

Original Research Article

Revival of the Yard in Contemporary Houses: Using Traditional House Solutions in New Houses (A Case Study of Hamadan City)

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ABSTRACT

This research presents a comparative analogy of spatial configuration and isovist in relation to communication between the courtyard and main living spaces in traditional and contemporary houses. It is assumed that in traditional houses main living spaces had deeper relation with the courtyard into contemporary ones. For this purpose, both traditional and contemporary houses were analyzed in space syntax software; UCL Depth Map. The interview method was used to identify any types of activities and their relations with spaces of traditional houses, and finally, indicators of space syntax software were evaluated, so the results were expressed. A comparison of houses shows that the courtyard in today's houses plays a more passive role than before and has less communication with the main living spaces. To stay safe from cold winter, in most cases, TANABI room has less physical and visual connection than the rest with the courtyard, which people spend their time in that in traditional houses, but the living room has must physical and visual connection toward the others at contemporary, which shows the attention of contemporary architects to the connection of the main living space (living room) with the courtyard.

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Introduction

Open or empty space has always been important in Iranian architecture so that its existential characteristic finds meaning in this architecture due to open space (Ahmadi, 2010). Outdoor space has been the main element of shaping, defining, and identifying factors in closed spaces in traditional Iranian houses so that it has always been directing it and has had a correct interaction with all the components (Farokhzad & Modiri Dovom, 2014). The center of all forces, events, and the gathering place of values in traditional Iranian architecture are its central courtyards. In such a way that the structural values, richness, identity, and desirable spatial qualities in this part of the house, both find meaning and reach their peak. In fact, the courtyard of a house is an integral part of this type of architecture. With its courtyard design, the Iranian architect seeks to realize human rights to benefit from nature and to have a correct and balanced relationship with nature. So that due to the existence of the courtyard, human perception of nature and subsequently of time and the environment around it is enhanced (Ahmadi, 2010). Attention to the issues of nature and visual connectivity with it in residential houses is a topic that is discussed a lot (Lee & Asakawa, 1992). In 2009, Ahmadi, by recovering the role of outdoor space in traditional Iranian architecture, while explaining the meanings and concepts of outdoor space in this architecture, offers solutions to improve and promote contemporary Iranian architecture (Ahmadi, 2010). In 2010, Einifar and Ghazi Zadeh studied the typology of residential complexes in Tehran with the criterion of outdoor space, which deals with the different layout types of residential complexes and their advantages and disadvantages in different ways, and in the end, they obtained the level of spatial diversity and a different spectrum of privacy and public space outdoors and natural lighting and ventilation in different types of apartments (Einifar & Ghazizadeh, 2011). In previous research, more attention was paid to the presence of nature in the courtyard of traditional houses and the use of courtyards and outdoor space, which with these findings; one can't obtain the right design models and strategies in today's houses. But methodologically, many studies focused on the spatial configuration in housing typology. In 2016, by examining privacy in traditional and

contemporary houses in Hamedan, according to the characteristics of space syntax, Alitajer & Nojumi concluded a reduction in privacy in traditional houses compared to traditional houses (Alitajer & Nojumi, 2016). In 2013, Adkan studied the architectural typology in Nigeria and, by analyzing spatial syntax, extracted the spatial model and principles of spatial configuration (Adeokun, 2013). However, entering the contemporary era, they have lost their role in shaping the spaces in houses.

Problems and Its History

In architecture, due to the existence of open space, man has a correct understanding of nature and, consequently, a correct understanding of their time and environment. In traditional Iranian architecture, this connectivity is very well formed (Ahmadi, 2010). Conversely, in the new context, man is dissatisfied with the connectivity between the living space and the courtyard and the open space (green space), and the type of spatial and visual connectivity available to them is not acceptable and critics criticize it (Farokhzad & Modiri Dovom, 2014). In the past, this satisfaction was greater (Daeipour, 2014) and they were able to create a unique quality in relation to the open space. We are now looking to extract the connectivity between spaces and courtyards in traditional and contemporary houses in two ways of connectivity and visual connectivity using spatial syntax, and after finding their differences, we can provide the proposed model to achieve the same desired quality.

Research Question and Hypothesis

The present study aims to answer the question of what difference exists between spatial and visual connectivity with the courtyard in traditional and contemporary housing?

In this study, it is assumed that the main living spaces in traditional houses have a deeper connectivity with courtyards than in contemporary houses.

Theoretical Foundations

The space layout (Peponis, 1985; Steadman, 1983) includes a set of techniques for modeling, quantifying, and interpreting the structure of the spatial configuration in buildings and structures (Hillier, Hanson & Graham, 1987) which is

proposed to study and find hidden structures, beyond the form of domestic settlements. This theory deals with how spatial configuration interacts with its social structures, activities, and user behaviors.

• **Space configuration**

This theory was founded by Hillier Wuhanson in 1984 whose basis is research into the connectivity between social and spatial forms. This theory believes that space is the primary core of how social and cultural events take place (Marki & Folkesson, 1999). The spatial configuration enables architects and urban planners to analyze the connectivity between spatial configuration and the social structure of space (Steadman, 1983). There are three main concepts in spatial analysis which include (Klarqvist, 2015) convex space, axial space, and isovist space.

- Convex space: In this system, a connectivity graph is defined based on how each line deals with the lines around it and is typically used for textures in a city, village, or neighborhood unit (Jiang, Claramunt & Klarqvist, 2000; Klarqvist, 2015; Penn, 2011, Montello, 2007).

