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Effective Patterns in the Formation and Spatial Evolution of Iran's Schools during the Seljuk Period and Post-Seljuk Evolved Schools

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ABSTRACT

Seljuk schools are milestones in the architecture of Iran's schools. These schools provided some features that the next schools followed their principles. However, the question is what kind of buildings influenced the structural pattern of schools constructed during the Seljuk period and afterward, and what is the architectural background of the main special elements and effective patterns in the formation and spatial evolution of these schools? This study aims to find the structural history of formal schools constructed in Iran after the Seljuk Era. Some researchers have presented theories about the root of schools that are attributed to specific building types. Regarding the lack of unity in these theories the reformist view of the authors to the historical-evolutionary approach, and the multifunctionality of schools' bodies, the authors of this study believe that certain patterns have influenced the formation of Seljuk schools and their evolution. Therefore, this study examined the patterns of buildings affecting structural elements of Seljuk schools (primitive type) and post-Seljuk schools (evolved type) through structural analysis, by using historical research, case studies, and descriptive-analytical methods. Findings indicate that core elements of Seljuk and post-Seljuk schools, regarding their specific functions- have inherited features of various buildings and have been influenced by the patterns of these buildings. Moreover, Seljuk schools (primitive type) are rooted in a nine-part introverted Achaemenid pattern while post-Seljuk schools (evolved type) are rooted in the combination of a nine-part introverted and extroverted Achaemenid pattern. In general, the nine-part Achaemenid pattern is the initial cell of the formation of Seljuk and post-Seljuk schools. Regarding its meaning richness and structural flexibility, this ancient pattern can be still considered a golden model in designing educational spaces.

Keywords: Seljuk Schools (Primitive Type), Post-Seljuk Schools (Evolved Type), Core Cell, Evolution, Pattern.

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1. INTRODUCTION

The history of formal schools goes back to the Seljuk Dynasty. The schools had a specific form and framework in that era. These schools had a courtyard with four porches and many rooms (Hojreh) around the courtyard for students' settlement. This model was followed in the next periods and some organs, such as dome house (Gonbad Khaneh) and Shabestan (underground space or nave) were gradually added to the pattern and structure. The issue considered in this study originates from the disagreements among researchers about knowing the formation origin of Iranian schools, and unknown formation roots and models of Iranian schools. Regarding the lack of a comprehensive and flexible model in the spatial-physical structure of contemporary Iranian schools and the gap between educational spaces and magnificent architecture of Iranian schools that were among urban landmarks with a particular social, ritual, and political position, this study aims to find the roots and patterns for formation of Iranian schools (Seljuk schools and afterward until Qajar Period) to use these models in the design of educational spaces and keep the Iranian architecture identity and continuity. It seems that some schools existed in Iran during the 3rd and 4th centuries before Seljuk schools. It is said that the first school belongs to Tabaristan's Alavids (Horr 2004). Also, Abuhatam Bosti Schools in the eastern part of Iran have been named as the first schools (Dorrany1997, 78). Abuhatam Bosti founded a school equipped with library and housing for students in his birthplace. Some historians have named Nizam al-Mulk as the first school founder. However, this theory is questionable because academic and educational activities existed in Nishapur and other cities of Khorasan in the early 4th century (Ibid), and some historians argue that the history of the first school goes back to one and half centuries before the Seljuk Dynasty (Hillenbrand 2004, 214). Education was done in various spaces before these primary schools were formed in the 3rd and 4th centuries and then during the Seljuk Period. The same case is true in Ancient Iran. In addition to some spaces like Gundeshapur were assigned to education in Ancient Iran, there were other places such as fire temples, houses, and palaces used for pedagogy and earning. The following questions are asked based on the points mentioned above: how the formal Seljuk and post-Seljuk schools founded through school pattern evolution were influenced by the structural effects of previous educational spaces? Were they influenced by a particular building? What are the structural roots or models affecting the formation of these schools? Accordingly, this study aims to examine the factors affecting the psychical formation of Seljuk and post-Seljuk schools reviewing all educational spaces or pedagogy-related places and those spaces with a body similar to educational centers from ancient Iran to the pre-Seljuk period.

2. BACKGROUND

Many studies have been done on the architecture of traditional schools in Iran. In the book "History of Iran's School, From Ancient Era to Darolfonoon" Sultanzadeh (1985) describes the background of education and training and schools founded during this period. This book also considers the social, urban, and architectural features of the schools. In his book "History of Schools Evolutions in Iran," Sami Azar (1997) not only examines the history of schools but also considers the history of these evolutions within four periods (pre-Islam, Islamic period, Safavid Era, Contemporary Period (advent of new schools)) regarding the cultural developments and educational system. Moreover, Sultanzadeh (2004) carried out another study on the history of schools and, the educational and administrative system of schools to examine the characteristics of schools' architectural space. In this case, some studies have considered the architecture and ornaments or decorations of schools paying attention to a particular topic or approach. For instance, Khazaie (2009) studied the schools constructed during the Timurid Era and compared them to find the development process of architectural structure and decoration of Timurid schools in Khorasan. In another study, Emami Meybodi (2022) studies the elements and spatial structure of the Muzaffarids and Timurid Schools in Yazd. Some researchers such as Hooshyari et al. (2013) have considered the typology of masjid-madrasa (Mosque-School) in the Islamic architecture of Iran during the Qajar Period, investigating the correlation between educational and devotional spaces. Mahdavinejad et al. (2013) conducted a study on the typology of mosque schools of the Qajar Era. In this case, some researchers have addressed the mutual effect between the educational system and traditional schools (Khodabakhshi, Foroutan, and Samiei 2015); (Hayaty and Gholami 2019). Some authors study the structural features of a particular school (Bemanian et al., 2008). Khani et al. (2012) studied and compared schools from the Timurid and Safavid periods in terms of their bodies and ornamentations. Mohseni (2019) studied the structural form of Iranian schools from Seljuk to Qajar Eras providing structural evolutions in the main elements of the schools. Sadrykia et al. (2021) explained the space organization effect on the creation of architectural patterns of Qajar Era Mosque; Hayaty and Behdarvand (2022) conducted a comparative study on schools of Seljuk, Timurid, Safavid, and Qajar Eras.

The available studies, however, have not examined the structural root of schools and their elements considering the patterns affecting the formation of formal schools during the Seljuk Era and afterward. There are of course other ideas in this context, but

there is not a consensus on the structural background of schools. Bartold believes that the Iranian school root is oriental (Buddhist schools in the east of Afghanistan) (Sami Azar 1997, 90). Godard searches the root of Iranian schools in the "Khorasan House" (a house located in the east of Iran) (Hillenbrand 1998, 216). Sami Azar (1997) introduces a third theory explaining that pre-Seljuk schools originate from pre-Seljuk mosques considering this theory more accurate and reliable than two previous ones. "This study seems more reliable regarding the Islamic pedagogy in early centuries and physical educational pattern at that era that confirms the absolute combination of teaching and worship, which such space can be realized in a mosque not school," he claims. Sultanzadeh (2004) also believes that schools' architecture is influenced by the architecture of mosques, explaining that "architectural space of schools was changed at the same time with evolution occurred in the architecture of mosques during Seljuk Dynasty, and four-porch design of these mosques" (Sultanzadeh 2004, 140-141). However, Godard (1998) explains that architecture four-porch mosques have been influenced by the four-porch schools of Nizamiya: "the influence of eastern four-porch school is seen in the creation of this kind of mosque (four-porch mosque). This case makes me search about this school from its advent in Khorasan to when it joined the four-portico mosque and creation of a building called mosque and school" (Godard 1998, 412). As mentioned before, he assumes that the schools originate from the houses in Great Khorasan. According to the mentioned assumption, there is no consensus on this case. Hence, it is necessary to investigate this topic more precisely. For this purpose, this study assumes that educational spaces of ancient Iran and early Islamic centuries and education-related spaces may have influenced the formation of the body of formal Seljuk and post-Seljuk schools to find the structural roots of these schools. Unlike previous theories, this study aims not to confine the formation origins of schools just to a single building believing that some patterns or patterns have been used in other buildings for other functions while their flexible qualities have made them suitable to be used for diverse functions in schools. In other words, the structural-spatial construction of the school is a creative collection and reorganization of ancient patterns that not only last forever but also keep unity with their contemporary buildings. In this way, a sense of unity appears within a gradual evolution. In one structure of space syntax, the arrangement of these words can express the shape of the school while expressing another type of building by another arrangement of words (patterns) in another structure. This study indeed tries to identify these patterns (words) and their combination and arrangement to achieve the original structural pattern and structure of schools.

