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Original Research Article

A Comparative Study of Traditional Iranian Schools Flexibility from the Seljukid Era to Qajar Era

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Abstract

Problem statement: Flexibility is one of the significant concepts in traditional Iranian architecture and Its role is highlighted especially in educational spaces due to crucial need of people. Today, however, the role of flexibility in new schools has diminished. Meanwhile, the architecture of traditional Iranian schools has valuable indicators in term of flexibility that can be considered in the design of new schools.

Research objective: The present study aimed to study the flexibility of traditional Iranian schools and to investigate the mode of changes in the flexibility of these schools from the Seljuk to Qajar historical era and also to identify the factors affecting the flexibility of traditional schools to use these factors in designing flexible educational spaces.

Research method: This study is applied in terms of purpose and descriptive-analytical in terms of method. For this purpose, first, data related to the field of flexibility extracted from library resources. Then, after content analysis, the theoretical framework identified and the manifestation of flexibility in case studies investigated by a field study and deductive reasoning methods.

Conclusion: This study shows that in addition to the fact that traditional schools have been flexible in all of these periods; Their flexibility has also changed along with their physical evolution and the addition of physical elements of the vault and nave. In general, in most of the physical elements of the studied schools, the farther we go from the Seljuk period and get closer to Qajar period, the component of functional diversity decreases the spatial diversity, adaptability and changeability become more prominent. Therefore, the flexibility of schools during this period has been a growing trend.

Keywords: *Flexibility, diversity, adaptability, changeability, Iranian traditional schools.*

Introduction and problem statement

Flexibility is an important quality in architectural design and its observation in the structure makes the building susceptible to meet the requirements

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of the users through adaptation of changes. For this purpose, flexibility in design time is studied by the architect to interact between the design and the various functional requirements of users (Einifar, 2003, 64). The purpose of flexibility is to adapt

architecture to environmental changes and functional changes of users that have existed in different eras (Mahdavinejad, Farajollahi Rad & Karam, 2011, 2) and considering this issue, especially in traditional schools due to various requirements of people and different scales of life is of high importance and influenced in its design. But nowadays, the role of flexibility in new schools has decreased. Therefore, the main purpose of this study is to investigate the flexibility and visibility of this concept in the main micro-spaces of traditional Iranian schools (from the Seljuk period to the Qajar period). For this purpose, after reviewing the research conducted in this field, at first, the various manifestations of flexibility were identified and then through a field survey of the flexibility in traditional schools in physical components and its main micro-spaces such as cell, porch, mezzanine, vaults and nave and a comparative comparison of the flexibility of these physical components analyzed in five periods of Seljuk, Ilkhanid, Timurid, Safavid, and Qajar.

Research background

In 1999, Bentley et al. introduced the multifunctionality of space as an effective factor for increasing users' choice and space flexibility (Chegeni, Didehban & Hessari, 2020, 59). Wieland and Wallenburg (2012, 890) in their research have stated that the concept of flexibility is affected by the basic thinking in the design and layout of space. We can refer to the article "Analysis of the flexibility of traditional housing in Iran." as another research about the issue of flexibility. In this article, the concept of flexibility is introduced in the form of three concepts of diversity, adaptability, and variability (Einifar, 2003, 157). Some other studies have been conducted in the field of flexibility that has mostly considered the residential application and this issue has been less studied in educational spaces. From among all the studies which have been conducted in the field of flexibility in educational spaces, we can mention an article entitled "Flexible learning environment" whose authors have studied flexibility in contemporary schools (Mardomi & Delshad, 2010). Mahmoudi (2011) in his book has

also compiled the principles of designing educational spaces with a flexible approach. In another study, Fe'li and Soltanzadeh have studied the concept of flexibility in Islamic schools and as an example; they studied Qazvin schools (Fe'li & Soltanzadeh, 2016). But what has not been considered in these studies yet is the analysis of flexibility in traditional Iranian schools (from the Seljuk period to the Qajar period) and the study of visibility of this concept in its micro-spaces and also is a comparative comparison of the flexibility of physical components of schools in historical periods. Therefore, the present study with a comparative approach tries to analyze the quality of flexibility in traditional Iranian schools.

Theoretical foundations and methodology

• The concept of flexibility

The lexical root of flexibility in Moin Encyclopedic Dictionary means the ability to adapt to any situation and any environment (Moein, 1992, 45). In architecture, the term "flexibility" refers to the organization of man-made space and change in it to achieve new conditions, needs, and applications (Einifar, 2003, 66).

In fact, "some environments without changing or reorganizing supply a lot of activity. Some environments can be easily changed to provide different activities" (Lang, 2009, 134). The construction is flexible that can adapt to the change in the needs of users at different times (Zandieh, Eghbali & Hessari, 2011, 95). The concept of flexibility from the viewpoint of others means the development of the construction by adding some part to it, through which the spaces are changed and therefore the ground for functional change is provided in it.

The concept of flexibility includes the ability to integrate and develop, change, and multitask. In the flexible architecture, sometimes with daily and seasonal movement in different directions of the building, separation, and aggregation of spaces, creates different scales of flexibility (Einifar, 2003, 68-70).

Therefore, flexibility in space occurs in two modes, consisting of "change of current functions in it"

and “change in the structure of the space” to meet the requirement of users. In the relevant literature, “diversity”, “adaptability” and “variability” are presented as different manifestations of flexibility (Kiaee, Soltanzade & Heidari, 2019, 65). In the continuation of the research, various manifestations of flexibility are presented.

• **Diversity (Multifunctional Space)**

The concept of diversity, which is better to be referred to as a spatial potential, means the ability of different use of space at the same time or at different times, without any change in the size of space (Einifar, 2003, 62). Among the properties of this capability are the easy accesses to spaces, a combination of various functions in one space, creating individual and collective privacy due to the variety of activities and useful use of access space to convert functions (Kiaee et al., 2019, 66). Diversity has been the most effective way to achieve flexibility in traditional Iranian architecture, which with the ability to change functions over time, has been easily matched to people’s daily lives (Einifar, 2003, 69). This diversity can be studied from both a functional and spatial view. Functional variability in space provides a variety of functions in that space (simultaneously or at different times) that can be evaluated in the functional dimension of the plan.

Spatial variability also allows for spatial diversity to meet the needs of users, which can be evaluated in the spatial dimension of the plan.