- Axial Space: A state in which all space is covered in two dimensions for spaces that do not behave linearly and are typically used for the interior layout of houses (Jiang et al., 2000; Klarqvist, 2015).

- Isovist space: The original idea for this mode came from visual fields that were visible from a certain point. For this reason, the basis for the formation of this model is the way in which light is reflected, which determines the models of people's motor behavior in the environment (Benedikt & Burnham, 1985; Montello, 2007).

- Integration: Integration of a point shows the connectivity between that point and the general structure of the set or its subsets. In other words, if it is possible to reach a space by walking through fewer spaces, that space has more integration, and vice versa. A space has high integration that has more integration with other spaces. This index is linearly related to the connectivity index and shows that more integration equals more connectivity.

- Depth: Depth is defined as the number of steps that must be taken to move from one point to another. In other words, depth is the number of spaces we pass in the city and the architectural space to reach the desired spaces.

- Connectivity: is defined as the number of points where one point is directly related to another. For example, the rate of connectivity of a room that has two entrances to adjacent spaces is two.

- Traversable depth: A visible field is a set of all points that are given from a vision point in space and are visible relative to the environment (Benedikt, 1979).

• **Isovist**

To analyze the spatial characteristics of the environment, Benedict proposed isovist as a basic and objective element, determinable by the spatial environment (Benedikt, 1979). Isovist (Fig. 1) is a polygon that explains spatial characteristics by describing the observable zone in the view of the observer. Isovist is a visual polygon of a place. From this polygon, several quantitative descriptions can be derived that reflect the physical characteristics of the relevant space, such as area, length of the perimeter, number of vertices, and length of open or closed boundaries (Karimimoshaver, Alamdari & Ahmadi, 2015).

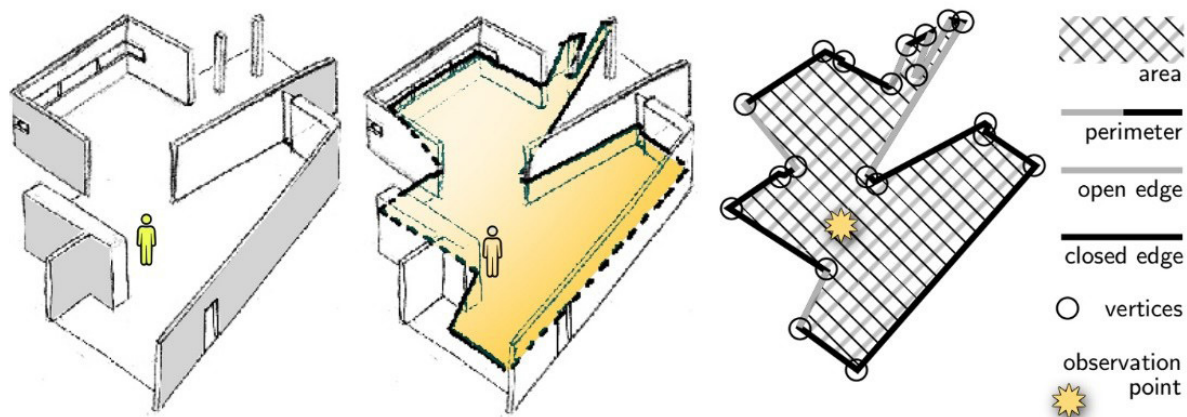


Fig. 1. A polygon isovist that is seen from the view of the observer. Source: Wiener & Franz, 2005.

Benedict's (1979) geometric dimensions in isovist analysis include area, perimeter, closure, circularity, and compression. Closure is the ratio of the perimeter in the mass fraction. Circularity in the square is the perimeter of the area. And indicates the sharpness of the isovist. The compression dimension examines the rate of the proximity of the isovist to the convex space. The shrinkage dimension indicates the longest line of vision of the isovists.

Research Method

In this study, first, the maps of the traditional houses of Hamedan were collected, and introverted samples were divided into four groups of multi-courtyard, volume on three sides, volume on two sides, and volume on one side, and two samples were selected from each group. To select contemporary houses, four samples of the works of two famous architects of the city were selected and the maps were examined with the help of AutoCAD software, with UCL dept map software. To achieve a way of life and a system of behavior in the traditional houses of Hamedan, several citizens who had the experience of living in these houses were interviewed. The activities and spaces in which the activities took place were identified. In this regard, the activities were identified and studied in two seasons, hot and cold. Then, the characteristics of houses in terms of spatial configuration and isovist were evaluated by the indicators of spatial syntax software, including integration, depth, connectivity, traversable depth, and the dimensional of isovist, and at the end, the results were expressed.

• Hamedan City (Climate and architecture)

In general, the climatic conditions of Hamedan are extreme and unbearable cold in winter and mild and favorable weather in summer, intense sunlight, and very large difference in temperature of day and night. According to this climate, traditional houses in Hamedan have a relatively dense texture and are usually built on two floors. The form of the building, like the urban texture, is designed and executed to deal with extreme cold. These houses have a central courtyard and the summer and winter living space, like other parts of Iran, are formed around the central courtyard and provide the conditions for the seasonal use of the building. Attention to the effect of this type of climate on the traditional and contemporary architectural

model in connectivity with the courtyard is very different (Figs. 2 & 3).

