



Investigating Sustainability of the Traditional Buildings in Kermanshah, Iran

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Abstract: Sustainability is known to be a worldwide issue. In a situation where fossil energy consumption, pollution, and climate change have all become problems for human societies, the need for a comprehensive review and modification of the building rebirth seems to be essential. This is particularly true given the challenges on today's global agenda, as renewable energy consumption requires that attention be paid to ideas and construction methods alike. Consequently, analyzing and investigating traditional architecture is one possible solution. Traditional Iranian architecture is a valuable template for the creation of more environmentally friendly buildings. In fact, it can be useful to investigate past experiences for underlying and worthy patterns if there is any hope of creating a better future. Kermanshah is one of the capital cities of Iran and has a rich heritage, valuable historical buildings, ancient civilization, and an architectural identity heavily influenced by the past. This research aims to explore the elements of sustainable architecture outlined by environmental and economic approaches of traditional Iranian buildings in Kermanshah. The cases that are analyzed include the traditional bazaar, holy building and mosque. This research found that Kermanshah has an architectural identity that conforms to the regional climate and environment. It also noted the use of renewable sources as passive strategies in these traditional buildings for energy efficiency, economic efficiency and environmental solution. For example, using domed roofs, introverted building form, dark color, and Ivan, among others, can be listed as some of the sustainable parameters found in Kermanshah traditional buildings.

Keywords: *Kermanshah, sustainable, traditional building*

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INTRODUCTION

Sustainable architecture is a historically important subject which deals with the issues of energy efficiency and environmentally friendly buildings, while also including social and economic approaches. Consequently, sustainability has emerged as a widespread concern and is increasingly important in academic and practical discussions (Caiado, de Freitas Dias, Mattos, Quelhas, & Leal Filho, 2017). Sustainable architecture includes consideration of energy consumption, ecological issues, and users' health (Taleb & Sharples, 2011). Sustainable architecture as a design phenomenon also includes considering the human as a user and providing the maximum indoor quality. Moreover, the attention given to the natural environment ensures a minimum negative effect and encourages the use of natural features (Mohammadian & Shahbazi, 2018).

For building design, the environmental condition and climate are important parameters. The aim of the building design is providing users comfort (Aram & Alibaba, 2018; Azizi, Abidin, Azizi, & Nasir, 2017). Designing buildings in a way that can cope with climatic conditions is an increasingly common objective that has led to the development of

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practical methods (Eiraji & Namdar, 2011). Climate has a direct and indirect influence on people's health and wellbeing. So, different climates need different architectural designs and also vernacular architecture (Soleymanpour, Parsaee, & Banaei, 2015). Sustainable buildings can be defined as those that consider the building's life and environmental quality, and the future values of occupants (John, Clements-Croome, & Jeronimidis, 2005). One of the important parameters in sustainable architecture is energy consumption. Vernacular architecture is a vital factor in this regard, which is applied in different varieties all over the world according to the particular climate, culture, and terrain (Charitha, Asoka, & Philippe, 2017; Zhai & Previtali, 2010).

Traditional Iranian architecture includes valuable parameters, which are intended to strike a balance between the building, occupants, and environment according to the local climate. Traditional buildings in Kermanshah, Iran contain a variety of sustainable patterns, especially those related to energy efficiency. Iran is a country divided into main four climate regions. Kermanshah is one of the capital cities located in the moderate and cold climatic region.

The aim of this paper is to investigate the sustainable design patterns according to the environmental, social, and economic dimensions. This research tries to analyze traditional building elements in a residential house, bazaar, and religious gathering places. All of the relevant cases are located in Kermanshah, in the western part of Iran.

The Kermanshah province is located in the western part of Iran and is about 525 kilometers from Tehran. Kermanshah is situated in the moderate and cold weather region of Iran.

In this region, the sustainable design used aims to provide a warm atmosphere by designing elevations toward the south to maximize sunshine. As such, solar energy and the sun play an important role. Additionally, the windows' proportion is large and the materials are used in a way that retains the sun's heat internally and spreads it into the indoor space during night time to provide indoor thermal comfort (Faghieh & Bahadori, 2009).

