

Persian translation of this paper entitled:

سنجش انعطاف‌پذیری نظام فضایی با استفاده از تکنیک چیدمان فضا

(مطالعه موردی: خانه‌های شهر قزوین)

is also published in this issue of journal.

## Measure the flexibility of the spatial system using space syntax (Case Study: Houses in Qazvin)\*

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Received 2018/07/14

revised 2018/09/03

accepted 2018/11/14

available online 2019/04/22

### Abstract

Any spatial organization with the ability to make internal changes can answer extra demands of its users at different times. Therefore, it can possess a better performance than to the performance of single-functional spatial organizations. The main purpose of this research is to measure the flexibility of spatial system of houses using the space syntax in three traditional, traditional- contemporary and contemporary patterns in Qazvin. To achieve this goal, on the one hand, various manifestations of the flexibility of the spatial system of the house and, on the other hand, features of the space syntax were identified based on valid books and papers; Subsequently, flexibility expressions were evaluated and analyzed with a number of architectural concepts related to space syntax through descriptive - analytical and logical research method. In the present research and in this theory, the measurement tools are the justification Charts, the DEPTH MAP software and the data extracted from these two. Results of the research indicated that the influence of the spatial system on the development of the traditional houses was much higher than traditional - contemporary and contemporary instances. Also, most of contemporary houses, regardless of their construction area, possess the equal rate of flexibility in their spatial system. However, with a change in construction area in houses of traditional and traditional- contemporary era, the flexibility will face change.

**Keywords :** *Houses spatial system, Flexibility manifestations, Space syntax indicators, Qazvin houses.*



\*. This paper is derived from the Ph. D. thesis of Mahdokht Kiaee, entitled "Reflecting The Evolution Of The Gender Discourse In Flexibility In Activity And Spatial Systems Of Aristocratic Houses In Qajar Era (Case Study: Qazvin Aristocratic Houses)", under supervision of Dr Hossein Soltanzadeh and the advice of Dr. Aliakbar Heidari in Islamic Azad University of Qazvin, Iran.

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### Introduction

Discussions regarding the subject of flexibility in the architectural spaces are one of the considered topics in the society of expert architects which have been analyzed by a number of the researchers

recently. Supplying and securing various demands of different users in different periods of time is one of the reasons of its importance. Therefore, according to this definition of flexibility, we can expect that this quality includes different applications. Most of the studies that were done in the field of flexibility have provided general definitions for these concepts and in some cases, the studies have introduced a number of solutions and tools in order to make the living space of people flexible; specially in the field of contemporary housing in which we can refer to the research about the factors that contribute to flexibility in the structural, service spaces, architectural design and equipment and furniture systems (Ghafourian & Aghaie, 2017) or its deficits and advantages of developing flexibility in modular housing units (Eghbali & Hessari, 2013) and similar points. By analyzing these articles, it seems that the concept of intangibility, is somehow considered and the conceptual aspects of this subject and its types of appearance have been less considered in different spatial patterns.

### **Description of the problem**

Housing possesses the highest rate of human presence among different uses of land, and therefore the most important expectation that we have from it is to answer the different (and sometimes contradictory) demands of its inhabitants. Also, changes in the activity system of housing users has a faster rhythm in comparison with other land-uses which demands the most rate of compatibility in the living space with this variety of activities. It seems that, based on such a vision, the concept of flexibility in the housing is one of the most important factors which has applications in this regard and by doing a comparative analysis in different patterns of housing, we can analyze the evolution of this concept in different stages of formation of Iranian housings. Based on this, after presenting this concept in the related literature, appearances of formation of flexibility in housing land-uses and the tools for analyzing it in the considered cases will be deliberated. Thereupon,

the research question which this study is after, is presentable in the following form:

- How is the quality of the flexibility in the traditional, traditional-contemporary and contemporary houses of Qazvin in the viewpoints and definitions of spatial organization architecture?

### **Research background**

One of the fundamental bases of the flexible design is to prevent the lack of flexibility. Einifar refers to the capability of changes in objects and matters in his definition of this quality. He considers the spatial flexibility and organization of the artificial spaces and changes in order to resolve such demands by proposing this term in the architecture and specifically in housing design (Ghafourian & Aghaie, 2017: 43); and in Grouter's definition of such housing, where he refers to the possibility of change in the space in a symmetric way with demands. In his opinion, flexibility would gain significance when the possibility of change in the space become possible, symmetric to the needs in a physical system without alterations in its maxims or main elements. In another similar definition, flexibility becomes synonymous with the capability of reaction and response to the changes in life, changes which are shaped with the origins of human demands, and not external forces, including environmental forces, issues related to the energy and inertia (Gharavi Al-Khansari, 2011: 82). It is important to pay attention to the point that in the idea of adaptation in time within the definition of flexibility. It means that a construction is flexible if it can be compatible with the changes in the needs and demands of users at different times (Zandieh, Eghbali & Hessari, 2011: 95). Some other consider the definition of flexibility as developing the building by attaching other parts to it, parts which impact the spaces; this way, a conceptual background is proposed for their functional changes. Also, according to others, by developing multi-functional spaces, we can take the most advantage. Indeed, flexibility includes all of the following instances of the attachability and adaptability, change and

multifunctionality (Khalou Esmaili, 2009: 87). This way, all of the definitions of flexibility are directly signifying a necessity for direct or indirect physical changes of the space in order to adapt with different functions of the users and it includes all of the physical structures and spaces or the building, excluding the service spaces (services and the installations) and structural (Till & Schneider, 2005, 288). Indeed flexibility in the primary potential stages of design and the spatial arrangement that can accept a number of variations (Wieland & Wallburg, 2012: 890), includes a chain; some physical variations which provide the ability for the building in order to adapt to the changes (Habracken, 2008: 291). In this instance, Grouter believes that achieving pure flexibility is not possible and there are a number of governing borders in-between, because the whole order and it's primary structure should be preserved (Grouter, 2009: 108). According to the mentioned definitions and also the studies of researchers, it seems that flexibility signifies the ability of changes that should include in all of the activity and physical fields of architecture in order to satisfy the demands of users. With these interpretations, it should be able to provide the context for answering the demands of users by having the capability of changes in their spatial and activity systems. It seems that changing the activity system, needs a certain time for it to become subjected to change and to develop a demand for adaptation with the occurring new conditions (as an instance, seasonal relocation of the family in the introvert traditional Iranian families, which was done based on the change of seasons and in order to answer the need of the residents for piece). Also, changing the activity system is necessary when user needs to change an architectural body in a specific time in order to answer his or her need (For instance, changes in the size of the room by adding a balcony to it, is with the birth of new children and the demand for a wider space). Therefore, we can argue in a sense that changes in the activity system are functions of time and changes in the spatial system are the functions of place.

