



# **Evaluating the Visual Quality of Houses in Qajar Period in Kashan City by Employing the Method of Isovist**

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## **ABSTRACT**

Visual quality is one of the important qualitative features of the environment and particularly the residential space. The level and possibility of viewing are among the aspects of visual quality. In the current study, the visual field of the historical houses in Kashan has been analyzed by placing the vertical visual field of the room on the yard, as an index, with the goal of practical familiarity with such tools. In the present study, ten houses in four historical neighborhoods dating back to Qajar Period were selected. Then by using the Depthmap Software and the Isovist analyses (area, the amount of thrust angle, the maximum radius line and enclosure), the visual quality of them was investigated by employing the method of logical reasoning. In the first step, the houses with multiple yards fell under five categories, in terms of form and physical body. In the second step, the viewing angle of the observer while sitting was analyzed by Depthmap Software. The results of the obtained diagrams and tables showed that the visual quality of the observer's sight, from the room to the yard, while sitting, has a direct relationship with the concept of family, as a social entity, and the social participation, as the key component of social life and the civil society of houses in Qajar period.

**Keywords:** *Houses of Kashan City, Isovist, Visual Quality, Yard*

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## **1. Introduction**

In traditional houses, in arid climate, the space was organized proportionate to the yard, in Qajar period, which is often forgotten in the modern architecture. The design of the houses started from the yard, and the closed and covered spaces were located all around it. The main spaces of the house had a direct relationship with the yard and they were sometimes named according to their relation with the yard [1]. The yard of the house produces the centripetal force. The centrality connects the apparently different parts of the house, and in this way, the house is transformed to a united whole.

Yard is regarded as the soul of the house, in which the heaven's garden is manifested, and its centrality lead to the close connection of all parts of the house [2]. Meanwhile, enhancing the visual quality of houses is an increasing necessity expected by operators and designers and has caused the designers including the architects to make creative spaces. In such circumstances, it has become necessary to prepare a tool in order for measuring the visual quality of houses, which might be an effective step in the evolution of the understanding of designers regarding the visual quality of the environment expected by operators.

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As a context for the human's living, a house interacts and is in relation with all aspects of human's life. Each residential area should be constructed while taking into account the different family structures and different place, social and spatial needs, and it should represent a unique environment by having spatial and social features specific to itself [3]. By making attempts to measure the qualitative aspects of the environment, various findings have been obtained, one of which is the Isovist which refers to a set of all points visible from a given vantage point in space and it is used for visual quality analysis in an environment [4]. In the current study, the indexes of Isovist including area, the amount of thrust angle, the maximum radius line and enclosure, in historical houses of Kashan are particularly used. In the first step, the houses fell under five categories, in terms of form and physical body: Houses with one yard surrounded by three volumes, with one yard surrounded by four volumes, with two yards surrounded by three volumes, with three yards surrounded by two volumes and with three yards surrounded by three volumes. In the second step, the indexes of field of view in these houses were analyzed by software. Therefore, the main question of the study is: What relationship exists between the observer's sight and the dimensions of openings in single- and multi-yard houses? To reach an answer to the question, first the physical body of houses is surveyed and then the space syntax of the house is presented by the Isovist approach.

## 2. Literature Review

Of the most important parts in the Theory of Space Syntax are its visual fields which are mainly used for analyzing the architectural spaces and urban neighborhoods. It seems that the word *Isovist* was first used by Tandy. In Tandy's opinion, isovist is a method for "the permanent record of the information of the site (architecture or landscape)". Years later, Benedict expanded and developed the characteristics of isovist to be able to describe the environment by its quantitative aspects. In Benedict's opinion, the fields of isovist are able to measure some of the basic spatial qualities in the environment; qualities that their conscious or unconscious perceptions create a more basic perception and more comprehensive description of the environment. Accordingly, he defined space as a set of visible points from one point in the same space [5]. Isovist creates a regular

geometric network in the building and the polygon of isovist produces each sq. meter of network from the center, which is usually located on the height of the observer's sight. In order to better describe the spatial features observed by an observer and to quantitatively explain the isovists of the environment, Turner et al. (2001) defined and expanded the analysis of the visibility graph. Taher and Brown analyzed the visibility and the access of residential spaces in traditional houses of M'zambite, using the method of language of space.