• **Adaptability (seasonal and daily movement)**

The concept of adaptability is one of the potentials of a space, which means the ability to adapt to one space with the required new conditions, provided that these changes do not create any change in the area of the construction. The act of adaptability consists of all internal changes such as personality changes, change of microelements, and composition of spaces. In traditional Iranian architecture, adapting daily and seasonal life by adjusting the horizontal and vertical relationships of the building, the use of different spaces at different times of the day and in different seasons has been possible. Spaces such as summer residence, winter residence, basement, attic, and roof provide the

possibility of adapting to different living conditions. The central element of the yard is the organizer of flexibility in this scale (ibid., 70). In other words, the adaptability of space provides the possibility of adaptation of the space to new functions. Among these, recognizing the functional differentiation of space to select the appropriate area to perform the user’s desired activity is one of the most important concepts related to the issue of adaptability. It means that in a spatial configuration, the possibility of spatial recognition of different areas by its users can help the issue of user adaptability to its appropriate space (Kiaee et al., 2019, 68). In between, recognition of the functional differentiation of space is done through visual vision. Thus, the more visible the space, the greater the visual access to it and the functional recognition of that space increases and as a result its adaptability to the required user increases.

• **Variability (separation and aggregation)**

The concept of variability refers to a slight increase or decrease or separation and aggregation of spaces in which it is possible to return to the original design after expanding or reducing the area of the construction (Einifar, 2003, 70). The variability of space provides the possibility of integration and separation of different parts of that space according to the program and functions required by users.

As mentioned, experts in the domain of flexibility have considered different manifestations for the concept of flexibility. By reviewing various studies conducted in this field, different manifestations of flexibility can be classified as in figure 1.

Overall, as mentioned, in all three manifestations of flexibility (versatility, adaptability, and variability), the space changes to suit the user’s requirement. But these three manifestations also have differences. The commonality of the diversity and adaptability manifestations is that, without changing the area, it is possible to perform various activities and adapt functions in space. But distinctive issue between versatility and adaptability arises when the number of a species in a space increases, in which case diversity decreases and adaptability increases. For

example, in Chaharbagh School, there is a nave, its nave is diversifiable due to various activities, but in Seyed Esfahan School, which has four naves, the activities are distributed among these four naves and its diversity has been reduced. Instead, its versatility increases due to the ease of adaptation of those functions in the four naves. In variability, space can change the area (in the case of “space” separation or space aggregation). It should be noted that with the multiplicity of one spatial species, it is possible to separate the “functions” without the need to change the area. Therefore, with the multiplicity of one spatial species, adaptability, and variability increase.

• **History of traditional schools and the educational system in Iran**

Before establishment of the official military schools of the Seljuk period, education was conducted in various buildings. In the early Islamic centuries, one of the functions of mosques was their educational aspect (Sami Azar, 1997, 71). Over time and the spread of learning, most mosques devoted space to educating children. As the number of children under education increased, the education of children gradually separated from the mosque, and classes were held in remote neighborhoods and passages and concentrated in Maktab (Dorrany, 1997, 69-67). The establishment of independent educational centers practically did not take place until the middle of the fifth century AH (Sami Azar, 1997, 86). Gradually, science institutes and schools were established in Iran, which was equipped with libraries and housing for students.

Finally, the Nezamieh School opened in Baghdad in 1167 AD, and this was the starting point of formal schools in the history of Iran (Hillenbrand, 2004, 216-217). In the military, in addition to educational spaces, the school had a mosque, library, bathroom, and a dormitory attached to the schools (Sami Azar, 1997, 96). These schools, while maintaining their connection with religious centers, always played a complementary function to these centers. The educational-religious function of schools was not only their important function, but often it was influenced by its socio-political role (Fe’li & Soltanzadeh, 2016, 18).

Regarding the method of teaching, it should be said that in the early centuries of Islam, religious information was provided only through induction, repetition, and admonition. From the third century onwards, the concept of teaching became synonymous with explanation, interpretation, and opinion and the method of discussion and debate became quite common. This process upgraded the teaching method from the elementary level of “simple repetition” to the more complete level of “analysis and critique”. The physical arrangement of the students in both “teaching” and “debate” was in the form of a circle. Extensive teaching circles were usually formed in the nave and debate circles were formed in the porches. In any case, the teacher was sitting in the middle of the crowd leaning on a pillar or wall, with students forming a circle on either side of him. In any case, the formation of the circle, in terms of teaching method, was a step beyond preaching in the early days of

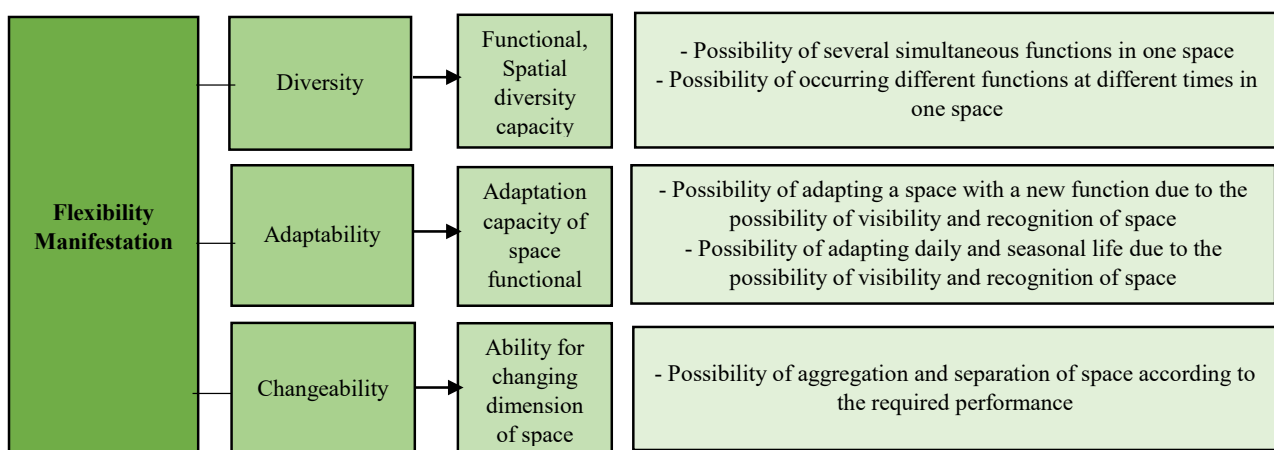


Fig. 1. Manifestation of flexibility. Source: Authors.

the arrival of Islam in Iran. (Sami Azar, 1997, 68). In general, the methods of education were of five types: 1. one on one education; 2. group education; 3. discussion and debate; 4. question and answer; 5. sermon and advice (Research Institute of Hawzeh and University, 2005, 154-164).