3. METHOD

This is a qualitative study in terms of nature, a descriptive-explanatory study in terms of research approach, and an interpretive-historical study in terms of research strategies that are conducted based on the structuralism technique. In the interpretive-historical strategy, Moratoria School has been considered based on the historical-evolutionary method. To find the origin of Seljuk schools and evolved post-Seljuk schools, authors could search for the origin of these schools only in a certain building type based on the historical-evolutionary attitude. This is like theories presented by some authors such as Godard, Bartold, Hillenbrand, Sultanzadeh, and Sami Azar who have found the origin of schools in a certain type of building, such as a house, mosque, etc. As school is a mixture of educational, residential, and religious functions, researchers have selected the pattern-attributed technique instead of a specific building-attributed way with a reformist view towards the historical-revolutionary attitude. The researchers have analyzed the buildings affecting the formation of "main micro spaces" of Seljuk schools (four-porch courtyard and room) and evolved post-Seljuk schools (room, four-porch courtyard, dome/or dome, and underground space), and patterns influencing the creation of these schools (Fig. 1). In this study, the Seljuk schools of Rey and Khargerd (Fig.s 2 & 3) are considered primitive types, and Ilkhanid Imamiye School (Fig. 4) and Safavid Chaharbagh School (Fig. 5) are chosen as evolved types.

In this lieu, documentary studies were done on historical scope, archeology, architectural history of schools, and history and philosophy of pedagogy, and field study was conducted on some available samples. Various spatial structures affecting the formation of Seljuk and post-Seljuk schools, including educational centers or the spaces related to pedagogy, such as houses, palaces, fire temples, and educational centers were examined from the Achaemenid to the Seljuk period to validate the research.

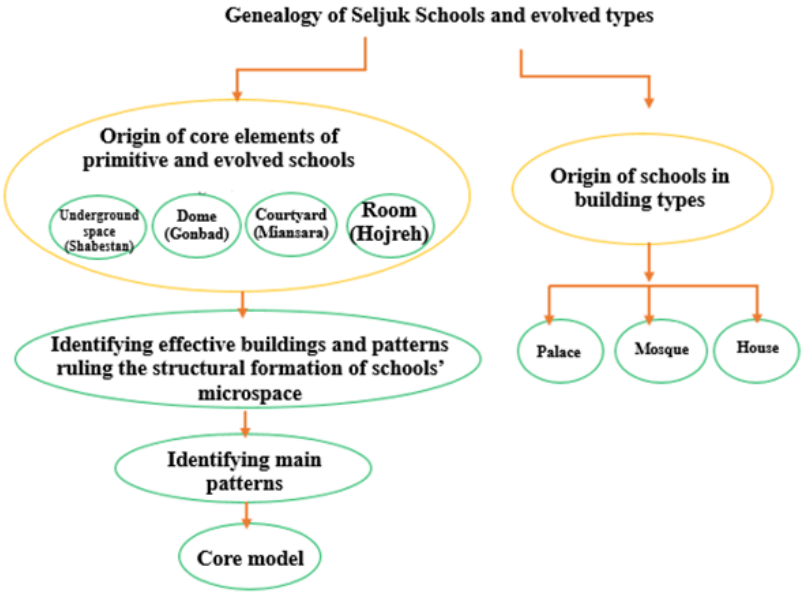

Fig. 1. Two Approaches to Face Schools' Origin Case

The structural root pattern of the main micro spaces of the mentioned schools and the effective core model (core cell) in the formation of schools' structure are presented based on a reformist view of the "historical-evolutionary" attitude and an analytical technique (structural analysis) (Fig. 1).

4. THEORETICAL FOUNDATIONS

4.1. Educational and Quasi-educational Spaces in Ancient Iran

Analysis of architectural dimensions in educational centers of Ancient Iran is almost based on the hypotheses and guesses due to the lack of any kind of architectural document, and most written documents remaining from this period guide the researchers in this context. There is an inseparable combination between ancient rituals and pedagogy in ancient Iran leading to connection or adjacency between educational and religious centers of that era. No important independent educational organization was created during the Medes Dynasty, or at least the available documents have not clarified such a case. Regarding the broad and central governance during the Achaemenid era, country administration needed skilled managers who had to attend certain courses of training, including reading and writing in educational centers (Sultanzadeh 2004, 119). Pedagogy was done in the family, fire temple, and royal education center at that time (Mohammadi 2010, 93). After the spread of the Zoroastrian religion, fire temples were used for education and special educational centers were created for military technique, physical education, and industry (Ibid). Educational centers were more embedded in the spaces and squares near the royal palaces and governmental buildings. Some of the educational centers constructed during the Achaemenid Dynasty included Arshoie, Borsipa, Miltos, and Saees educational centers, and some libraries, the treasury of documents, and royal archives have been mentioned in historical and religious references (Shekari Nayeri 2005, 105). According to the mentioned points and lack of any sign from educational spaces of that era, design patterns of religious, governmental, and administrative buildings, treasuries and houses during the Achaemenid era can help to find the structural patterns of educational centers built in that era. Many important educational institutions and centers were created during the Sassanid era that had a central government (Sultanzadeh 2004, 119). However, society had different classes at that time, so pedagogy was developed in two separate fields: 1. At the public level for all people based on the ethical teachings presented in Zoroastrian temples or physical teachings in public places; 2. At higher levels nobles and aristocratic classes depended on the government that was presented in higher centers, such as Gundeshapur (Sami Azar 1997, 241). In addition to administrative and religious affairs, medicine was also at the center of attention at that time, so medical education centers sometimes depended on the religious system or were independent. Gundeshapur School was famous in the field of medicine and philosophy during the Sassanid Era (Sultanzadeh 2004, 121). However, there is no information about the architecture of this school. The possible case is that the architectural design of palaces was used for educational centers at that time (Sami Azar 1997, 242).

4.2. Educational spaces of Iran and schools during the Islamic Era (before the Seljuk Period)

Education became public after Islam. Order and advice of Islam Religion for learning science was a

firm reason for the spread of science among Muslim Nations for centuries (Dorrany 1997, 61). Islamic teachings were inspired by the Muslims' interest in understanding and spreading divine religion. Such expectations from education could be realized everywhere requiring no specific place (Sami Azar 1997, 63-64). Hence, we find various types of educational centers when examining these centers in Iran during the Islamic Era: houses, mosques, Maktab , Beyt Al-Hakameh , Dar Al-Elm , Dar Al-Kotob, library, bookstore, palace, and school, which last became the formal space for education since the Seljuk Era.

Mosques were the first educational Islamic centers in which, religious knowledge was promoted. The mosque's environment indeed prevented the introduction of non-religious teachings to that place. The advent of other topics such as scientific and technical discussions gradually revealed the need for creating educational centers independent of mosques. Schools were the first independent centers that were founded in the 2nd and 3rd centuries to develop and spread religious sciences (Hayati and Gholami 2019, 747). Historians do not agree on the establishment date of the first school. It has been said that the first schools were built during the Alavid Era in Tabarestan. The Great Naser founded this independent school in Amol during the late 3rd century (Horr 2004, 13). Abu Hatam Bosti School in eastern Iran is one of the first schools (Dorrany 1997, 78). Abu Hatam, founded a school equipped with library and housing for religious students in his birthplace. Some historians have introduced Nizam al-Mulk the first founder of the school. However, this theory is not acceptable because scientific activities existed in Nishabur and other cities of Khorasan in the early 4th century (Ibid). Fakhrieh School in Sabzevar is the oldest school building remaining from that era. The school's origin goes back to the time of Fakhr al-Dawla Deylami (4th century) (Pirnia 2013, 346). Only two rooms and a corridor have remained from the main building of this school, unfortunately. The main structural patterns of this school cannot be judged because this building has been renovated several times. The Ibn Sina School in Isfahan which is now just a dome may probably have remained from a school constructed during the Buyid dynasty (Hooshyari 2013, 41) (Fig. 21). It is possible that some pre-Seljuk schools were houses assigned to education. The features of pre-Seljuk schools have been similar to houses or mosques in early phases but independent schools were constructed during the Alid and Buyid dynasties, some of them had library and settlement spaces but no architectural information is available for these schools.

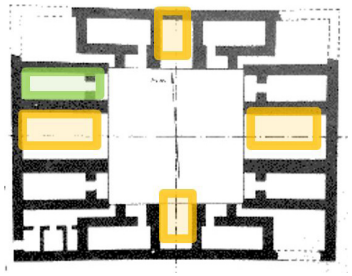

Fig. 2. Rey School

(Pirnia 2003)

Seljuk Era, four-porch courtyard pattern and rooms around the courtyard

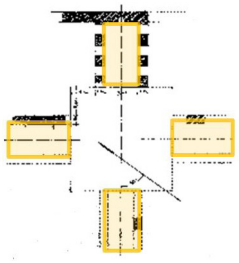

Fig. 3. Khargerd School

(Godard 1998)

Four-porch courtyard pattern

4.3. Formal Schools during the Seljuk Period

Nizam al-Mulk founded some schools of the same name in different cities during the Seljuk Era (Hillenbrand 2004, 216-217). Some rooms were designed in these schools for students' settlement observing a kind of standard in their structural patterns (Sami Azar 1197, 96).