What has proposed above, have defined the concepts of flexibility. Different studies were also done in relation with the subjects of flexibility in architecture which can be referred to in two different categories of "different appearances of flexibility" and the "outcomes of employing flexibility" in architecture. In regard to the subjects of "results of using flexibility in architecture, we can refer to the research by Jeremy Till and Tatjana Schneider (2005), with the title of "the means to the end" in which they have presented two hard and soft strategies for the flexibility in housing (Till & Schneider, 2005). Also, in 2007 they have criticized the current condition of housing in Britain [by the time] in another article and have introduced the socio-economic and environmental productivity as the benefits of flexible housing (Till & Schneider, 2007).

But we can categorize the conducted studies regarding the "different appearances of flexibility in architecture" in the two levels of objectives and subjectivities. Some of the most important studies which have considered the subject of flexibility in the objective level can include those instances with an emphasis on the mobile components of the architecture, including the furniture, and they consider the subject of flexibility related to the interior and furniture design. As an instance of these subjects, we can also refer to the work of Robert Kronenburg "Flexible Architecture" (2007) in which he criticized a diverse range of public and specific architecture subjects like interior design and the furniture patterns. Also, the book series of transportable environments (1999, 2003, 2005) are some other works in which the developed projects or proposed ideas in the field of transportable environments are proposed in the works of green architecture and interior design.

Another group, considers the subject of flexibility as beyond the changes in the furniture and the mobile elements of the space and they extend it to the scale of the whole building or a collection of them. We can refer to the two works by Kronenberg as instances of these studies. In his book "Mobile dwelling units" (2003) he reflects

that how houses have turned into mobile cargo containers (Kronenberg, Scoates & Betsky, 2003); and in another book entitled "Mobile Houses" (2002), he offered a historical survey on different type of transportable, prefabricated architecture which has the advantages in the installation and removal of the construction (Kronenberg, 2002).

In some other studies in this context, the subject of flexibility is considered in the dimension of design which is mentioned as the open-ended design. In this approach, the subject of flexibility is considered in the form of using industrial products and modular parts in the building in which the structural issues, the subject of dividing dry and humid spaces or separating the connecting spaces, etc., are the bases for the flexible design (Ostuzzi, Jan, Lieven & Jelle, 2017). The above proposed subjects were the studies which considered the flexibility in relation to the physical elements of the construction. While in the objective look over the topic of flexibility, a number of researchers have analyzed the subject of flexibility in relation to the building's function and have introduced the flexibility of a space as equal to the diversification of different functions. This approach is also considered in the field of urban design; the factors for the success of a space is known as its multifunctionality, it's power for answering different needs of the users, giving them more right for selection and in result more liveliness in the space (Bentley, et al., 2014: 157). Jenny's studies were also done using the relative difference factor, it indicates that by defining weak and (unfocused) borders and using certain circles, the highest extent of flexibility will be resulted (Guney, 2005).

The second approach to the topic of flexibility is the subjective approach in which different readings of a single environment in the mind of the users, define the concept of flexibility. In this regard, the most important theories which have considered flexibility indirectly is the theory of "capabilities" in the psychology of the environment (Gibson, 1996) and the extent of this adaptation depends on the number of perceived capabilities by the users. In other words, the increase

in the available capabilities in an environment - the possibility of eliminating a more spectrum of the demands of individuals will be provided; In such instances, we can refer to that space as a flexible environment in the cognitive point of view (Lang, 2002). In this context, studies that include a hermeneutic or interpretive look over the architecture also consider the flexibility in the perception type of the audience in respect to the architectural form and space. From the executed studies in this domain, we can refer to the Architectural actions (2003) by Jonathan Hill, which specifically studies the quality of the impact of the work of architecture on the perception of users. In this book, the relationship between the artist, the work of art and the audience were into focus and the igniting level of the work in the viewpoint of the audience is introduced. According to this book, the higher amount of this extent can increase the different interpretations from it and this matter indicates more flexibility on recognizing the essence of that work (Hill & Jones, 1998).

Also, the subject of flexibility is considered in a number of domestic studies, in which we can refer to the article with the title of "evaluating the flexibility of traditional Iranian housing", in which the concept of flexibility is proposed according to three concepts of: 1. Diversification (Short-term): the capability of proving different uses in a space., 2. Adaptability (Mid-term): the capability of coordination of a space in new conditions, and 3. Changeability (Long-term) the capability of answering the growth of families (Einifar, 2013: 157). "Deconstructing the damages and limitations of flexibility in the contemporary housing of Iran among the designers, employers, users and legislators" is the title of another research that analyzes the barriers for the development of flexibility in the architecture of housing units in Iran and considers the formation of it as dependent to the possibility of more connection between the users and the designer (Hosseini & Sharifzadeh, 2014). "Interaction between stability and dynamism in the work of architecture" is the title of another study which pays attention with a quintessential look to the

subject of flexibility and considers its fulfillment as subordinate to the interaction and coexistence between the two concepts of stability and dynamism (Gharavi Al-Khansari, 2011). In another study with the title of “Methods for designing flexible housing” the subject of flexibility is analyzed through the two viewpoints of primary and constant in which the primary flexibility is the capability of the project on presenting different choices before the inhabitation and in the constant viewpoint, the capability of combining the potential and practical spaces in a certain space for the changing population (Zandieh, Eghbali & Hessari, 2011). The contributing factors of flexibility are analyzed in a study with the title of “Impact of elevating on flexibility of the environment and its sustainability” in which factors like depth, access, and height, reducing the columns, using atriums, semi-open spaces and semi-public spaces as influential on the development of flexibility in a construction (Seyyedini & Aghli Moghaddam, 2015). This subject is essentially analyzed in the residential land-uses in a research with the title of “recognizing and prioritizing the indices of flexibility on designing apartment housing in Iran” and appearance of flexibility is defined in the structure of the systems, architectural design and equipment, and furniture (Ghafourian & Aghaie, 2017). By analyzing the aforementioned subjects, it seems that the concept of flexibility is a concept related to the physics of the space and the current activities within and the meanings that are interpreted from it. But the thing that is yet not considered in the studies is the way of appearance of this concept throughout the time and with the change in the spatial patterns of houses from the traditional to the contemporary era. According to this, the following study is done with a comparative viewpoint, and it strives to analyze the evolution of this concept in the three regarded patterns (Traditional, traditional-contemporary (transition era) and the pattern for contemporary houses).

### The theoretical basis of the research

- **The concept of flexibility and related concepts**

The etymology of the word flexibility is taken from

the word “conjunction” in the sense of “tendency toward something and to return to the primary state again”. In English, it is equal to flexibility as the “capability regarding adaptation with the new condition” (Aryanpur Kashani & Delgoshaei, 2015: 538). Therefore, what we can understand from the formal meaning of this concept is that it revolves around changes in a flexible phenomenon in different conditions and to return to the primary conditions in order to adapt with that condition. In other words, something is flexible which can adapt to the environment in different conditions and return to the primary condition whenever it is mandatory. This concept is generally known in the field of architecture as the multi-functionality of the space without a reorganization, and it is cited as an approach for answering various demands of the users (Tavasoli, 1997: 8). Some of the spaces can supply a variety of activities without the need for reorganization and some others are changeable in order to answer different needs. Therefore, in a space, flexibility emerges in two forms of “alterations in their current functions” and “change in the structure of the space” in order to answer the needs of users. In the related literature “Diversification” and “Adaptability” and “Changeability” display the possibility in the spatial and activity spaces of the house using the physical specifications of the space.