• Selected houses

To select the traditional houses, first, valuable houses were identified and maps were collected, and in some cases, the houses were visited and the maps were drawn and corrected by AutoCAD software. They were classified into two types, introverted and extroverted. In the classification of introverted, in which the spaces enclose the courtyard, there are two types of multi-courtyard and single-courtyard forms, which can fall into three groups: volume on three sides, volume on two sides, and volume on one side (Fig. 2). In the classification of extroverted, the houses are centrally located in the garden. After classifying the houses, the introverted form was chosen for a more detailed study, and in connectivity with the selection of the samples, an attempt was made to select those that were registered in the

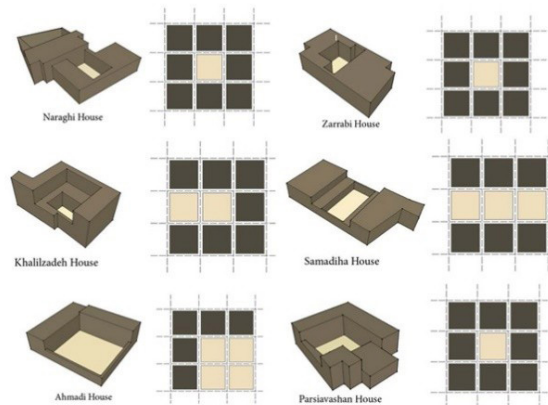


Fig. 2. Full and empty models in traditional housing in Hamadan. Source: Authors.

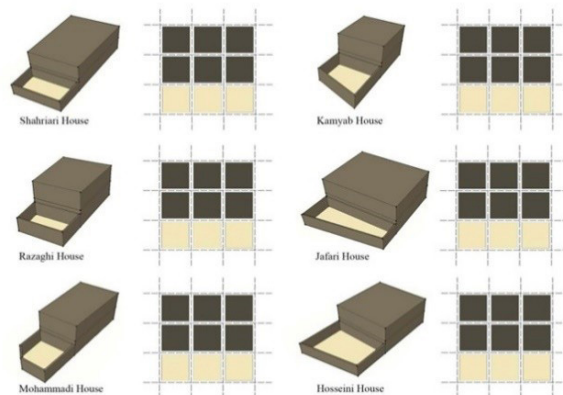


Fig. 3. Full and empty models in contemporary housing in Hamadan. Source: Authors (sample of north houses).

cultural heritage and that there be variety in the designs and maps. In contemporary houses, two types were identifiable, houses with courtyards and apartments, and because this study seeks the connectivity between living spaces and courtyards, the second type was removed due to the lack of clear connectivity between spaces and courtyards, and houses with courtyards that were designed by famous city architects, were considered for more detailed study (Fig. 3). In connection with their selection, an attempt was made to consider the

variety of maps and the existence of both types of north and south houses (courtyard in the front part of the building, and courtyard in the back part of the building, respectively). The documents related to the selected samples are given in Table 1.






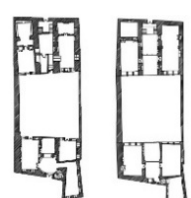

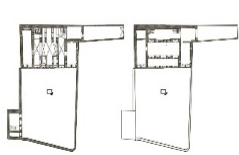


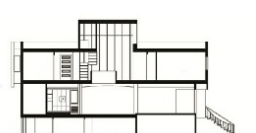
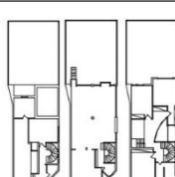
Findings

The findings of this project are presented in two parts: 1- Behavioral system, 2- Analyses.

• Behavioral system

The builder or architect creates a single form by

Table 1. Documents of the selected houses. Source: Authors.

		Documents of the selected traditional and contemporary samples	
		Façade and section	Floor plan
Multi courtyard house	Shahbazian's house		
House with the volume on three sides	Khalabani's house		
House with the volume on two sides	Samadian's house		
House with the volume on two sides	Seifi's house		
Contemporary houses	House No. 1		
	House No. 2		

arranging spatial units. A building is a creation of spaces by components and elements that are formed for specific functions for their users and create special connectivity between the user and the desired space. Here, the existence of order between spaces means the internal connectivity of spaces that is used by its user. The internal information that lies in the architectural space is the same as the hidden biological model in architecture. In the architectural space, the social relations that have arisen from the behavior of their users can be recognized (Memarian & Tabarsa, 2014). According to the research hypothesis, the main living spaces in traditional houses have a deeper relationship with the courtyard than in modern houses. It is necessary to know the way of life of the people in the past. In this regard, identifying the behavioral system may be the most tangible expression of the way of life. To better understand

the effect of activities on the spatial structure of traditional houses, the system of behaviors must be separated (Madahi & Memarian, 2017). The activities in this study are divided into three categories. 1- Daily activities related to living; 2- Activities related to preparing and maintaining the necessities of life; 3- Social activities.

As detailed in the research method, this behavioral system and the spaces related to them were obtained through the interview method, which is given in Table 2.

• Data analysis

Given the transformation of maps into graphical analyses related to the characteristics of integration, depth, connectivity, and traversable depth (based on visibility graph analysis and rate of isovist in isovist analysis), we will discuss graphs and graphical analysis for each house.

In Shahbazian's house (Table 3), the pond room

Table 2. Behavioral system and the related spaces in traditional buildings. Source: Authors.