According to documents, accommodation spaces have been an initiative aspect of Nezamiyeh Schools (Dorrany 1997, 29). However, settlement places of religious students in Dar Al-Elms and Abu Hatam Bosti School was designed differently, The Khargerd school is one of the schools constructed at that era.

In the opinion of Godard, the Khargerd school (Fig. 3) is the first and oldest large school with four porches (Godard 1998, 417). Godard believes that the building explored by Eric Schmidt in Rey is a school built during the Seljuk period (Hooshyari 2013, 42) (Fig. 2). This building has a four-porch courtyard and rooms around the courtyard. Regarding the few documents that remained from this period, it can be stated that the physical structure of schools had a framework in this period among which, a four-porch plan and settlement space can be seen in most schools (four-porch and room courtyard pattern).

Fig. 4. Emami School in Isfahan
(ArtHut.com)
Ilkhanate, courtyard, four-porch, room, dome pattern

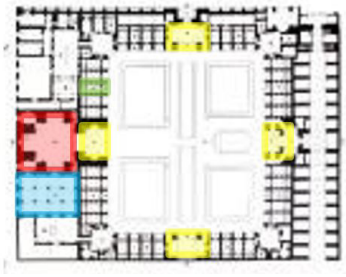

Fig. 5. Chahar Bagh School
(Pirnia 2003)
Safavid, Courtyard, four-porch, room, dome, columned nave pattern

4.4. Post-Seljuk schools

The four-porch pattern of Seljuk schools was repeated in the schools constructed in the next periods. However, some changes occurred in the structural formation of schools. In addition to the four-porch courtyard pattern of Seljuk schools, the dome house was added to the Emami School in Isfahan (Fig. 4) and was constructed during the Ilkhanate period. The dome pattern is also repeated in Timurid schools so four domes are designed in some schools of that era. In some schools, such as Chahar Bagh school in Isfahan (Fig. 5) that was constructed during the Safavid era, the columned nave was added to the pattern, which was repeated in some schools during the Qajar Era (see Mohseni 2019).

4.5. Historical-evolutionary Attitude (study of Historical Evolutionary Attitude to find the Origin of Schools' Formation and Evolution)

In total, history is a science, and the history of architecture is also a science in particular so that users can use this science to achieve the considered goals. Historians of architecture history can use a sequential technique to review the history of buildings and put them on a timeline within a certain time. However, the case does not end here. Some researchers see a building like how evolutionary biologists see a creature considering the building a phenomenon that may belong to a certain "generation tree" and developed in this group (Fig.s 6 & 7) (Memarian 2005, 139). When organs of a building create a structure becoming a representative of some buildings, they can be named "species or type" (Memarian 2018, 30). Morphological typology is the more general kind of typology in architecture. In this typology, a building is investigated in terms of its morphological and structural elements, and relevant classifications are based on the differences and similarities between structural elements (Mahdavinejad et al. 2013, 8).

In the historical evolutionary attitude of Moratoria, the time spread of a type encompasses its evolutionary process from an initial type to its current status (Fig. 7). Reconstruction of the initial type and its development until reaching its current status are the most important parts of the typology process. The initial type is a unit that complete types are generated from it (Ibid, 212). Moratoria believes that the initial type has an older root, so consider it the core cell. These definitions are similar to those seen in the evolutionary branch of biology (Memarian 2014, 140) (Fig. 8).

The Moratoria technique can be somewhat used in the formation and evolution of Seljuk schools. Schools have a specific form with a combination of functions during the Seljuk period. In other words, a combination of several types of buildings is seen in Seljuk schools. In the First phase, educational and accommodation functions were integrated during the Seljuk Era, and other spaces such as dome and nave were added to the primitive type to achieve religious functions and create evolved types in the next periods, including Ilkhanate, Timurid, Safavid, and Qajar periods (Fig. 9).

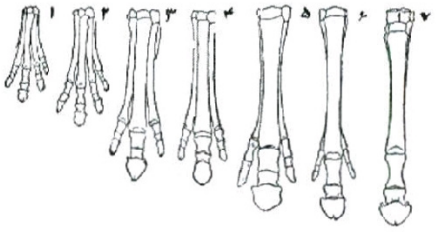

Fig. 6. An Example of the Evolution of Hand and Fingers in the Species appeared from the early Eocene, from the third to Late Period of it one After Another.

(Memarian 2005)

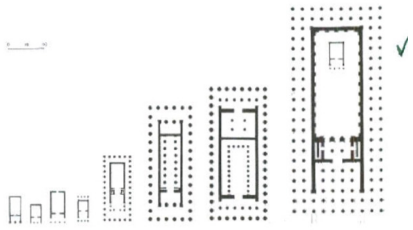

Fig. 7. The Evolutionary Process of Greek Temples' Plan from Simple to Complex Types

(Memarian 2005)

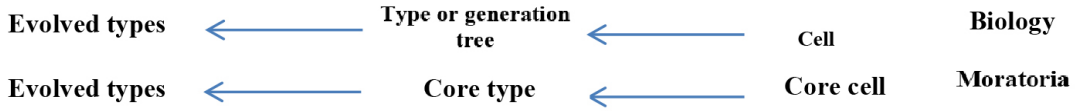

Fig. 8. Typology of an Initial Type in Biology and Moratoria Architecture School

(Memarian 2005)

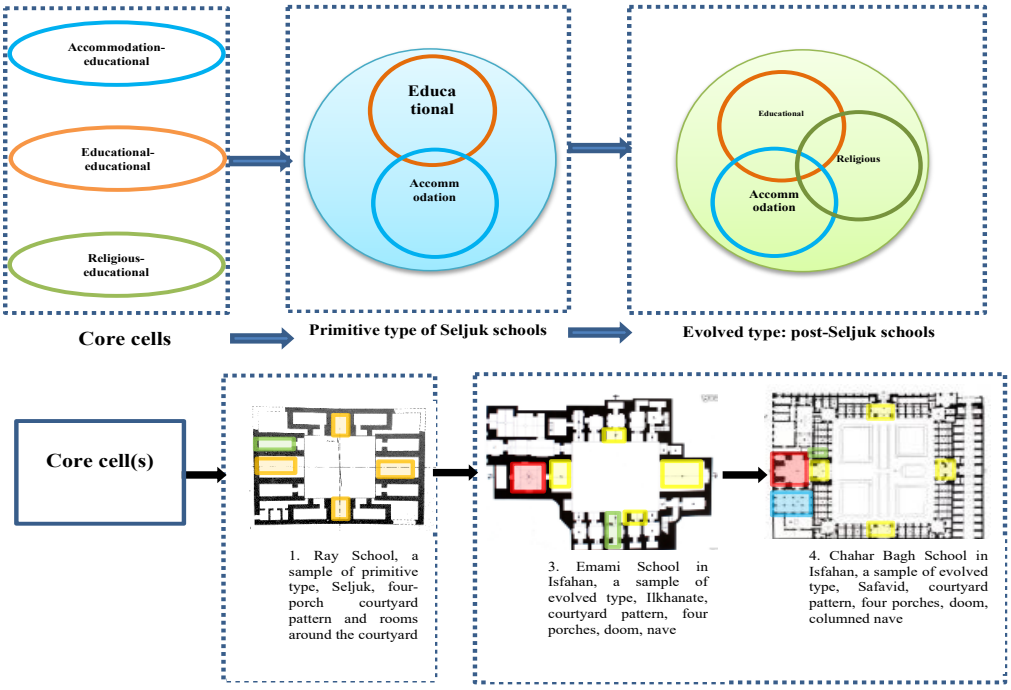

Fig. 9. Up: Diagram of Functions provided by Core Cell, Primitive Type, and Evolved Type of Schools; down: Introducing Samples of Primitive and Evolved Types of Schools

In Moratoria theory, core type and core cell are the same but various buildings have been involved in the formation of schools, so core cells from various types instead of one core cell have been effective.

Because the core cells affecting the formation and evolution of schools are from various types, it is difficult to find their origins. As mentioned before, there are various theories about the creation of schools, and each of them has introduced a certain type of building as the main origin for schools. Hence, this method is not responsive alone, so the essence and foundation of the formation, which is a structural pattern of core cells must be considered as the origin (Fig. 10).

