A STUDY ON INSTANCES OF SUSTAINABILITY IN THE ARCHITECTURE OF THE COLD, WARM AND DRY CLIMATES BUILDINGS

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ABSTRACT:
Architecture and urban design in Iran's central and desert areas, having the most compatibility with its climatic, cultural, religious, social and natural contexts, fully represent the pure original Iranian architecture and urban designing. Such close relationship which is evident between architecture and urban design as a side; and human and nature, as the other side, whose footprints can be traced in every single place of Iran's architecture and urban design; has the capacity to be inspiring for not only contemporary Iranian architects, but even non-Iranian ones according to its many positive aspects, involving sustainability. Many concepts and qualities proposed on sustainability, sustainable development, sustainable architecture and urban design, among national Iranian and international scientific assemblies, are capable to be studied and recognized in Iran's rich history of architecture and urban design. By analysing sustainability instances in Iran's architecture history and Relying on this ancient treasure Pool, this study tries not only to reach solutions for current climatic issues, but also to move toward Iranian architectural identity.

KEYWORDS:
Warm and Dry climate, Cold Climate, Residential Architecture, Introversion.

INTRODUCTION

By analysing the qualities of solving climatic issues in every urban context, one may reach to the point that: "In order to meet his basic needs, such as residence, human being has always endeavoured to conquer his environment's climatic issues", that's why diverse architecture types are seen in Iran's various geographical regions, each of which indicates a kind of absolute compatibility with its own surrounding climate; according to the diverse and various qualities of different geographical areas of the country. Solving such issues, has its specific methods in each geographical region and climate, every single of which is unique to its own climate; items as materials, architectural designed elements, introversion or extroversion of buildings, central courtyards, special measuring indexes taken into consideration in buildings' way of design are among samples of the methods used by Iranian architects during this country's history.

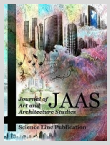
In this study, although limited by my level of knowledge and time, I am to study issues such as interactions between climatic qualities on the architecture of buildings, materials used in their construction, the way of energy saving used in them, consuming renewable energy types in them and etc, in warm and dry climates, and also cold ones.

Solving climate issues in the architecture of Iran's warm and dry regions

While generally analysing the manner of solving climatic issues of an area, studying the residential architecture type of that climate as a category of the local architecture, can be absolutely helpful to the researcher in finding information about the ways that regional architects have used in order to solve such matters. By mentioning this topic, I am to analyse the architecture of Iran's warm and dry climate–localized within the central plateau of Iran-having the special quality of introversion; and as a particular sample, we address to the residential buildings of Kashan and Yazd cities [2].

Characteristics:

- The cities within this area have a compact context, around which fruit orchards and agricultural lands act as a green belt. These green spaces, not only have protected the city against the desert dust, dry air and pesky winds, but also have acted as an important factor in the natural ventilation of the city. The old map of Kashan, in which a green belt surrounds the city, confirms this point (Figure 1).
- Meandrous covered passages (as called Saabaat), having high walls, not only has prevented wind from interfering but also has had a significant role in shadowing and ventilation [10]. Such kind of architecture is vividly seen in the cities within Iran's



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warm and dry regions, such as Yazd, Kashan, Laar, etc. Of course it is necessary to explain that the type of materials used in these passages has differed according to the cities. For example, in southern cities like Laar and Bandar Abbas, the roof of the covered passages, has been constructed by means of some tree trunks such as tamarisks and palm trees which have been different from the type of roof materials used in regions like Kashan and Yazd (Figure 2) [7].

Figure 1: The old map of Kashan [2]

Figure 2: Covered Passage - The Old context of Yazd

- The accommodation the citizens' lifestyle with the climatic circumstances in different seasons, is vividly observed in the introvert houses of the warm and dry regions, in which the rooms around the house's yards have been used according to the seasons. Being introvert, the enclosed spaces of central courtyard houses, have provided the maximum shadow possible.

Modelling the central courtyard pattern, has resulted in the capacity of enjoying each side of the building according to the different seasons; for instance, the northern warm and sunny side of the courtyard was used in the winter and has been called as the "Winter stay" [4]. Reversed the action has taken place on the rooms of south side which have been back down to the sun, which were known as the "Summer-Predominantly" [8]. There have been spaces below the deflector and the throne room in the "Summer-Predominantly", with more height and lighter volume in comparison to the "Winter-Predominantly". The reason for it has been nothing but the wind ventilation, and better air circulation for cooling the space in the summer (Figure 3).

