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MEASURING THE RELATIONSHIP BETWEEN SPATIAL CONFIGURATION CONCEPT VARIABLES AND FLEXIBILITY COMPONENTS

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Abstract. Flexibility has been one of the valuable concepts in architecture due to the emphasis on the formation of a variable space to meet the needs of users and their peace and comfort over time. The main components of flexibility in a space system are multi-functional space, seasonal and daily displacement, and component separation and aggregation. Overall flexibility is a structural and conceptual concept that means the ability to make internal changes in a spatial system. On the other hand, the concept of spatial configuration emphasizes that space is the main factor and core of how events occur. To understand and explain the spatial configuration, one should look for a suitable method that responds to the environmental characteristics, one of the most important methods for understanding the spatial configuration is the space arrangement method. This method determines the configuration of a spatial system with the help of its variables, which are: coherence, depth, space difference, isovist, and visual accessibility. The main goal of this research is to know the relationship between spatial configuration variables and flexibility components in the spatial system of traditional houses in the Sufian neighborhood of Borujerd. This research is of applied type and has been done through correlation strategy and space layout method. The tool for collecting information in this research is documentary and library research and a survey through a questionnaire. To evaluate the variables and components of spatial configuration and flexibility, the relationship between the components and variables is first measured using the correlation method and spss software. The statistical population for measuring the relationship between flexibility components and spatial configuration variables is 25 experts and university professors. In the next step, five houses from the traditional houses of the Sufian Boroujerd neighborhood will be measured and evaluated using specialized space layout software to determine the variables of the concept of spatial configuration and their relationship with flexibility components. The results of this research show that the multi-functional space component in flexibility with depth and visual accessibility variables in the concept of spatial configuration, the seasonal and daily displacement component in flexibility with interconnected variables, space difference and isovist in the concept of spatial configuration and the component of separation and aggregation in flexibility is related to the interlinking variables, depth, and difference of space in the concept of spatial configuration.

Keywords: flexibility, spatial configuration, space arrangement, correlation method, Boroujerd Sufian neighborhood.

Introduction

One of the topics that have attracted the attention of many architects today is the issue of flexibility. In general, flexibility means the ability to make internal changes in the space system, which makes it more responsive to changes over time and will lead to a more desirable and appropriate function for each space (Kiaee et al., 2019, p. 61). On the other hand, the basis of spatial configuration theory is research on the relationship between the spaces of a set. This theory believes that space is the main factor and core of how things happen. Thus, it can be concluded that any change in the arrangement of spaces will cause changes in the overall space system and spatial configuration. To quantify and understand spatial configuration more concretely, there are various methods, most of which rely on visual and physical aspects, metric distances, and geometric aspects of configuration. One of the successful theories and methods that study the structure and configuration of urban and residential spaces is the theory of spatial arrangement (Mohareb, 2009, p. 254). Spatial arrangement is a theory and a tool for analysis in architecture and urban planning. This attitude was founded by Hillier in London in the early 1980s (Montello, 2007, p. 10). Spatial arrangement is a set of techniques, methods, and theories that with the help of its variables study the theory of spatial configuration at the scale of architecture and urban planning to get the effects of how spatial configuration. This is a technical method for

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quantitative analysis of qualitative factors (Rismanchian & Bell, 2015, p. 20). In other words, any change in the map of spaces or their arrangement causes changes in the spatial configuration and the collection of the spatial system (Sajjadzadeh et al., 2017, p. 2). Thus, it is clear that the concepts of flexibility and spatial configuration seek to recognize the functional efficiency of spaces in a spatial system to determine the course of changes in spaces. Among the various spatial systems, housing is the most human presence and changes in the activity system of users in housing are faster than in other uses. In this study, to measure the functional efficiency of spaces in a space system, five traditional houses of Boroujerd in the Sufi neighborhood of Boroujerd were evaluated. Sufian neighborhood is located in the northwestern part of the historical context of Boroujerd. The area of the Sufian neighborhood is 51.7 hectares, which due to the vastness of the historical context (271.8) includes about 20% of the area of the historical context of Boroujerd (Chegeni et al., 2021, p. 172). Therefore, the purpose of this study was to investigate the relationship between the concepts of flexibility and the theory of spatial configuration and also to measure the spatial configuration of houses in the Sufi neighborhood of Boroujerd, to identify the features and principles that can affect the functional efficiency of houses. It is desirable and gives quantitative and qualitative value to its spaces, it is through the questionnaire tool and specialized space arrangement software. Therefore, the main question of the research is: What is the relationship between spatial configuration variables and flexibility components in a spatial system?