### Appearances of flexibility in the architecture of housing

- **Diversification** : Definition of diversification which it is best to be referred to as a spatial potential, signifies the possibility of using different standards of the space in a time or different times, in the form of the daily and short-term spans and those without changes in the size of the space (Einifar, 2013: 62). Some of the most important virtues of this possibility includes the easy and readable access to the rooms, combination of various functions in a space and development of personal and collective privacy based on the variety of activities.
- **Adaptability** : This concept which is rooted in



the potentials of a space, signifies the possibility of becoming coordinated with the new conditions during the day and night or different times in a year, or in a mid-term scale of time. In this unchanging condition of the house area and only by changing the elements inside of the house or changing different spaces, all of the daily or seasonal activities will be fulfilled (Einifar, 2013: 63). One of the most important specifications that are resulted from this capability is the possibility of the appearance and fulfillment of a broad spectrum of activities in the house, lack of isolation for different spaces of the house and taking the maximum advantage from it, is in order to answer the residents of the house in different times of the year.

- **Changeability** : This concept which is along with the detachment and integration of the space, is the capability of answering the family growth throughout their lives and in long-term time-scales. Change in the size of the house into the formal horizontal or vertical development of it, or to separate the spaces without a changes in the area size is the approach of compatibility in the dimension of the family which will be fulfilled in the case of possessing the capability of change (Ibid). Some of the characteristics of this capability are: The ability of adapting the house with changes in the scale of family and to extend and reduce the activities in order to change the plan size, possibility of possessing adjacent areas of the house and the possibility of detachment of the house into different parts according to the demands of its residents.

- **Tools for analyzing the flexibility**

As it was proposed before, flexibility is a two-dimensional concept which is related to the physical structures in one hand, and in relation to the behavioral patterns within them on the other hand. According to this, in order to analyze different formation contexts of flexibility in a configuration system, it is essential to analyze the spatial relationships between its components. In his book entitled "Space is a machine", "Hillier" puts the concept of "flexibility" along with "extent of space integration"

and "extent of permeability" as the factors of spatial function efficiency (Hillier, 2007: 229). Efficiency of space-functions means to minimize the permeability of unrelated groups to each other and suitable organization of the related spaces together that with the help of spatial organization indices including "depth", "connectivity", "integration", "diverse accesses", etc., we are able to describe some of the specifications of the space (Peponis, et al., 1990). According to the fact that the best method for analyzing the spatial structures, is the spatial organization method (Heidary, Ghasemian asl & Kiaie, et al, 2017), in this research, different patterns are used in order to evaluate the extent of flexibility in the considered patterns and also their governing social logic will be discovered (Hillier & Hanson, 1984). On the rest of the paper, the concepts of spatial arrangement which were related to each of the instances of flexibility that were proposed above, are introduced.

**1. Diversification:** Diversification is a concept related to the current functions in a spatial configuration and refers to the capability of executing different activities within a space. In a land-use like a housing unit, the more public the spaces become, the capability of doing various activities become possible and the more space becomes private the capability of doing a variety of activities, especially those which are related to the public domain of the house decreases. According to this, one of the instances which impact the quality of diversification of the activities of spaces in housing is the public or private nature of it (Eika, 2015: pp. 3-5). Therefore, we can analyze the current diversification of activity in it and in result its extent of flexibility. One of these factors is the analysis of the permeability of a space, quality of permeability signifies the possibility of the access to different parts of a space and it has a direct relationship with the extent of their private or public nature. This means that increasing the permeability equals to increase the access to space and in return its generality and reduction in the permeability signifies the reduction in the access, as the space becomes

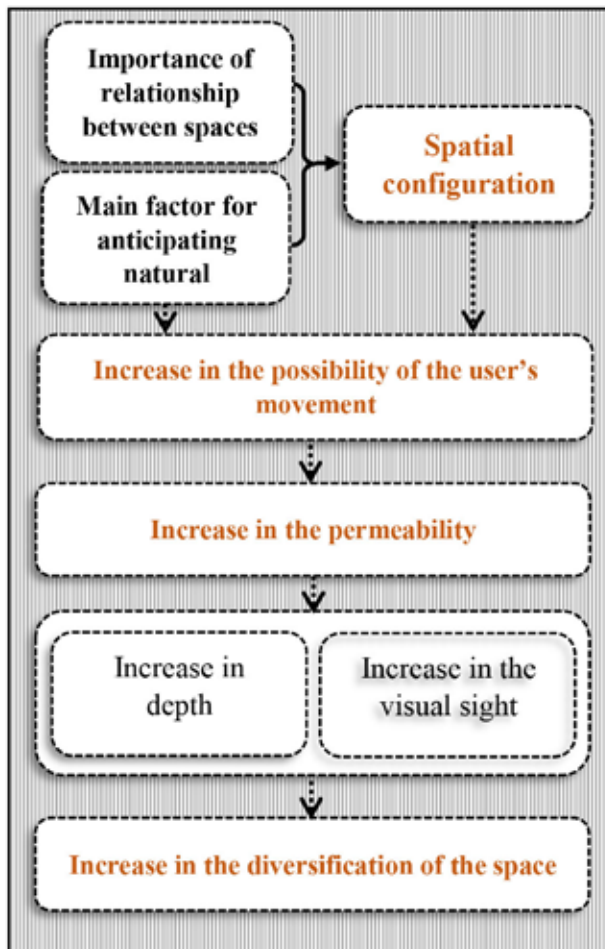


Fig. 1. Relationship between the natural movement and diversification of the space, Source :Authors .

more private. The permeability index, is also analyzable using the spatial depth factor in addition to the visual access index (Bentley, et al., 2014: 162); it means that situation of spaces in the lower depths in respect with the entrance, causes the increase of infiltration in it and in return the space become more private (Hillier, 2007: 288; Peponis, 1985: 360). Hillier proposes that by increasing the permeability, also the possibility of natural movement of the users will increase, too (Hillier, 2007: 120). Therefore activity diversification in a space is measurable using the capability of natural movement in the space. It means that by increasing the visual access and reducing the permeability, the possibility of natural movement and the capability of typicality in a space would increase.

**2. Adaptability :** It is also another appearance of flexibility which depends rather more on the users and

their demands than to space and the current activities inside of spaces. Therefore distinguishing the functional difference and the possibility of selecting the proper field for executing the considered activities is one of the most important concepts of spatial arrangement, which is indeed related to the subject of adaptability. It means that proper detachment of the housing spaces into the two set of public and private sectors can provide the field for the perception of the users of this subjects and to develop the possibility of best adaptation of their activities with the related arena. In addition to the applied aspects, this subject is considered in the visual aspect; it means that, in a spatial configuration, the possibility of spatial identification of different areas in the space by the users can help the subject of adaptability of land-use with the proper space for it. According to this, in this research, the subject of functional difference is analyzable in the functional dimension using the spatial difference factor together with using the IsoVist instrument in the visual dimension (view cone).