	Activity	Warm seasons	Cold seasons
Daily spaces related to living	Cooking	Kitchen	Kitchen, main living room
	Preparing bread	Baking place (stove)	Baking place (stove)
	Having breakfast and dinner	Porch, roof	Main living room, room, basement
	Having lunch	Main living room	Main living room, porch, living room
	Daily resting	Porch, main living room	Main living room, basement
	Washing dishes	Yard, pond room	Yard, pond room
	Washing clothes	Yard, pond room, out of the house	Yard, pond room
	Keeping clothes	Inner warehouse	Inner warehouse
	Sleeping	Porch, courtyard, roof	Main living room, living room, basement
	Collecting mattress	Room (as a cushion), inner warehouse	Room (as a cushion), inner warehouse
Spaces for providing and maintaining necessities of life	Preparing charcoal	Courtyard	
	Keeping charcoal	Charcoal place, warehouse	Charcoal place, Warehouse
	Keeping food	Basement, warehouse, inner warehouse	Basement, warehouse, inner warehouse
	Preparing a tomato paste and pickles and stew meat	Courtyard	-
	Keeping domestic animals	Corner of courtyard	-
	Preparing flour	Courtyard	-
	Keeping wheat	Basement	Basement
	Keeping bread	Basement	Inner warehouse
	Preparing nuts	Roof, room, basement	-
	Keeping fruit	Basement	Basement
Spaces related to social activities	Gathering of family members	Porch, courtyard	Main living room
	Overnight stay	Porch, courtyard	Room
	Guest hospitality	Guest room	Guest room
	Holding religious rituals	Guest room	Guest room
	Holding ceremonies (weddings, etc.)	Rooms, courtyards	Rooms

Table 3. Characteristics of space syntax in graphs shown in traditional multi-courtyard house. Source: Authors.

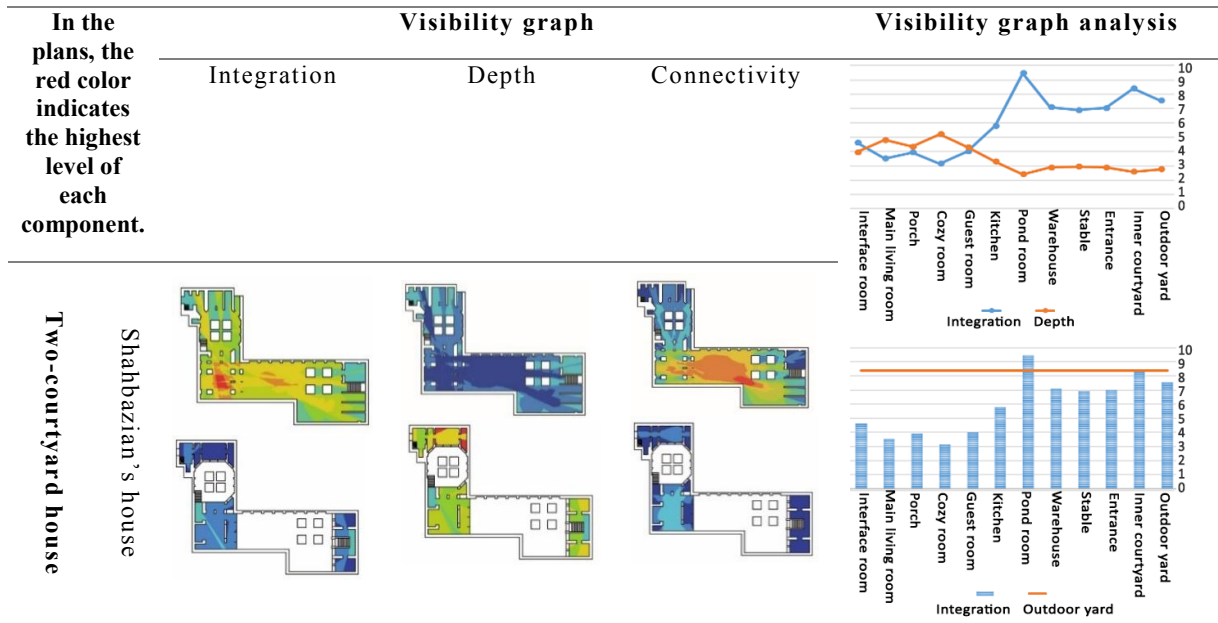
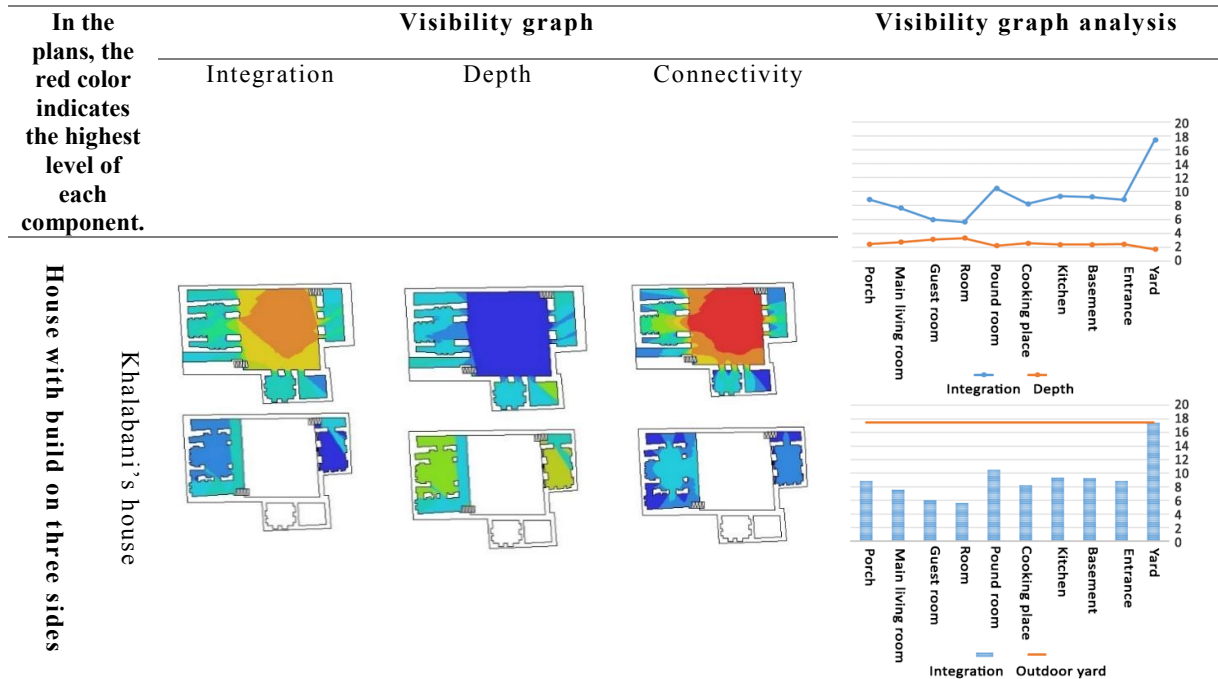