1. Theoretical foundations of research

1.1. Flexibility

The idea of creating a flexible space emerged in architecture in the early twentieth century as part of the modern movement by architects such as Le Corbusier, Vanderrohe, and Habra Kan. This thinking was due to the events that took place in technology that made it possible to separate the fixed structures of space from its movable elements, and with the emergence of various methods such as folding furniture, movable partitions, and the possibility of functional overlap of spaces in interior compositions. Spaces were provided (Ali Al-Hesabi & Borhani Darian, 2007, p. 21). The lexical root "flexibility" of "inflection" means "to desire something" and "a means of relating" and the lexical meaning of this root in Persian means "to be doubled" and "to return" and "to bend" has been stated (Dehkhoda, 1998). The concept of flexibility is defined in general terms as the ability to bend, change, not be sensitive to correction or change, and can adapt to different purposes or conditions, freedom from stiffness or stiffness. One of the basic principles of flexible design is to prevent inflexibility (Ghafourian & Aghaei, 2016, p. 43). The concept of flexibility in the early stages is the actual thinking in the design and layout of the space that can make a difference in the space (Wieland & Wallenburg, 2012, p. 890). Much research has been done on understanding the lexical concept of flexibility, and various theories have been proposed. In the following, the lexical meaning of the word flexibility as well as the indicators and components of flexibility from the perspective of some experts on this subject have been examined (Table 1).

Table 1. Definitions of the concept of flexibility from the perspective of experts (source: authors)

Components considered	Definition	Year	Pundits
Separating inflexible spaces from others to create flexibility	Flexibility is the general term for separating dry or wet spaces from each other, as well as the use of industrial products and modular components in architectural design	2017	Ostuzzi et al.
Creating flexibility in arranging spaces	The concept of flexibility in the initial stage is the actual thinking in the design and arrangement of the space that can make changes in the space	2012	Wieland & Wallenburg
Emphasis on physical and social characteristics to create flexibility	Flexibility involves both physical and social chains in space. Therefore, it can be described as an emphasis on compatibility	2008	Habraken
Changes in space over time to create flexibility	According to him, flexibility is achieved when in a physical system, without changing its essence or its main elements, it is possible to change the space according to the needs	2009	Grutter
Willingness and capacity to have space for flexibility	Flexibility is defined in general terms as the ability to bend, to change, to be insensitive to correction or change, to be ready and able to adapt to different purposes or conditions, and to be free from stiffness or stiffness	2007	Schneider & Till
Willingness and capacity to have space for flexibility	Space flexibility means responding to a range of activities at a single time or during a time, without the need for reorganization or physical changes	2002	Kronenberg
Creating flexibility with internal and external development	Friedman introduces flexibility in two forms: internal development and external development. In conditions where it is possible to add a part of the interior space to other components of the space, it is internal development, and in the conditions of adding the external space of a building, such as a semi-open space, it is external development	2002	Friedman
Creating flexibility through horizontal and vertical access to space	The flexibility feature considers the block stands as a horizontal or vertical extension of space and introduces the conditions for vertical expansion from a new angle. Access to such a spatial capability will be related to the availability of space and the capacity of the existing structures	2001	Blakstad
Organizing spaces in the complex to create flexibility	In architecture and design of the environment, the lexical meaning of this word is to organize the man-made space and change it to achieve new conditions, needs, and applications	2001	Phillips

1.2. Recognize the components of flexibility

In the research literature, the components of flexibility are interpreted and summarized as "multifunctional space", "seasonal and daily shifting" and "segregation and aggregation". The multi-functional space component means the ability to provide different uses of space (Eghbali & Hessari, 2013, p. 99). This component of flexibility is related to the two variables of space and time. Space can be used for several functions simultaneously and with different functions. Multifunctional space can be achieved by designing a map with a regular geometric structure. Thus, this component allows for flexibility, regardless of physical changes. The seasonal and daily movement component to create flexibility causes changes in the internal and external body continuously. But, as is clear from the features of this component, this component seeks to change the micro-elements of space and combine spaces in a spatial set to create more flexibility. This component seeks to change the function of spaces over time without fundamental changes in body and structure so that by making limited changes in indoor and outdoor spaces, spaces have the ability and potential to return to their original state. The separation and aggregation component makes it possible to change the size of the space, either to make it smaller or to make it larger, to create flexibility. The concept of separation and integration is related to the study of infrastructure changes, spatial needs, and the shape of spaces. Regarding the component of separation and integration, it can be said that this component seeks to adapt a space to new conditions and needs in changing periods and has the greatest impact on the body compared to other components of flexibility (Chegeni et al., 2020, p. 61).

