Iranian Sustainable Vernacular Architecture

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ABSTRACT

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Background: In recent years, sustainable development has turned into a broad area that embraces all methods and techniques in different levels of human activities and knowledge aiming to save energy, time, money and natural resources. Objective: For its unique characteristics, the green architecture holds a special place among the architecture experts. Since vernacular Iranian architecture possesses all the sustainability factors, it has always had appropriate answer in conformity with the environment and climate. In the beginning of this article through descriptive methods and based on the findings of field research and academic studies we inspect and analyze the Iranian architecture in hot and dry climates specifically Kashan city. This city has been studied using available sources and relying on the content analysis and values hidden in the vernacular architecture. Results: The result of the study will be used to identify the design elements of Iranian Vernacular designs towards a green and sustainable school building in hot and dry climate. Therefore, finding from this research is expected to encourage designers to develop and create a guideline for green school design in Iran. Conclusion: In the end while understanding and scrutinizing the principles of green architecture in educational centers, a suitable design for green architecture in these buildings based on Iranian vernacular architecture using modern technologies will be concluded.

INTRODUCTION

Climate has a major effect on the performance of the building and its energy consumption. Reducing energy consumption, using natural resources and providing comfortable, healthier and sustainable living spaces are the aims of a climatically responsive green building design [1].

One of the main reasons of the expansion and importance of sustainable development in architecture is that construction and in general built environment designers affect their surrounding environment directly. Environmental effects of every new building are very evident and when urban houses replace a green area and or a residential tower shadows the surrounding houses you can easily criticize the built environment’s designing method [2]. Therefore, designer’s attention towards sustainability issues in architecture and creating an approach where buildings are designed in the most proficient and aesthetic manner and meanwhile imposing the least possible harm on the environment have been one of the major issues in architecture designing.

Rogers writes about sustainable design in design Architecture and says: in sustainable design we are looking for realizing the human’s current needs without compromising the natural resources and leaving them for future generations. This process should be compatible with social and economic principles and pay close attention to energy consumption and ecological effects of the buildings and cities. The factors which we need to consider for these purposes are: low energy; suitable compatibility and proper usage of the resources [3].

Green architecture, a termed entitled to the architectures which dedicate great importance to the environment, is one of the characteristics of the sustainable design in which environmental sustainability is more important [4].

They created aesthetic structures. They created these environmentally suitable structures with empirical knowledge and this unstoppable endeavour continued until technology and industry were introduced. After the changes of industrial age, modern life raised its head and the different needs of people transformed the pattern of construction in Iran.

It seems that in the age of advancement and evolution new structures with new materials were built which were not in concordance with the environment and as a result they were not as strong and moreover, due to the
building techniques and in order to overcome the unfavourable climates more fossilized energies (non-renewable energies) were consumed [5].

Due to the rich history of traditional architecture in Iran, scholars and experts need to analyze the positive features of the past architecture (not just imitate them) and make an attempt in order to build environmentally compatible structures using the new construction materials and advanced technologies.

When sustainable design and construction strategies of Iran’s traditional architecture are under scrutiny, then it is possible to observe how traditional buildings in this region were designed in harmony with the local cultural, topographical and climatic conditions and how their design and construction could be integrate in today’s design practices.

Green schools require greater attention and due to the nature of their existence, the role they play in educating of students, innovation and compatibility with the surrounding environment is very important.

In order to achieve the goals following issues are discussed in this article:

•Analyzing the features of Iranian vernacular architecture in hot and dry climate (Kashan city).
•Identifying the characteristics of green schools
•The methods of applying Iranian vernacular architecture in green schools using modern technologies based on green architecture criterion

Research Goals:

This paper is to emphasize on the role of learning from the traditional architecture patterns to supply the economic and sustainable buildings.

This was followed by an investigation of some methods those are based on learning from the Iranian vernacular architecture in hot and dry climate. We were specifically interested in understanding and scrutinizing the principles of green architecture in educational centers, a suitable design for green architecture in these buildings based on Iranian vernacular architecture using modern technologies will be concluded. The results will reveal the major principles of environmental sustainability in school design. This, in turn, opens new doors to future studies about adoption of traditional architecture with new developments regarding to the concept of environmental sustainability.