Methodology

This research is applied in terms of purpose and descriptive-analytical in terms of method. For this purpose, in the first stage, data related to the research background in the field of flexibility extracted from library and documentary sources. Then, by applying this information and field research, the three manifestations of flexibility (diversity, adaptability, variability) in the structure of the physical elements of schools investigated in a descriptive-analytical manner. In the following, the flexibility of the component of

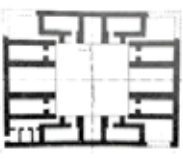

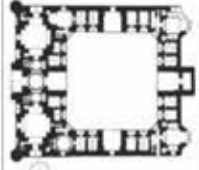
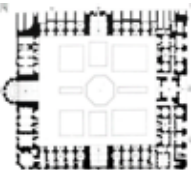

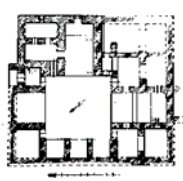

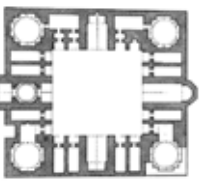
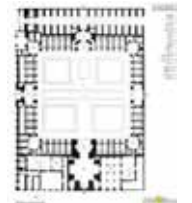

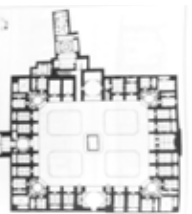
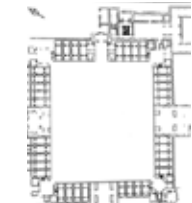
each school in the Seljuk to Qajar historical periods compared. The samples selected from five periods of Seljuk, Ilkhanid, Timurid, Safavid, and Qajar, and in each historical period, an attempt was made to examine the samples that had physical changes compared to the schools of previous periods (Table 1).

Discussion

• Flexibility of traditional school components

The flexibility of schools, like other construction, depends on the flexibility of its micro-spaces. Due to different scales of life in educational spaces, different types of flexibility (versatility, adaptability, and variability) are seen in them (Mahmoudi, 2011, 83). The main elements of traditional Iranian schools are chamber, small porch (iwanche), porch (iwan), yard, vault, and nave. Of course, the vault and the nave did not exist in all schools and have been

Table 1. Examples examined from the Seljuk period to the Qajar period. Sources: Pirnia (2003); Hillenbrand (2004); Haji Ghasemi (1996); <http://www.arthut.ir/school>.

Historical Period	Seljuk	Ilkhani	Timurid	Safavid	Qajar
School Name	1. Ray School 2. Chahardah School	1. Emamieh School 2. Ziaiye School	1. Ghiasieh School 2. Dodar School	1. Khan School 2. Chaharbagh School 3. Nimavard school	1. Seyed School 2. School Sepahsalar 3. Sadr School
Sample plans	 1	 1	 1	 1	 1
	 2	 2	 2	 2	 2
				 3	 3

added to the structure of some schools over time (see Mohseni, 2019). In the following section, different manifestations of flexibility in the components of traditional Iranian schools are examined.

The chambers were both a place of residence and living, as well as a place for individual and collective study (small groups) of students, and in other words, they had functional diversity and therefore were Diversifiable. In some chambers, there is a section called a pastoo that allows functional separation, and such chambers are also changeable (Fig. 2). Small porches (iwanche), which were a space in front of the chambers, have been a resting place, individual study and collective study (small group) in warm seasons, as well as a spatial articulation and they, are a diverse, adaptable, and changeable space (Fig. 3). The porches were the place where lessons were held and in schools, the porches facing the qibla were considered the place of prayer. Of course, sometimes individual study and discussion (in smaller groups) were also conducted on the porches. Besides, porches have sometimes been the site of religious and political ceremonies. Therefore,



porches have been diversifiable due to their functional diversity and adaptability due to their visibility and versatility. School porches have also been changeable because due to the existence of multiple porches, the formation of multiple circles of discussion and study was possible (Sami Azar, 1997, 80), and thus it was possible to separate the classrooms or functional separation of one porch compared to other porches. For example, one porch was limited to the entrance (Fig. 4). The courtyard, which provided a suitable climate by creating a microclimate, air conditioning, and lighting, was at the same time a space for access to different school spaces, as well as a place for religious and political gatherings, etc. Therefore, since different functions were performed in schoolyards it was diversifiable; and because it has high generality and visibility, it is adaptable (Fig. 5).

Vaults are also usually places of worship, lectures, congregational prayers, gatherings, and religious ceremonies; therefore flexibility of the type of diversity is seen in them.

Due to the high visibility of the vaults and the



Fig. 2. Adversity, adaptability and changeability of chambers. Source: Left: <https://www.farsnews.ir>; Right: <https://www.tasnimnews.com>



Fig. 3. Adversity and adaptability of small porches (iwanche). Source: Left: <https://article.tebyan.net>; Right: <https://www.farsnews.ir>.

possibility of separating the prayer and educational space (in schools that have a vault), these spaces are also adaptable and changeable. Vaults are also usually places of worship, sermons, congregational prayers, is the place of religious gatherings and ceremonies, and therefore the flexibility of the type of diversity

is seen in them. Due to the high visibility of the vaults and the possibility of separating the prayer and educational space (in schools that have a vault), these spaces are also adaptable and changeable (Fig. 6). The naves, like the vault, are the places of worship, lectures, congregational prayers, gatherings, and

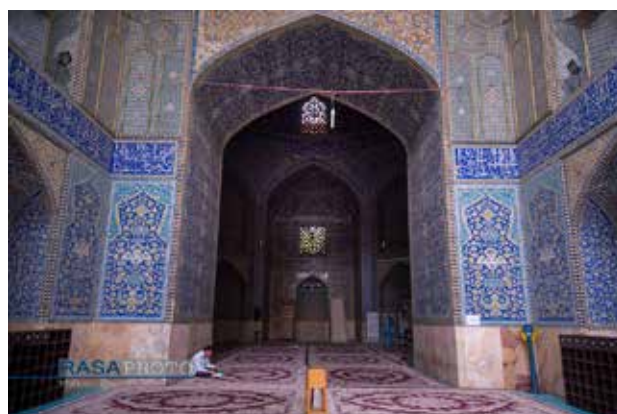


Fig. 4. Adversity and Adaptability and Changeability of School Porches. Source: <https://rasanews.ir>



A



B



C



D

Fig. 5. Adversity and adaptability and changeability of schoolyards. Source: A: <http://jria.iust.ac.ir>; <https://media.hawzahnews>; <https://fa.wikishia.net/view>; <https://sedayiran.com>

Table 2. Assessment of the flexibility of traditional school components. Source: Authors.