Memarian criticizes the Moratoria theory explaining that this theory had a material-based attitude towards the world and man considering the origins as physical elements (Ibid, 199). He explains that such an attitude towards some places such as historical cities of Iran results in contradictions. Some factors that affect

the formation of types perform as a covert pattern, so cannot be identified in the body of the building at first look (Ibid). Therefore, consideration of the transcendent origin(s) of the pattern(s) influencing the creation of schools can complete the Moratoria attitude (Fig. 10).

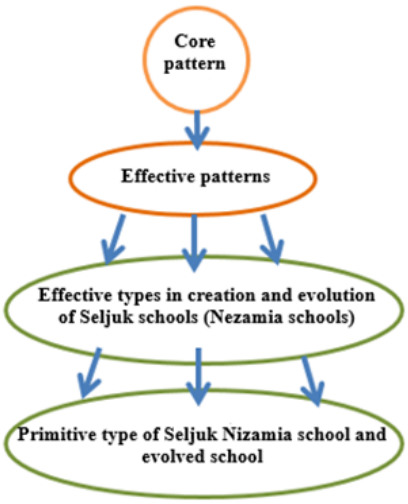

Fig. 10. Authors' Approach to Find Origin of Primitive and Envolved types of Schools

5. FINDINGS (BACKGROUND OF PHYSICAL OR STRUCTURAL COMPONENTS OF PRIMITIVE AND EVOLVED TYPES OF SCHOOLS)

The elements creating the "type" of Seljuk schools and their "evolved type" must be considered to find the origin and formation process of Seljuk schools that have a special physical structure, such as a four-porch pattern and integration of rooms with this four-porch courtyard, as well as evolution of these schools in which dome and nave were added during post-Seljuk periods. For this purpose, we investigate the origins of these constituent elements in effective educational and quasi-educational spaces in the formation of schools. Since the authors of this paper consider a pattern or some patterns effective in the creation and evolution of schools, this rooting is done through the "pattern rooting" of schools' constituent elements.

5.1. Room-Courtyard Combination

Accommodation of religious students is one of the features of schools constructed during the Seljuk Era (Fig. 2). The students' need for settlement led to the creation of a space called Hojreh (room). Accommodation of students has been done in Nizamia for the first time confirmed by the documents. However, Abu Hatam Bosti School also had a space for the settlement of students. Nevertheless, the room-courtyard combination pattern (as created in Seljuk schools) has an older background. As mentioned before, a part of educational activities was done in house, administrative, and governmental buildings. The room-courtyard combination is one of the structural patterns seen in some residential, administrative, and religious spaces from the Achaemenid to the post-Achaemenid periods. The position of the house in pedagogy and its effect on the physical structure of schools cannot be eliminated. "The first pre-Seljuk schools have a kind of house nature based on their esoteric and informal features. In many cases, a house was used as a school without any structural change in it, or such building served as both house and school in sequence" (Hillenbrand 2004, 266).

Godard believes that "Nemooneh Khorasan House" (in Bamyan) is the architectural source of the school (Fig. 11) (Ibid, 216). This house has nine spaces with a courtyard in its center, four porches, and four rooms in the corners of the courtyard.

Another version of this pattern is seen in the west of Iran, Ctesiphon, in a house attributed to the Sassanid era based on archeological reasons (Reuther 2008, 688). This Sassanid house (Fig. 12-1) has a courtyard surrounded by other spaces. This courtyard with Chalipa form has four porches. As shown in Fig. (12-2), other spaces follow the nine-part pattern.

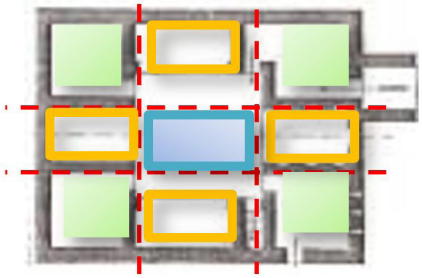

Fig. 11. Khorasan House
(Sami Azar 1997)
1st century, nine-part introverted pattern (four-porch courtyard)

Fig. 12. Left-hand: Sassanid House in Ctesiphon, Right-hand: House Pattern
(Pirnia 2003)
Right-hand: a combination of four-porch courtyard pattern (a mode of nine-part pattern) and nine-part pattern

In the Sassanid period, a courtyard-room combination pattern is seen in Khajeh Mountain, Sistan (Fig. 13). However, this religious building has a Parthia background. The Khajeh Mountain area consists of a fire temple and public spaces attached to it. This fire temple has a domed central space with four entrances reaching the portico (Mard Gard). Also, a porch is seen in the main entrance of the fire temple (porch-dome combination pattern). The complex attached to the fire temple has a two-porch introverted courtyard (two porches in the eastern-western direction). The entrance of the complex and fire temple is located in the northern-southern direction of this courtyard. There are some rooms similar to the rooms of schools and caravanserais that surround the courtyard (combined courtyard-porch-room pattern). Pirnia believes that the specific spaces created in this complex, including the courtyard, courtyard-facing porch, and dome were then used in all traditional schools, caravanserais, and mosques after Islam (Pirnia 2003, 109).

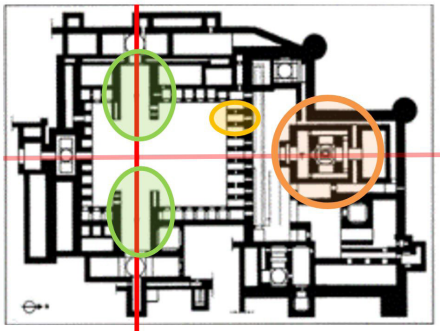

Fig. 13. Khajeh Mountain
(Pirnia 2003)
Combined pattern and dome + combined courtyard-room pattern

This model (courtyard-room combination) was seen previously in public buildings and houses during the Achaemenid Era. A public building called Building No.2 (Fig. 14) existed in the ancient area of Dahaneh Gholaman at that time. This building has a central courtyard with a porch (its four sides are covered with a columned porch) surrounded by eight rectangular-shaped rooms. These rooms have been divided into smaller parts with some walls (Seyed Sajadi 1996, 48-49). This building has 45 rooms (Davtalab, Heidari, and Sarabani 2021, 26). The combined columned courtyard with a porch-room pattern is seen in this case. Building No.15 in this ancient area (Fig. 15) includes a combined central courtyard-room pattern (rooms on four sides of the courtyard) (Seyed Sajadi and Zehrabi 2018, 405).

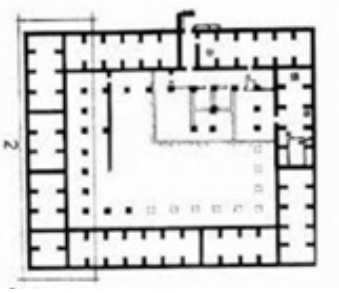

Fig. 14. Building No. 2 of Dahaneh Gholaman

(Davtalab, Heidari, and Sarabani 2021)

Courtyard-room combination (based on the none-part (pattern

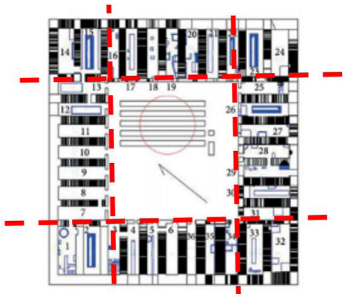

Fig. 15. Building No. 15 of Dahaneh Gholaman

(Seyed Sajjadi and Zehrabi 2018, 405)

Pattern: a combination of the columned courtyard with (porch and room (based on the nine-part pattern

This building has 36 rectangular rooms (Davtalab, Heidari, and Sarabani 2021, 28). Courtyard-room combination is seen another way in House No.6 in the ancient area of Dahaneh Gholaman (Fig. 16), which fortunately has not been much hurt. In this house, four large rooms are formed around a central hall, and four rooms are deployed in corners (Seyed Sajadi, spring and summer 1996). Nine-part pattern (as well as the nine-part × nine-part pattern) (Mohammadkhani 2012, 9) is seen in the plan of this house (Fig. 16). A combination of nine-part patterns is seen in other houses in this area (see Mohammadkhani 2012). The same pattern is seen in a place of worship called Temple No. 3 in this area. This temple has a courtyard with four rooms in the corner and four columned porches (Seyed Sajadi 1996, 42-43) (Fig. 19). This building has a nine-part introverted pattern, which is one of the origins of the four-porch pattern (Fig. 19).