RESEARCH METHODOLOGY

In this paper, the methodology which is applied is a descriptive and analytical method in conjunction with a site survey. In order to achieve the research aim, case observation and document survey were used in collecting data, including library documents, books, articles, and reliable websites. This research intends to illustrate the common pattern of sustainable architecture in the traditional buildings found in a moderate temperature and cold region climate. The cases analyzed for this paper are located in Kermanshah, Iran, including: Tekyeh Biglarbeigi, Tekyeh Moaven al-molk, Shafei Mosque and Tarikeh Bazaar (Dark Market). These case studies were analyzed to determine the sustainable elements included in their architectural designs, which are categorized based on the building elements. Iran is located in the warm climate region, which lies between 25° and 40° latitude (Khalili & Amindeldar, 2014). The historical building of each country represents the identity of that country (Shahamat, 2014). The traditional architecture of Iran has a solid relationship with sustainable architecture parameters, which is highlighted in this research.

SUSTAINABILITY OF TRADITIONAL IRANIAN ARCHITECTURE

One of the important dimensions of sustainability is the environment. Building designs should be in harmony with the environment. Nature is an important factor in traditional Iranian architecture, as water, light and plants are used as natural elements in the center of the building as the courtyard (Mohammadi & Sani, 2018). The traditional Iranian architecture based on the Pirnia had different principles, such as: Human-conformity, Autonomy, Purposefulness, Introversion, and Structure and Modulation. Furthermore, in Iranian sustainable architecture, other parameters like climate, bio ecology, location, roof type, exterior façade, central courtyard, windows and etc. are also important points (Shahamat, 2014). All of these parameters result in the production of sustainable architecture.

Accordingly, Traditional Iranian architecture can be characterized as successful buildings. In the ancient time, architects needed to completely rely on natural energy as renewable sources because of the lack of mechanical systems to produce internal thermal comfort (Faghieh & Bahadori, 2009). Traditional Iranian architecture, therefore, presents many valuable methods for optimizing energy consumption and the ecological utilization of different types of energy. In addition, ancient Iranian architecture has valuable sustainable patterns and also a minimum adverse impact on the environment (Hatamipour & Abedi, 2008).

To improve users' indoor comfort, integrating a passive cooling system into the building design can be a sufficient solution. The central courtyard style from the Iranian traditional concept can be described as an old civilizational development dating back to about 3000 BC. The Iranian traditional courtyard has various functions, such as a place for gathering, playing, cooking, and sleeping during the summer time. However, the courtyard concept is shaped with

respect to the Islamic ideology, which means it must have privacy (M. Hosseini, Tardy, & Lee, 2018).

Traditional Iranian buildings applied a variety of techniques for passive cooling and heating. These systems can be mentioned as: thermal mass design (tremendous walls in building), solar systems (as winter-space and summer-space in the building courtyard), urban underground spaces (as Abanbar, which is used as an underground water reservoir, Yakh-Chal as ice keeper, and Sardab as ventilated basement), underground living spaces (Shabestan, Sardab and Shavadan which are different typologies of basements for residents with differences in depth design), and natural ventilation (as wind Cather which are mainly applied in warm regions) (Saljoughinejad & Sharifabad, 2015).

Another example of traditional Iranian architecture in a different climate and culture where thermal comfort was negatively affected by the problems of being very hot (during the day) and very cold (during the night) is the use of thick stone or brick walls. These sorts of walls act as heat reservoirs and isolators during the hot hours, and facilitate the heat transfer from the external to the internal environment (Bahadori, 1978).

