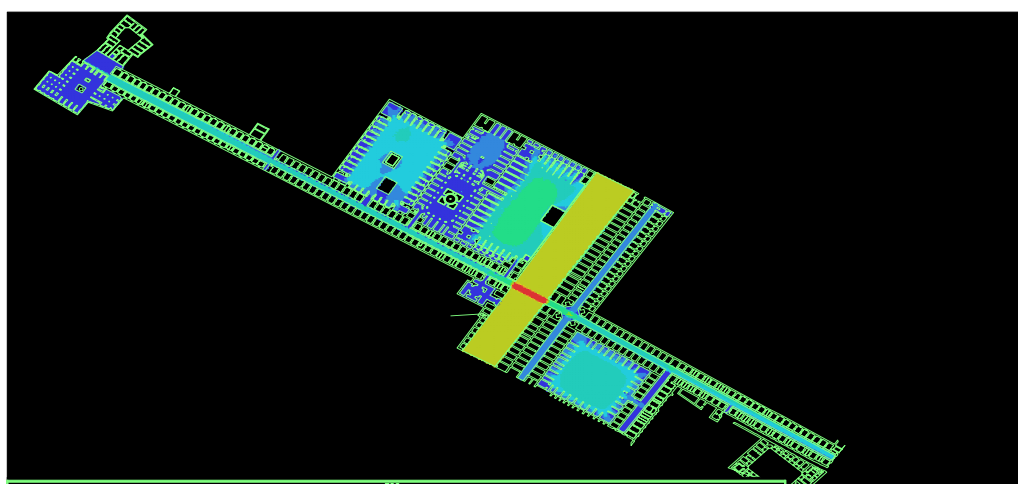


Fig 9. In connectivity analysis, connection with the bazaar main aisle is a suitable criterion for understanding various indicators, especially the connectivity index

Table 5. Connectivity index

Fil Caravanserai	Moshir Hall	Farsh Hall	Roghani Caravanserai	Ahmadi Caravanserai	Gomrok Caravanserai	In-between space of bazaar aisle
2163	3308	2183	2864	784	1957	3310

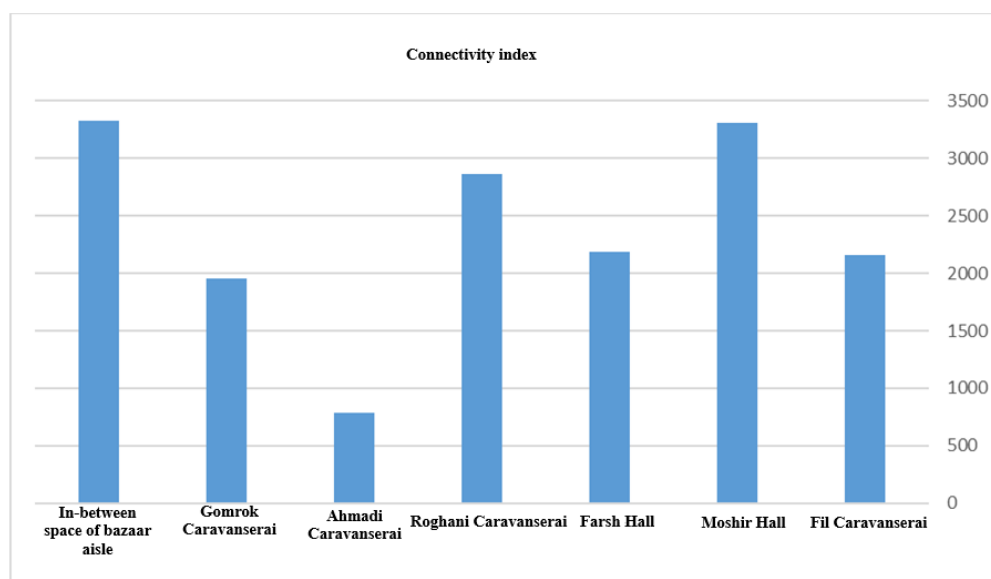


Diagram 4. Comparative graph of connectivity index

Visual depth analysis

Depth is the opposite of permeability. Therefore, the lower the depth, the higher the space permeability will be. As is seen in the analysis, dark blue colors have appeared in the bazaar aisle and street, and the relative depth of this space is less than in other areas. The value of the relative depth of the main in-between space which is the bazaar aisle varies between 2.38 and 2.59 (Fig 10.).