Table 4. Indices of spatial syntax in visibility graphs in traditional house with volume on three sides. Sources: Authors.



and the inner courtyard have the highest level of integration, and in the main living room and the cozy room above it, the lowest level of integration is observed; the inner courtyard and then the pond room have the highest connectivity and the main living room and the room above it and the division space have the lowest connectivity. The main living room and the cozy living room above it have the highest level of depth, and the outer courtyard

and then the inner courtyard has the lowest depth. The courtyards have the highest integration and the highest connectivity and the lowest depth. In multi-courtyard houses, the role of the inner courtyard is higher than the outer courtyard in higher integration and connectivity. And also in this house, the highest level of integration and the lowest level of depth is seen in the pond room as the pond room is located between the two

organizing elements (inner courtyard and outer courtyard).

In multi-courtyard house, the courtyards also have a high level of integration and connectivity and low depth.

In Khalabani's house, the highest integration is seen in the courtyard and then in the pond room, and the lowest is related to the room and guest room. The highest level of connectivity belongs to the courtyard and then the pond room and the lowest level belongs to the main room and living room. The highest depth is related to the room and the main living room and the lowest is related to the courtyard. As can be seen in the house with volume on three sides (Table 4), the courtyard has the highest level of connectivity and the lowest depth.

In Samadian's house, the entrance space has the highest level of integration, and after that, the courtyard has the highest integration, and the lowest integration belongs to the main living room and the guest room. The highest level of connectivity can be seen in the courtyard and then in the entrance space, and the cooking place (stove) and the inner storage have the lowest connectivity. The highest depth also belongs to the guest room and main living room, and the lowest depth is seen

in the entrance space and the courtyard. As can be seen, in house with volumes on two sides (Table 5), the courtyard has a high level of integration and the highest connectivity, and it also has the lowest level of depth. In these two houses, next to the courtyard, another space acts as a joint. Next to the courtyard, a high integration, a lot of connectivity, and a shallow depth is seen which is the corridor in Samadian's house and in front of the entrance in Zarabi's house.

In Seifi's house, the courtyard and the corridor have the highest integration, and the main living room and the cozy room above it have the lowest level of integration. The highest connectivity also belongs to the courtyard and then the kitchen. The entrance space and the main living room have the lowest connectivity. The highest depth is seen in the main living room and the cozy room above it, the porch and the guest room, the courtyard, the corridor, and the cooking place (stove) have the lowest depth. In these two houses, the courtyard has high integration and the highest level of connectivity and still has the lowest depth.

In house No. 1 (Table 6), the private living room, entrance, and living rooms have the highest level of integration, and bathrooms and bedrooms have the lowest level of integration. The highest

Table 5. Characteristics of spatial syntax in graphs shown in traditional house with volumes on two sides. Source: Authors.