1.3. Spatial configuration

Spatial configuration was founded by Hillier and Hanson 12 in London in 1984 and is based on research into the relationship between forms and how spaces are arranged together. This theory holds that space is the primary nucleus in how social and cultural events occur (Blanchflower & Oswald, 2011, p. 8). However, since space itself is formed through social, cultural, and economic processes, it is usually considered a platform for social and cultural activities to the extent that its form is not considered as usual and is assumed and felt invisibly (Rodriguez et al., 2012). The definition of spatial configuration can be seen in Hillier's language and expression in that spatial configuration refers to its totality before referring to the components of a spatial set. This theory is a set of relationships between objects that have complex and internal relationships in the overall structure of space. According to Hillier and Hanson, the configuration is a way of formalizing ideas that are simple to express but do not have time for mathematical and logical expression. If the spatial relationship is redefined based on what is happening, then wherever there is a connection between the two spaces, there is also configuration, and wherever this relationship changes, the configuration also changes. This is the official definition of configuration (Hamedani Golshan et al., 2020, p. 88). The main purpose of this concept is to strengthen and emphasize the role of spatial communication that can give each space a social relationship appropriate to the behavior (Rajaei et al., 2018, p. 28). In general, spatial configuration refers to how spaces are arranged next to each other and how they relate to each other. Thus, it can be concluded that any change in the arrangement of spaces will cause changes in the overall level of spatial configuration and also affect the amount and manner of activities in space (Jeong et al., 2015, p. 151).

1.4. Arrangement of space

To understand and explain the spatial configuration, one must look for an appropriate method that responds to the environmental characteristics. The main method for understanding spatial configuration is the space layout method (Ali Tajer et al., 2019, p. 101). The spatial arrangement method is a developed approach that is used in the analysis of the spatial structure of man-made environments (Manum, 2009, p. 3) which aims to describe spatial models and display these models in the form of graphic shapes As a result, facilitating scientific interpretations of the desired spaces in a spatial complex. This method is also called the "space syntax technique" in architecture and urban planning. In this technique, by transforming the spatial structure of the artificial environment into graphic patterns, the relations are presented in the form of mathematical data. So from the analysis of this data, we can understand the interrelationships between the body of the environment and the behavior of its users. The most important tool used to analyze the structure of spatial configuration by space syntax is Depthmap software. Developed by Turner and colleagues at the London Academy of Sciences, the software enables researchers to analyze space at all micro and macro scales with much higher accuracy and with much greater indexes (Pinelo & Turner, 2010). This method, along with theoretical advances and the development of computer analysis techniques and methods, has attracted the attention of architects and urban planners. In this method, the pattern of spatial communication is analyzed using graphs and examined through syntactic variables. The use of this tool in understanding the spatial structure is done by analyzing the relationship between these variables and social qualities (in the context) and the individual aspect of these variables has no value (Hillier & Vaughan, 2007, p. 216). In this method, the spatial configuration is analyzed using indicators such as mutual connection, depth, ISO, visual access, and space difference. In this regard, before explaining the relationship between spatial configuration variables and flexibility components, a brief definition of spatial configuration variables is first given (Table 2).

Table 2. Definition of spatial arrangement variables (source: authors, based on Hillier et al., 1993; Hillier, 2007)

Definition	Variable
Integration is the main variable of space arrangement. The mutual connection of space indicates the connection or separation of a point from the general system or the lower system, quadratic. Space has a lot of mutual connection that is more integrated with other spaces	Integration
The depth of space means that to reach that space, one has to go through several other spaces, or in other words, the depth represents the number of global changes that are required to reach from one space to another. As a result, the greater the depth of space, the greater the degree of privacy of the space	Depth
Visual access means a certain amount of space in a residential unit or complex that can be perceived by the visual power. Visual access is directly related to human vision and is examined at a 120-degree angle. This index is directly related to the concept of permeability in traditional and old houses and generally means the amount of space in a residential unit or complex that can be perceived by the eye	Visibility Isovist
This variable in the graph system determines the visual volume of the eye cone of individuals at the moment of placement in a single set	Isovist
Indicates the difference between the properties of space and their various functions in a single set. This variable is calculated by the spatial graph and the concept of the loop	Relative Difference Factor