Another famous element in traditional Iranian architecture is the courtyard. The courtyard in traditional Iranian architecture had a sustainable function. Traditional Iranian architecture with the central courtyard date back to about 8000 years ago and initially emerged due to the country's climate (Khajehzadeh, Vale, & Yavari, 2016). The courtyard also had an effect on building energy consumption; the long and deep courtyard with a shading effect helped reduce energy usage. Additionally, the shallow courtyard style performed a suitable function for the cold region because it can absorb more solar radiation (Almhafdy, Ibrahim, Ahmad, & Yahya, 2013). Material selection also has an important and effective role in attaining the target of the sustainability (Florez & Castro-Lacouture, 2013).

Yet another important parameter in traditional Iranian architecture is light. Light has direct and indirect effects on the mental and physical health of users. The users' privacy and light shaped the building spaces as indoor spaces, which are divided into a semi-dark layer as an intermediate space and the dark layer as a private space (S. M. Hosseini, Mohammadi, Rosemann, & Schröder, 2018). On the other hand, Islamic Iranian architecture had a special identity in the sustainability approach, particularly its social dimension (Zarghami & Fatourehchi, 2018). Continuously, it led to special attention in design towards transmitting light into internal spaces, aesthetic, and etc.

RESULTS AND DISSCUSION

Kermanshah is one of the important cities in Iran because of its location. The city is located on the Silk Road and along the route to the holy Karbala city of Iraq. This is the main reason for the presence of many holy buildings in Kermanshah. Tekyeh Biglarbeigi is one particular holy traditional building in Kermanshah, which dates back to the Qajar period. In regards to the sustainable social dimension of this traditional building, it can be described as a place for people to gather and participate in religious mourning. The mirror work in the interior design of the main hall in this building made this place unique.



Figure 1 *Main Façade of Tekyeh Biglarbeigi*



Figure 2 *Mirror Room of Tekeyh Biglarbeigi*

Tekeyh Moaven al-molk is another famous holy building in Iran as one of the important places for religious mourning and social communication. This traditional building, because of the ceramic work, looks similar to an art museum. These ceramic works were used for explaining myths, sagas, and religious stories. In fact, this building is as a visual encyclopedia for illustrating the religions, lifestyle, beliefs and national myth of the people.



Figure 3 *Ceramic Working of Tekeyh Moaven al-molk*



Figure 4 *Ceramic Working of Tekeyh Moaven al-molk in Internal Courtyard*

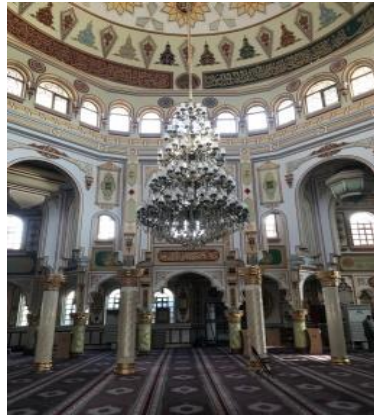


Figure 5 *Internal Aesthetic of Shafei Mosque*

Shafei Mosque is built on a 1060 m² area with Islamic architecture and is located in Kermanshah. This mosque has a wonderful internal plasterwork. Tarikeh Bazaar (Dark Market) was built more than 200 years ago. This traditional bazaar was the biggest bazaar in the Middle East during that period. Tarikeh Bazaar has 18 serial shops lined with the roof (Figure 6).



Figure 6 *Tarikeh Bazaar (Dark Market)*

Building Form

The introverted building style has been a common pattern in Iranian architecture for many decades. Iranian culture and regional climate led to the emergence of this introverted building form. From a statistical view of sustainability, the building form and structure of traditional Iranian architecture is based on geometry, which prioritizes the maximum functional usage of the space (Hatamipour & Abedi, 2008). Generally, the building form in this climate includes the following features: 1. Using the courtyard with Ivan (room with the open platform to the courtyard). 2. Introverted building forms. 3. Rooms with small dimension in height and space. 4. Buildings openings have a smaller size than other areas. 5. Usually used cube or rectangular cube to minimize connection with the outdoor space and temperature transition.

In the climate of Kermanshah, the volumes of the buildings are in such a way that provides the minimum connection to the outer area by maximizing insulation through density. Additionally, the use of high-density external walls minimizes heat transfers. Usually, buildings in this area had a basement with a short height as the heat insulator. The courtyard was also typically on a lower level than the outdoor (the street) and the building floor had a higher level than the courtyard.