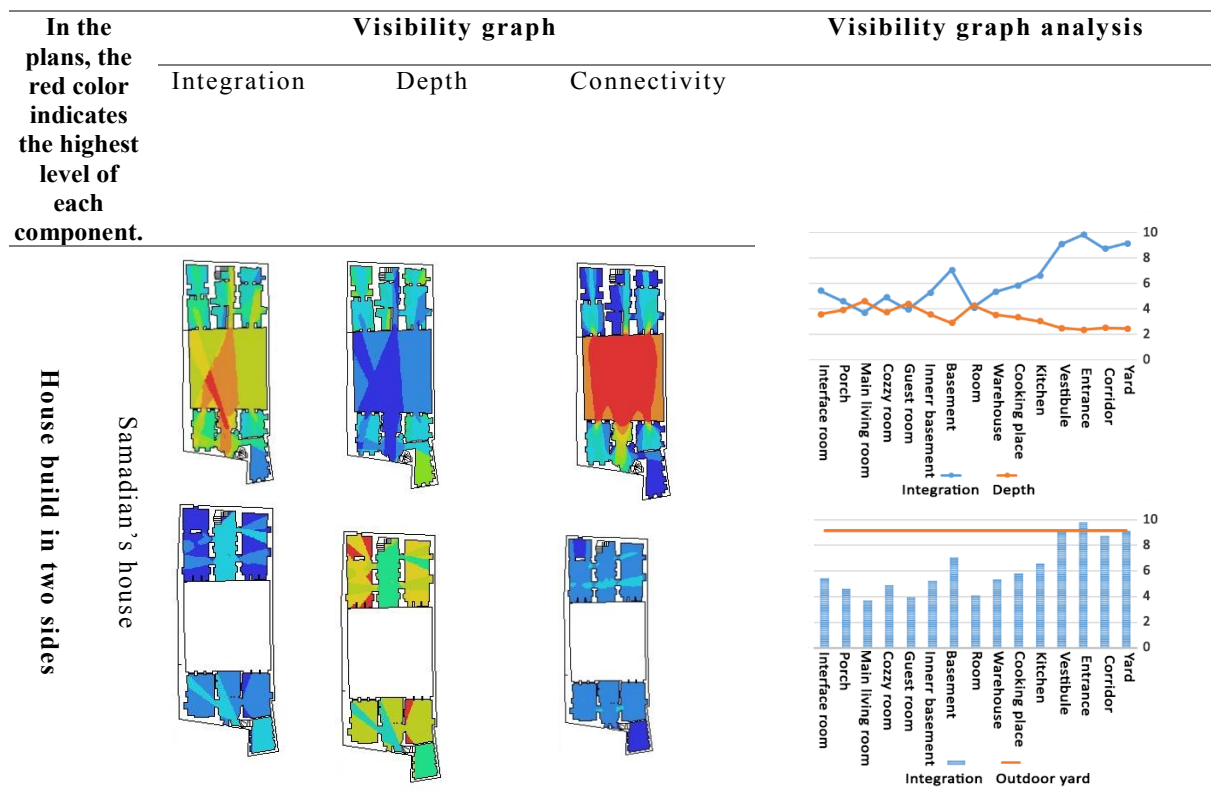
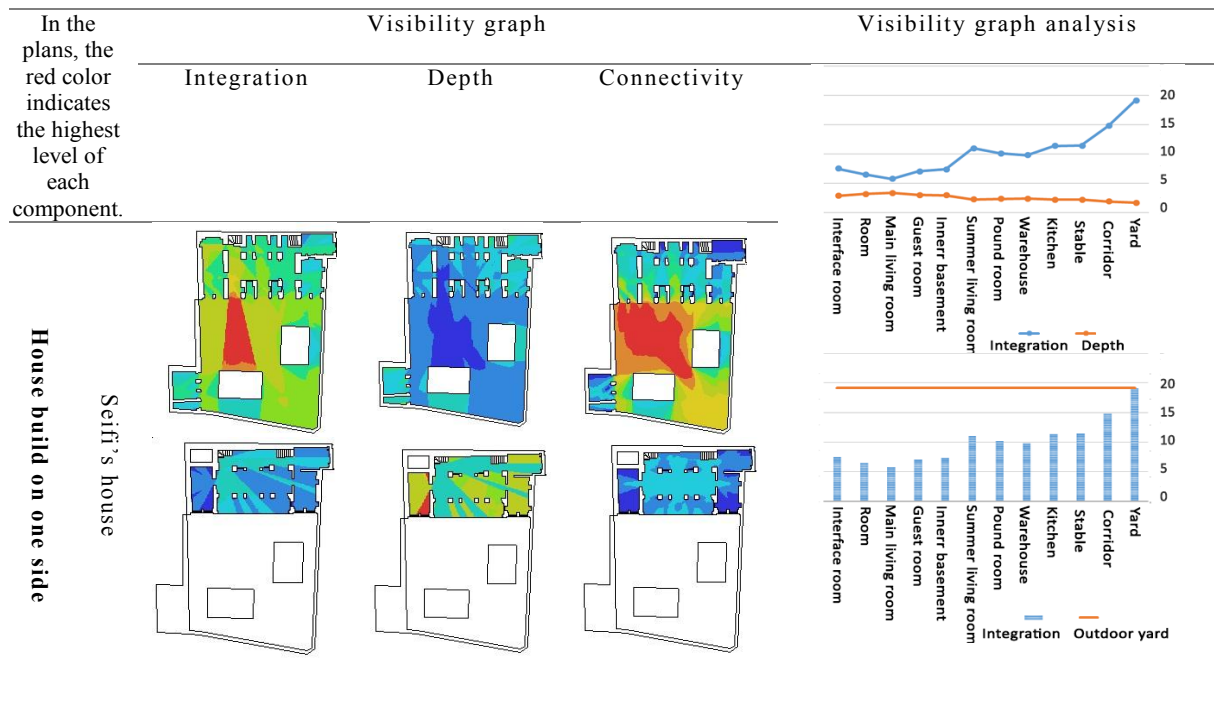


Table 6. Characteristics of spatial syntax in visibility graphs shown in traditional house with the volume on one side. Source: Authors.



level of connectivity belongs to the courtyard and living room, and the lowest level of connectivity belongs to the bathroom and toilet. The highest depth belongs to the bathroom and the bedroom and the private living room and living room have the lowest level of depth.

In this house, the courtyard has relatively high integration and the highest connectivity, and relatively low depth.

In house No. 2 (Table 7), the lowest level of integration is related to the bedroom and toilet, and the highest level of integration belongs to the living room and the division space. The living room and the courtyard have the highest connectivity and the lowest connectivity belongs to the bathroom and toilet. The highest depth is related to the kitchen and the lowest depth belongs to the living room and the division space.

In this house, the level of integration and connectivity of the courtyard is not low and the level of depth is relatively low.

The courtyard has a low integration and the connectivity is high and has the highest level of depth.

Now, we examine the obtained graphical analyses for the traversable depth index of the living spaces relative to the courtyard in the visibility graph analysis (Table 8). In Shahbazian's house, the highest level of traversable depth compared to the

courtyard is the cozy room above the main living room and the porch, and the lowest of which is the pond room and stable. In Khalabani's house, the basement and kitchen have the lowest traversable depth compared to the courtyard, and the rooms, the guest room, and the main living room have the lowest traversable depth. In Seifi's house, the main living room and the guest room have the highest traversable depth compared to the courtyard, and the pond room and kitchen have the lowest traversable depth compared to the courtyard. In traditional houses, the service areas have less traversable depth than the courtyard, and the main living spaces have more depth than the courtyard, which may be due to the extreme cold in the city of Hamadan.