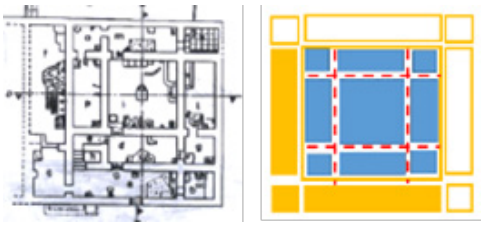

Fig. 16. Achaemenid House, Dahaneh Gholaman

Left-hand: (Scerrato 1987, 147)

Right-hand: nine-part pattern (nine-part × nine-part pattern)

Fig. 17. Jamé Mosque of Isfahan

(Pirnia 2003)

1121. Four-porch pattern

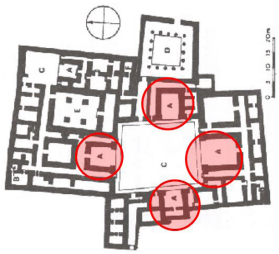

Fig. 18. Parthia Assyria Palace

(Pirnia 2003)

Combined courtyard-porch pattern

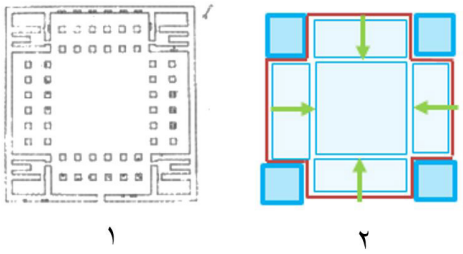

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Fig. 19. Achaemenid worship place, Dahaneh Gholaman

(Scerrato 1988, 146)

Had-right: a nine-part introverted pattern (columned four-porch courtyard)

5.2. Four-Porch Courtyard

The four-porch pattern is one of the most significant architectural patterns in Iran, which became one of the main bases for the physical structure of schools. There is disagreement on whether this pattern has been shaped in mosques, schools, or other buildings. Sami Azar (1997) introduces a theory considering that pre-Seljuk schools (from the 3rd century to the mid-5th century) originated in pre-Seljuk mosques. He argues that this theory is more accurate than other theories in this field due to the Islamic pedagogy concept in early centuries and the physical-educational pattern of that era that confirm the absolute mixture of pedagogy and worship, and regarding this case that such space can be realized in the mosque not school (Sami Azar 1997, 93). Sultanzadeh also believes that schools' architecture is influenced by the mosques. He explains that the architectural space of schools became a four-porch shape at the same time of evolution that occurred in the architecture of mosques during the Seljuk period (Sultanzadeh 2004, 140-141). However, Godard (1998) explains that the architecture of four-porch mosques is affected by the design of four-porch Nizamia Schools: "The role of oriental four-porch school has been confirmed in the creation of this kind of mosque (four-porch mosque). This subject encourages me to find the origin of the school from its creation time in Khorasan to the time when it joined the four-arch mosque and a building called mosque-school emerged" (Godard 1998, 412). As mentioned before, he introduced houses in Great Khorasan as the origin of schools. However, Godard assumes that the interesting point about four-porch mosques is that these mosques are affected by the oriental four-porch schools (east of Iran) (Ibid).

According to the construction background of porches in Jamé Mosque of Isfahan (Fig. 17) and comparing it with the history of the first four-porch Nizamia schools (Khargerd School) (Fig. 3), the accuracy of this theory is confirmed. According to this argument, four-porch mosques have not influenced the four-porch design of schools constructed in the Seljuk Era. However, other components of the mosques, such as the dome and nave have been inspiring structural changes in Ilkhanate's schools.

This pattern (four-porch courtyard) has been used in the pre-Islam period in buildings with religious and ritual functions (e.g., fire temples), public and governmental buildings (e.g., treasuries and administrative buildings), and residential buildings (e.g., palaces and houses). The Parthia Assyria Palace is one of the buildings constructed based on this pattern (Fig. 18).

On the other hand, historical documents have confirmed that education has been provided in religious, governmental, and residential buildings of ancient Iran. Evidence shows that most of the educational centers that were monitored by the religious system were located in or near the fire temples (Sultanzadeh 2004, 121). The reason is that religious knowledge and science were not separated in the ancient period, Avesta was the main source for all sciences, and fire temple heads were responsible for teaching and educating people (Ghadyani 2000, 203). Temple No. 3 in Dahaneh Gholaman of Sistan is one of the worship places that remained from the Achaemenid era (Seyed Sajadi 1996, 42-43) (Fig. 19). This worship place has a courtyard with four rooms in corners and four columned porches. This building provides a nine-part introverted pattern and is one of the origins of the four-porch pattern (Fig. 19).

Libraries and treasuries (a place for keeping documents, etc.) of shahs were assigned to education. There are some points to libraries constructed next to large fire temples or Shah's treasuries around the palaces to keep the documents. There is no doubt that many other treasuries and libraries existed in popular fire temples and great religious centers, such as Azerbaijan, Rey, and Balkh (Zargaran 2011, 106). According to ancient documents, one of the famous libraries of the Achaemenid Era called Shapikan or Shizikan Treasury is located next to the Azargoshasp fire temple in Azerbaijan (Shekari Nayeri 2009, 187). The evidence also shows the construction foundation inside the Shah palaces called "Akra" in Ecbatana city, which is the place for the Shah treasury and keeping documents of Mada and Pars shahs (Zargaran 2011, 103).

Persepolis' treasury and Azargoshasp Fire Temple's treasury are the samples that remained from the Achaemenid and Sassanid libraries. Persepolis' treasury (Fig. 20) includes several columned halls in addition to two columned introverted courtyards with porches (influenced by a nine-part pattern), which the sample of the columned courtyard with porch (four-porch columned courtyard) can be seen in Temple No.3 in Dahaneh Gholaman.

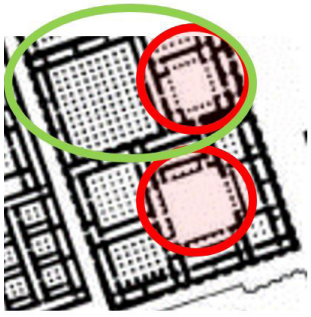


Fig. 20. Persepolis's Treasury
(Pirnia 2003, 75)
Nine-part pattern (combination of columned hall + columned four-porch courtyard)

5.3. Dome

The physical element of the dome was added to the structure of Seljuk schools during the Ilkhanate and Timurid periods (See Mohseni, 2019) (Fig. 4). However, it should be found whether this dome existed in pre-Seljuk educational and quasi-educational spaces. Dome may have been a part of some schools in the pre-Seljuk period. Probably, Ibn Sina School in Isfahan has remained a school related to the Kakuyids period. This school is a single dome and architects believe that this building has probably had some rooms that were destroyed (Memarian 2013, 348) (Fig. 21). It is not surprising that the dome pattern that was common in mosques having dome has existed in pre-Seljuk schools. The reason is that the pedagogical aspect of mosques was one of the performances provided by mosques during the early Islamic centuries (Sami Azar 1997, 71). This criterion is not acceptable because no firm antecedent exists about the Ibn Sina School. The initial mosques have had educational functions in Ira. In the early years after Islam's introduction to Iran, some mosques were created by changing the dome-shaped Chahartaq of fire temples, single porches, and Mithraeums. These spaces later completed the Iranian mosques by joining the 40-column naves (Memarian 2013, 265).

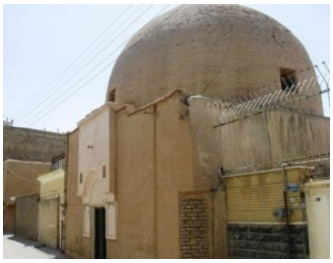


Fig. 21. Ibn Sina School, Isfahan, Kakuyids

(https://www.imna.ir/news/239732)

It means that the Chahartaq pattern of fire temples such as the Jameh Mosque of Golpayegan (Fig. 22) and the single-porch pattern such as the Mosque of Neyriz (Fig. 23) were continued and evolved in some cases. Some other mosques were constructed with a nave pattern. Education became popular in the separate spaces of schools due to the inclusiveness of public education and the lack of educational space required in the mosques.

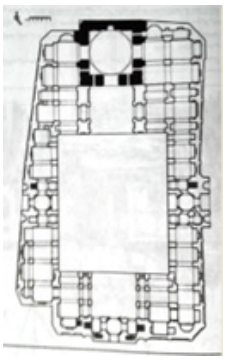


Fig. 22. Jameh Mosque of Golpayegan

Dome-shaped pattern

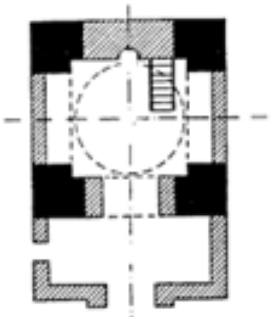


Fig. 23. Izadkhast Mosque in Yazd

Dome-shape pattern

As mentioned before, the dome-shaped pattern of schools was affected by the dome mosques and evolved dome mosques and Chahartaq of previous fire temples. The interesting point is that education and pedagogy have been done in some fire temples, so examination of their architecture can be an effective way in this case.

