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A comparative study of the central courtyard typology in the sustainability of traditional climate is hot arid and cold arid (Case study: Yazdand Ardebil)

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ABSTRACT

Climate and architecture relationship is like soul and body which cannot be separated. The central courtyard is an element that has been used in traditional Iranian architecture since long time ago. And not only it was a decorative element, but also it has caused sustainability in various climates and these climates led to the creation of several species of the central courtyard. In this study, we discussed the climatic factors in the development of the central courtyard in the historical houses in warm and dry climate (Yazd) and cold arid climate (Ardebil) and I have studied form and spatial features and that the central courtyard of these regions has caused an amazing sustainability in their architecture. The research has a descriptive comparative approach and is based on studies in the library, books and articles. As a result, central courtyard space is designed, geometrically, regular and important that exists in climate of Yazd and Ardebil with slight differences about the ratio of house to yard and also the ratio of trees and water to yard. The central courtyard in the cold arid climate and hot arid climate with optimum use of renewable energy creates comfort for the residents and the best response to climatic hardships and pleasant of spatial. And the least damaging effects on the surrounding Natural built environment which means sustainability.

KEYWORDS: Traditional Iranian architecture, Central courtyard, Typology, Sustainable Architecture, Yazd, Ardebil

1.INTRODUCTION

The form of the built environment provides variety of facilities for potential users. The structure of environment provides visual and sense of touch motivation and also smell and hearing motivation. Furthermore, features built environment supports some behaviors and limits some others. These capabilities are almost unlimited. Initial classification of the built environment demonstrates range of its capabilities with a combination of vertical surfaces, inclined and horizontal, provides shelter for climate change, hide, security and parade. These combinations associate meanings such as signs and symbols. Some of these capabilities are understandable only to members of a particular culture and others, for everyone[1].

During history of architecture and building, Designers have always considered the different climate situations. Even the primitive architectures of the climate designing had a clear and elaborate declaration in designing plan of traditional central courtyard houses in order to keep the night chill in the hot arid climate. Climate is considered as the basis for life and human activities in the houses of indigenous and native styles that ultimately led to the form and beauty of buildings [2].

The archaism of buildings with courtyard is about eight thousand years. Buildings and particularly houses have passed about six thousand years to be like a complete form of central courtyard and they have had shelter with such usage during each historical period. The most basic way to enclose a shelter within a fence can be seen in the stony dolmen walls in Azerbaijan [3].

Courtyard has built as a relation between a few spaces in explored ancient houses of Teppe-Zagheh belonging to the sixth millennium BC. Based on Ghirshman's opinion, Zogha Zanbil had been built containing central courtyard.

Achaemenid period gives many samples of residential courtyard and Parthian palace of the Assyrian, Firuz Abad Sassanid palaces and Sarvestan have courtyard designing and have very elaborate planning. Courtyard plan is more feasible in urban areas, which creates a centripetal force and can provide basic communication with nature that is very important for Iranians[4].

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In millennium age old Persian architecture, a series of different factors go hand in hand together that the climate is one of them and makes the final shape of the building. The resident feels that he is in a comfortable circumstance and simultaneously, he receives variety of massages from his nearby. Of climate point of view, level of humanity decrease to a simple creature that only needs a adequate atmospheric conditions. As we mentioned above, attending to the climate condition is one of the most important basics of the Iranian architecture and it's not the whole story. [5]

A courtyard is a common architectural feature that has been applied for thousands of years in many parts of the world particularly in houses. Courtyards were often the primary meeting places for specific purposes including gardening, cooking, working, playing, sleeping, or even in some cases as places to keep animals. [6]

The design variants of courtyards, i.e. its shape, size and details of the enclosing walls of a courtyard varied among regions and functions. Moreover, the differences are influenced by the social, cultural economic and environmental conditions. Although the overall design remains similar, the variants of the design are influenced by functions and location. [6]

Courtyard as a space can provide climatic as well as visual or acoustic protection. The courtyard geometry as well as its material makeup should be considered in the design stage in order to provide the highest level of thermal comfort possible. [6]

MATERIALS AND METHODS

Current study is the descriptive comparative. So we have described cases such as sustainability discussion and central courtyard then we compared both of the hot arid climate and cold arid climate and we have studied climate of Yazd and climate of Ardebil of the point of view courtyard typology and its geometry and the average of pool, plants and trees surfaces toward courtyard surface and also the effect of the mentioned items on sustainability of this type of traditional central courtyard.