They came to this conclusion that in those houses, the visual fields are dependent on the residents' need to be in a quiet place [6]. In a study by Hillier and Hanson, the space is regarded as a set of axial lines which creates the longest view lines in a convex space. Their study shows that the language of space has used the isovist analysis to translate the visual perception. The language of space includes a series of technologies to analyze the spatial structures using the diagrams that merely include path and node [7]. Hosseini et al. have conducted a study on the analysis of urban environment using the visual quality approach, in Iran, and to transform the visual quality to quantitative and measurable aspects they used the isovist tool in syntax2d software. By surveying two different paths in the old fabric of Bushehr city, they analyzed the urban network of the two paths. The results of their study showed that there is a relationship between urban form and its visibility, and the paths with different physical forms have different visual quality. Tabibian et al. conducted a study on modeling the natural movement of pedestrians based on the observer's sight in urban and architectural spaces. They analyzed the spatial visual perception based on the observer's sight, using the isovist. The results of their study indicated that the visual perception about the surrounding environment is a very important factor for selecting and directing the movement path of humans and by its omission, many problems arise for the movement of individuals [8]. Moreover, Alalhesabi et al. investigated the relationship between the function of spaces in houses with old fabric in Bushehr and their visibility, using the isovist analyses. The findings of their study showed the spaces with different functions have different visual fields (isovist) in relation with their function [5]. In a

study entitled, “*The Effect of Yard on the Formation of the Configuration of Iranian Traditional Houses in Kashan*”, Hajian et al. analyzed houses in Kashan, in Qajar period, using the method of space syntax. The results of the study showed that the amount of the effect of each space of the house depends on its spatial organization, and the data related to the yard shows the special effect of this space on the formation of the configuration of Iranian traditional houses compared to other spaces. Behpur et al. (2018) conducted a study entitled, “*Space Syntax the Way to Perceive the Arrangement of the Spaces of a House in Yazd City in Qajar, Pahlavi and Islamic Republic Periods*”, and investigated the change in the arrangement of spaces and the spatial organization of houses by the method of space syntax. The findings of their study showed that the configuration and spatial organization of houses in Qajar period continued to the beginning of Pahlavi period, and the culture of society had an important role in the formation of spaces and the way they are organized, but by changing the life style, the emergence of modernism and lack of the required time to become coordinated with the needs of society, an eclectic perception was derived from the attitudes of other cultures [9]. Karimi et al. (2015) conducted research, entitled, “*A Comparative Study of Samples of Urban Fabric in Sanandaj City by Using the Isovist Analyses and the Visibility Graph Analysis*”, and investigated four urban fabrics in Sanandaj by using such methods. The results indicated that the indexes of isovist analyses and the visibility graph analysis clearly show the differences and similarities among the mentioned fabrics, in terms of spatial characteristics and the visual quality [8]. As shown earlier, the issue of visibility has been investigated in various studies, from different aspects. However, little studies have been conducted on the simultaneous analysis of sight from downstairs and upstairs. Reviewing the literature shows that the isovist analysis is an introductory way for quantifying the visual quality of space. Since many investigations have not been conducted regarding the visual quality of houses in Kashan, it is important to carry out studies in this field.

### **2.1. The Yard**

If we want to refer to the essence of the spatial organization in Iranian houses, we could mention the structure of the central yard; a

structure that by an interconnected and integrated form has provided suitable responses to the materialistic and spiritual life of residents [10]. Designing a yard has been an ancient pattern while constructing a house, which has been used remarkably in different cities of Iran. Moreover, the residential spaces have been shaped around the yard, by employing different measures [11]. In addition to organizing the rooms and its surrounding space, a yard has had different functions under the influence of the culture of different societies [12]. The yard has been used with different concepts in Iranian houses. The yard unifies several elements of a house; it relates several spaces to create a green and alive environment as an artificial ventilator for the suitable blowing of the wind; it is an important element for organizing several spaces, and it is a safe and calm privacy for the family's comfort. In historical houses of Iran, the yard has been a necessity for living, and various kinds of traditional yards have been shaped based on the materialistic and spiritual needs and the observance of the hierarchy of private and public areas inside and outside of the house [2].