**3. Changeability :** According to the proposed subjects in the literature of the research, as the capability of developing changes in the spatial structure of a set in order to execute the activities that are demanded by the users, which indeed is one of the manifestations of flexibility. This concept that is rather in proposed related to the physical structure and body of the building can be surveyed into two forms of developability and changeability, in which in relation to the possibility of aggregation and division of spaces through the use of intermediary elements among them and also the capability of changing it into a larger or smaller space. Employing these techniques makes possible the development of flexibility in different spaces of a house. In the space organization technique, this capability is measurable using the concept of spatial integration. This means that if space is in relation with its adjacent space in a spatial configuration in which, the possibility of their communication is possible, and they can find their own primary separate entity in the case of lack

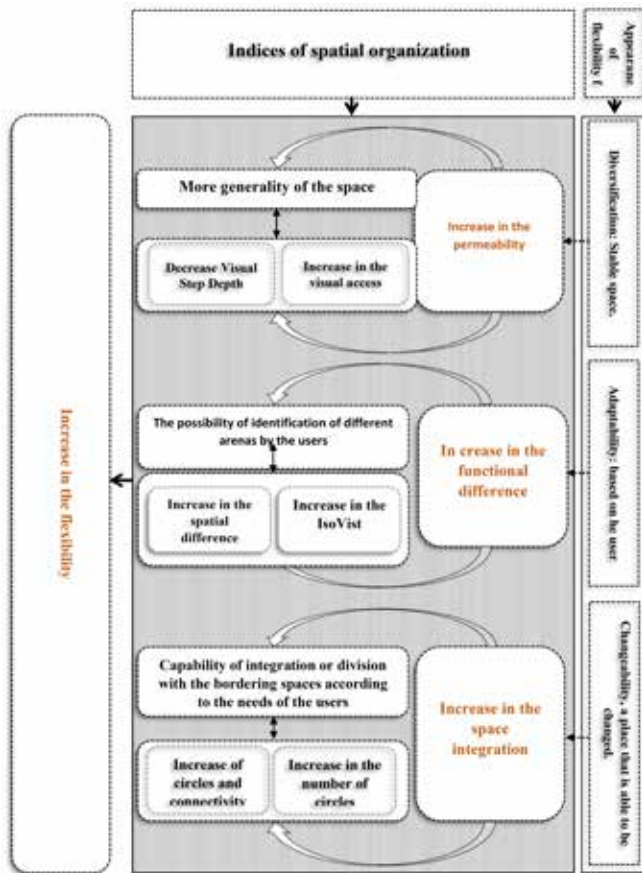


Fig. 2. Analyzing different appearances of flexibility using the space organization instruments (Souce, Authors).

needs of their users. In other words, housing units are flexible in response to the new conditions of the inhabitants. If we accept that the mentioned instances are the patterns that exist in the root of the buildings, then we can endeavor to discover these patterns using spatial arrangement, because the spatial organization method pays attention to study the spatial organization and spatial order in a physical environment in order to discover the hidden patterns in a physical environment (Hillier, 1985). This method describes the hidden patterns in a space using instruments like DepthMap and the space syntax software (Kwon and Sailer, 2015). In the following study, the spatial arrangement method is employed along with the perception of the diversification patterns, changeability and adaptability of the space; in a way that by identifying the spatial arrangement, we can make a logical argument that diversification has a relationship with visual access and depth, adaptability in regard to IsoVist and spatial difference and changeability in respect to the circle and integration. In the final stage, using the Space Organization software while attributive diagrams

of need to any of them. In this case, an integrated set is formed between them. This matter paves the way for the formation of flexibility in the building. In the spatial organization theory, we can analyze this concept using the association, connectivity, and circulation. This way, increasing the association means to increase the possibility of communication between that space and other surrounding spaces which form a ring in a spatial configuration form circles, which posses the capability of integration in the demanding conditions and in the case of lack of need we can employ them as separate spaces in order to do specific activities by blocking a portion of this communications.

### Research method

The process of the research started with the presupposition that in the spatial system of houses, functional changes exists in order to answer different

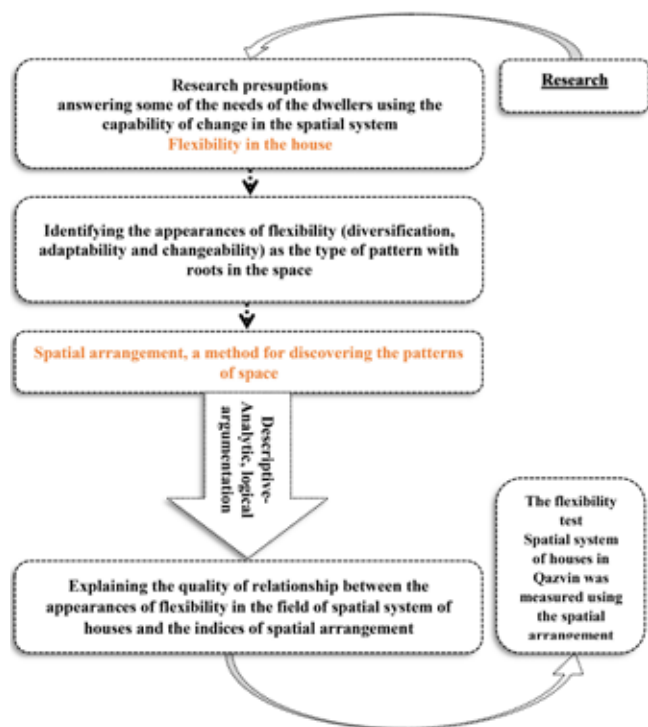


Fig.3. Research process diagram, Source: Authors.



are employed in order to check the flexibility of the houses from three eras (traditional, traditional-contemporary and contemporary) of Qazvin were evaluated.

### Findings of the research

Framework for the concepts of spatial arrangement brings the evaluation of flexibility into a more general stage; these concepts which have roots in the appearances of flexibility with logical statements, bring the research from the qualitative subjects into the newer and more pragmatic stages by proposing quantitative data. Concepts revolving the spatial organization, different appearances of flexibility, including diversification, adaptability, and changeability are presented in three architectural concepts of permeability, functional difference and spatial integration, which in order to evaluate the spatial organization software are used, also about the space integration in which the number of circles should be defined, the A Graph software is employed. The concept of flexibility in the house is one of the most important subjects which is applied in this context and we can find out the evolution of this concept in different times of the development of housing in Iran. As a historical city, Qazvin includes various houses that are constructed in the school of Qajar (with traditional plan) and Pahlavi (with traditional-contemporary plan) within; also this city, as a developing urban area, include numerous houses with contemporary plans symmetric to the daily needs of the users. For this purpose, 12 houses are selected among the housing units in Qazvin that fall into two three with four instances in the groups of traditional, traditional-contemporary and contemporary. When we refer to the form of plan, we mean to refer to the point that in traditional houses, courtyard played the role in dividing the space; in the traditional-contemporary houses, living rooms were playing the same role; while in most of the contemporary houses, division of the space is gone through the use of narrow corridors. The reason behind considering these plan-related specifications is the framework

of spatial arrangement concepts on measuring the flexibility of different houses since the “position of the entrance space” in the space arrangement software is much important and decisive. According to this, in each of the traditional, traditional-contemporary and contemporary groups, four houses with different space areas were included to evaluate the impact of the space area on the flexibility. The reason behind deciding four instances for each of the eras is that in this research physics of the space has significance and analyses indicated that according to the limited diversity in the plans, houses, especially during the traditional and traditional-contemporary eras, the same number of houses has the final answers for the research goals. Also, due to the importance of the role of the courtyard, especially during the traditional and traditional-contemporary era, all 12 houses were selected undecided from the houses that included courtyards in the city of Qazvin. Plan of the traditional houses was three-sided and four-sided and the plan of traditional-contemporary houses was selected among the variety of a stratum of them in order to make possible all of the demanding spaces in a house to be included in a single floor.