Among the fire temples remaining from the Sassanid Era, the Azargoshasp complex, Tol Jangi in Kazerun, and Firuzabad Fire Temple can be named. Like the Khajeh Mountain (Kuh Khajeh) Fire Temple, Azargoshasp Fire Temple (Fig. 24) is a connected fire temple with a Chalipa pattern (Fig. 13), a central domed space, and four entrance gates around the portico. A large porch is the entrance gate to this dome. This pattern of "porch-dome combination" was later seen in the architecture of Iranian mosques and schools.

Firuzabad Fire Temple (Fig. 25) has three domes. The access to the middle dome is done through a large entrance porch. This middle dome reaches the courtyard through another porch. The courtyard has two porches surrounded by many rooms. Two important patterns of "porch-dome combination" and "courtyard-dome combination" are seen in this case.

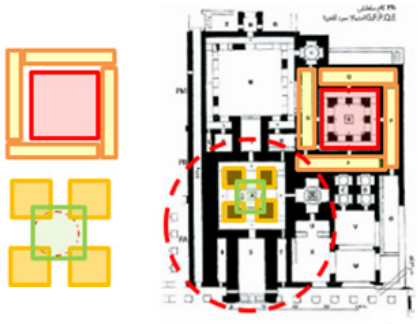


Fig. 24. Azargoshasp Fire Temple

Left-hand at the middle: room-courtyard combination with nine-part pattern in Anahita Temple (Azargoshasp)

Right-hand: porch-dome-courtyard combination pattern (with Chalipa plan)

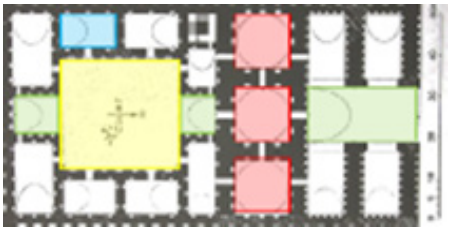


Fig. 25. Firuzabad Fire Temple

(Pirnia 2003, 112)

Combination of two "dome" and "courtyard-room mixture" patterns

Bazeh Hur and Kuh Khajeh are two fire temples that remain from the Parthia period. However, Kuh Khajeh is related to Parthia and Sassanid eras. Bazeh Hur Fire Temple (Fig. 26) which is a separate fire temple has a central space with dome coverage and four thick columns in its corners with four entrance gates in four main directions and a Chalipa pattern (Fig. 26). Kuh Khajeh Fire Temple (Fig. 13) is a fire temple connected to another complex. The pattern of this fire temple is similar to Bazeh Hur having a dome central space and four entrance gates around the portico (Mardgard). Also, a porch is seen in the direction of the main entrance gate of the Fire Temple (Porch-Dome combination pattern).

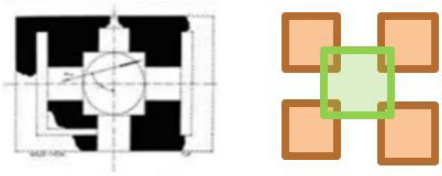


Fig. 26. Parthia Bazeh Hur Fire Temple

(Pirnia 2003, 109)

Nine-part pattern

The complex connected to the fire temple has a two-porch introverted courtyard (two east-west-facing porches). The entrance gate of the complex and fire temple is located in the north-south-facing direction of this courtyard. There are many rooms around the courtyard like those seen in schools and caravanserais (courtyard-porch-room combination pattern) (Fig. 13). Pirnia believes that the specific spaces created in this complex, including the courtyard, courtyard-facing porch, and dome were later used in all traditional schools, caravanserais, and mosques after Islam (Pirnia 2003, 109).

Persepolis in Soffeh is another fire temple of that time discovered by Herzfeld (Fig. 27). The plan of this temple includes a central hall or courtyard with four columns. A long portico is located in front of this temple surrounded by small rooms on three sides (Godard 1998, 188). This fire temple also has a nine-part pattern (Fig. 27). The parts of another fire temple that remained from the Achaemenid era Were discovered in Shush (Fig. 28). This fire temple consists of a central hall with four columns and a corridor in front of it. A corridor is also located around the central hall and a porch with two columns exists in front of its entrance gate. This complex ends in a courtyard surrounded by a portico. As it is seen, this building has two nine-part sections, one of which is extroverted and another one is introverted (Fig. 28).

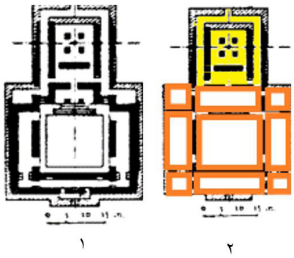


Fig. 27. Achaemenid Fire Temple, Persepolis
(Godard 1998, 188)
Nine-part pattern

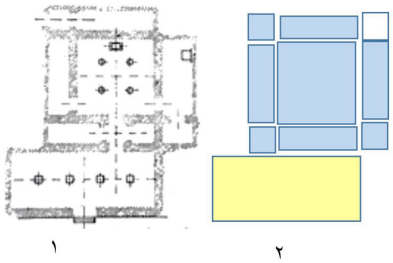


Fig. 28. Achaemenid Fire Temple, Shush
(Godard 1998, 188)
Nine-part pattern

Apadana Palace in Persepolis (Fig. 29) has a columned central hall and four rooms in the corners, and a columned porch is deployed in the space between rooms (except for one direction). The nine-part extroverted pattern is seen herein (Fig. 29). This nine-part pattern (both introverted and extroverted) is seen in other spaces of Persepolis and other governmental buildings and palaces of the Achaemenid era such as Shush (Fig. 30).

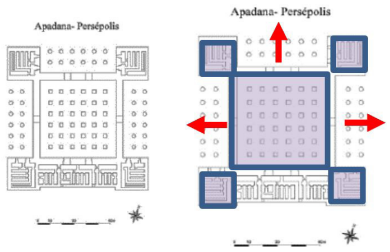


Fig. 29. Apadana Palace, Persepolis
(Mohammadkhani 2012)
Nine-part extroverted pattern

Fig. 30. Shush Palace
(Pirnia 2003, 86)
A combination of introverted extroverted nine-part spaces

5.4. Shabestan (Nave)

Like the dome, Shabestan was created to develop religious and social space of schools in the evolved type of Nizamia Seljuk Schools during the Safavid and Qajar periods. The Shabestan in Chahar Bagh School is one of the first samples of Shabestan created in the structure of Iran's schools (Fig. 9). This pattern was previously used in Shabestan mosques during the Islamic period. Tarikhaneh Mosque in Damghan (Fig. 31) is the oldest primary mosque with Shabestan design in Iran. Shabestan is indeed a repetition of the Chahartaq pattern (Fig. 31). Although some researchers such as Godard believe that the design of this mosque is adopted from Arabic mosques while considering the dome-designed mosques such as Izadkhast a completely Iranian mosque (Godard 1998, 374). As mentioned before, Shabestan patterns are rooted in Sassanid Chahartaq-like domes. Also, this pattern was used in another way during the Mada period, particularly during the Achaemenid period in the public section of palaces. The Apadana Palace in Persepolis (Fig. 29) has a columned central hall and four rooms in corners, and a columned porch exists in the spaces between spaces (except for one direction). The nine-part extroverted pattern is seen in these cases and other governmental palaces and buildings of the Achaemenid era such as Shush.

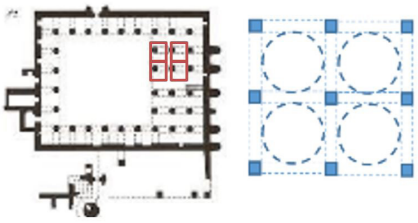


Fig. 31. Tarikhaneh Mosque in Damghan
(Pirnia 2003, 142)
Right-had: combination pattern of the single-porch courtyard and columned Shabestan, which itself is based on the Chahartaq domed

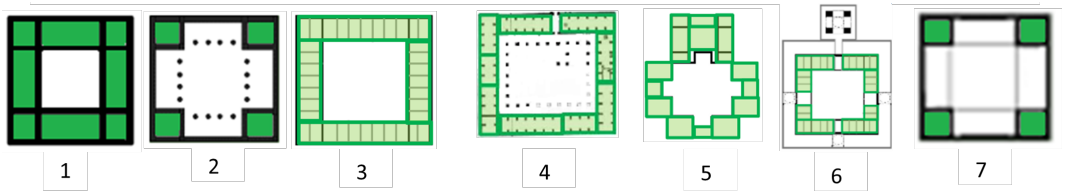


Fig. 32. Different Types of Rooms Arrangements around a Courtyard based on a Nine-Part Introverted Pattern

6. DISCUSSION

According to section 4.1, there were various types of combined room-courtyard patterns before and during the Islamic Era (from the early years of the Islamic period to the Seljuk Era) and all of them affected the formation of rooms' arrangement around the four-porch courtyard of schools. Three patterns existed for the arrangement of rooms around the courtyard or in-between spaces during the Achaemenid era. One type of this pattern is seen in House No. 6 in the Dahaneh Gholaman area where rooms are deployed in four cornets in line with two axes of the nine-part introverted pattern (Fig. 32-1). Another one is seen in a worship place (Temple No.3) in Dahaneh Gholaman where rooms are deployed in the corner of a nine-part introverted pattern around a columned four-porch courtyard (Fig. 32-2), and other patterns are observed in Building No. 15 (Fig. 32-3) and Building No.2 (Fig. 32-4) in Dahaneh Gholaman where rooms are designed around a courtyard. The combination of room and courtyard is seen in the Sassanid house of Ctesiphon, as well as the Firuzabad and Kuh Khajeh fire temples during the Parthia and Sassanid periods. In the Ctesiphon house, some rooms are designed with a nine-part combination behind one of four porches of the courtyard, and others are deployed around the courtyard (Fig. 32-5).