### **2.2. Visual Quality**

Another aspect of the visual quality is the possibility and level of visibility because it affects the perception of residents and the spatial behavior of the environment [13]. Locating the semi-open spaces between the open and closed spaces, and the existence of several openings on the wall of the closed spaces have provided the possibility of landscape and lighting expansion for the traditional houses [1]. The existence of open space(s) (the yard(s)) at the heart of the closed spaces, and the priority and order of arranging the spaces around the yard in Kashan's houses resulted in having a better vision to the yard and sky, from different spaces and rooms of the house.

### **2.3. The Indexes of Isovist**

When searching and discovering in an unfamiliar environment, the decisions to select a path to move on includes regular patterns that are mostly resulted from the form and spatial configuration of the environment and the visual-spatial feature of each decision point along the path. Attempts have been made to measure the qualitative aspects of environment and different findings have been obtained. One of such measurement tools is the Isovist which refers to a set of points visible from a given vantage point

in space and it is used for visual quality analysis in an environment [4].

Therefore, the indexes of Isovist are defined as follows [14]:

A. Area: This index considers the level of view expansion from the point the observer is standing and is in relation with the spatial experiment of “expansion and spatiality”.

B. The amount of thrust angle: This index explains the distance between the observer’s point and the center of the polygon mass of isovist, which actually shows the power of visual attraction and the visual orientation in the point where the observer is assumed to be there.

C. The maximum radius line of vision: This index considers the longest possible line of sight and is in relation with the experience of the landscape.

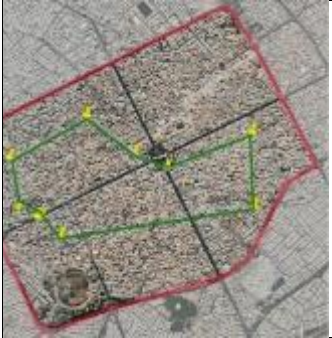


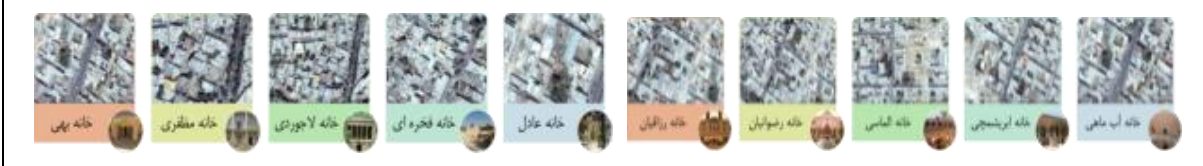
D. Enclosure: This index is equal to the length of all closed edges. The closed or blocked edges are those the levels of which are unknown or undefined in the spatial experience. This index is in relation with the mysterious spatial experience.

### 3. The Area under Study: City of Kashan

In the current study, the historical houses of Kashan were analyzed in three neighborhoods, namely, Taher Va Mansour, Soltan Mirahmad, and Mohtasham. These houses are valuable sources of architecture of Qajar period in Iran. Each neighborhood, as an administrative,

social, cultural, economic and religious unit, was considered a part of the city. The whole city, neighborhoods and the city center would create a united and homogenous composition in physical body and spatial terms [15]. Table 1 introduces the boundaries of Kashan city and the houses under study. Despite of their coordination and unity, houses of Kashan benefit from a variety of physical bodies, which indicates the artistic abilities of the past architects in designing and creating the space (in the precise sense). The houses under study have been constructed in one period of time, on the lands with less than 800 sq. meter area and they have the same number of floors, and a wide variety of houses with the same specifications as that of the samples have been located in the neighborhoods under study. The most prominent element of these houses (houses of Razzaghian, Abrishamchi, Almasi, Fakhrei, Mozaffari, Abmahi, Adel, Lajvardi and Behi) is their yards, which are located downstairs or upstairs. The selection of each ten samples of historical houses makes it possible to investigate the spatial characteristics of each by software programs and the indexes of isovist analyses. Moreover, by such a diversity of samples, the efficiency and power of the mentioned software programs and indexes might be tested.

**Table 1.** The Area under Study (Source: Author, 2020)

Map of the boundaries of houses under study	Map of the geographical boundaries of Kashan	Map of the comprehensive plan of boundaries of Kashan City
		
		

From left to right: Behi’s house, Mozaffari’s house, Lajvardi’s house, Fakhrei’s house, Adel’s house, Razzaghian’s house, Rezvanian’s house, Almasi’s house, Abrishamchi’s house, Abmahi’s house.