Flexibility gives the inhabitants the possibility of organizing the house symmetric to their spatial and behavioral demands. In the following research, flexibility is analyzed through the use of spatial arrangement and this means that flexibility is evaluated in the context of spatial orders of the house. Writers if this article is aware of the importance of behavioral patterns of the housing on flexibility but due to the existence of this important position, paying attention to that demands a separate detailed study. Therefore, results from this research have only considered the permanent, and semi-permanent elements (activity system of the house) in the flexibility are not considered within them.

**Diversification:** As it was mentioned, in order to increase the visual access, the space will become more public and this quality (which is in a direct relationship with the extent of flexibility in the space) (Kiaei, 2017: 57) makes the space more

Table 1. Plans of the selected houses and illustrated graphs based on them (Order of placement of houses in three sets based on the increase in the area of the houses). Source: authors.

Mortazavi	Saed Soltaneh	Yazdi	Akhavizadegan	traditional
				Plan
				Graph
Soleimani-Alamouti	Hoseini	Shafie-Alamouti	Hedayati-Asl	Traditional contemporary
				Plan
				Graph
Nikjoo	Ghaemi	Azadravesh	Yousefi	Contemporary
				Plan
				Graph

susceptible to grow their diversity. This means that higher rates of visual access, turn the private nature of it, as it is used by general residents of the house and this way various activities become more available symmetric to their needs. Diagram analysis of the data related to the traditional housing indicates different confrontation with the visual access in the houses from different eras, as the capability of visual access is more available in respect the two

other eras, namely the traditional-contemporary and contemporary. The existence of multiple openings in a space that increases the possibility of side views can be considered as one of the main reasons for the diagram to stay on the top in respect to the other two. This quality of spatial generality made possible for a place in the traditional houses (for instance with three doors), to have the capability of executing various activities (leisure, making rugs, sustenance,

Table. 2. Evaluating the flexibility using the concept of spatial arrangement, Source : authors.

Contemporary				Traditional-contemporary				Traditional							
Nikjou	Ghaemi	Azadavesh	Yousefi	Soleimani-Alamouti	Hosseini	Shafi-Alamouti	Hedayati-Asl	Mortazavi	Sad Soltan	Yazdi	Akhavizadegan				
8	79	0	11	0	0	0	15	12	22	10	6	Min (m <sup>2</sup> )	Visual access	Permeability	Diversification
591	3834	498	468	610	314	239	217	1256	1097	1108	584	Max (m <sup>2</sup> )			
335/777	2105/55	280/78	301/40	292/65	177/43	97/47	115/41	550/02	415/51	474/72	315/11	Average (m <sup>2</sup> )			
2/48	2/13	1/95	2/21	2/07	1/29	1/63	1/56	3/77	3/24	2/62	2/37		Mean depth difference	Functional Difference	Adaptability
0/47	0/46	0/43	0/44	0/43	0/35	0/44	0/32	0/87	0/64	0/70	0/46		Spatial difference		
173/95	186/87	159/09	121/04	165/99	84/73	59/70	217	803/51	342/67	414/61	145/43		IsoVis		
3/10	3/92	2/96	3/12	1/52	2/04	3/39	3/05	2/40	2/85	2/81	3/18	Min (m <sup>2</sup> )	Integration degree	Spatial Integration	Changeability
5/11	14/67	12/30	10/83	8/78	17/72	69/70	11/39	8/18	13/32	13/80	21/61	Max (m <sup>2</sup> )			
7/54	9/01	7/56	6/61	17/54	8/46	7/25	5/72	5/10	7/73	8/06	11/74	Average (m <sup>2</sup> )			
0	1	0	0	5	4	2	1	15	18	27	28		Circle		
328/68	316/35	262/40	255/60	269/47	141/41	132/25	125/13	2/38	731/88	670	342	(m <sup>2</sup> ) Total Area			

etc.) during the day and night. The high rate in the visual access in traditional houses have causes the ease in leading the natural movement of the users; because by raising the visual access, the extent of permeability will also increase in result the possibility of anticipating the natural movement of users will increase. Data indicates that visual access of the traditional-contemporary era is less than the previous and more than the next one. Coordinated and pervasive increase in the number of openings in the traditional-contemporary era in respect to the traditional and contemporary eras have led to the condition in which the capability of visual access decreases for the space and the generality of the space would follow the same in rates (coordinated and pervasive in the sense that straight and smooth line of the diagram for the visual access shoes that number of openings in the spaces of traditional-contemporary houses (with different space areas have increased in a public and pervasive way). This way, the capability of diversification in the

traditional houses will increase, also the smooth linear and non fluctuating diagram of visual access in the traditional and traditional-contemporary eras shows that the extent of attention and consideration for the visual access within the houses, in spite of varying sizes, in a time interval within the each of the mentioned eras is stable and probably the same applied values, was answering the demands and needs the people of their ages (Fig. 4).

Changes in culture and lifestyle in the contemporary era, have also revolutionized the body of housing as the data indicate that the possibility for visual access of houses is experiencing severe fluctuations, too, in addition to the overall reduction in respect with the traditional era. Cultural changes in the new era, have influenced the type of overlook on visual access, and based on the existing plans, it seems that this property is not considered by the designers, While in the Ghaemi House (House No. 3) we can observe that there is a corridor after the entrance, which is given an immense visual access

through the use of its opening at the courtyard (Fig. 4); while other plans do not have such an opening to the courtyards. Therefore, we can argue that visual access, is not an invariant property in contemporary houses and we cannot measure the diversification of contemporary houses based on them.