- Using depressions and protrusions in facades and elevated parapet have caused the maximum shadowing. The shadow created by the parapet on the roof, not only reduced the temperature, but also prevented dust and annoying wind from entering.
- Among other techniques of the climate, we can mention going down into the soil and building houses, with the consideration of using the heat capacity of the soil in variant seasons, and also consuming local building materials with high thermal capacity, store the chill at night and release it gradually during the day when the weather is warm (Figure 4).

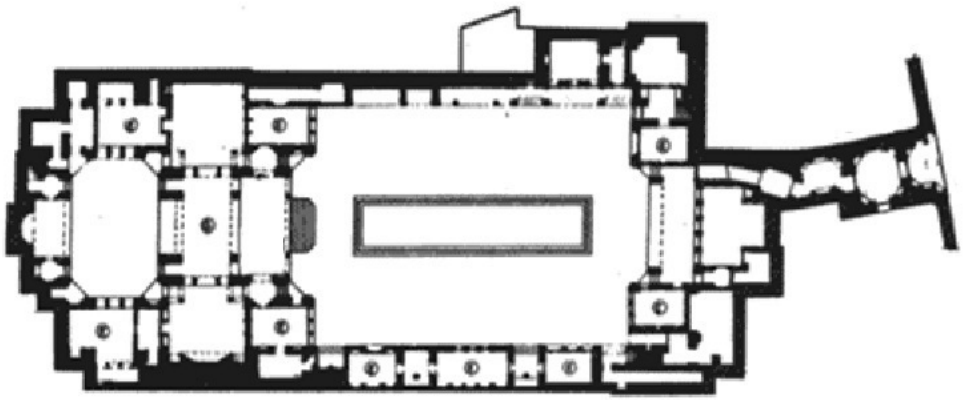

Figure 3: The ground floor plan of "Borujerdie's house" located in Kashan [8].

- Wind catchers have been taken advantage of as another sample of the architectural answers to the climatic issues of this region; They have performed their action as members of a natural cooling system, having a significant role in the cooling and ventilation of the air by blowing it; and also as devices of warm air suction to expel the polluted air.
- Planting types of low water demanding trees, in addition to creating shadow and beauty, had compensated for the lack of moisture in the climate and also had provided the temperature decrease. The existence of courtyards and deep gardens with a pond full of water and green spaces reduced the temperature by means of water vapor (Figure 5).