#### 4. Research Method




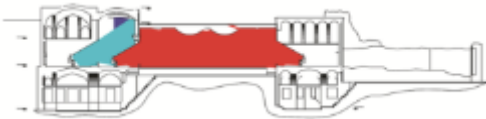
In the current study, the computer program of Space Syntax was employed for the purpose of modeling, and by the method of logical reasoning with field based documentation-historical approach and by using the Persian and Latin texts including dictionaries, books, specialized journals and theses, and the analytical techniques of isovist, the line maps of the space syntax and its analytical methods, ten houses of Kashan City belonging to Qajar (Behi's house, Mozaffari's house, Lajvardi's house, Fakhrei's house, Adel's house, Razzaghian's house, Rezvanian's house, Almasi's house, Abrishamchi's house, Abmahi's house). period have been analyzed to reach a physical-form logic. Through field-based surveys, first, the historical houses of Kashan are studied with the goal of typifying them and recognizing the dominant types of them. Next, such types of houses are normalized to reduce the role of environmental interfering factors. Then the visual quality of them is analyzed by extracting the isovist indexes in the context of houses. The Depthmap Software has been used for the isovist analysis. In lines with this, the network analysis of isovists and some points of observer's station, in five physical types, in ten houses of Kashan belonging to Qajar period, in one section, have been drawn by omitting the interfering details and with determined stations from room to yard. In lines with this, the network analysis of isovists and some points of observer's station, in five physical types, in ten houses of Kashan belonging to Qajar period, in one section, with

determined station from room to yard, have been drawn. The selected stations have different aspects. Some of the houses have a view to the downstairs, some other to the upstairs, and in other samples relative simultaneous view to the two spaces. Finally, the relationship between the physical pattern and its desired visual view of the region is obtained. This pattern might recognize the manner of climatic designing by the native architects and it might be used as a practical pattern in lines with the new designs.

#### 5. The Isovist Analysis of the Case study

As for the selected samples, the visual relation of the room to the yard in the specified houses has been extracted in the form of justifiable diagrams by using the drawing tools (AutoCAD for simplifying the sections and Depthmap for analyzing the isovist of the sections). As stated earlier, the visibility might be analyzed through the aspects of isovist. In the current study, the Depthmap software has been used to study ten aspects of isovist, in the houses of Kashan, from Qajar period to the beginning of Pahlavi period, according to Table 2. The aspects include area, the amount of thrust angle, the maximum radius line and enclosure. To reach the results, first the houses under study were categorized based on the number of yards and the location of the volumes around the yards. Then, the place of the observer's sight from the center of the room was determined by the AutoCAD software, and considering the human's visual angle, the visual lines were drawn for accurate analysis.

**Table 2.** The Isovist Analysis and Typification of Samples (Source: Author, 2021)

Historical Period	The pattern of three yards surrounded by two volumes	Aerial Photo	Picture	House
Late Qajar period and the beginning of Pahlavi period				Almasi's house
Software analysis of isovist indexes				
			41.9183	Area
			14.7692	The maximum radius line
			7.3211	The thrust angle

		15.2076	Enclosure
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Historical period	The pattern of two yards surrounded by three volumes	Aerial Photo	Picture	House
Qajar				Razzaghian's house

Software analysis of isovist indexes




		99.5274	Area
		20.7139	The maximum radius line
		11.6982	The thrust angle
		27.0861	Enclosure

Historical period	The pattern of two yards surrounded by three volumes	Aerial Photo	Picture	House
Late Qajar period and the beginning of Pahlavi period				Fakhrei's house



Software analysis of isovist indexes

		62.1331	Area
		20.5117	The maximum radius line
		9.8470	The thrust angle
		34.8323	Enclosure

Historical period	The pattern of three yards surrounded by three volumes	Aerial Photo	Picture	House
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Qajar				Abrishami's house
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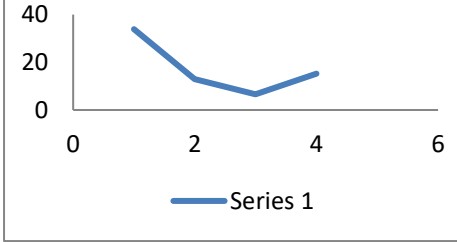
Software analysis of isovist indexes