2. Research background

There has been a lot of research on the concept of flexibility and various theories and experiences have been proposed most of the research has been done in the field of housing, while less research has been done to identify and explain the term flexibility. Habraken (2008) in a study entitled "Alternative Support System for Industrial Production" emphasizes the separation of support elements and free units to achieve flexibility. Gharavi Al-Khansari (2017) in his research "Convergence model due to architecture" on two strategies of integration and separation and the ability to develop such and similar effective solutions in flexibility. Chegeni et al. (2020) in a study entitled "Explaining the causal process model of components and flexibility strategies" using the causal method model and taking advantage of the relationship between research propositions, The relationship between flexibility components and strategies is discussed. The studies done to understand flexibility in housing have all defined several flexible components in the housing. The theory of spatial configuration and its method, the arrangement of space, are almost new concepts, although it has been about thirty years since its formation; it has only expanded in the last decade. Some of the research that has been done in the field of spatial configuration and arrangement of space inside and outside the country are as follows: Hanson and Zako (2007) in the study "Understanding spatial configuration in the environment" on the effect of spatial configuration on the environment People's behavior has been addressed. In their research, Mustafa et al. (2010) recognized the privacy of traditional and modern homes in the Iraqi city of Erbil with the help of spatial configuration. Allard et al. (2014) in his research "Increasing awareness of household mobility, leverage to change housing options and improve national sovereignty" deals with the relationship between spatial configuration theory and property value. Ali Tajer et al. (2019) in their research "Privacy at home: analysis of behavioral patterns in a spatial configuration of traditional and modern houses in the city of Hamadan based on the concept of space syntax" examine the old houses and new houses in Hamadan from In terms of privacy, they have also provided graphical analysis using space layout software. As can be seen, various researches have been done about the concepts of flexibility and spatial configuration, but the relationship between these two concepts has not been measured in any research. However, in this study, the relationship between these concepts is done using the correlation method. Hessari and Chegeni (2021) in their research "The influence of the environment structure on the spatial configuration of traditional Iranian housing (case study: comparison of traditional housing in Dezful and Borujerd)" have compared traditional housing in two different regions. Yazhari Kermani and Amini Goharrizi (2022) in research titled Analysis of Spatial Configuration, Dastkand Architecture of Iran, by looking at the architecture of Kandavan and Meimand villages, using the technique of space syntax, examine the architecture of the village using the technique of space arrangement. As can be seen, various researches have been conducted in connection with the concepts of flexibility and spatial configuration, but the relationship between these two concepts has not been measured in any research. However, in this research, the relationship between these concepts is done using the correlation method.

3. The study area

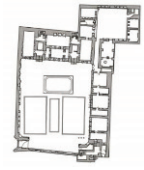
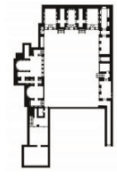
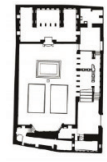
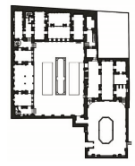
The city of Borujerd is one of the cities of Lorestan province in Iran with a cold and mountainous climate, which is 1560 meters above sea level. The population of Borujard city is 334,000 people (Statistical Center of Iran, 2019). Borujerd has a valuable historical context, which is evidenced by the presence of the Jame Mosque, which is more than a thousand years old, and houses with authentic remains. But due to lifestyle changes, migration and economic changes, a large part of the valuable fabric of this city has undergone major transformation and

changes during the last several decades. In this regard, it is essential to know the spatial and physical organization of the houses of this city and to analyze the patterns used in these houses (Hessari et al., 2022, p. 26). Due to the formation of the Sufi neighborhood and the antiquity of this neighborhood, now the best houses in Boroujerd, both physically and in terms of antiquity, are located in the Sufian neighborhood. There were large gardens in this neighborhood and in these gardens there were large monasteries that were standing and settled until the end of the Qajar government. Eventually, the Qajar government, out of fear of the Sufis, destroyed their gardens and monasteries and assigned them to residential areas of the same name as the Sufian. For this reason, most of the residential houses in the Sufi neighborhood belong to the Qajar period (Boroujerdi, 2007). There are a large number of traditional houses in this neighborhood, 5 of which were purposefully selected. The reason for choosing each of the houses is the location of the building in the Sufi neighborhood of Boroujerd the historical antiquity of the work and the registration of the building in the Cultural Heritage Organization (Table 3).

4. Research method

This research is divided into two main parts in terms of research method. In the first part of the research, a qualitative method in the form of a questionnaire was used to explain the relationship between spatial configuration variables and flexibility components in the architecture. In this way, after the detailed knowledge of spatial configuration variables and flexibility components, their relationship is measured through a questionnaire, and then the obtained information is evaluated and explained through SPSS software. The statistical population of the research to explain the relationship between variables and components of spatial configuration and flexibility was 25 university professors who were purposefully selected from among university professors and experts related to the research field. "Cronbach's alpha" test was used to measure the validity and reliability of the questionnaire, the coefficient of which is 0.921, which is an acceptable value. Also, to measure the normality or non-normality of the data, the Kolmogorov-Smirnov test is used, which shows that the distribution of the data is normal. Finally, the bivariate correlation test was used to measure the relationship between the variables and the research components,