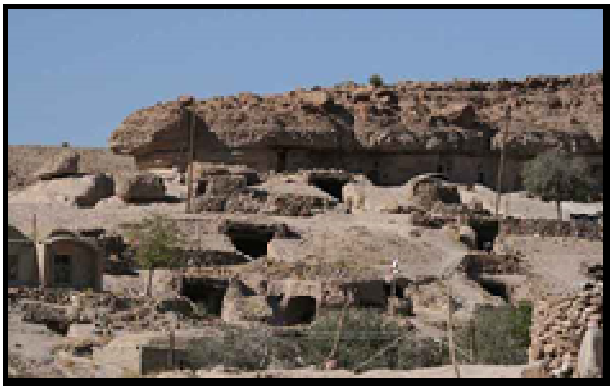

Figure 4: The Meymand Village in Kerman

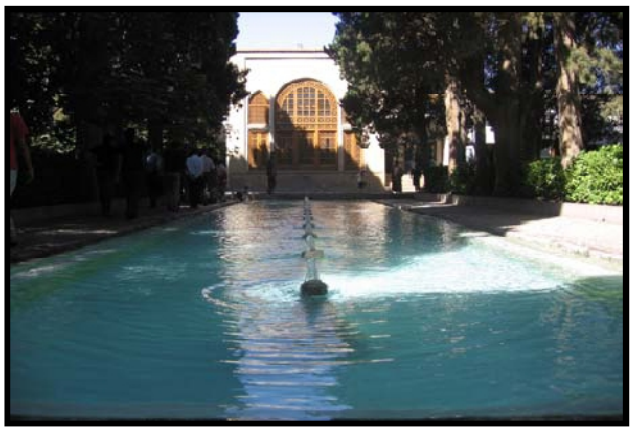

Figure 5: The Feen garden of Kashan

- The form of the arches and domes which are often convex or spherical, are definitely appropriate to reflex the emitted sunlight, accelerate the cooling process. With the sunlight emitted in an oblique way, half of the dome gets under the shadow of the other half. And due to being protruded, the arches and domes are exposed to wind and cause roof temperature to reduce. It is to be mentioned that, the elevated height of the roof, plays an important role in such a temperature decrease.
- Using double-shell roofs and the air between the two shells, has acted as a thermal insulator, moderating the air in winter and summer. The air between the layers acts as a thermal insulation and is transfers less heat from the roof to indoors (Figure 6).
- Mostly, the traditional homes in the warm and dry regions have had basement floors, which have been used by residents in the yearly warm seasons. An important reason to construct underground floors, in addition to the warm climate of the region, is the good soil with its appropriate combination that has shaped such kind of basement floors in the soil, which has been protected by a thick shell composed of the surrounding land, which prevented the outdoor heat from penetration to indoors. In most of these regions, the terms as hypogeum, basement floor and seraglio are used to talk about the use of basement floors.

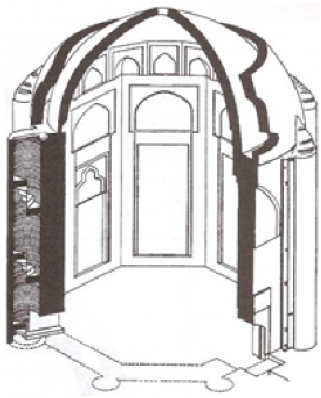

Figure 6: Using double-shell domes.

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Solution of climatic issues in the architecture of Iran's cold climate

By studying architecture in cold regions, we can reach to solutions similar to those was studied in the hot and dry regions' architecture, but some differences arise according to the necessities of this climate type. Cold climates can be described with their very cold winter and hot and dry summer. To meet the climatic issues, the building must be constructed so as to attract and absorb the maximum heat in winter and the lowest in summer. Cities located in this region such as Tabriz, Sanandaj, Hamadan and etc, have similar principles in their traditional architecture, which are different in the details. Compact context, central courtyard, using materials with high thermal capacity and small size of the openings are the common principles of the cold climate's traditional architecture and their differences are composed of the massive size of the building and architectural plans.

Characteristics:

- The spatial structure: In the cold regions the placement of the houses is towards the north – south axis; and in order to protect the rooms from the cold weather of winter, all windows are applied in a redoubled manner. Two facing windows, one of which opens inwards and the other one, opens outwards. Due to cold winds, the urban spaces in this climate type have a compact and dense context which is restricted. Sometimes in the foothills and towards the south, there are interconnected buildings to provide the greatest amount of heat absorption and reduce the risk of flooding in these areas. It should be noted at the top of the hills, there are no buildings constructed.
- The construction's settlement is in such a way that it is not in the direction of the prevailing winds of winter, but if exposed to winter winds, the buildings are made up with low heights so that the largest amount of direct light and heat is driven into the building (Figure 7).

Figure 7: Oraman village, located around Sanandaj

- Materials used in traditional buildings in cold regions:
- Use of indigenous materials: Indigenous materials are used in traditional buildings of every region; and nature has wonderful materials that can be used to construct buildings; as requiring lower expenses, transporting these materials is easier.
- Materials used in the architecture of buildings in cold climates, are majorly stones for walls and wood and thatch for roofs; because in addition to the fact that all of these materials are of low cost due to their easy availability, they are suitable economically and climatically.
- Traditional houses of cold areas like the ones of hot and dry climate are introverted and have central courtyards, but they are smaller in comparison with the courtyards of the warm and dry climates, also they have smaller porches and openings.
- In the traditional architecture of cold climates, shard walls and interconnected context are used in addition to materials as clay and bricks applied to build thick walls, which cause the walls to keep the heat generated during the day and release it slowly at night.
- Roof Coatings: The traditional architecture of the building roof is such that it has the maximum radiation and heat gain in summer, also it has had the most heat loss in winter, that's why the roof is coated by an insulator from inside so that it does not absorb heat in the summer and lose heat in the winter. If both roof insulation and wall insulation are used, in order to prevent losing its optimal properties, there shouldn't be any discontinuity between them in joints and angles [17].
- The verandas of the buildings in this climate are designed to have very little depth and they lack any sitting application. Their only practical usage has been to prevent rain and snow from entering the building from its entrances.
- In the traditional architecture of the region, the openings are designed in few numbers and small sizes (specially on the north side of the building), and if for some reason a large window is built, certainly canopies had to be added to the building to prevent the plaintive winds and cold weather from depriving the biological safety and security. In addition, all the windows and openings should be sealed to reduce the air circulation and prevent the creation of windburn in the building [17].
- In the traditional architecture of cold climates usually the level of the courtyard has been 1-1.5 meter below the surface of the sidewalks to conduct the flowing water streams to the garden or water reservoir; also to use land as thermal insulation, which prevents heat exchange and heat dissipation.