Iwan is one of the common spaces in Iranian traditional houses. According to the thermal comfort analysis in this space, buildings with an Iwan experienced significant decreases in air temperature. This condition also continued during periods of high solar intensity (Shaeri, Yaghoubi, & Habibi, 2018). In the Tekyeh Biglarbeigi, the Iwan is used during cold seasons as a sun path and during summertime as a semi-open area for decreasing the internal temperature.

Windows

One of the fundamental elements of a building is the window. Openings as windows facilitate the connection between the indoor and outdoor environment. A suitable window design is necessary for controlling internal temperature (Saljoughinejad & Sharifabad, 2015). In the Tekyeh Biglarbeigi and the Shafei Mosque, the windows' proportions are smaller than other similar traditional building in other areas. Additionally, in the Tarikeh Bazaar shops' line arrangement, there is no opening to the outdoor areas. So, all of the opening types are viewed from only from the indoor spaces.

Façade

Generally, in the cold climate region of Iran, the use of a dark color for the outer façade is common. A brown color is commonly used for absorbing more solar radiation. Consequently, this brown color is the common color used in the Tekyeh Biglarbeigi, Tekyeh Moaven al-molk, Shafei Mosque and Tarikeh Bazaar (Dark Market).

Dome Roof

The famous traditional roof system for many years is a domed roof, which is used for covering large spaces. The domed roofs have other important functions according to Iranian architecture, such as having a passive cooling influence on the building and decreasing heat gain from the roof (Sadooghi, Kibert, Sadeghi, & Jafari, 2019).

The domed roofs used in the main areas of the Tekyeh Biglarbeygi, Tekyeh Moaven al-molk, and Shafei Mosque have many advantages in regards to energy efficiency, which include: providing natural ventilation, solar energy absorption, wind circulation, and passive cooling by reducing heat gain temperature.

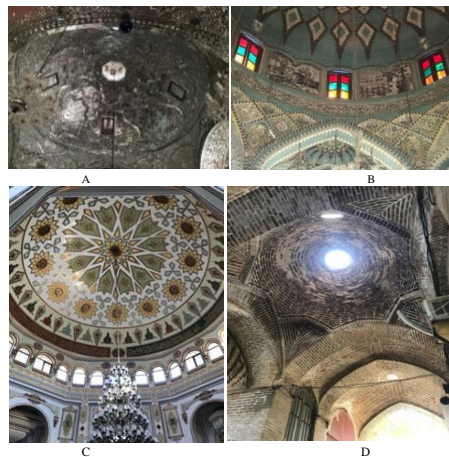


Figure 7 Doomed Roofs as (A) Tekyeh Biglarbeigi, (B) Tekyeh Moaven al-molk, (C) Shafei Mosque, (D) Tarikeh Bazaar (Dark Market)

Vernacular Material

The main materials which are used in the Tekyeh Biglarbeigi, Tekyeh Moaven al-molk, Shafei Mosque and Tarikeh Bazaar (Dark Market) are brick, stone, and wood. These materials are accessible, easy to use, and also have energy efficiency according to the Kermanshah climate.



Figure 8 Tekyeh Biglarbeigi (A) Outdoor Building Façade; and (B) Indoor Main Room

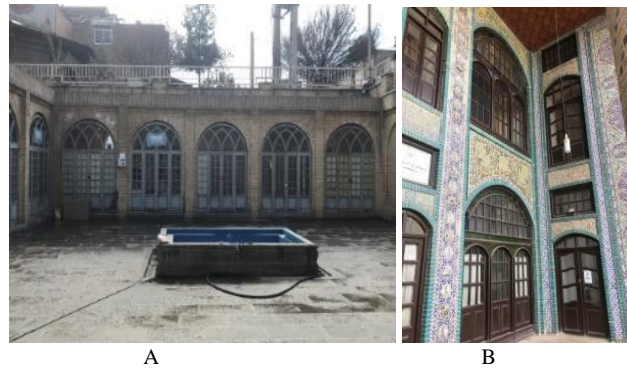


Figure 9 *Tekyeh Moaven al-Molk* (A) *Outdoor Building Façade*; and (B) *Ivan Façade from the Inner Courtyard*