DISCUSSION

Sustainable architecture and central courtyard:

Sustainable development in relation to Construction activity and Built environment often is called stable building or stable structure. The construction sector is one of the largest sectors of the economy and society in Europe and with built environment has effected on the change on the natural environment. The construction sector and built environment has considered as two key areas in Global sustainable development.[7]

According to the OECD, sustainable buildings are defined as buildings as buildings that the least damaging effect to built and Natural environments and as well as their overall context. with harmful effects on both environment and development. Sustainable development definition: it meets the needs of the present without compromising the ability of future generations to meet their own needs. [8]

One of the three major areas is environmental. The task of architects are so important. Issues that directly or indirectly, sustainable development has focused on that because architecture are responsible for 75% of climate change. [9]

The central courtyard prepares not only adequate respiratory natural spaces for introverted buildings but also spatial relations and by the result by merging spatial relative to courtyard, the spatial relatives come to the minimum point which is treated as value in sustainable architecture. [10]

All of these make the courtyard house consumes less energy and natural resources; and fewer producers of bad effects on the environment and achieve one of the most important points in Sustainable Architecture. [11]

Even without modern, mechanical heating or cooling systems, the courtyard house provides a comfortable living environment through seasonal usage of sections of the structure. [12]

Central courtyard:

Placing the constructed spaces around the courtyard and specially in the large houses courtyards that are surrounded by rooms or walls in four ways have made the central courtyard expression that is called "Mian Sara" also in ancient books. [13]

Burkhart has aimed the courtyard, one of the signs of Muslims houses and he has said: Muslims houses don't receive lightness and air from street but from its own central courtyards.

Whenever you take a look at Islamic maps, you see series of dead ends and Winding alleys along with the main streets that is the main way of frequentation for several large houses. [14]

Dehkhoda has defined "Courtyard" as enclosure or every area that is surrounded by walls and lobby, in his dictionary. Other words such as "Sahat", "Sahn", "Mian Sara", "Sahn Sara" have the same meaning. Courtyards are used in different ways in Iranian houses that are mentioned below: Courtyard

- As the sign of limits of possession
- As something that gives unity to some of house's elements
- As something that makes relation between several spaces
- For creating a verdurous and lively area
- As an artificial air-cleaner where winds pass through
- An important element for organizing different parts
- As a safe and calm area where the family can relax [3]

In plan sketching, organizing different parts with regard to the effects that follow has been one of the main operations of courtyards. With regard to the effect of the circulation of the Sun on different fronts of the house, builders have assigned each front to different season and different time. So the front that sun shines is the winter part, the front that has no sun shine is the summer part and western front is considered for some hours of winter's cold days and to avoid sun shines eastern front the false arches have been constructed in many parts. [3]

The placement of the central courtyard, its size and orientation are important aspects of the design. The courtyard plays a major role in the modification of the harsh summer and winter environment by providing a comfortable microclimate for the haveli. [15]

As an open space within a cluster or urban fabric, courtyard fulfils various functions, social, leisure and microclimate. The importance of such a space was by their being located in central sites within the urban fabric or building. Surrounded by arcades and colonnades, paved, landscaped with water bodies, various plants, shade and light, they all played an important role in our social and working life. [6]

courtyard can be utilized as an appropriate place for promoting natural, healing environment. Architects could place healing components of nature in courtyards within the building footprint, along with windows at the end of corridors to allow natural light to filter through to the public and private areas. Shade, water, trees and flowers, wind, pavement, and colors could induce positive effects towards the five senses of the human body. [6]

So, courtyard dimensions vary based on the whole surface and the space that is needed. By attending to the work capacity and the house's plan, courtyards are divided to two parts: indoor and outdoor. In Yazd, having one courtyard has been more regular although the number of the houses with two courtyards was not inconsiderable. [3] These two courtyards (indoor and outdoor) have been existed in Ardebil, too.

The outdoor courtyard: the general form of the outdoor courtyard had four angles like a square but they used to creating some sections in some sides or adding some other features. The largest side of the outdoor courtyard was in north-south, the principle axis, direction. We can classify this kind of courtyard with regard to its shape and the number of its fronts:

Type 1: courtyard is limited to the front just in one side and it's surrounded by simple walls or false arches, from the other three sides.