Physical components of the school	Type of activity (performance)	Neighborhoods (adjacent spaces)	Type of flexibility
Chamber	Residence, individual study, small group study	Small porch (iwanche), pesto (in some cases), yard (in some cases)	Diversifiable, adaptable and changeable
Small porch (iwanche)	Rest, vision, individual study, group study (small group), spatial joint (connection with the yard)	Yard, chamber	Diversifiable, adaptable, and changeable
Porch (iwan)	Place of holding class, lecture, place of prayer, in some cases connection to the entrance	Yard, chamber, corridor, and porch (in some cases)	Diversifiable, adaptable, and changeable (in some cases)
Courtyard	Spatial articulation, place of religious and political gatherings, traffic, ...	Small porch (iwanche), porch (iwan)	Diversifiable, adaptable and changeable
Vault	Place of worship, lecture, congregational prayer, place of meetings and religious ceremonies, the tomb of the school founder	Porch, nave, chamber, and porch, ... (case to be investigated)	Changeable, adaptable, and Diversifiable
Nave	Place of worship, sermons, congregational prayer, place of meetings, and religious ceremonies, ...	Vault, porch, chamber, and courtyard, ... (case should be investigated)	Changeable, adaptable, and Diversifiable (in some cases)

religious ceremonies, etc., and have a variety of flexibility and changeability (by creating a nave, functional separation is possible) and in some cases, schools with winter and summer camps are also compatible (Table 2 & Fig. 7).

A comparative study of the flexibility of school components in historical eras

• Chamber and small porch (Iwanche)

One of the main features of schools (after the establishment of formal schools) has been the issue of providing students with accommodation. In the Rey school (Fig. 8-1), which was built during the Seljuk period, the living space consisted of a chamber and a small porch (iwanche); In the chamber, activities such as rest, sleep, study (individual), daily life have been done and the iwanche, group study (small group of two or three people) and individual study, rest, vision provided desired perspective. The small porch (iwanche) was also the spatial link between the chamber and the yard. In this period, due to the functional diversity in the chambers and courtyard,

flexibility is of the Diversifiable type. Also, in the small porch (iwanche), due to the possibility of spatial recognition of this area of construction by users and its adaptability to the needs of residents, the flexibility of adaptable type can be seen.

In the Ilkhani era, in the Imami school of Esfahan (Fig. 8-2), establishing a third space called the pastoo, caused the separation of functions and created flexibility of the diversifiable type. In the Timurid era, in Dodar school in Mashhad (Fig. 8-3), despite the pastoo, flexibility is of the type of adaptability and variability. In the Safavid period, there are two-part and three-part chambers in the school plan (such as Mullah Abdullah and Chaharbagh schools), but in Khan Shiraz school, the chambers are specially developed and divided into four parts, including the small porch (iwanche), chamber, pastoo (two floors) and the space behind the pastoo that is connected to the garden behind the school (Fig. 8-4). Thus, in this case of school chambers, due to the possibility of spatial recognition and spatial adaptation, the flexibility of the adaptability type, and also the



Fig. 6. Adversity and adaptability and changeability of school vault. Source: Left: <https://fa.shafaqna.com>; Right: <http://www.iscanews.ir>



Fig. 7. Adversity and adaptability and changeability of school naves. Source: Left: <https://iqna.ir>; Right: <https://www.farsnews.ir>

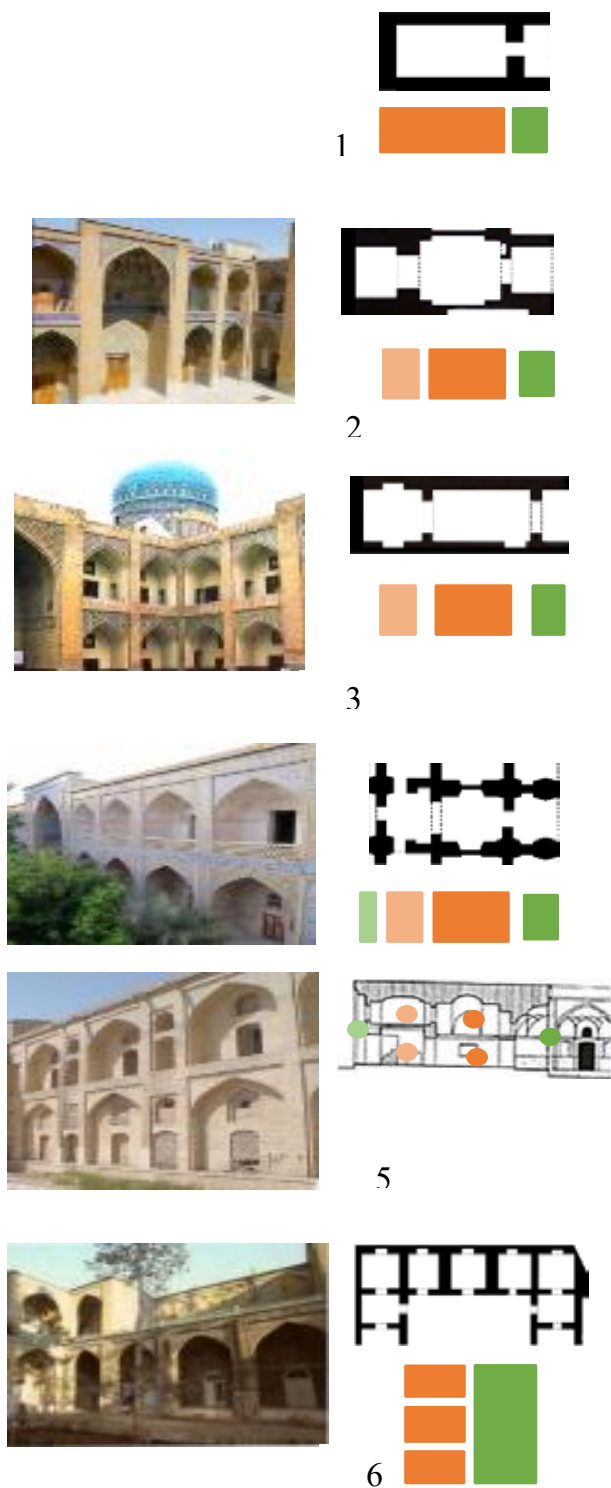


Fig. 8. Comparison of chamber and small porch (iwanche) flexibility from the Seljuk to Qajar period. Source: Authors.
 Fig. 8-1. Chamber and porch (two sections) of Seljuk Rey school; Fig. 8-2. Small porch (iwanche) and chamber (with pastoo) (three sections) of the Imami Ilkhanate School; Fig. 8-3. Small porch (iwanche) and chamber (with closet) (three sections) Timurid school two doors; Fig. 8-4. Iwanche and chamber (with two-storey pastoo) and small porch (four sections) of Safavid Khan Shiraz school; Fig. 8-5. Moonlight (Mahtabi) (a porch for several rooms) and room.

separation of the pastoo into different classes, variability has increased.