MATERIALS AND METHODS

This study is based on descriptive methods and the findings of field research and academic studies, which has been carried out on building techniques used in the hot-dry areas of Iran and relying on the content analysis and values hidden in the vernacular architectur.

Finding and discussion:

Architecture of hot and dry climate in Iran:
climate categorization in Iran:

Iran is divided into four major climates: (hot arid, hot humid, mild humid and cold)

Considering that the average raining in Iran is a lot lower than other parts of the world and as a result weather in most parts of the country is hot and dry [6], therefore in this article we analyze the architecture sustainability in hot and dry climates particularly Kashan.

Geographical Location of the Area under Study:

This study was done in city of Kashan as a tourist attractive place considering it as a gateway between Tehran (current capital of Iran) and Isfahan (capital of Iran in 16th century). It was at the end of mountains and at the beginning of desert (latitude 33° 59’E and longitude 51°27’ N). Kashan is a city in the central region of Iran and is located in the province of Isfahan. The climate of central region of Iran is relatively similar to desert climate. This region represents a hot and dry area with a high temperature difference between day and night.

Hot and dry climate characteristics in Kashan:

•hot and dry weather in summer, cold and dry in winter.
•low raining
•very low weather wetness
•very low plant cover
•too much day and night temperature difference
•winds with dust in desserts
•condensed city texture [6].
The climate in Kashan during summer is characterized by fierce heat, which tends to be unbearable towards the end of the summer season. During winter, it is cold and sometimes rainy in November and December. Detailed information on temperatures and rather high solar radiation levels in Kashan are given in Table 1.

![Kashan climate information](image)

**Fig. 1:** Kashan climate information [7].

Vernacular architects proposed logical solutions for human comfort, one of which was to idealize the architectural space with the conditions of their surrounding environment. (Man first made his home to protect himself from rain, wind, sun and snow. These goals were to protect them from the environment and serve their survival) [8].

Iranian architecture that first emerged in Plateau of Iran and later in other territories influenced by Iranian culture, similar to all other architecture that has roots in native culture, takes the subject of climate into consideration, valuable examples of this architecture, up to the 14 century, still exist [9]. It was revealed the spaces that were formed exclusively on the basis of climate specifications and where the issue of climate has been the main concern.

This is what has made the connection between climate and architecture and shows that the structural and architectural features of each area are defined by its special climate.

**Morphology and texture:**

![Morphology](image)

In these regions the urban texture is condensed and compressed to each other. Houses have merged or combined walls and the border between them cannot be identified. The compression and combination of the buildings led the external surface of each building to be the least. The structure of the city is planned in such a way that cities are open in the direction of desirable winds and close in the direction of undesirable wind and sand storm. One of the reasons for applying narrow lanes, which have high walls and arch’s roof, is to create the shadow on the surrounding houses and also to control the wind speed of the plateau.

Shaping city textures and providing a proper environment for living was one of the greatest achievements of vernacular architecture in Iran. [6]. Climate is one of the effective elements in city morphology and Iranian
vernacular architecture in hot and dry climates. In this climate, vernacular cities are built with a condensed texture and the houses are attached to each other to the extent that boundaries among them were difficult to identify. Because of the compression of buildings, the outer surfaces of the buildings have been reduced to the minimum; hence causing the houses to save enough energy for long time usages. This also explains the crowdedness of the cities, and also eases access to the other areas of the city.

The main streets in the town face the direction of the prevailing wind. Of course, the streets are narrower than streets built for other purposes (in other regions). Surely if the streets were not narrow more sand would have been blown into the streets from the desert and ferocious winds would have penetrated into the city districts. Meanwhile the compact nature of the buildings prevents very high temperatures to develop by exposure to the sun.

Fig. 3: Narrow and irregular street in compact texture of Kashan (Ghobadian, 1996)

Narrow and walled alleys make movement within the building blocks easier; the tall walls inclosing the alleys create shadows that protect people from the harsh heat in the summer and the twistedness of the alleys slows down the desert winds. The walls and the ceiling are usually built thick to protect the inside from the outer heat. The city structure is designed in a way that the airways open in comforting wind and close during sandstorms. [6].

Fig. 4: Narrow and walled alleys (Ghobadian, 1996)

Structural features in hot and dry climates:
Orientation:
most of the hot and dry areas of the world are located at equatorial latitudes right where the strongest sun light in the summer can be absorbed from eastside and westside of the building and in the winter the most amount of sun light can be observed on northern and southern walls.