The less the relative depths (which is equal to the number of intermediary spaces between the connection of two spaces in the house) are, we can develop the generality of houses by reducing the distance between the links of two main space as the diversification in the house would follow and increase. Existence of The less the relative depths (which is equal to the number of intermediary spaces between the connection of two spaces in the house) are, we can develop the generality of houses by reducing the distance between the links of two main space as the diversification in the house would follow and increase. The existence of multiple rooms within other rooms in the traditional houses have caused a relative depth in these types of houses to possess a rapid rise and most of the distant spaces in respect to the courtyard, possess less generality and in result less diversification. The lower average of relative depth in traditional-contemporary houses, in comparison with the two succeeding and preceding eras, can reflect the inclinations of designers of that era to eliminate the in-between spaces in the house. Direct localization of the most spaces in the house around the central hall (first space after the doorway) can be a reason for such

results. Therefore, the traditional-contemporary houses of Qazvin, throughout different eras, are the ones with the lowest of depth, in the terms of relative depth, and therefore, they include high levels of diversification due to their generality. Localizing relative depth of the houses in the traditional and traditional-contemporary era can be due to the total elimination of the traditionally nested spaces and employing new intermediary spaces, namely the small corridor for the division after its doorway. This way, the connectivity between two main spaces in these types of houses, are not similar to traditional houses (through the use of multiple intermediary spaces) or traditional-contemporary houses (direct connectivity) as they can include medium diversification by having relative mean depth. Also, according to ascending diagram of relative depth of the traditional houses, we can tell that in the traditional system, by increasing the dimensions of area, in the houses of Qazvin, the number of spaces, and in result relative depth will also increase. While according to the fluctuating diagrams of the traditional-contemporary and contemporary eras, there is not such a direct relationship between the area of the house space and its relative depth (Fig. 5).

The data indicate a general indications of a direct relationship between the visual access and mean relative depth; this means that the more we increase the access to the space, its depth will be increased accordingly (while in both diagrams, the traditional is on the top and the traditional-contemporary

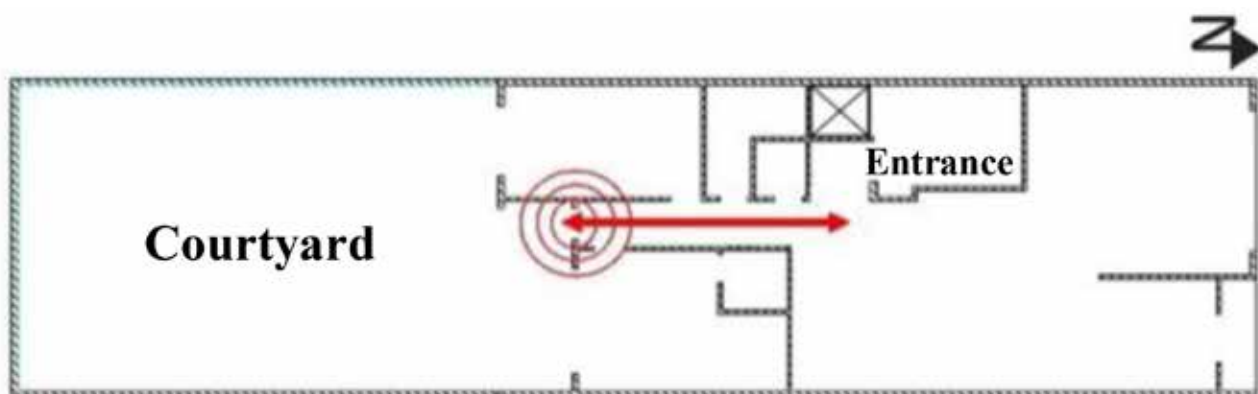


Fig.. 4. Openings at the end of the corridor in Ghaemi house which have contributed to the considerable rise in the visual access. Source: authors.



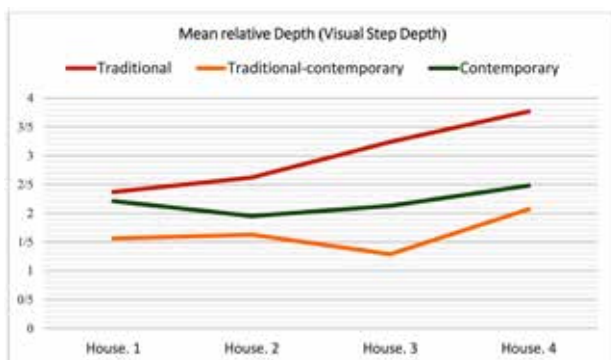


Fig. 5. Comparison of the visual access index in three traditions, traditional-contemporary and contemporary patterns in the houses of Qazvin. Source: authors.

era is under the other two). Since for achieving higher permeability in the space, there should be a negative relationship between the visual access and the relative mean depth, therefore this can be perceived that in all of the houses from the three eras in Qazvin, the capability of guiding the natural movement was available in a way, and the possess the equal diversification capability, too, which all have borrowed certain aspects according to the condition of their times for the house to keep their diversification capabilities. Also, this shows that diversification is a sustainable and important quality for the houses in all of the eras in which the passage of time and cultural and technological, etc. variations have not reduced their values.

**Adaptability :** The higher the difference between the space and IsoVist is, the possibility of functional difference would also rise, and with this rise, the adaptability of the space would increase, too. Data of the spatial arrangement indicates that the difference of space and IsoVist in the traditional houses of Qazvin was standing on the top of others with a rather long distance and therefore they possess more adaptability in respect to the next era. The fact that traditional-contemporary houses have the lowest of amounts shows that these type of houses have a less capability of adaptability compared to their previous and next eras, in time. Also, the capability of adaptability of contemporary houses, is more than traditional-contemporary and less than traditional houses; because the spatial difference diagrams for the space and IsoVist of the contemporary houses stays in between the diagrams related to the

other two previous and next periods of time.

A one-to-one comparison of the spatial difference diagrams and IsoVist (View Cone) indicates that these two are in a direct relationship with each other (as in the both diagram, the traditional era is on the top, the contemporary era in the middle and the traditional-contemporary era stays in the bottom). Therefore, by increasing the IsoVist (spatial view cone) the ability to judge functional differences and the possibility of selecting proper field for performing would also increase in the regarded activity by the user (Figs. 6 and 7).

Also fluctuation of the spatial difference diagrams and IsoVist in the two traditional and traditional-contemporary eras indicates that in houses in each of these eras, the possibility of recognizing the functional difference of the spaces was not equally available, as for instance the house of Akhavizadeh (House No. 1) possess a lower capability for distinguishing the functional difference compared to the House of Mortazavi (House. No. 4), on the other hand, the straight and non-vibrating lines of the graphs for the spatial and IsoVist difference in the contemporary houses indicates that the spaces of contemporary houses in most of the houses with any areas of space, there exists an equal capability of functional and IsoVist differentiation (Figs. 6 and 7). It seems that the residents of traditional houses has a more possibility for identifying the functional

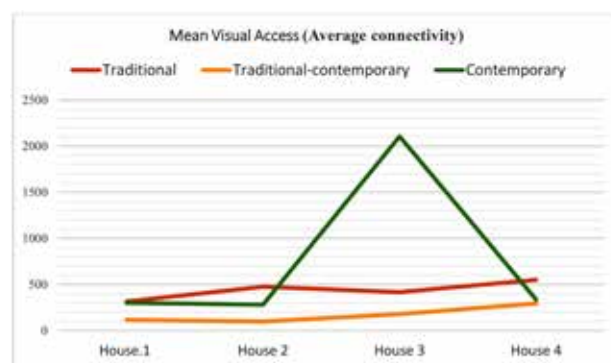


Fig. 6. Comparison of the index of mean relative depth in three traditions, traditional-contemporary and contemporary patterns in the houses of Qazvin. Source: authors.

difference and to choose the proper field for selecting proper field in order to execute their activities and in result the house possessed a more capability of adaptability than to their next eras.