In Qajar schools, examples of two-part and three-part chambers can be seen as in previous era schools, but in several schools such as Sepahsalar and Seyed schools, with a change in spatial attitude (space opening), a space called moonlight (Mahtabi) replaces several courtyards (opposite the upper floor rooms) (Fig. 8-5), in which case the variability and adaptability in the moonlight are greater than in the courtyards. In general, it can be concluded that with the physical evolution of chambers from the Seljuk period to the Qajar period, the two components of adaptability and variability have increased (Table 3).

• **Porch (Iwan)**

The porch (iwan) in the Seljuk era (Fig. 9-1) was directly connected to the courtyard and the plan form of the porches was a simple rectangle. During this period, the porches were the place of holding classes, sermons and gatherings, and prayers. With the four porches of schools in this period, it was possible to form separate classrooms in each of the porches of these schools. Therefore, in this period, due to the functional diversity of the porches and their visibility, flexibility of the type of diversity and adaptability is seen in the porches. There is also variability due to the possibility of spatial separation of these porches (possibility of separation of teaching circles).

In the Ilkhani period, school porches were used as places for holding classes, lectures, and gatherings. With the difference that in this period, the vault was added to the schools, and part of the activities that were previously done in the school porch was transferred to the vault. By adding vaults to schools, such as the Imamiyeh School (Fig. 9-2 & see Table 1), the diversity of the porches of such Ilkhani schools is reduced compared to Seljuk schools, and the versatility of porches located in the vicinity of the vault or adjacent to it was increased, because, despite the vault, the visual emphasis on these porches will be greater. It is noteworthy that in the plan form of this school, changes can be seen compared to the simple plan of the Seljuk porch,

which is the beginning of spatial changes in the plan of the school porches.

The height of the porches also increases during this period, which increases the visibility and, consequently, the adaptability. Also, due to the possibility of separating different functions with the addition of the vault, the variability of the porches of this period increased compared to the previous period, (see Table 1 & Table 3).

During the Timurid period, in some schools the number of the vault of schools increased and in schools such as Ghiasieh Khargerd and Dodar, four vaults were built in the four corners of these schools (see Table 1 & Fig. 11-2) and some activities such as worship that were previously performed on the porches was transferred to these vaults. Thus, the diversity of school porches (in terms of function) in this era decreases compared to the Seljuk and Ilkhani eras. However, during this period, changes are made in the plan form of some porches and the porch is divided into two spaces, which increases the spatial variability of these porches. Also in this period, one of the porches of the school is located in the direction of the entrance, thus, the adaptability of these porches is more than in the previous period. By allocation of a porch to the entrance, and its functional separation from other porches, the variability of porches also increases, and also by changing the plan form of some porches, the possibility of spatial separation has increased, and therefore, in general, the variability of porches in this period increases in comparison with periods Seljuk and Ilkhani (Fig. 9-3 & see Table 1 & Table 3). In the Safavid period, the investigation of the porches of two case studies of Nimavard school (Fig. 9-4) and Chaharbagh of Isfahan (Fig. 9-5), shows that the porches undergo special changes in this period. For example, in Nimavard school, the southeast porch is divided into two parts, outer and inner (porch and Madras) (see Table 1) and also in the southwest porch, something new happened in terms of space; as the stairs to access the chamber on the upper floor, is located next to this porch and in the plan and facade, the porch is divided into three

parts (see Fig. 9-4). Due to these changes, functional variability has decreased in the school porch. In Chaharbagh School, with the addition of the nave and the vault, some of the functions that were previously performed on the porches have been transferred to these new physical parts. In the same school, two north and west porches are dedicated to the entrance.

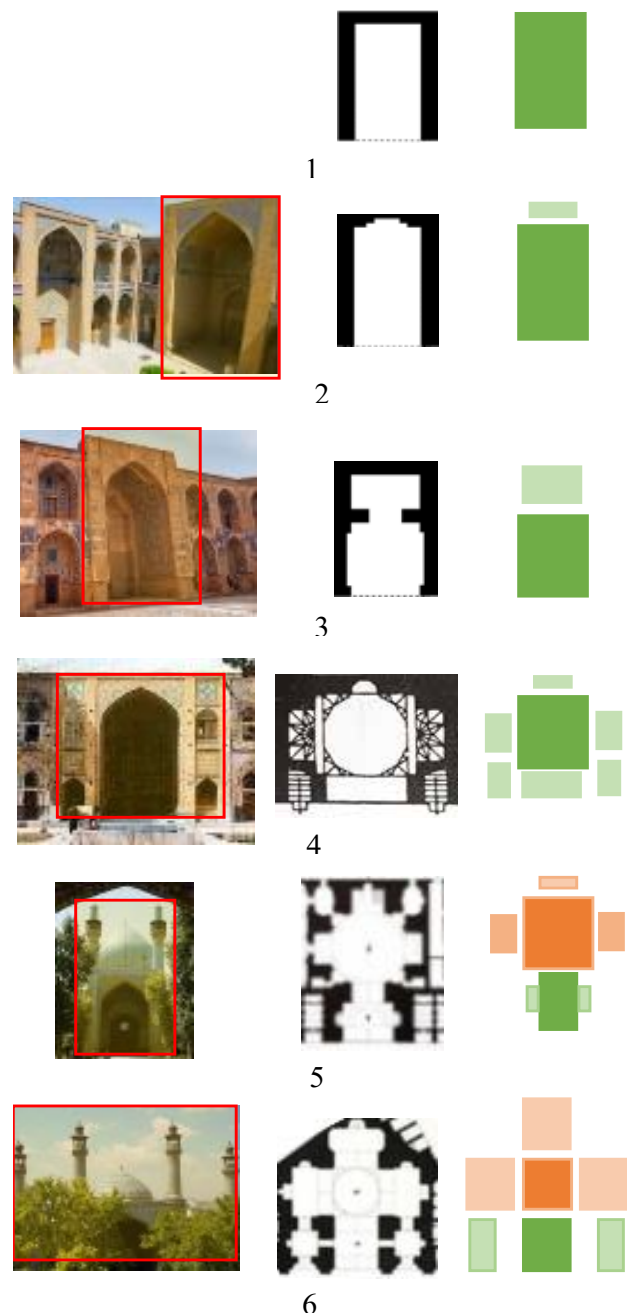


Fig. 9. Comparison of the flexibility of porches from the Seljuk to Qajar periods. Source: Authors.
 Fig. 9-1. Seljuk porch (Rey School); Fig. 9-2. Ivan Ilkhani (Imamiyeh School); Fig. 9-3. Ivan Timurid (Ghiasieh Khargerd School); Fig. 9-4. Safavid porch (Nimavard School); Fig. 9-5. Safavid porch (Chaharbagh School); Fig. 9-6. Ivan Qajari (Sepahsalar School).