Table 3. Details of selected research houses (source: authors)

Features	Picture of the building	Location	Plan	Building name
Course: Qajar Area: 1550 m Number of inputs: 3 Ron is right		Safa St. – Red Crescent St. – Hosseini Alley		Eftekhar
Course: Qajar Area: 540 m Number of inputs: 1 Ron is right		Safa St. – Red Crescent St. – Hosseini Alley		Birjandi
Course: Qajar Area: 780 m Number of inputs: 1 Ron is right		Safa Street-Safa Boulevard		Moradi
Qajar period Area: 830 m Number of inputs: 2 Ron is right		Safa Street – Hosseini Alley		Messri
Qajar period Area: 1620 m Number of inputs: 3 Ron is right		Safa St. – Red Crescent St. – Hosseini Alley – The end of Iftikhar Alley – next to the museum		Moghesh

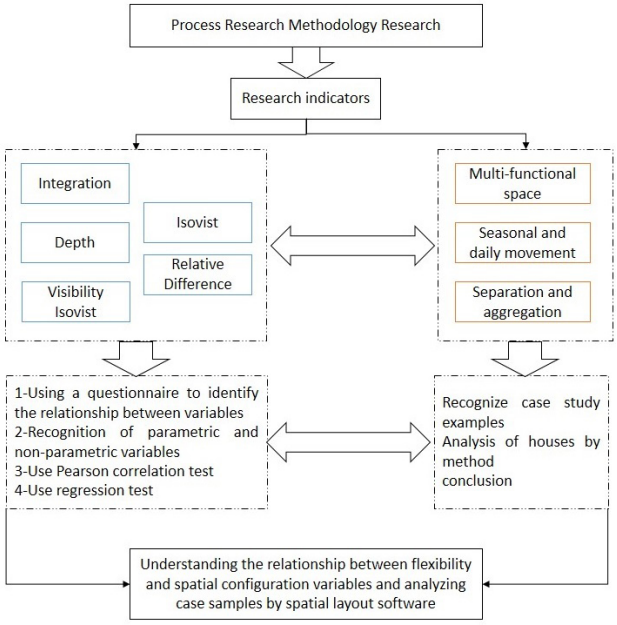


Figure 1. The process of research methodology

and the information was determined in SPSS22 software for quantitative data analysis and evaluation. In the second part, the plans of the desired houses in different scales are analyzed for space configuration (Figure 1).

5. Research findings

In this part of the research, first, the correlation between spatial configuration variables and flexibility components is investigated, and in the next part, the spatial configuration of traditional Sufi houses with specialized space arrangement tools and software is examined. Finally, the relationship between spatial configuration variables and flexibility components in the housing space system is determined.

5.1. Investigating the correlation between multifunctional space components with spatial configuration variables

Also, as shown in Table 4, according to the results of regression analysis with the entering method, the multivariate correlation coefficient for combining spatial configuration variables with multifunctional space components is equal to MR = 0.927 and 859 0.0 = RS, which is significant at the 0.05 level. Among the spatial configuration variables, the depth variable with a beta coefficient of 0.403 and the value of t = 2.73 and the significance level P = 0.013, the visual access variable with a beta coefficient of 0.456 and the value of t = 3.39, and the significance level P = 0.003 is significant at the 0.05 level, so they play a good role in predicting for the multifunctional space component.

5.2. Investigating the correlation between seasonal and daily displacement components with spatial configuration variables

Also, as can be seen from Table 5, according to the results of regression analysis with the Enter method, the multivariate correlation coefficient for combining spatial configuration variables with the seasonal and daily

Table 4. Regression analysis for the multifunctional space component (source: authors)

Multiple correlations MR	Determination RS(R^2)	F (Linear regression)		Enter Statistical indicators	
				Probability P (for linear regression)	
0/927 = R	0/859 = R^2	23/16 = F		0/001 = P	
Sig(p)	t	Beta	B	Independent variables	Dependent variable
0/22	1/25	–	2/65	Constant regression	Multi-functional space
0/84	0/200	0/028	0/045	Integration	
0/013	2/73	0/403	0/523	Depth	
0/003	3/39	0/456	0/610	Visibility Isovist	
0/40	0/861	0/100	0/165	Relative Difference Facto	
0/40	0/854	0/161	0/243	Isovist	

Table 5. Regression analysis for the seasonal and daily shift component (source: authors)