Type 2: courtyard is constructed in two sides and it has its own facade.

Type 3: courtyard is constructed in three sides.

Type 4: regarding that the building is extrovert courtyard has been outspreaded all around the building. [16]

Indoor courtyard: which is placed in northern area of the houses, but there is not any considerable large side and this helps to the sincerity of environment. It has either four or eight angles. [7]

Courtyard and its inner elements are constructed in two ways, in Yazd:

- Flat courtyards that a pool usually exists in its longitudinal axis and parallel to it, there are two or four gardens. These pools and gardens are designed very nice and various.
- Courtyards with garden pit: garden pit and its surrounding spaces operate like a part of the basement areas. With the help of garden pit, they have accessed to the water underpass. [16]

In Yazd climate, outdoor courtyards were not in the category above. And almost of them are surrounded by fronts in four ways and in Ardebil climate, outdoor courtyards include type 2 and 3 and courtyard is constructed in two or three directions.

The number of performances of the surrounding areas determines the courtyard dimensions. Every courtyard possesses usually one pool and several gardens that have a different shape based on local conditions such as weather and cultural factors. [17]

The application of courtyard that disregards its basic design characteristics and placement would affect their potentials. The design variants that are said to affect its performance include its configuration and aspect ratio, orientation, boundary conditions and degree of exposure, and wall types. [18]

Traditional texture environmental compatibility of hot arid and cold arid cities:

The vast territory of Iran is one of the few countries in the world that during its life era has presented a special type of architecture culture. Iran's geographical and cultural properties have caused a variety of forms in its architecture. If we want to have a brief study on architecture of different areas with regard to the geographical classifications, we will see that even a limited geographical area provides a variety of architecture types in its different parts. [3]

Courtyard is a building element that originated from the hot dry regions. [18]

Residential buildings in hot arid areas:

In arid areas, buildings are constructed in introverted styles and they place a part of construction in between and by limiting that with walls and buildings in four ways (constructing the buildings in four directions around a center) which are called four-seasoned houses, they establish climate tranquility in residential areas. The most important features of traditional residential buildings in arid areas are mentioned below:

- 1. Space introversion and restrictedness
- 2. The special building elements like basement and hypogeum, narthex and loading area and central courtyard
- 3. Rooms which frequently have arcs or domes with nearly high altitude and existence of thick walls
- 4. Building's and courtyards' floors are in a lower level in comparison to passage's floor

The way of preparation of the openings to the central courtyards has cut the relation of lively indoor spaces with the outdoor spaces and creates special desirable micro-climate in traditional architecture. [16]

Geographical situation and Yazd province climate

Yazd province is situated in Iran's central mountain range and includes different topographies and pits and desert floors. Yazd arid climate has two main reasons: 1. it's situated in global aridity belt. 2. it's far away from the free oceans like Oman, Persian Gulf and inner lakes and moisturized marine winds. All parts of this province-besides Shirkooh, the mountainous area- have hot arid climate and it's full of deserts that while it goes from western and south-western areas to the north-eastern and eastern area, it becomes more arid.

Yazd climate possess cold and moisturized winters and long hot arid summers, because Yazd is situated in global aridity belt. [16]

Cold arid cities' local texture

In these areas, too cold weather is the main factor in forming the urban and rural texture.

- Small and enclosed urban and rural areas
- Dense urban and rural texture and connected buildings
- Sun direction and land taxes are determinant factors in the way of settlement, deployment and general appearance of the city and village
- Alleys and main streets are parallel to ground level and have low width usually

Summers are usually short and have a nearly moderate temperature. The southern parts of buildings are rarely used. These houses have usually a basement with short ceiling level in that is situated in winter part of them. [19]

The general characteristics of the form of mason in these areas:

The form of the mason which is designed for cold areas describes as below:

The introverted buildings with central courtyard: The traditional masons in cold climate have central courtyard like central area of the Iranian Plateau and other parts are surrounded to this courtyard. The rooms are located at the northern part in order to take advantage of direct heat radiation of the sun during the winter. The northern front of the building is more less used the cause of shortness and moderate of summer. Therefore the northern rooms and also western and eastern rooms are used as depot or a service rooms such as attendance room or toilets. [16]