Also in Nimavard School, the southeast porch, as mentioned, is divided into two parts, the outer and the inner. Therefore, functional variability has decreased, but the spatial variability of porches in this period has increased due to changes in the plan form of some porches, and the creation of more diverse spaces. The spatial versatility of some porches of this period also increases due to the proximity to the vault and the entrance. Because by emphasizing the matter of these porches, the possibility of spatial recognition is somehow increased. This adaptability in the south porch of Chaharbagh School has been greatly increased due to the presence of minarets next to this porch (Fig. 11-3).

Also, with the three divisions of the porches, which have provided access (both horizontal and vertical access), the adaptability has increased, as a result of which the spatial adaptability has increased in comparison with the Seljuk, Ilkhanid, and Timurid periods. Due to the possibility of better separation of different functions in Nimavard school and especially in Chaharbagh school (due to the vault and nave), variability has increased.

In some examples of the Qajar period, with the addition of vaults and naves (such as Seyed and Sepahsalar schools), the functional diversity of porches has decreased. The adaptability and variability of schools in this period are the same as in the Safavid period and has not changed much.

In general, according to the cases which have been studied, the flexibility of porches, from the Seljuk period to the Qajar in two components of adaptability and variability has increased (see Table 3).

• **Central courtyards**

In general, in all courtyards of traditional schools, as presented in section “flexibility of traditional school components”, due to the ability to perform different functions in the courtyard, there is a variety of flexibility in the schoolyard. But with the change in the form of the yard plan in schools of different periods, their degree of diversity is different. This diversity increases in the Timurid period, in Ghiasieh Khargerd school (Fig. 10-3

& see Table 3), by sloping the corners of the yard and creating suitable access for the spaces located in the corner of the yard increases in comparison with the Seljuk and Ilkhanid schools. The same issue has evolved in Safavid schools such as Chaharbagh (Fig. 10-4 and see Table 3) and more functional and spatial diversity has been created in them.

The Qajar Sadr School (see Table 1) is the same and there is no change in the diversity of this period compared to the examples of the Safavid period. Besides, due to the visibility of the yards and the

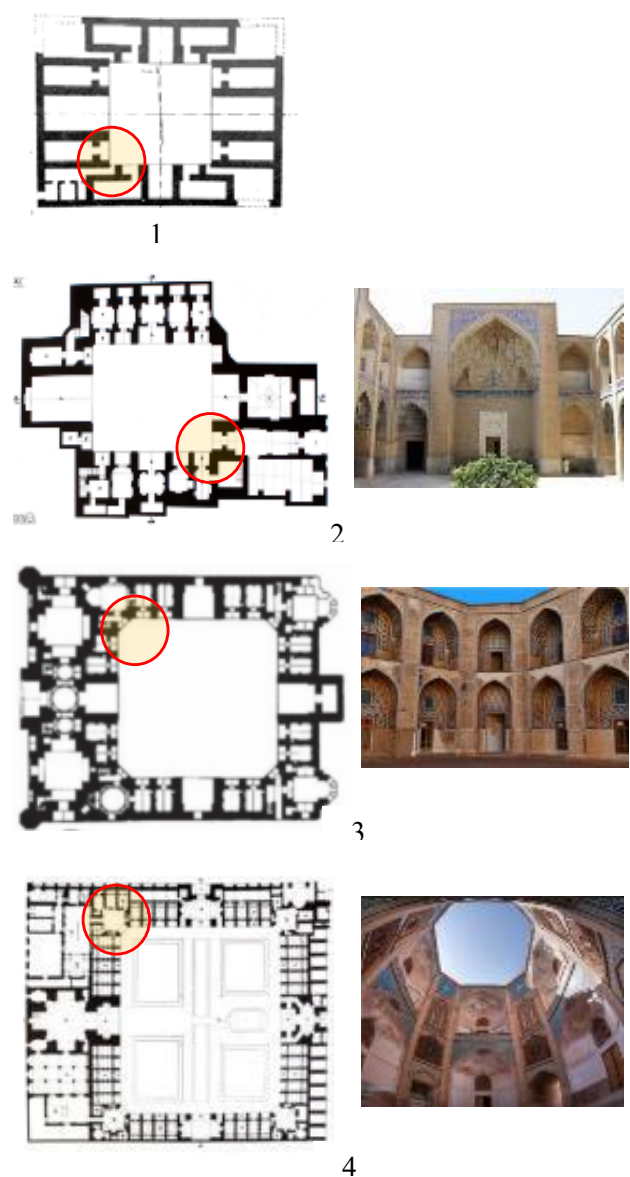


Fig. 10. Comparison of flexibility between courtyard of Seljuk to Safavid schools. Source: Authors.
 Fig. 10-1. Seljuk courtyard (Rey School); Fig. 10-2. Ilkhani courtyard (Imamieh School); Fig. 10-3. Timurid courtyard (Ghiasieh School); Fig. 10-4. Safavid courtyard (Chaharbagh School).

possibility of adapting the schoolyard with various functions, the schoolyard has high adaptability. This adaptability in the Timurid period in Ghiasieh School, with the beveling of the plan, the visibility and the possibility of spatial recognition (courtyard corners) is improved, and therefore the adaptability of the courtyard of this Timurid model compared to the Seljuk period (Fig. 10-1) and Ilkhanid (Fig. 10-2) increases (also see Table 3). The same is true of the Safavid examples (Chaharbagh and Nimavard) as well as the Qajar Sadr School, and the adaptability in these periods is not significantly different from the Timurid period. In terms of variability, due to the possibility of temporary spatial separation, schoolyards can be temporarily changeable. Also, in the Safavid school of Chaharbagh, with the creation of side courtyards that have been formed by sloping the main courtyard, there is a possibility of spatial separation and this variability has increased. The degree of variability of Qajar schoolyards in comparison with the Safavid period has not been significantly different.

According to the mentioned cases, along with the physical changes of the schoolyards, from the Seljuk period to the Safavid period, the flexibility of schools has increased in two components of adaptability and variability. During the Qajar period, the same Safavid patterns were adopted and no remarkable change was made in the courtyard of the schools (see Table 3).