In Kuh Khajeh's space, rooms are arranged around a courtyard with two axes (one axis in line with the fire temple and one axis perpendicular to it with two porches in its direction) (Fig. 32-6). Nine-part pattern's footprint is also seen in this space. another kind of room arrangement around a courtyard (two-porch courtyard) is seen in the Firuzabad Fire Temple. In the early years of the Islamic Period, the room-courtyard combination in Nemooneh Khorasan House (Fig. 11) is seen in the rooms arranged in four corners of a nine-part pattern with four porches (four Soffeh) in line with the main axes of the introverted nine-part pattern (Fig. 32-7).

Accordingly, the arrangement of rooms around the four-porch courtyard in Seljuk Schools (e.g., Rey School) is rooted in the room-courtyard combination in houses constructed during the early years of the Islamic period, which itself originated from Sassanid houses and side spaces connected to fire temples during historical Parthia and Sassanid eras. This combination in the Sassanid Era has a more ancient origin in houses, public spaces, and worship places of the Achaemenid Era rooted in the nine-part introverted pattern of this period (Fig. 33 and Table 1).

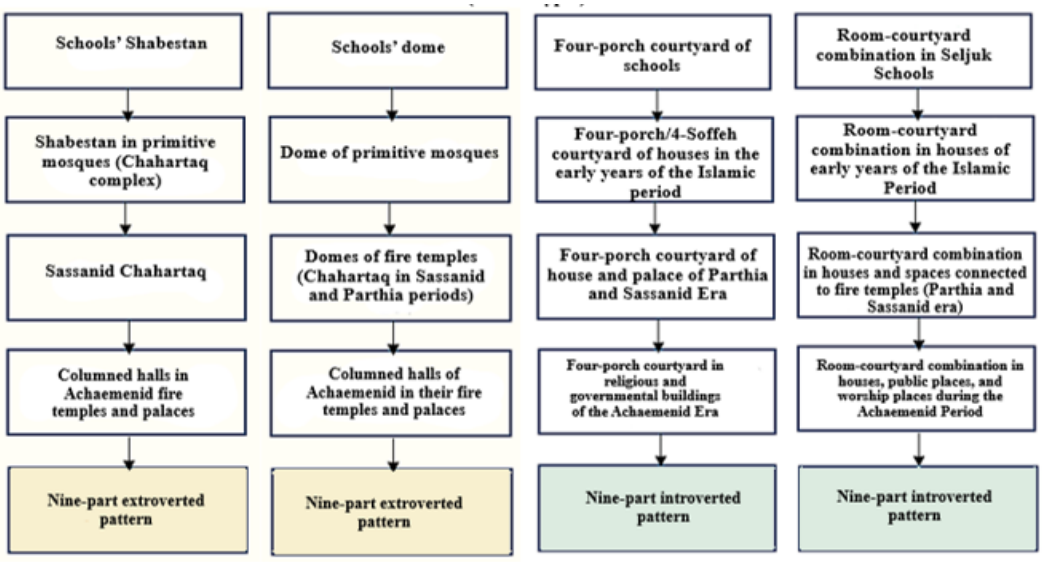


Fig. 33. Origin-Patterns of Physical Elements of Seljuk Schools(Primitive Type) and Post-Seljuk Schools (Evolved Types)

The four-porch courtyard pattern of Seljuk schools is seen in Seljuk mosques too. As mentioned before, it is doubtful whether these mosques are the origins of Seljuk schools. This pattern was first rooted in four-porch houses in the early years of the Islamic period and more ancient origins in four-porch houses and fire temples and palaces during the Parthia and Sassanid eras, as well as columned four-porch courtyard of Achaemenid (Fig. 33 and Table 1).

Table 1. Patterns and Types of Buildings Affecting the Formation of Physical Elements of Schools (Primitive and Evolved Types)

Physical Elements of Schools	Effective Buildings	Effective Historical Periods	Pattern's Origin
Room-Courtyard Combination	Houses, administrative and public places, spaces connected to fire temples	Pre-Islam	Nine-part introverted pattern
	Houses, primitive schools of the Islamic period (Pre-Seljuk)	Early years of Islamic period (Pre-Seljuk)	
Four-Porch Courtyard	Fire temple, treasury (palace or fire temple)	Pre-Islam	Nine-part introverted pattern
	Houses (four-Soffeh)	Early years of the Islamic Period (Pre-Seljuk)	
Dome	Fire temple (Sassanid Chahartaq), fire temple, and Apadana during the Achaemenid Period (columned halls of Achaemenid)	Pre-Islam	Nine-part extroverted pattern
	Mosques' dome, probably dome of schools in the early years of the Islamic and Seljuk periods	Early years of the Islamic Period (Pre-Seljuk)	
Shabestan	Fire temple (Sassanid Chahartaq), columned halls of Achaemenid	Pre-Islam	Nine-part extroverted pattern
	Mosques with Shabestan design	Early years of the Islamic period	

Dome of schools (evolved type: Emami School of Ilkhanate Period and Chahar Bagh School of Safavid Era) is an element that was later added to the physical structure of Seljuk Schools in the post-Seljuk period. This attached space is indeed an extroverted pattern combined with introverted school patterns. As mentioned before and regarding the educational nature of mosques constructed in the early years of the Islamic Period, it is confirmed that the domes of mosques built during the Seljuk Era and mosques of the early years of the Islamic period originate from the mosques' domes. However, the dome of Islamic mosques is rooted in Chahartaq and domes of connected and separated fire temples of the Sassanid Era. The origin of a nine-part pattern of Chahartaq goes back to the nine-part extroverted pattern of columned halls of the Achaemenid Era. These nine-part columned halls were integrated with other spaces (introverted spaces) during the Achaemenid Era (Fig. 33 and Table 1).

The pattern of Shabestan in evolved schools that was added to the physical structure of primitive schools during the Safavid Era goes back to the Shabestan of mosques constructed in the early Islamic Period. These spaces are a collection of Chahartaq and as was mentioned, Chahartaq spaces have evolved a nine-part extroverted pattern of the same columned halls or columned in-between spaces of Achaemenid era with a nine-part extroverted pattern (Fig. 33 and Table 1). However, the evolved schools were created under the influence of social-religious spaces of dome and Shabestan of mosques constructed in the early Islamic period to meet religious and social needs in a better way, assign a separate space to these functions, and magnify the spaces of school in urban spaces. On the other hand, the pattern of the dome and Shabestan that is rooted in the nine-part extroverted pattern of the Achaemenid era was added to the Seljuk schools (primitive type) that were rooted in the nine-part extroverted pattern (Fig. 34).