		37.976	Area
		13.8167	The maximum radius line
		7.0327	The thrust angle
		27.0262	Enclosure

Historical period	The pattern of one yard surrounded by three volumes	Aerial Photo	Picture	House
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Qajar				Abmahi's house
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Software analysis of isovist indexes




		33.8738	Area
		12.9403	The maximum radius line
		6.5773	The thrust angle
		12.6873	Enclosure

Historical period	The pattern of one yard surrounded by three volumes	Aerial Photo	Picture	House
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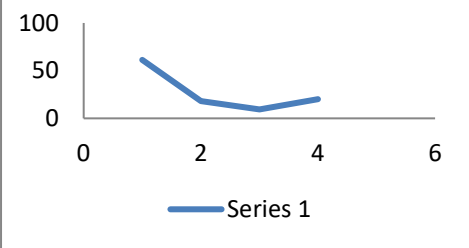
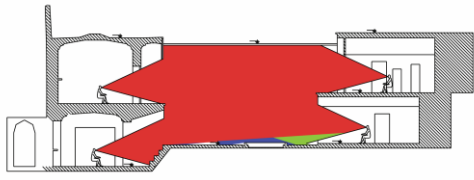
Late Qajar period and the beginning of Pahlavi period				Adel's house
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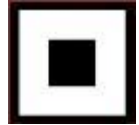


Software analysis of isovist indexes

		31.5621	Area
		12.00	The maximum radius line
		5.9059	The thrust angle
		17.7835	Enclosure

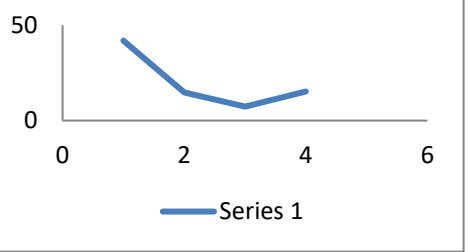

Historical period	The pattern of one yard surrounded by three volumes	Aerial Photo	Picture	House
Pahlavi				Rezvanian's house




Software analysis of isovist indexes

		61.2928	Area
		17.9540	The maximum radius line
		9.3669	The thrust angle
		20.0807	Enclosure

Historical period	The pattern of one yard surrounded by four volumes	Aerial Photo	Picture	House
Qajar				Behi's house

Software analysis of isovist indexes

		41.9183	Area
		14.7692	The maximum radius line
		7.3211	The thrust angle
		15.2076	Enclosure

Historical period	The pattern of one yard surrounded by four volumes	Aerial Photo	Picture	use
Qajar				Lajvardi's house

Software analysis of isovist indexes

		47.0853	Area
		16.2946	The maximum radius line
		7.7205	The thrust angle





Historical period	The pattern of one yard surrounded by four volumes	Aerial Photo	Picture	House
Qajar				Mozaffari's house

Software analysis of isovist indexes

		43.4503	Area
		16.629	The maximum radius line
		8.659	The thrust angle
		14.7813	Enclosure

Due to the existence of downstairs and upstairs in the structure of houses in Kashan, for the first time, the observer's sight from inside the room to the upstairs and downstairs while sitting on a point, was analyzed and studied. The aspects of area and radius line had the highest amount in houses with two yards surrounded by three volumes. The houses with one yard surrounded by three volumes had the minimum amount of area, and the houses with three yards surrounded by three volumes had the minimum amount of radius line. The maximum amount of thrust angle was observed in houses with the pattern of two yards surrounded by three volumes and the minimum amount in houses with the pattern of one yard surrounded by three volumes. The maximum amount of the index of enclosure was seen in the houses with the pattern of three yards surrounded by three volumes, and the minimum amount in the houses with the pattern of one yard surrounded by three volumes.