Southern wall of the central yard is in fact considered the northern wall of the yard since the central yard and some of the rooms around it and its southern wall possess the most amounts of shadows during the year [8]. The rooms behind the southern walls are cold in winter but in summer because of being in the shadow, they are cool and comfortable.(North side of the yard where winter’s mild sunlight lays on is the winter sitting area because it gets more heat and the south side of the yard which is covered by shadow is the summer sitting area since it is cooler) [10].

For example Boroujerdiha house is basically divided in to two quarters, where one part is on the north, and the other part is summer living quarter on the south. In addition this house has the ground floor and a basement. The basement is usually used during the summer, especially in the afternoons. Since,
basement is cooler compared to the ground floor during the hottest period. Furthermore, the construction of the building is with load-bearing walls, vaults, and domes. These kinds of materials are adobe and brick, which can be easily reused for new constructions. The external surfaces of the buildings are made by bricks and the interior surface is rendered with plaster. The walls have thickness about 60 cm. Therefore, they can act as a thermal mass for minimizing the fluctuation of temperature between day and night.

Fig. 5: Plan and section A-A of Borujerdiha house in hot and dry region (Ghobadian, 2006)

The main purpose of orientation in hot and dry climates is to maximize the summer breeze and reduce the daily temperature inside the building and also to maximize the sun light in winter. Northern-southern orientation is preferred [11].

Central yard:

Fig. 6: Central yard (Farshchi, 2010)

The central yard in a hot dry climate is usually the heart of the dwelling spatially, socially, and environmentally. This method has been very effective in creating comfort in traditional houses which was determined by the climate.

Although, the size of the land, to some extent, is influential, the average sizes of the central yards are generally determined according to the latitude. They are narrow enough to maintain a shaded area during the heat of the day in summer, but wide enough to receive solar radiation in winter. A courtyard can provide security, privacy, and a comfortable place within the buildings.

The central yard is the most important area for the houses in this part of the country. Pond and the garden are considered as the major parts of the yard and their length axis are usually in vertical position from each other. Rooms are located along the main axis of the house and the pond is in front of these rooms which create a direct visual connection among the people in these rooms [10]. Therefore, providing cool and desirable air for every housing unit along with preserving deep yards and the condensed houses breathing through these yards has been possible. The yards are roofed from every side, like a pit settles the cold weather of the night and uses it during the hot day [12].

Roofs:
Mostly roofs of the introvert houses with a central yard are flat and have a sheltering wall taller than vision level which fences the entire roof. These sheltering walls are not only for privacy and security when sleeping or sitting on the roof but they also protect the body of the building from direct sunlight during the day. It needs to be stated that the roof is exposed to sunlight and it heat more than any other section of the house. (Soflaiy. 2004). In desert areas dome shaped roofs were built on mosques and water reservoirs. These roofs beside structural benefits, causes the sun light to adjust during the day by the different curved surfaces. At night they rebroadcast the radiation and help cool the night. [18].

Fig. 7: Roofs (Memari, 1996).

Wind catchers:

Another element of hot and dry climate architecture is wind catcher. Wind catcher is located on the roof and is used to cool, heat and ventilate the structure. In some houses it passes through to the basement. The pond in the yard and plants in the garden help circulate temperate air in the house [14].

One of the traditional elements which is an architectural masterpiece among Iranian sustainable features in buildings and used in ancient times is wind catcher. Wind-Catchers are built in the direction of the most strong and pleasurable winds. Traditional wind-catchers have various types they are in 1, 2, 4, 6, 8 sides or sometimes they are circles which direct the wind through its way. It is used to dislocated, move and cools spontaneously the internal air of buildings by employing wind blow and varied air temperature.

Fig. 8: Wind catchers (Soflaiy. 2004).

Walls:

In respect to both material and thickness walls are designed according to the climate. E.g. in hot and dry climates the walls are very thick, sometimes one meter thick. There are a few benefits to this thickness, first it increases the delay (the time between absorbing the heat from one side of the wall and letting it out from the other side), and second it decreases the temperature swing between day and night since the heat absorbed during the day is released at night. Third, thick walls lose heat at night through transformation, therefore during the day the walls are cooler than human skin. Human body will radiate on it even if the temperature is high. These walls
will provide the most comfort during the day and at night will bring the necessary cold through transformation [12].