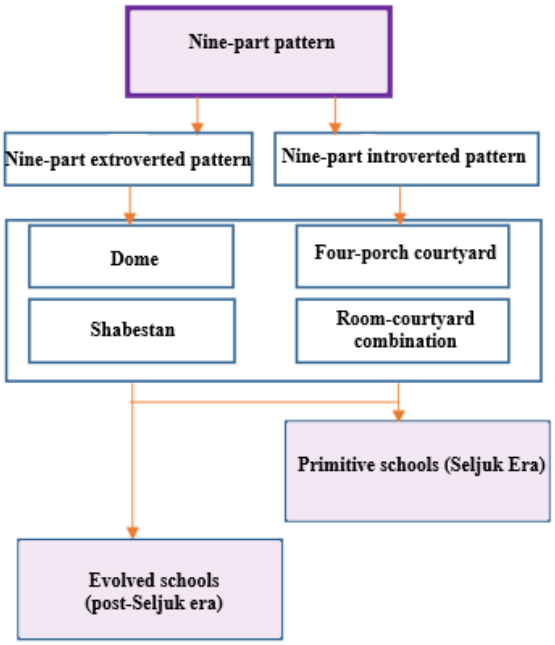
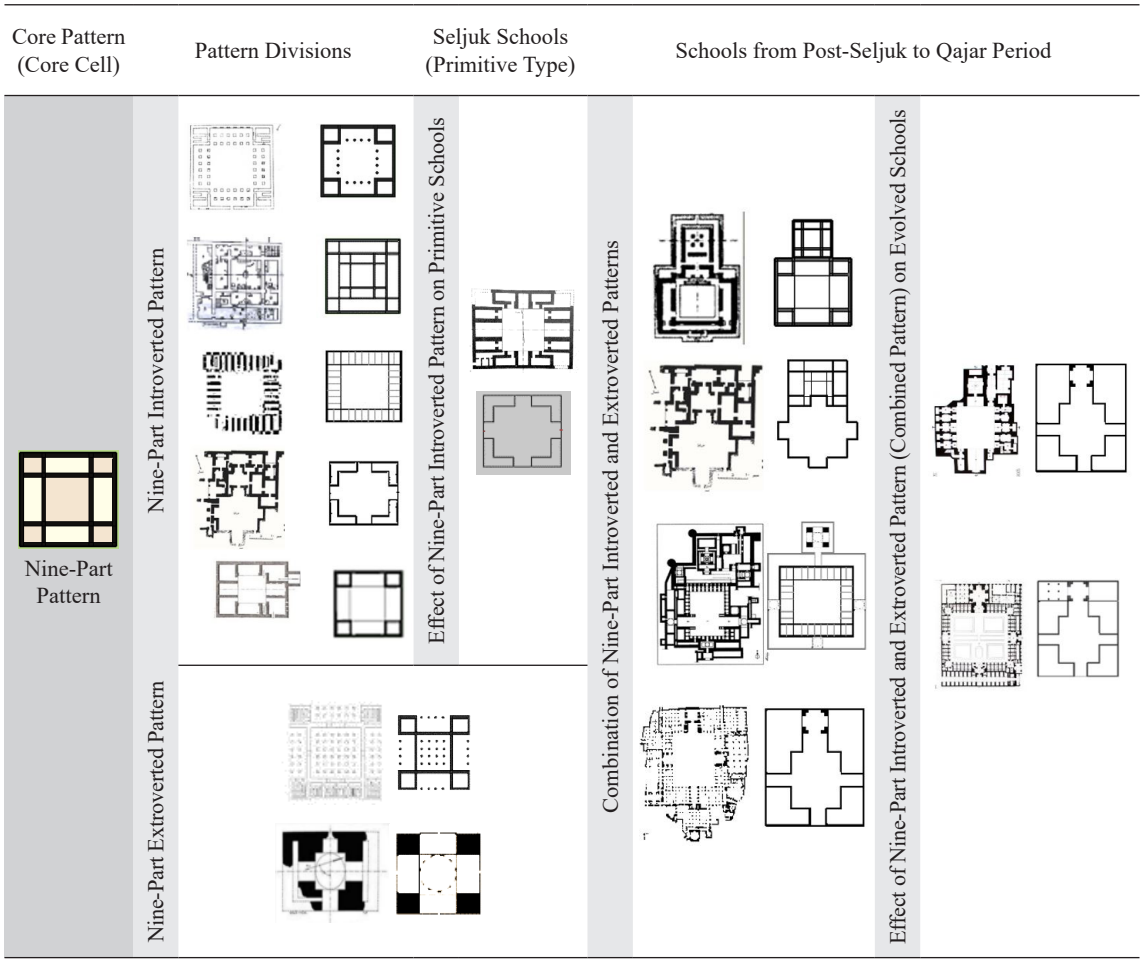


Fig. 34. Origin-Pattern of Primitive and Evolved Schools

In general, the evolved type is rooted in a combination of nine-part introverted and extroverted patterns. This combination has been formed and evolved in different historical periods to meet different needs in the building and the multifunctionality of the building (religious-residential, governmental-residential). This combination has reached the evolved schools that have spaces with diverse scientific-residential-religious/social performances.

Table 2. reports the evolution process from the nine-part "core cell" or "core pattern" of the Achaemenid period in the effective buildings (residential, religious, governmental, residential-governmental, residential-religious) to the formation of "primitive types" of Seljuk schools (academic-residential) and "evolved type" of these schools (academic-residential- religious/social). It is worth noting that before the creation of formal schools in the Seljuk Era, pedagogy and education were done in residential, religious, governmental, residential-governmental, religious-residential spaces in previous periods (early years of the Islamic and post-Islam periods).

Table 2. Evolution Process from the Primitive Cell (Nine-Part Core Pattern Of Achaemenid) to the Creation of Primitive Type (Seljuk School) and Evolved Type (Post-Seljuk Schools)



7. CONCLUSION

According to assessments of this study, the space body of formal Seljuk schools and post-Seljuk evolved schools are rooted in the spaces in which, pedagogy and education were done directly and indirectly. These spaces provide a wide diversity. From houses, academic centers, medical schools, libraries, palaces, and worship spaces (where education was done in them or centers next to them) before Islam to the primitive mosques where pedagogy was done. This study shows that the genealogy of Seljuk and post-Seljuk evolved schools can be done within two techniques. First, the effect of different buildings on the formation of Seljuk and post-Seljuk schools (originated from buildings) is examined, which has been used by Godard, Bartold, Hillenbrand, Sultanzadeh, and Sami Azar. In this lieu, findings indicate that the room (room-courtyard combination) in the formal schools constructed during the Seljuk Period was influenced by some buildings, such as houses, palaces, and public buildings. Moreover, the four-porch courtyard of these schools was affected by some buildings, such as a fire temple, palace, house, treasury, and public buildings. In post-Seljuk schools, the domes were rooted in dome-shaped four-porch mosques constructed during the Seljuk period these evolved mosques were mosques with domes and Shabestan that were influenced by the body of palaces and fire temples. According to these findings, no single origin or root was found for schools, so the authors selected another genealogy approach.

This approach studied the genealogy and structural origins of Seljuk and post-Seljuk schools considering the effect of ancient patterns on the structural formation of schools (pattern assignment technique). According to this perspective and regarding the multifunctional structure of Seljuk and post-Seljuk schools (Seljuk schools: academic-residential and post-Seljuk schools: academic-residential-religious, social), each main element of Seljuk schools (room, four-porch courtyard) and post-Seljuk schools (room, four-porch courtyard, dome, Shabestan) was affected by various buildings with particular patterns considering the specific performance of each element. This study confirms that the room-courtyard combination and four-porch pattern of these schools

are rooted in the nine-pattern of introverted spaces of the Achaemenid era so that the origin of Seljuk schools (primitive type) that are designed to meet the academic and residential needs of users is related to the nine-part introverted pattern of Achaemenid Era. In contrast, post-Seljuk schools that emphasized more on creating a separate and specific space for religious and social performances added the pattern of dome and Shabestan-that is rooted in the domed-shaped mosques with Shabestan in early years of the Islamic period and Seljuk era- to the physical structure of Seljuk Schools. the main origin of dome and Shabestan patterns goes back to the nine-part pattern of the Achaemenid era, and the evolved type of these schools provides a combination of nine-part introverted and extroverted patterns.

Regarding the intrinsic nature of schools where science and knowledge are acquired and the world of meaning and spirituality is experienced and since schools have been governmental and urban landmarks of various historical periods in Iran, the design of schools has been done based on the nine-part pattern that is full of profound meanings that are rooted in the Iranian ethnicity and ancient Iranian-Islamic traditions. This pattern is rich in material and spiritual aspects. Movement from its surrounding area to the center and the middle part is spiritual symbolizing unity and travel in the meaningful world and creating peace, comfort, and concentration. Movement from the middle area to its surroundings is the symbol of traveling in a world of diversity and plurality, so it can provide various functions physically and structurally. Therefore, the purpose of Seljuk Schools (primitive type) is to create concentration allowing students to acquire science and knowledge, live, and rest. To do this, these schools have used a nine-part introverted pattern. The post-Seljuk schools have used combination and adjacency of two types of nine-part introverted and extroverted patterns. This combination has been used over Iran's architectural history to provide multifunctional spaces. nine-part extroverted pattern and its combination with nine-part introverted pattern has been used in governmental and ritual spaces, which have had a special social-religious position and have been urban landmarks in terms of their architectural design. This combination has been revived in post-Seljuk schools (evolved type) to create urban, social, and religious identities.

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The authors have no conflicts of interest to declare.

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The authors commit to observe all the ethical principles of the publication of the scientific work based on the ethical principles of COPE. In case of any violation of the ethical principles, even after the publication of the article, they give the journal the right to delete the article and follow up on the matter.

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