Relatively thick walls have been used in these buildings for the purpose of isolating the heat exchange from the indoor space to the outdoor area. The brick used in the Tekyeh Biglarbeigi provides a thermal comfort atmosphere for the users. Brick had a maximum average for energy efficiency and is also an easily accessible material in this area. In the Tekyeh Biglarbeigi, while brick was used as the main construction material in this building, wood, stone, plasterwork, and mirror work were also used in the indoor spaces. Similarly, although brick was the fundamental material of the Tekyeh Moaven al-Molk, ceramic was used in decorating the building façade.

It is widely accepted that the entrance construction of Tekyeh Moaven al-Molk is based on columns. The main entrance area had a roof that was constructed using five wooden columns with a stone pedestal. However, nowadays this roof is no longer available. The reason for the use of these materials is their accessibility and high quality.



Figure 10 *External Building Façade of the Shafei Mosque*



Figure 11 *Tarikeh Bazaar (Dark Market)* (A) *Indoor Façade*; and (B) *Another Side of Bazar*

In the Shafei Mosque, brick was used for the building façade and some parts were covered in ceramic. Plasterwork and stone were also used in decorating and covering the indoor space. Additionally, in the traditional Tarikeh Bazaar,

brick was used for the walls, while wood was utilized for the truss ceiling.

Enclosed Yard

The benefits of the courtyard in a hot and humid climate obviously relate to its provision of thermal comfort for the users. Regarding the energy efficiency strategy, in the cold climate region, the central enclosed courtyard provided sunny areas during winter and increased temperature throughout summer time.

On the other hand, a courtyard with the central pool in a rectangular or circular shape has a semiotic meaning for users, which is directly related to the social aspect of sustainability in these traditional buildings.

Due to the cold regional climate, the room height is shorter than other building spaces because a shorter height both warms the space and keeps it warm. However, an Iwan is used for space which is adjacent to the courtyard.

The Iwan is a semi-open traditional space designed as a connecting space between enclosed yards and the main building spaces. This Iwan (or arcade) provides links between the outdoor environment and the building's rooms in terms of light, climate, and nature.



Figure 12 *Tekyeh Biglarbeigi (A) Main Courtyard; and (B) Private Courtyard*



Figure 13 *Tekyeh Moaven al-molk (A) Entrance Enclosed Yard; and (B) Main Central Courtyard*

CONCLUSION

Generally, Qajar architecture is shaped like a combination of eastern and western architectural features. Consequently, in the traditional buildings of the Qajar period, you can see a combination of different architectural styles. The sustainability building concept can be described as the relation of the users' values to environmental factors. According to the field research, this study illustrates that the climate, environment, users' religion and people's lifestyle shaped Kermanshah traditional architecture. Kermanshah used vernacular materials which have the best function according to the climate condition. Consequently, in the cold climate area of Kermanshah city, the materials used were those with a high heat capacity. Additionally, for absorbing more solar radiation in this area, a dark color was used for the outer roof surface. Continuously, there is a dense urban design and most buildings have a connection with each other.

Furthermore, sustainability can be found in every part of the traditional Iranian architecture, from the design, materials, passive strategies, social aspect, etc. For instance, in Kermanshah, vernacular materials such as stone and wood were used because they are environmentally friendly and economically sufficient. Stone was used in the building foundation because it has the best function for cold climates and doesn't transfer snow into the building floor during winter time. Also, the traditional building designs were done completely based on the users' beliefs.

Passive strategies that were used in this region include the use of thick building walls and high mass thermal material for the purpose of decreasing the building heat transfer. Additionally, other parameters that affected the building orientation were the street and adjacent spaces, wind direction, and sun path.

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