Multiple correlations MR	Determination RS(R^2)	F (Linear regression)		Enter Statistical indicators	
				Probability P (for linear regression)	
0/938 = R	0/881 = R^2	28/04 = F		0/001 = P	
Sig(p)	t	Beta	B	Independent variables	Dependent variable
0/66	0/447	–	0/852	Constant regression	Multi-functional space
0/018	2/60	0/340	0/528	Integration	
0/99	0/002	0/001	0/001	Depth	
0/12	1/63	0/201	0/264	Visibility Isovist	
0/027	2/39	0/256	0/615	Relative Difference Facto	
0/04	2/10	0/354	0/523	Isovist	

displacement components is equal to MR = 0.938 and / 881. RS = 0, which is significant at the 0.05 level. Among the spatial configuration variables, the correlation variable with a beta coefficient of 0.340 and a value of t = 2.60 and a significance level of P = 0.018, a variable of space with a beta coefficient of 0.256 and a value of t = 2.39, and a significance level P = 0.027, the isovist variable with a beta coefficient of 0.354 and a value of t = 2.10 and a significance level of P = 0.04 is significant at the level of 0.05, so in predicting for the seasonal and daily displacement component it plays a good role.

5.3. Investigating the correlation between separation and aggregation components with spatial configuration variables

Also, as can be seen from Table 6, it can be concluded that according to the results of regression analysis by the Entering method, the multivariate correlation coefficient for combining spatial configuration variables with separation and aggregation components is equal to MR = 0.972 and RS = 0.944, which is significant at the 0.05 level. Among the configuration variables, the correlation variable with a beta coefficient of 0.327 and a value of t = 3.65 and a significance level of p = 0.002, the variable of space with a beta coefficient of 0.254 and a value of t = 3.47, and a significance level P = 0.003, the depth variable with a beta coefficient of 0.369 and a value of t = 3.97 and a significance level of P = 0.001, is significant at the level of 0.05, so it plays a good role in predicting for the variable component he does.

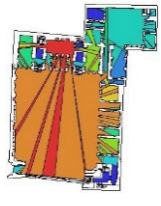
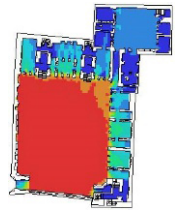
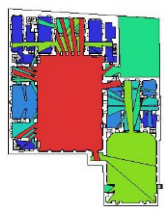
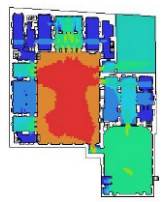
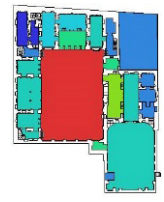
5.4. Understanding the spatial configuration of houses in the Sufian neighborhood of Boroujerd using the space layout technique

In this section, the spatial configuration of selected houses in the Sufian neighborhood of Boroujerd is introduced. It is necessary to explain that for a more accurate analysis, the mean of the variables is considered (Table 7).

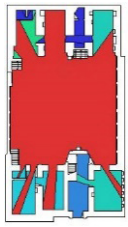
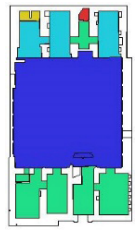
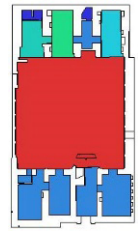
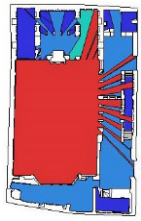
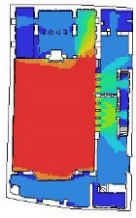
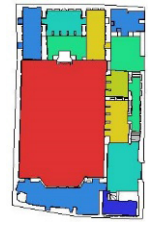
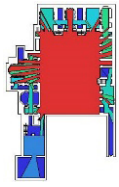
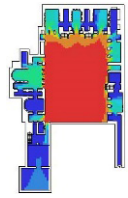
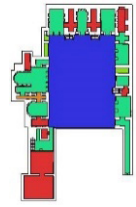
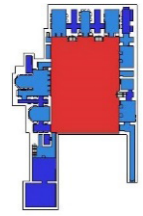
Table 6. Regression analysis for segregation and aggregation component (source: authors)

Multiple correlations MR	Determination RS(R^2)	F (Linear regression)		Enter Statistical indicators	
				Probability P (for linear regression)	
0/972 = R	0/994 = R^2	64/21 = F		0/001 = P	
Sig(p)	t	Beta	B	Independent variables	Dependent variable
0/19	1/35	–	1/79	Constant regression	Multi-functional space
0/002	3/65	0/327	0/517	Integration	
0/001	3/97	0/369	0/777	Depth	
0/27	1/12	0/095	0/127	Visibility Isovist	
0/003	3/47	0/254	0/620	Relative Difference Facto	
0/20	1/30	0/155	0/234	Isovist	