Among the studied caravanserais and halls, however, all of them are in the color spectrum from bright blue to green in terms of relative depth. Therefore, they have a low relative depth and relatively high permeability. Depth is less in the area visible through entry and permeability is higher in these areas. In general, depth is somewhat higher in Fil Caravanserai which may be due to its connection with the main aisle of the bazaar through an intermediate space.

In the case of the visual depth index, followed by the bazaar aisle space that is highly different from other spaces, the lowest rate is seen in Moshir Hall which is located in the connection route. Other spaces are connected to the main aisle of the bazaar through an intermediated space within entry hierarchies, resulting in a higher relative depth of these spaces. The relative depth value of other spaces is the same although the relative depth of Fresh Hall is to some extent less than other Caravanserais due to the better connection of this hall with the bazaar aisle (Table 6 and Diagram 5).



Fig 10. In-depth analysis, dark blue colors have appeared in the bazaar aisle and street, and the relative depth of this space is less than in other areas.

Table 6. Visual depth index

Fil Caravanserai	Moshir Hall	Farsh Hall	Roghani Caravanserai	Ahmadi Caravanserai	Gomrok Caravanserai	In-between space of bazaar aisle
4.03	2.53	3.53	3.67	3.85	4.04	2.38

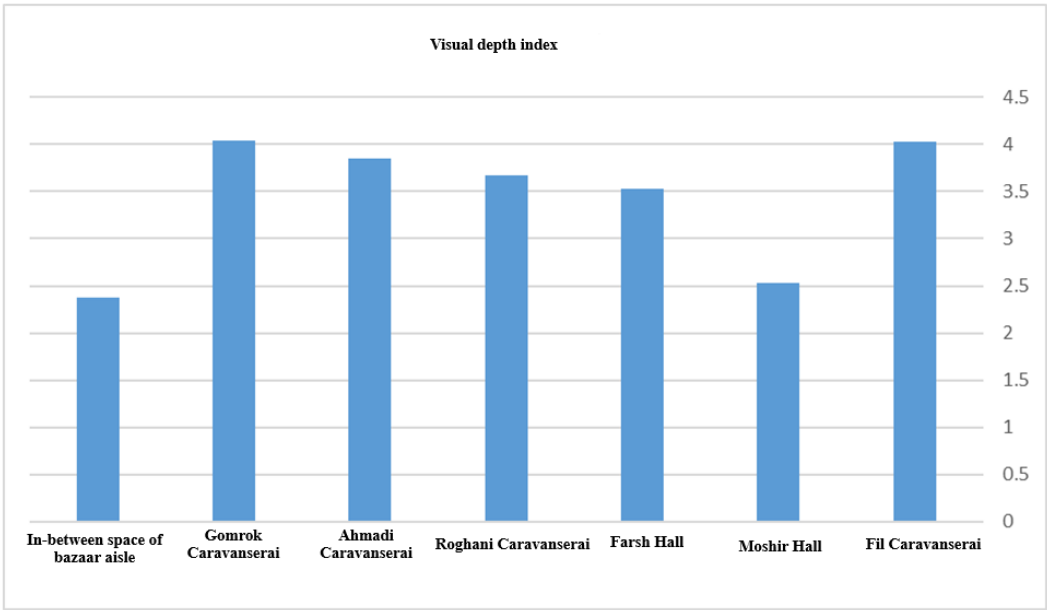


Diagram 5. Comparative graph of depth analysis index

Conclusion

In this research, a part of the bazaar complex has been examined to address the role of the entry hierarchy. This area includes the main aisle of the bazaar as the main in-between space, a street, and several halls and caravanserais with relatively similar plan structures (as in-between subspaces) that are different in spatial area and dimensions.