**Changeability :** Visual integration (which is shaped in relation to the space depth and it increases would follow a type of spatial integration), in the traditional and traditional-contemporary and contemporary houses of Qazvin, is somehow equal to each other but they confront internal fluctuations; therefore we can consider visual integration can be interpreted as the fixed specification in the houses from different eras. In this section, this will be pointed out that the increasing diagram of visual integration in the traditional houses indicates that this index (similar to the relative depth index depends on the area of the house plan; in a way that by increasing the unit area,

visual integration would increase (relative depth will be relatively increased (and in result the integration of the space is increased (Fig. 8).

The number of the circles in the space (which signifies movement in more than one spaces and the possibility of coming back to the starting point without moving twice from the same space) will increase by increasing the number of spaces and openings within each space. According to the fact that, space area of the traditional houses and eventually the number of these houses were more than the same measure for the next era, and also, according to multiple openings in them, we can observe that the diagram for the number of circles have stayed on top with a considerable difference in respect to the traditional-contemporary and contemporary houses. Tendency toward public spaces and individualism of

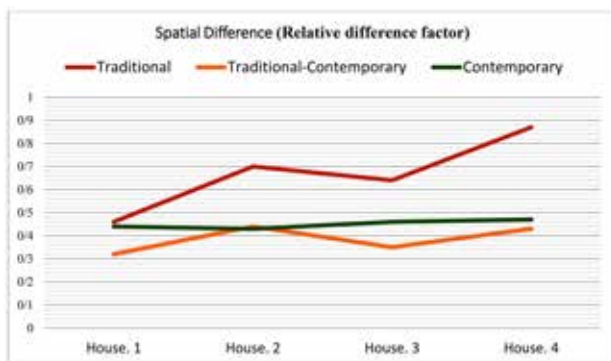


Fig. 7. Comparison of the spatial difference index in the three: traditional, traditional-contemporary and contemporary patterns. Source: authors.

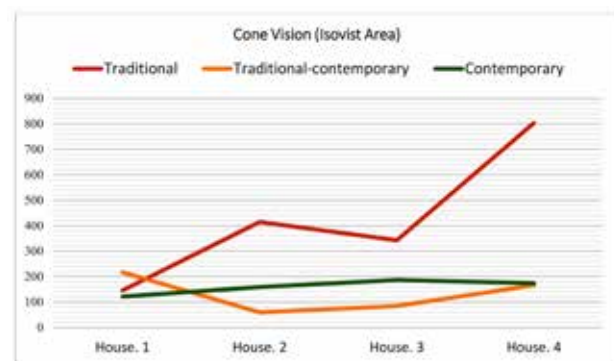


Fig. 8. Comparison of the view cone index in the three: traditional, traditional-contemporary and contemporary patterns. Source: authors.

the contemporary era have caused the lack of various openings in the houses of these eras in a space, and the possibility of moving through multiple spaces and return to the starting point would be much more limited in respect to the eras in the past, and as it is evident in the diagram, number of circles in the contemporary houses of Qazvin is staying with the lowest values (Fig. 9). According to the fact that as a shared specification, integration is introduced, in general, by relying on the number of circles, traditional houses are more integrated and return to their detached and primary nature in the time of need is higher. Therefore, the capability of changeability

in the measures of spatial integration is higher in the traditional houses, more than traditional-contemporary and contemporary houses (Fig. 10).

### Conclusion

After analyzing the concept of flexibility in three different traditional, traditional-contemporary and contemporary housing patterns as the representative of the constructed housings in the late Qajar era to the contemporary era, results of the study indicated that in the traditional housings (with the central yard pattern), spatial organization and invariable elements has a bold role on the development of flexibility among

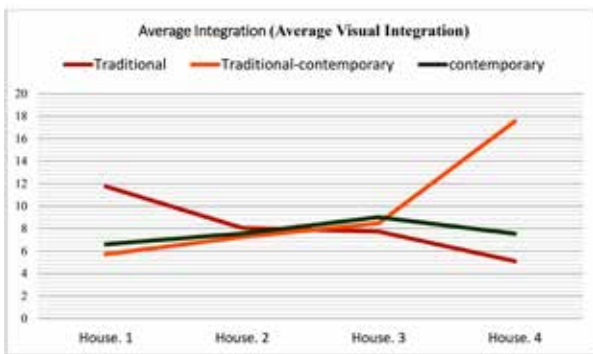


Fig. 9. Comparison between the integration index in the three patterns of traditional, traditional-contemporary and contemporary. Source: authors.

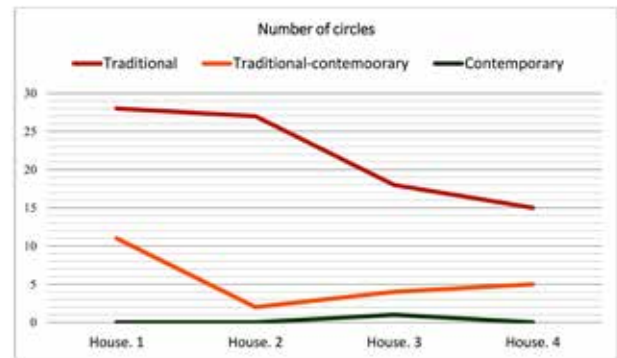


Fig. 10. Comparison between number of circles index in the three patterns of traditional, traditional-contemporary and contemporary. Source: authors.