Table 7. Measurement of the spatial configuration of houses in the Boroujerd Sufian neighborhood

Relative Difference Factor	Visibility Isovist	Isovist	Depth	Integration	Spatial configuration variable
					Building name
It is determined by the loop variable					Eftekhar
14 rings	4378/17	478/36	2/43	1/56	Average numbers
It is determined by the loop variable					Moghesh
13 rings	1806/69	236/03	3/19	1/88	Average numbers

End of Table 7

Relative Difference Factor	Visibility Isovist	Isovist	Depth	Integration	Spatial configuration variable / Building name
It is determined by the loop variable					Birjandi
7 rings	4417/46	713/49	1/54	1/76	Average numbers
It is determined by the loop variable					Messri
6 rings	3115/51	208/43	3	1/17	Average numbers
It is determined by the loop variable					Moradi
11 rings	1806/67	218/59	2/50	2/37	Average numbers
10 rings	3104/47	371/05	2/53	1/74	Overall overall variable

5.5. Analysis of the main parameters of spatial configuration in the houses of the Sufian neighborhood

Interconnectedness: The interconnected variable of the space arrangement method indicates the proximity and proximity of spaces to each other in a spatial complexity that is easily understood by people in spaces. The correlation variable plays an essential role in determining the function of spaces. This is why this variable plays an essential role in showing the communication and placement of spaces in a set. The factors that affect the interconnected variable in a set are a spatial layering of the set (separation of parts from each other), attention to the hierarchy in the set of spaces, accuracy in the areas used for spaces, attention to privacy. Understanding the function of spaces to determine the correct relationship between spaces and different parts (Hessari & Chegeni, 2021).

Depth: This variable means that deep spaces have to go through a lot of interface spaces to reach them, they have more depth than other spaces. This makes the spaces that have a lot of depth separate from the overall configuration of the collection. Among the space layout variables, the depth variable is generally related to the issue of privacy. Items that are associated with the depth variable in a set are accuracy in the circulation used in a set to travel the distance that leads to space, and attention to the area used spaces in a set (Hessari & Chegeni, 2021).

Isovist: The main purpose of the Isovist variable is to make a connection between the architectural space and the descriptive and perceptible features of each space so that it can present the logic of the spaces quantitatively and measurably. In a residential complex, isovist refers to several points and surfaces that can be seen and perceived from one point. Visible points are very important in measuring isovist because they represent the position of the observer and the set being researched. Therefore, the more open the space and without obstacles, the higher the numerical value of this variable (Rahimbakhsh, 2019). The factors that affect the isovist variable in a set are the correct placement and position of people in the spaces of a set, the proper use of spaces in a set, and attention to the different uses of spaces in a set (Hessari & Chegeni, 2021).

Visual access: This index is directly related to the concept of permeability in traditional and old houses and generally means a certain amount of space in a residential unit or complex that can be perceived by the eyes. Visual access is directly related to the public and private nature of the home space, which means that where there is high visual access, the space becomes public, and where there is little visual access, the space becomes more private. Also, this index of spatial configuration has a direct relationship with the number of openings in the plan, which means that wherever the number of openings is more, there is more visual access and it facilitates the natural movement of users in different places of the space. Items related to visual access include ease of penetration into a complex (attention to the public and private nature of the sections), proper use of openings (doors and windows), and outdoor area in a collection (Hessari & Chegeni, 2021).

Space difference: The space difference index is measured in the space layout software using the concept of a loop. This index is directly related to the issue of privacy in residential spaces. As it follows from the concept of the ring, this index is related to the direct relationship of spaces with each other, that is, it expresses how different spaces are directly or separately in a set (Kiaee et al., 2019). The things that are related to the difference in space are: creating the connection of spaces in a set with each other, layering the set to establish a connection between spaces, and the correct connection of spaces in a set by their function (Hessari & Chegeni, 2021).

After recognizing the relationship between spatial configuration variables and flexibility components through the correlation method and also determining the characteristics of spatial configuration variables, the relationship between variables and components and expressing their characteristics in a spatial set is explained (Table 8).

The relationship between flexibility components and spatial configuration variables is shown in Figure 2.