**Fig. 9:** Thickness walls (Farshchi, 2010).

_Bazshoha:_

Bazshoha are literally translated as openers, their number and size is dependent on the climate and the culture of the area. In dessert areas openers are small and located under the ceiling. They are mostly on north and east side of the structure. In cold areas openers are generally bigger and are located in southern part of the structure to benefit from the sun light. In temperate areas openers were placed in wind path to purify the air inside the structure [13].

**Construction materials:**

In the past (in Iranian vernacular architecture) materials were produced with the least possible harm to the environment, consuming the least amount of fossilized energy and having the least amount of non-biodegradable material. Also in order to reduce the heavy transportation costs and provide repairing for the structure ant any needed time the vernacular architects used to use native materials considering the point that each area’s material suit that same area the best. Therefore, in native architecture there is an evident similarity between structures of the same region which to the inevitable conclusion that in the same climate the same materials were used. Overall the reason for Iranian vernacular architecture’s sustainability was working with good quality materials (e.g. mud, mud-brick and brick) which were developed and evolved during millenniums and centuries of traditional fabrication [15].

**Color:**

A very important and controlling element is color. The temperature different of a structure with white ceiling with another structure having a black ceiling is 40 kilos. [8].

((Light colors for the outer surfaces are very effective in reducing the daily temperature, by reflection the sunlight, and this heat reduction causes temperature sustainability and eventually comfort at night. If proper regular gatch work does not be done on the building, the structure will absorb the most amount of energy from the sun.)) [8].

**Fig. 10:** Plant covering (Soflayi. 2004).

_Plant covering:_

In every region the plant coverage depends on the amount of water and its accessibility in that area. For the following reasons plant coverage is very important for the structures in hot and dry climates, it…
Plants ability in adjusting the temperature changes is one of the important elements of controlling solar energy. The area under the shadow will faster absorb the heat. Wetness of the plants reduces the temperature and therefore in parts with plant coverage, heat will exist for a longer period [8].

**Green schools:**

Schools are one of the public buildings which have an important effect on their surrounding environment. Since these spaces are one of the major recourse users of a society, it is necessary to apply green architecture features in them.

In order to design and build green schools, there need to be some standards for the designer to follow for green architecture. The effective factors for obtaining a license for green educational centers are based on the following:

**Site selection and landscape:**

Following the main factors of site section for the green schools before designing and starting the project and choosing a proper site are the two most important issues in the sustainability of an green school. Paying attention to the climate of the site and proper orientation towards the sun in a way that central spaces inside the green school, like the rooms, benefit from natural light are of importance too. In this approach existence of plant coverage is an important priority.

**Energy and ventilation:**

Using clean and renewable energy resources are very important factors which special attention needs to be paid to. Green schools are among the facilities that consume a lot of energy. In order to help reduce this consumption different building method need to be considered [16].

**RESULTS AND DISCUSSION**

Studying green schools architecture and considering the knowledge of the architects and designers show that different methods exist in applying these principles. What needs to be noted is that these methods are for creating principles that help preserve energy, be compatible with the climate and realize the needs of the users. Since the circle of life in adjoined, to achieve these out sets we need to follow the general architecture where all the green architecture principles are concentrated. This is what has happened in Iranian vernacular architecture. Iranian architecture is formed by considering the different sites and climates and cultural and social elements. Using non-fossilized fuels, clean and renewable energy and organic growth are all for the respect to the environment. Iranian architecture can today be an example for architects.

Climate responsive design strategies in hot and dry area of Kashan were discussed in this paper. distance between buildings, enclosed urban environment and narrow and irregular streets were considered. Review and development of these traditional urban patterns should beconsidered in hot and dry cities. building form, building envelop, self-efficiency in materials and optical and thermophysical properties of building envelop in this paper. Sustainable architecture force us to re-think what we do and synchronize traditional methods of construction and the use of domestic materials. Finally, some strategies demonstrate some more relevant architectural design methods which are the same as contemporary passive systems. As an illustration, old wind-catchers have been developed into advanced passive cooling systems in recent years.

Consequently, consideration and development of the above strategies allow contemporary architects and designers to build contemporary architecture in a more sustainable, comfortable and self sufficient way.

**REFERENCES**