**6. Results and Discussion**

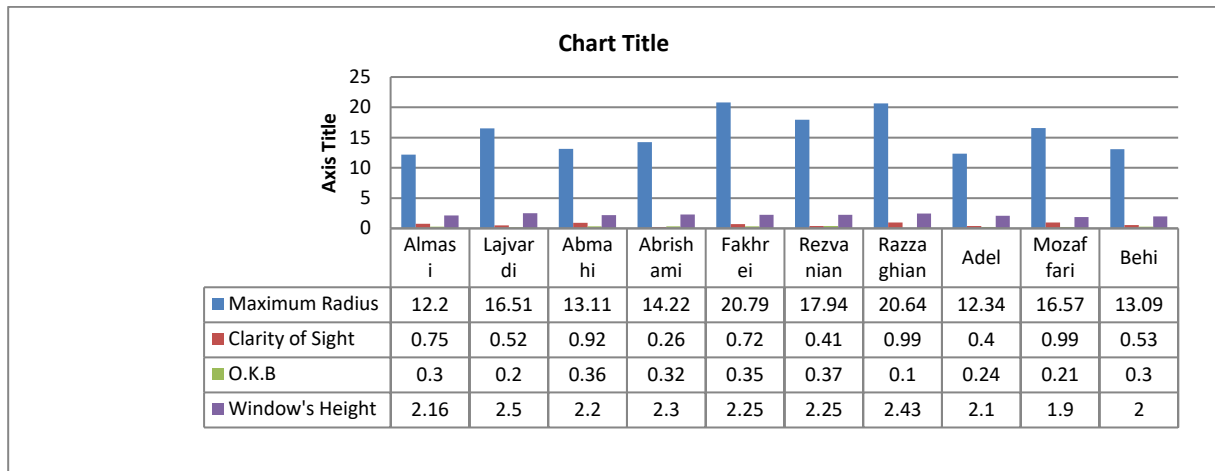
In the current study, the isovist tools were used to obtain a quantitative explanation for the visual quality in historical houses of Kashan.

These tools were evaluated and analyzed in Depthmap software, and the results of the obtained diagrams and tables showed that the visual quality of the observer's sight, from the room to yard, while sitting, has a direct relationship with the concept of families, as a social entity, and the social participation as the key component of social life and the civil society of houses in Qajar period, since the houses under study, in all patterns, first omitted the disturbing sight to the neighboring houses, and then the arrangement of spaces around the yard would make the best observer's sight to the yard. Based on the results, the center of visual attraction in all houses is the yard, and the longest radius line from the standing point of the observer, belongs to the yard of the house. Moreover, in houses with several yards, by the increase in the standing points of the observer, more enclosure is created, and this theory indicates the principal of privacy in houses of Qajar period. The analysis of visibility from the rooms in downstairs and upstairs show similar behaviors regarding the visual integration. Considering the studies related to the historical houses of Kashan, it is recommended for the contemporary houses to consider at least 220

cm for the height of the window and at most 30 cm O.K.B for the windows opening to the yard,

for more clarity of sight and more pleasant visual quality (Diagram 1).

**Diagram1.** The Clarity and Radius of Sight in the Dimensions of Openings (Source: Author, 2021)



## 7. Conclusion

In the current study, the isovist tools were used to reach a quantitative statement of the visual quality in the historical houses of Kashan. The tools were evaluated and analyzed by the numerical output of Space Syntax Software and by drawing up the diagrams, and in addition to the competency of this method, it was demonstrated that by using the isovist indexes analysis, it is possible to introduce a new approach to the measurement of visual quality of spatial structures. The analyses of the current study were made by the Depthmap software, for the first time, in the section of houses, by the normalizing method, omitting details and setting up the observer's visual angle in the sitting position, from inside the room to the yard, and the results proved that there is a relationship between the dimensions of openings and the area and number of yards in the historical houses of Kashan with the isovist indexes, which could be a source for house designers and operators. Among the results obtained from the Space Syntax tables and

analyses is the effect of social and cultural relations in Qajar period on the architectural space of houses. The current study cannot give absolute or relative superiority to any of the cases in terms of visual quality, but it has analyzed the visual features of each of them to present a tool to the designers, so that they become able to apply their intended visual qualities to the designs. Furthermore, in the current study it was determined that there is a high inter-correlation between the criteria of isovist and the typification of houses, but despite the high potential and the horizontal analyses in the plans of houses, different results have been obtained. Therefore, the analyses of the present study regarding the houses have been done for the first time in Space Syntax Software, and they are not still completed and are not transformed to the independent spatial criteria. We hope that by conducting more studies, this method could be used by other scholars, as a suitable pattern for other similar studies.

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