- The plan, form of the mason and the way of settlement: The masons have compacted texture and plan
- Small rooms with low level altitude: in cold and snowy areas, room size decreases and external surface in relation to the whole building surface decrease to its own size
- Little openings: in comparison to the hot arid climate, opening dimensions in this climate area is increased for using the heatedness energy which is provided by the sun.
- Thick walls
- Flat roofs [16]

Ardebil province geographical condition and climate

Ardebil province is situated in north-west of Iran plateau, and forms 1% of Iran (18,050 km). General form of Ardebil Township is affected by Sabalan, Talesh and Bazghoosh Mountains and these natural factors have made it enclosed. Most of lands of this area have 2000-3000 latitude from sea level. This township has too cold winters and moderate summers. The average of its temperature is 7°C. [16]

The courtyard house form makes it respond well to different cultures and climates. [20]

RESULTS

Case study of Yazd city:

In this study, 8 samples of historical houses have been chosen from Yazd: 1- Mehrban Goudarz house, 2-Lariha house, 3- Gerami house, 4- Yazd Golshan house, 5- Kolahdouzha house, 6- Arabs house, 7- Mortaz house, 8- Rasoulian house (table 1)

Mason name	Yard plan(pool and garden)	Yard surface ratio to house	Water surface ratio to yard	Trees surface ratio to yard
MehrbanGoudar z house		%16	%4	%8
Lariha house		%21	%12	%19
Gerami house		%24	%15	%23
Golshan house		%22	%21	%15
Kolahdouzha house		%26	%15	%20
Arabs house		%25	%10	%10
Mortaz house		%38	%14	%25
Rasoulian house		%30	%17	%10

Table 1: Courtyard position and surrounding areas (writer)
(Reference of maps: www.miras_ar.ir)

Case study of Ardebil city:

In this study, 8 samples of historical houses have been chosen from Ardebil: 1- Khademhouse, 2-Sadeghi house, 3-Vakil Raaya house, 4- Reza Zade house, 5- Ershadi house, 6- Ebrahimi house, 7- Manafzade house, 8- Khalil Zade house (table 2)

Mason name	Yard plan(pool and garden)	Yard surface ratio to house	Water surface ratio to yard	Trees surface ratio to yard
Khakdem house		%51	%4	%50
Sadeghi house		%48	%3	%36
VakilRaaya house		%22		
Reza Zade house		%51	%2	%43
Ershadi house		%22	_	
Ebrahimi house		%36	%5	%18
ManafZade house		%60	%3	%37
Khalil Zade house		%46	%2	%9

Table 2: Courtyard position and surrounding areas (writer)

The results of both tables illustrate that more surface is being used for the pool in Yazd city because of having a hot, long and dry summers while in Ardebil this surface has decreased because of moderate summers. In the Yazd city, in order to make a draft and pleasant of air, the ratio of trees is less than Ardebil. In both climates, central courtyard was used but the scale of the courtyard was changed related to scale of activity and function of its surrounding area.

Table 3:Compare of	central courtyard in	both climate(w	vriter)
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City	Yard diagram	Yard surface ratio to house	Water surface ratio to house	Trees ratio to house
Ardebil	Regular	%42	%3	%25
Yazd	Regular	%26	%14	%17

Conclusion:

Central courtyard space is designed, geometrically, regular and important that exists in these two climates with slight differences. The structure of the central courtyard is the best option to adjust the sunlight, amount of shading, distribution of light and other relevant factors in hot arid and cold arid regions and throughout decreasing consume of energy by temperature and light, the pleasant of the nearby spaces can be increased. Iranian traditional architecture made the environment for residents of its climate much peaceful and comfort by creating the central courtyard in both hot arid climate and cold arid climate and also best usage of renewable energies such as wind and sunlight with the least damaging effects on the surrounding Natural built environment which means sustainability.

Central courtyards in traditional houses have been formed in the best way of foresight in front of in conditional climate which support residents needs. This space is the most fundamental spaces of these climates and the best response to climatic hardships and pleasant of spatial. The trees beside supplying shadows, they amend the lack of moisture and a group of water and plants and etc... help to generate a sustainable Micro-Climate. Nowadays, architectures must start to design attending to all aspects particularly climate aspect and other central courtyards should not be use as backyards that would not be such a non-usable or non-identity but be like a little paradise inside the house with full of sense of presence.

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