In isovist analysis (Table 9), we examined the level of the dimension of the area from living spaces to the courtyard, based on which:

In Shahbazian's house, the highest level of the area dimension towards the courtyard is observed in the guest room and the lowest level of the area dimension belongs to the main living room.

In Samadian's house, the highest level of area dimension to the courtyard belongs to the three-door room, and the kitchen has the lowest area dimension.

In Seifi's house, the highest level of vision to the courtyard was observed in the guest room, and the

Table 7. Characteristics of space syntax in visibility graphs in contemporary houses. Source: Authors.

In the plans, the red color indicates the highest level of each component.	Visibility graph			Visibility graph analysis	
	Integration	Depth	Connectivity		
Contemporary houses	House No. 1				
	House No. 2				

kitchen has the lowest level of isovist dimension to the courtyard. In traditional houses, the highest isovist is seen in the guest rooms and rooms and the lowest isovist is in the main living rooms and

kitchens. In modern houses (Table 10), in houses No. 1 and No. 2, the highest isovist to the courtyard is seen in the living room and the lowest isovist belongs to the private living room and kitchen,

Table 8. Traversable depth compared to the courtyard in the visibility graph. Source: Authors.

Side: Red color indicates the highest level of traversable depth.	The traversable depth compared to the courtyard in the visibility graph analysis
Multi courtyard houses	Shahbazian's house
	
Houses with volumes in three sides	Khalabani's house
	
Houses with volumes on two sides	Samadian's house
	
Houses with the volume on one side	Seifi's house
	
Contemporary houses	House No. 1
	
	House No 2
	

Table 9. Isovist dimension towards the courtyard in Isovist analysis in traditional houses. Source: Authors.

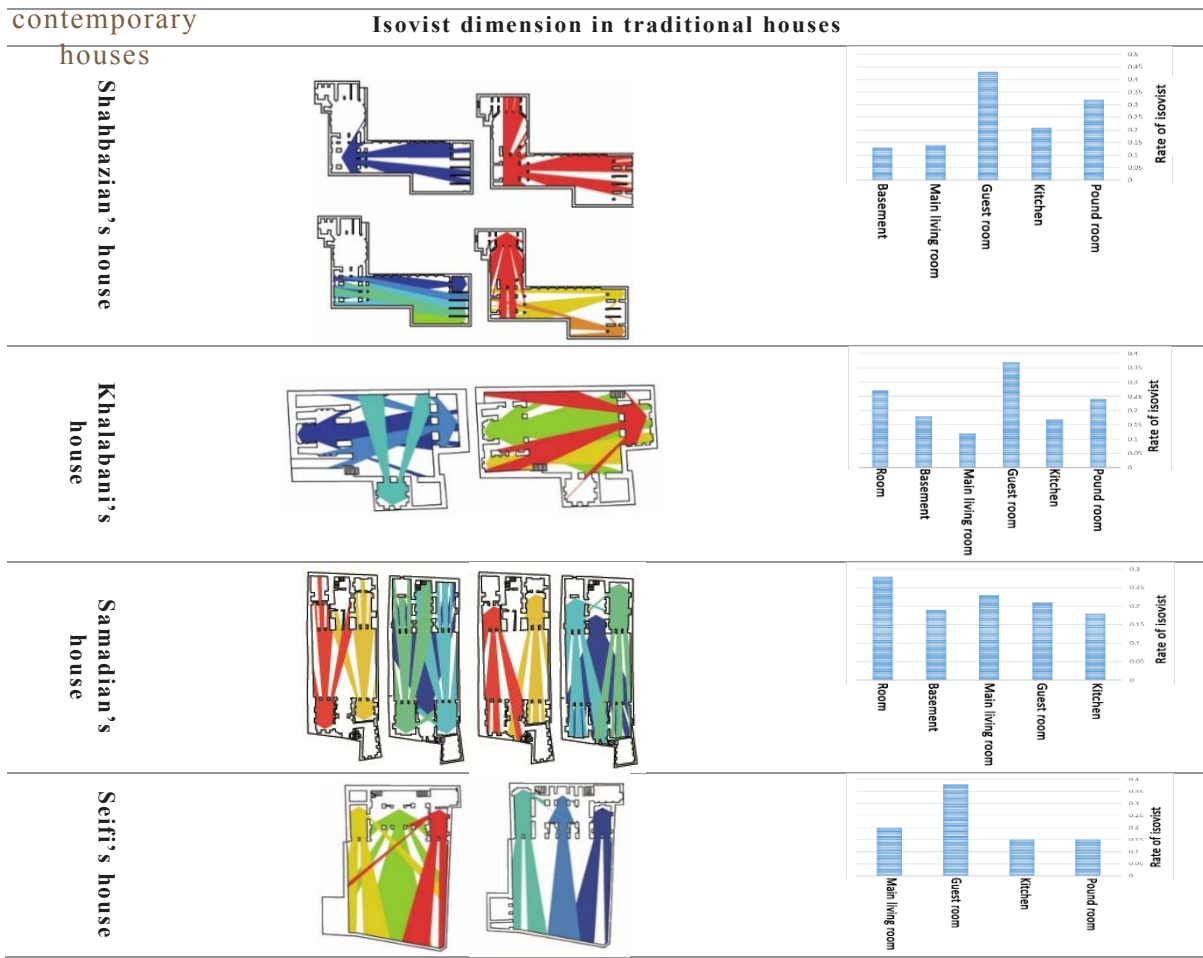
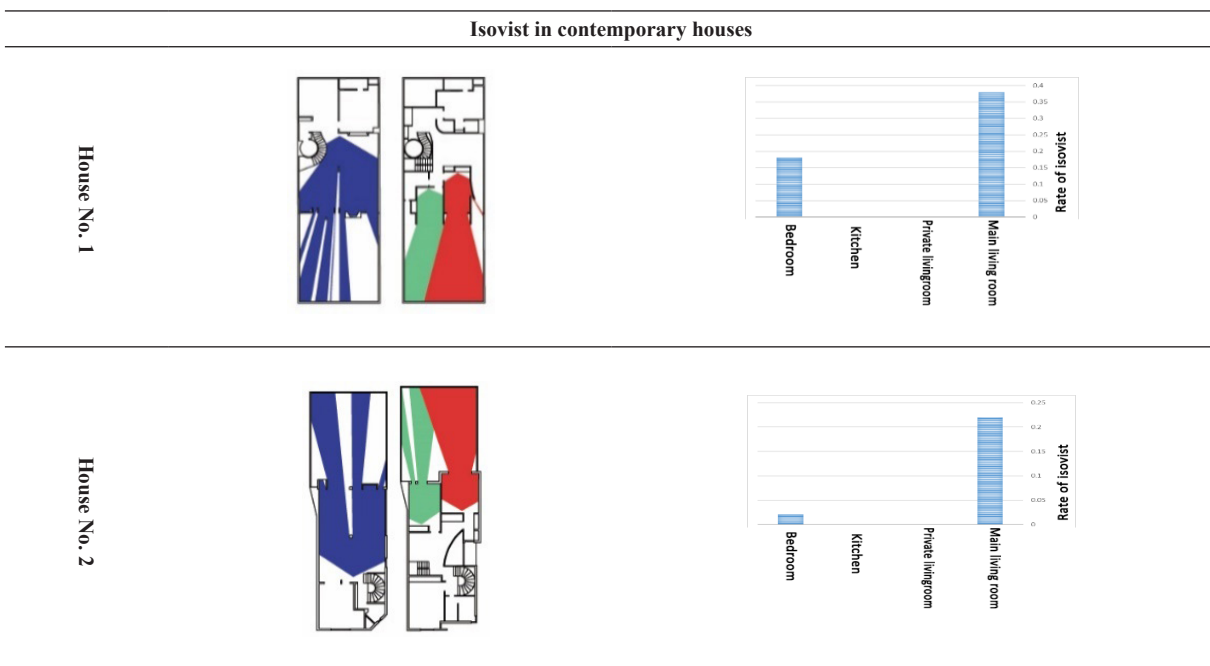