• Vault

In the studied samples, in the Seljuk and Ilkhanid periods, the vault of the school had not been formed yet. But in the Ilkhani period, the vault became part of some schools. As described in section “flexibility of traditional school components”, school vaults are diversifiable, adaptable, and changeable. In the Ilkhani sample of Isfahan Imamiyeh School (see Table 1), the vault is located in the direction of the south porch and its prayer function is dominant. However, in vault schools, in addition to worship ceremonies such as prayers and religious ceremonies, the vaults are the center of scientific and political communities and in some Ziaieh schools in Yazd, the vault has been the tomb of the school founder

(Fig. 11-1 & see Table 1). In the Ilkhani example of Isfahan Imamiyeh School (see Table 1), the vault is located in the direction of the south porch and its prayer function is dominant. However, in vault schools, in addition to worship ceremonies such as prayers and religious ceremonies, the vaults are the center of scientific and political communities and in some like Ziaieh schools in Yazd, the vault has been the tomb of the school founder (Fig. 11-1 & see Table 1). Therefore, such vaults have a high diversity. Also, due to the ability to adapt to various functions and also the visibility of the vault (due to its special shape and height) have a high degree of adaptability. In such schools, due to the ability to separate some functions (holding worship ceremonies) by creating a vault, these vaults are also changeable. Timurid schools were built on a much larger scale than was common in other Islamic lands. One of the side effects of the large dimensions of this building was that it had a lot of space for sub-units (such as the library, monastery, separate summer, and winter sections) (Hillenbrand, 2004, 287-289). Some schools have several vaults, sometimes up to four (Mohseni, 2019, 75) that these vaults (especially their two vaults) were very high (Fig. 11-2 & see Table 1). Due to the increase of vaults in the samples of the Timurid period, the diversity of the vaults of these schools compared to the vaults of the Ilkhani period has decreased. Due to the high visibility of the vaults (due to the height) and also due to the possibility of applying various functions to these vaults, Timurid vaults are adaptable, but due to the multiplicity of vaults, their functional recognition rate decreases. In these schools, due to the multiplicity of vaults, the separation of functions is easily done, and therefore, the vaults of this period have a high variability compared to the Ilkhani period. In the Safavid example, the Chaharbagh School, next to the dome, a nave was also built (see Table 1). Due to this issue, the functional diversity of this school has decreased compared to the Ilkhani vault schools that had one vault and have increased compared to the Timurid examples (four vaults). However, due to the cruciform shape of the vault of

Chaharbagh School, the spatial variability of the vault of this school has increased compared to the Ilkhani sample. The adaptability of the vault of Chaharbagh school, due to the existence of minarets and emphasis on the prayer space, increases compared to the Ilkhani period, but its variability has decreased compared to Timurid examples. In the Qajar example (Sepahsalar School and Seyyed School) (see Table 1), according to the large naves that exist in these schools; the functional diversity of the vaults of these schools has decreased compared to Safavid schools (especially in Seyed school). However, the spatial variability of the vault of Sepahsalar School (Fig. 11-4) has increased compared to Chaharbagh school (Fig. 11-2). The adaptability of the vault of Sepahsalar School due to its height, the number of minarets around it, has increased compared to the vaults of Ilkhani, Timurid, and Safavid schools (Fig. 11). The variability of the vaults of Seyed and Sepahsalar schools, due to the greater number of naves, increases compared to the Safavid period. Therefore, from the Ilkhani period to the Qajar period, the diversity of vaults has decreased and their adaptability and changeability components have increased (see Table 3)

• **Nave**

Until the Safavid period, the nave did not build yet in schools. As mentioned in section “flexibility of traditional school components”, the school nave has the flexibility of diversity, adaptability, and variability, which is also true for the Safavid school nave in Chaharbagh (Fig. 12-1). In Qajar examples, some schools have a nave that is not different from the Safavid pattern in terms of flexibility, but in the case of Seyyed school, where the number of nave are more (Fig. 12-2) and the area is larger, the functional resolution is easier (it has summer and winter naves) and is more changeable than the Safavid model nave. But its versatility has decreased and its adaptability has also increased. In general, from the Safavid period to the Qajar period, the flexibility of school naves has increased in the two components of adaptability and variability (see Table 3).

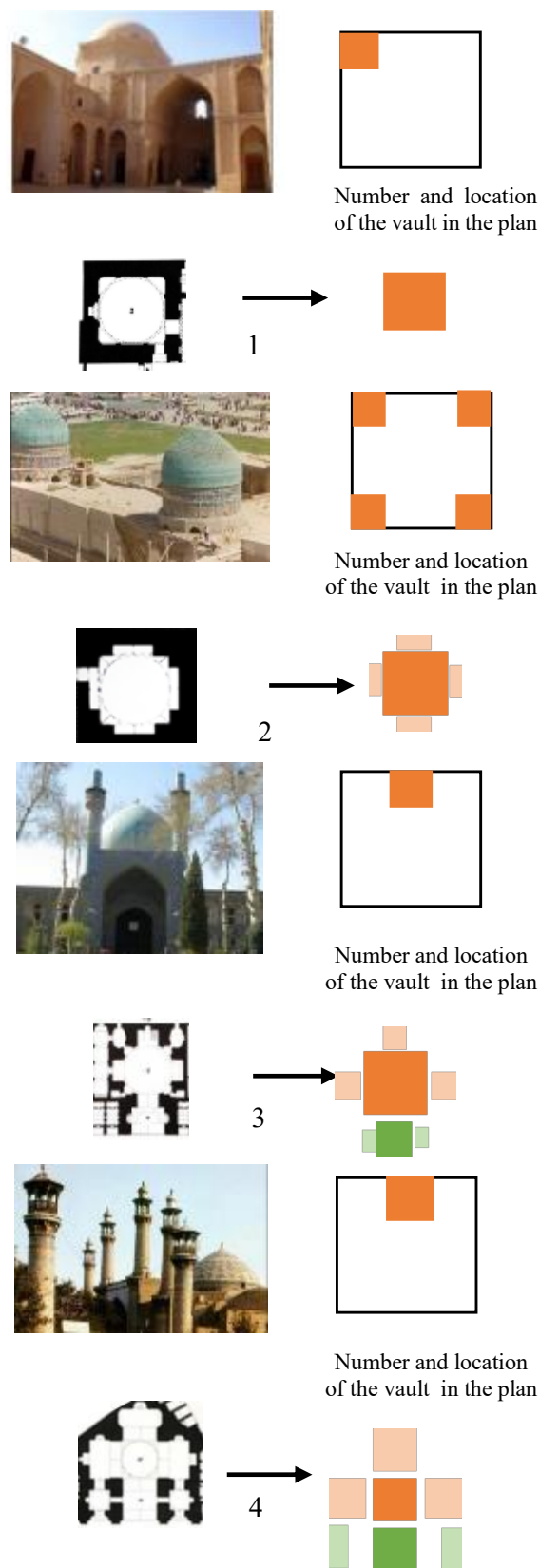


Fig. 11. Comparison of flexibility of school vaults from Ilkhani to Qajar period. Source: Authors.
 Fig. 11-1. Ilkhani vault (Ziaieh school); Fig. 11-2. Teymorid vault (Dodar school of Mashhad); Fig. 11-3. Safavid vault (Chaharbagh school); Fig. 11-4. Qajar vault (Sepahsalar school).