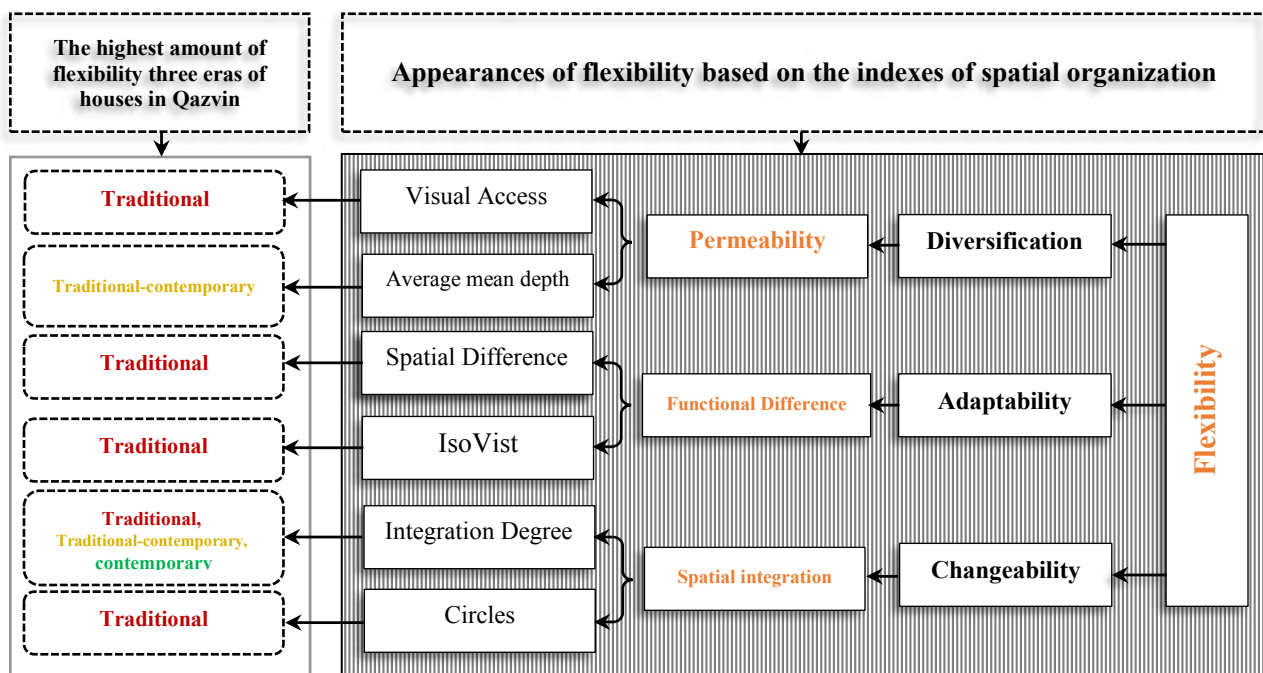


Fig. 11. Diagram of the relationship between the appearances of flexibility and the concepts of spatial organization and the results from applying them in the houses from three different time-periods in Qazvin. Source: authors.

the three different analyzed patterns in this research. While, this important role has lost its significance throughout the time and as the studies indicate the efficiency of the spatial system on developing the flexibility of traditional-contemporary housing and in the traditional housing afterward; this has happened in a way that in contemporary housings, this role is assigned to the semi-fixed elements of the space, including the furniture. Although we should not disregard the role of activity system on the formation of flexibility; in other words, as the spatial system and invariable elements of traditional housing has a bold

role on the development of flexibility, this significant role has been transferred to the system of activity and stable, semi-stable and non-transportable. We can conclude accordingly that the physical and spatial organization of traditional houses form the different representations of flexibility (diversification, adaptability, and changeability) and semi-stable elements including furniture, non-transportable elements (activity system) and the adjusting factor for them in the contemporary era. On one hand, data of from the spatial organization in the following research also has a focus on the

point that the traditional-contemporary pattern stays in a lower level in respect to the indices of flexibility, in the two traditional and contemporary era. This point indicates that the lower standing of flexibility as the field of research in this housing pattern. Undoubtedly the role of spatial organization of these types of houses are decisive and important for reaching this result. Since the prevalent pattern in these traditional houses is based on the establishment of division space (the living room) in the center of the building and multiple ordering of the rooms around it, therefore, in this pattern, least connection is established between spaces and the highest level of expertise in the space (definition of a room as a place for a specific activity). According to these indices of diversification, changeability and adaptability decrease in respect to the two patterns of traditional and contemporary.

In the contemporary housing pattern, the spatial order is based on the integration of the spaces of the kitchen with the general space of the house (living and dining room). According to this, the most visual and physical connection occurs between these two spaces, which later on will lead to an increase in the diversification and adaptability of these spaces in relation to different activities. In spite of this, in this pattern rooms are only places for sleeping and taking a rest, which reinforces increase in their flexibility.

In the traditional patterns, by locating the courtyard in the center of the building and organizing rooms around them, the possibility of access to the spaces is developed based on the hierarchical pattern. Also, internal links of the spaces with each other provide the possibility of connectivity or detachment of the spaces from each other in the time of need, which finally all of the aforementioned specifications have to lead to the increase in the flexibility of various spaces in respect to the traditional-contemporary and contemporary patterns.

Finally, it seems that the traditional-contemporary era with the mentioned specifications of spatial organization, is located between the traditional and the contemporary era as we can refer to it

as the transition era from the viewpoint of the spatial integrity, spatial communication, guiding natural movement, spatial diversity and finally the flexibility. Also, according to the fact that houses from all of the three eras, possess an equal level of permeability (Figs. 5 and 6), we can also come along a new conclusion regarding the point that natural movement has a direct relationship with the extent of permeability, which is possible in all of the mentioned orders, this means that the configuration of a major portion of the houses in Qazvin is constructed in a way that the natural movements of the user become possible inside of it.

Also by noting that in all of the three mentioned time intervals, four houses are selected in different space areas, comparison of the six diagrams of the high spatial organization, indicates that generally, the flat and non fluctuating lines of the contemporary era of Qazvin, with any space area dimensions, specifications of spatial arrangement are established with a stable extent, and in result these type of houses in general also have equal flexibility in their spatial system. While the diagrams for the spatial arrangement in the traditional and traditional-contemporary houses of Qazvin, constantly confront internal fluctuations as even the appearances of flexibility are fluctuating in both of the mentioned eras (in the form of increase and decrease). In other words, unlike the public opinion, contemporary houses possess equal internal flexibility and this means that flexibility of the spatial system of contemporary houses, was equal, regardless of having various space areas, and in the two traditional and traditional-contemporary eras, some of the houses include more flexibility and others have less flexibility - by adjusting the space area dimension.

Results also indicate the capability of adaptability has the most impact on the spatial system of the traditional era during the traditional, traditional-contemporary and contemporary eras; necessity of paying precise attention to the seasonal and daily variations according to the technological limitations of the era, can be one of the reasons behind



paying much attention to the rise in adaptability of traditional housings against these types of changes within the house. As a space for business in the past, the house was more employed in this sense also presence of diverse stages of the presence of people in the house which demanded serious adjustment of personal and collective privacies which have led to the act that diversification has an equal share in the traditional and traditional-contemporary houses with respect to each other. In this case, according to the fact that during the contemporary era, housing units usually have dwelling functions (and not economic and similar functions), therefore diversification of these houses is reduced in respect to their ancestors. Research results show the capability of changeability of the three eras which are only evaluated using the current plans and spatial system (by having awareness of interventions similar to evolution in the structure systems during the contemporary era and the ease in the movement of walls, etc., in this period) and it reflects the fact that all of the houses from these three eras in Qazvin are changeable. Therefore, houses of all three eras are flexible according to their demands against changes in the dimensions of the family and some relocations of the semi-stable and stable ? (which were essential to exist in each era).

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#### HOW TO CITE THIS ARTICLE

Keyhanpoor, M. (2019). *The destructive Culture or destructed by culture...! A study on cultural practices and expressions as the primary causes for damages in historic-cultural properties – A case study of Iran*. *Bagh- e Nazar*, 16 (71):65-82.

DOI: 10.22034/bagh.2019.86874

URL: [http://www.bagh-sj.com/article\\_86874\\_en.html](http://www.bagh-sj.com/article_86874_en.html)