Table 10. Isovist dimension to the Courtyard in Isovist analysis in contemporary houses. Source: Authors.



where this value is zero. They have no view of the courtyard.

Conclusion

Analyses of traditional and contemporary houses in Hamedan with the characteristics of integration, depth, connectivity, and traversable depth in space syntax towards the courtyard, we find that the level of integration and connectivity of the courtyard in contemporary houses has diminished and the index of traversable depth is increased compared to the courtyard which shows the reduction of the role of the yard in today's houses. The component of the depth of courtyards has increased compared to the past, which indicates that the courtyards play a more passive role in today's houses and their connectivity with the main living spaces has diminished compared to the past. By comparing the size of the isovist dimension level, the spaces of traditional houses were determined. The main living room, which is a private living space (eating, relaxing, and gathering family members according to Table 2), has a relatively low view of the courtyard and also this space has a great traversable depth to courtyards. Considering that family members spend most of their time in this space and Hamedan is a cold city with harsh winters, it can be said that to protect from severe cold, in most cases this space has less connectivity with the outdoor space, which is one of the main daily spaces to live. Examining the traversable depth in the contemporary houses of Hamedan, which were designed by prominent architects of this city, we find the attention of these architects to the main living spaces (living room and kitchen) because these spaces have less traversable depth than other spaces. In traditional houses, the level of view of guest rooms (mostly used in relation to social activities) (see Table 2) has the highest size. In contemporary houses, this high level of view continues in the living room. By examining the traversable depth in contemporary houses, it was found that guest rooms have the lowest level of traversable depth to the courtyard, so it can be concluded that in contemporary houses, living rooms have the most physical and visual connectivity with the courtyard. By examining and comparing the traversable depth and the level of isovist in the spaces of contemporary houses, it was determined that bedrooms have high traversable depth towards the courtyard

so that if we do not have a suitable view of the courtyard from the bedroom, this space will lose its connectivity with courtyards. Recommended solutions: In contemporary houses, according to the rules and regulations of the municipality, the courtyards are located on one side of the building volume, and this type of open and closed layout can be a factor in reducing the connectivity between living spaces and private outdoor space (courtyard). In this regard, the proposed suggestion is to amend these laws, and according to it, based on the form and size of the land, the volume of residential buildings can be placed on three sides of courtyards, or the courtyard can be divided into several smaller courtyards and place inside the building volume. To easier understand the research, we replaced the spaces with traditional local names with similar names and placed them in this section for the reader:

- Main living room: Tanabi
- Basement: Ceyzan
- Kitchen: Matbakh
- Cooking place (oven): Tanoor
- Inner warehouse: Pastoo
- The cozy room above the main li

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