Among the case studies, Roghani Caravanserai is the largest one that is located adjacent to the street without any intermediate with the main bazaar aisle. The smallest space is Moshir Hall which is located in the main aisle of the bazaar and Farsh Hall (Zarabkhaneh) which is spatially located in front of Roghani Caravanserai and unlike Roghani Caravanserai, has a small size in terms of spatial area. Regarding the Small size and direct access to the main aisle of the bazaar, Farsh Hall and Moshir Hall have higher visibility and accessibility in most of the analyses.

In general, the conclusion of this study shows that visibility and accessibility indicators have a direct relationship with the spatial structure of the caravanserai's plan, the size of the plan, its connection with the main structure of the bazaar, and the aisle of the bazaar, the last factor seems the most important index. While central courtyards have relatively good visibility and accessibility and can control the surrounding spaces, the surrounding rooms are designed in a way that provides the lowest visibility and accessibility and the highest privacy for them. The entrance gate of Caravanserai plays a significant role in controlling direct visual access to other spaces of the house. Also, the form and size of the courtyard have a considerable impact on expanding the visibility and accessibility of spaces, and subsequently the security of each space.

Overall, the plan structure of caravanserais is not complicated, but Ahmadi Caravanserai has a more complicated spatial structure that decreases legibility and makes navigation and understandability more difficult for the user. Assessment of software structures indicates that the higher the visual integration, visual control index, and connectivity index in spaces and the lower the visual depth, the higher the attendance of people in public spaces such as bazaars will be. Visibility and accessibility of spaces are the most important factors for assessment of attendability in public spaces of bazaar or other words, the in-between spaces (that consists of bazaar aisle and public space of caravanserais). Examination of this index can provide coherence and integration of spaces, private space, and privacy, physical and visual accessibility, and has a direct relationship with legibility rate and hierarchy of spaces. Therefore, VGA presents the best response for these indicators, which can be used to examine the attendance rate of individuals in the spaces with bazaar use (Fig 11.).

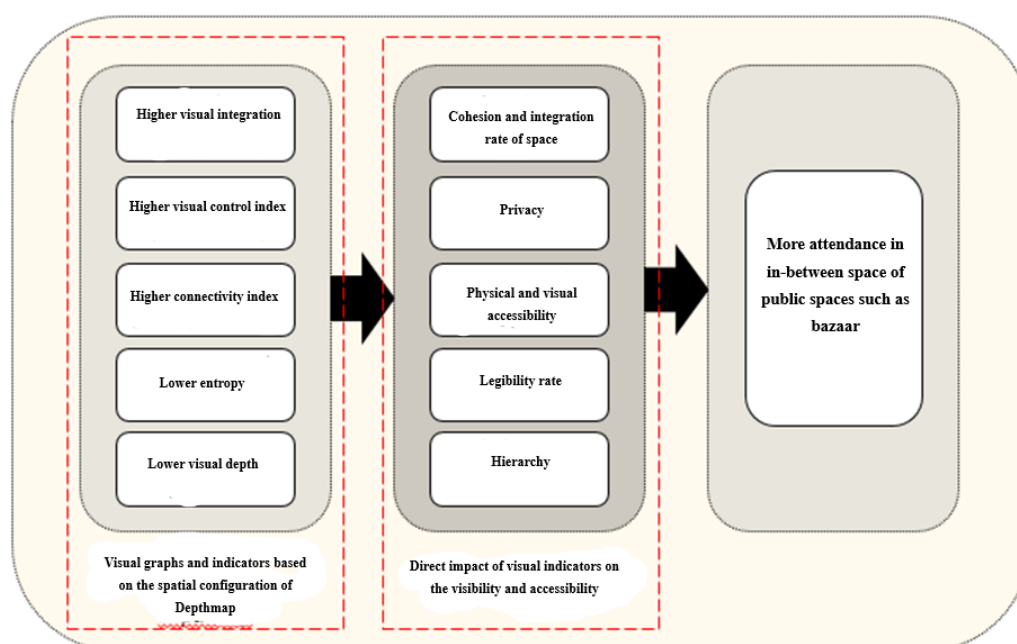


Fig 11. Impact of visual indicators on the visibility and accessibilities that lead to attendability

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