Research findings

According to the cases studied earlier, the flexibility of the physical elements of schools from the Seljuk period to the Qajar period, along with the changes in schools, has had some changes. Chambers are diversifiable in the Seljuk period and later periods, their functional variability is reduced and their spatial variability, adaptability, and variability, and finally their flexibility are increased. The porches of the Seljuk period also have high functional diversity, but after the Seljuk period and with the creation of vaults and naves, the amount of functional diversity of porches has decreased, but due to the spatial change and evolution of porches adaptability, variability, and consequently the flexibility of porches increase. During the Ilkhani period, a new vault body was formed in schools, which in addition to the prayer function, had other functions as well, in other words, they had a variety of functions. During the Timurid period, the number of the vault of some schools increased, which causes the diversity of functional vault to decrease and instead of the component of adaptability and variability of these domes increases compared to the Seljuk period. The vault of some schools of Safavid and Qajar periods, due to the creation of naves in these schools, have less functional diversity than the Ilkhani period, but the two components of adaptability and variability have increased compared to the Ilkhani period and therefore the flexibility of vault has grown. During the Safavid period, the structure of the nave

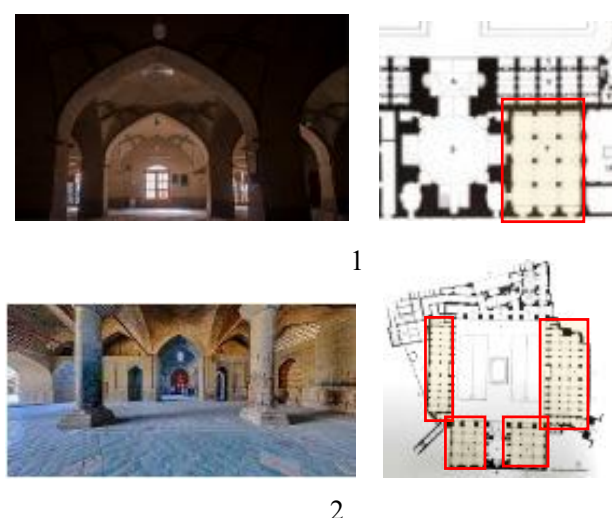


Fig. 12. Comparison of school nave flexibility. Source: Authors.
Fig. 12-1. Isfahan Chaharbagh School nave, (Safavid period); Fig. 12-2. Seyyed Isfahan School Nave (Qajar Period).











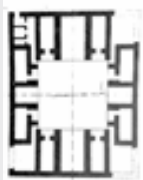
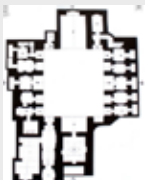
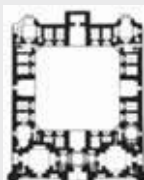
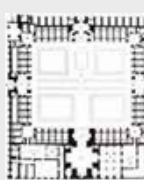
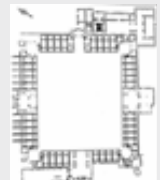





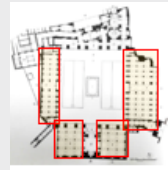
is added to some schools and this feature continues in some Qajar schools and Seyed School the number of these naves increases, and this school has summer and winter naves, which is the case of adaptability and change. It has made the naves of this school more flexible than the Safavid model. Table 3 summarizes the flexibility of the physical elements of schools and compares the flexibility of their physical components from the Seljuk period to the Qajar period.

Conclusion

This study shows that various factors have been involved in the flexibility of traditional Iranian schools. First, these schools, besides serving as an educational space, were also the residency of students and a place of worship, social and political gathering, and in fact, sharing the facilities of schools with the community has been one of the important factors of the flexibility of these schools. Furthermore, the spatial diversity and multiplicity of collective spaces with different dimensions for forming school circles and performing religious, political and social practices (such as porches, domes and naves) have affected the flexibility of schools. Also, the formal diversity of physical elements and the index nature of the forms for more visibility and close relationship between the physical components of schools and the courtyard and the number of entrances and their indexity, have all been other influential factors in the flexible design of traditional Iranian schools. However, due to the physical changes of schools during the Seljuk to Qajar historical periods, the flexibility of schools has also changed.

In general, the flexibility of the physical elements of traditional schools, with the evolution of schools in the Seljuk to Qajar historical period and the addition of new spatial elements of the vault and nave, has a growing transformation and the five physical components of schools (chamber, porch, courtyard, vault, and nave) have had an upward trend in two components of adaptability and variability, and since the flexibility of school micro-spaces has grown in these two components, it can be concluded that school flexibility, from the Seljuk period to the Qajar period, has an evolutionary and ascending trend.

Table 3. Comparison of the flexibility of the physical components of schools from the Seljuk period to the Qajar period. Source: Authors.

	Seljuk schools	Ilkhani Schools	Timurid schools	Safavid schools	Qajar School
How flexible the chamber and small porch (iwanche) are	 Chamber: Diversifiable Iwanche: Diversifiable, adaptable, changeable	 Chamber: Diversifiable Iwanche: Diversifiable, adaptable, changeable	 Chamber: Diversifiable Iwanche: Diversifiable, adaptable, changeable	 Chamber: Diversifiable Iwanche: Diversifiable, adaptable, changeable	 Chamber: Diversifiable Iwanche: Diversifiable, adaptable, changeable
Remarks	The chambers are diversified in the Seljuk period and later periods, their functional variability has been reduced and their spatial variability, adaptability, and variability are increased, and the small porches (iwanch) are adaptable and changeable in all periods.				
How flexible the porch are	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable
Remarks	Porches are diversifiable, adaptable, changeable in all eras. While after the Seljuk period, due to the addition of domes or vaults as well as naves to schools, the component of functional diversity has been reduced and the components of spatial diversity, adaptability, and variability is increased accordingly.				
How flexible the courtyard is	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable
Remarks	Schoolyards have three components of flexibility. With the difference that from the Timurid period, with the chamfering of the corners of some courtyards, and in the Safavid and Qajar periods, with the creation of side yards in the corners of the yard, the adaptability and variability components of the courtyards of such schools increases.				
How flexible the vault is	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	
Remarks	School vaults have three components of flexibility. During the Timurid period, due to the multiplicity of domes in schools, functional diversity decreased, but spatial diversity, adaptability, and change increased. In Safavid and Qajar, the addition of the nave increases adaptability and variability.				
How flexible the nave are			 Diversifiable, adaptable, changeable	 Diversifiable, adaptable, changeable	
Remarks	Nave in traditional schools is diverse, adaptable, and changeable. During the Qajar period, in schools where the number of kindergartens is more than one, diversity decreases, and the component of adaptability and variability increases.				

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