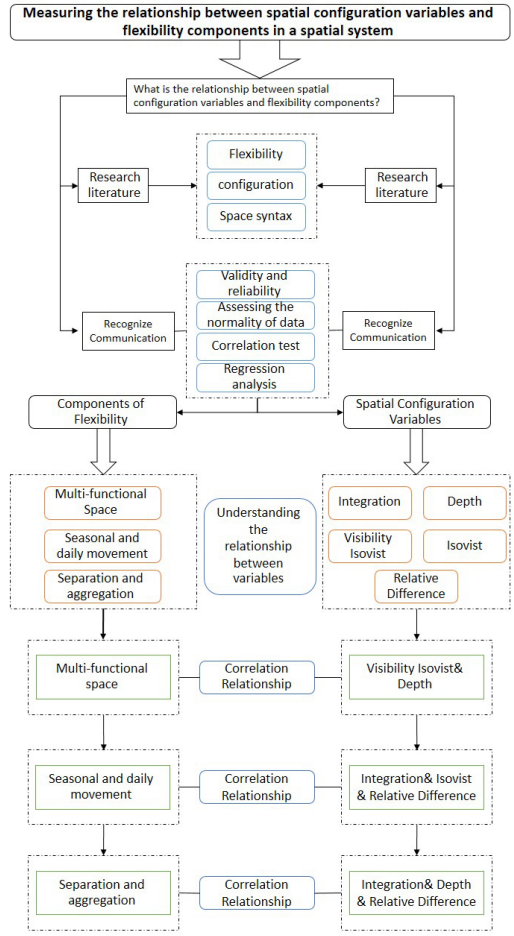


Figure 2. Understanding the relationship between flexibility components and spatial configuration variables (source: authors)

Table 8. Measuring the relationship between spatial configuration variables and flexibility components

Description	Explain the relationship between variables and components	Components of flexibility	Spatial configuration variables	Row
This relationship expresses the correlation between variables and components in the fact that spaces are private and public in a set, which is the same as permeability in a spatial set	Visibility Isovist and depth variables are correlated with the multifunctional space component	Multi-functional space Seasonal and daily movement Separation and aggregation	Integration Depth Visibility Isovist Isovist Relative Difference Factor	1
This relationship expresses the correlation between variables and components in the concepts of spatial configuration and flexibility, in fact, functional distinctions and selection of appropriate domains in the spatial set	Correlation variables, space difference, and isovist are correlated with seasonal and daily displacement components	Multi-functional space Seasonal and daily movement Separation and aggregation	Integration Depth Visibility Isovist Isovist Relative Difference Factor	2
This relationship expresses the correlation between variables and components in the concepts of spatial configuration and the flexibility of communication between spaces in a spatial set	Correlation variables, depth, and difference of space are correlated with the component of separation and aggregation	Multi-functional space Seasonal and daily movement Separation and aggregation	Integration Depth Visibility Isovist Isovist Relative Difference Factor	3

Conclusion and discussion

Measuring the concepts of flexibility and spatial configuration is effective in understanding the physical characteristics of artificial environments. This measurement helps to better understand the relationship between the body of the house and the patterns and values. Understanding this issue leads to understanding the beliefs, customs, and behaviors of people in artificial environments over time. This research is by the research question and by using the selection of houses that are all related to the Qajar period, it seeks to measure the relationship between the flexibility components and the variables of the spatial configuration of the environment, and further investigates the configuration of the houses. According to the explanations, the results are as follows:

Regarding the multi-functional space component, it should be known that this component means the ability to perform different activities in one set. Therefore, one of the things that affect this concept and this ability is the discussion of public and private spaces in a collection. The discussion of public and privateness is the same as the discussion of permeability in space, which is related to the variable of visual accessibility. Also, the discussion of permeability can be expressed with the concept of depth, which is one of the variables of space configuration. Therefore, the multifunctional space component is related to the variables of visual accessibility and depth. Another component of flexibility in architecture is the component of seasonal and daily displacement. Seasonal and daily displacement depends on the way and type of people's desires in a space instead of depending on the activities in a complex. Therefore, functional distinctions and choosing suitable areas in the collection are the most important features related to this component compared to the concept of spatial configuration. To provide these features in a spatial complex, separating the private and public parts from each other is a suitable solution that helps people to understand and perceive the same complex. This component is related to two areas, the functional area, and the visual area. These cases reveal the relationship between the seasonal and daily displacement component with interlinked variables, and the difference between space and isovist. The component of separation and consolidation is more flexible in line with the structure and physical body of the collection. This component promotes flexibility in the space of the collection by using separation and integration of spaces with the help of equipment and interface tools. This concept is related to three interrelated variables, depth, and difference in space. According to the nature of these three spatial configuration variables, it is clear that these cases express the increase in communication between the spaces of a complex.

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Suggestions for the future

Measuring and analyzing spatial configuration variables in a spatial complex and its effect on people's satisfaction can be a topic for future research. It is also possible to measure the effects of the environment structure on the spatial configuration by using the spatial configuration analysis in two different climates.

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