Comparing the manners to response to the climatic issues in the warm and dry and cold climate

Now, according to the studied characteristics, we compare the methods of responding the climatic issues in these two climates:

- In cold climates, depending on the climate and the rate rainfall, sloping roof has been used. Steep roofs, are much better than flat roofs because the rain water flows away from them easily. Nevertheless, the flat roof maintaining the snow on them, act as powerful insulation against cold air and prevent heat exchange from the ceiling. Attic and under truss structure spaces, prevent heat exchange, as a good thermal insulation.
- In cold climates the correct orientation of the buildings considering the pesky wind, using solar thermal energy, the appropriate coverings of the building aspects, and generally presenting many practical ways against heat loss, we can minimize the amount of energy consumption while using mechanical and electrical utilities; and prevent toxic contaminants created by the fuel combustion from entering air inside of the house. This proves an appropriate kind of energy management that helps to improve environmental quality [14].
- In hot and dry areas, as well as the cold ones, some elements are affective on the decrease of energy consumption; elements mentioned, include items such as: the construction materials and coatings, arrangement of the buildings due to solar radiation, considering the favorable and annoying winds, applying elements such as wind catchers, which can reduce the use of mechanical and electrical utilities, and finally the presence of green space and waterfront (Table 1).

Comparing the manners to response to climatic issues in Iran's traditional and contemporary architecture

In 1987, the World Commission of Development and Environment, defines sustainable development as a kind of development which answers today's needs and doesn't threaten the next generations in the way of meeting their needs [5]. To reach to sustainable development, we have to reduce the consumption of non-renewable resources and make possible efforts to enrich our natural environment. Architecture won't approach in the field of sustainability, unless it accomplishes a high efficiency in the field of consuming renewable energy sources, avoiding pollution and complying with environment, with a systematic and coordinated management. Generally it can be said that sustainable architecture, is a kind of architecture that: is responding and acting towards the environmental and spatial qualities; and optimally uses the potentials of its ecological framework in order to create favourable environmental conditions. Therefore, it will have ecological balance, in other words, it minimizes the damages to the environment. Moreover, it is flexible according to the circumstances and needs, and as a result it is sustainable; and according to its unique geographical and regional characteristic, is distinct and separable [6].

Now; Iran's traditional and contemporary architectures are compared leading to making conclusions (Table 2).

CONCLUSION

In order to meet the new functions, nature wouldn't create a new member, rather with the alterations in its members and organs; it brings them to meet the specific needs [1].

Iran as a land, with diverse cultural, economic, and geographic features, has created various architectures, depending on their scale and performance; Architecture which is looking for ways to adjust the harsh weather conditions with least costs; and this character of it has been performed not only in architecture but also in urban design. Water, wind, earth and sun light affect the formation of the architecture regarding climate issues. Soil has been used scientifically as concrete, clay, brick in walls, and thatch and mud as mortar as coating. Rotating of the buildings towards suitable winds in order to making benefit of their power for ventilation and cooling the spaces, and preventing the disturbing winds from entering the residential spaces, (The creation of a significant architectural element called "ventilator" in the architecture of this country) is just one of many samples that Iran's traditional architecture has considering sustainability and harmony with the climate. Constructing the buildings with proper orientation with respect to the sun rotation, for optimal use of its thermal energy, has ended in the appearance of urban orientation in larger scale; Cities and towns are other samples proving Iranian architects' responsibility towards sustainable architecture considering climate issues.

Dr. Pirniya, calls "indigenous materials" as one the five principles of Iran's traditional architecture, and declares that: Using indigenous materials with appropriate thermal capacity, not only takes the architecture forward in consistence with nature, but also prevents the expense's and energy of construction from increasing. These materials are easily repaired and returned to their natural cycle [13].

This basic, has caused much progress in our architecture, as the creation of forms like vaults and domes.

Another quality which is mentioned by dr. Pirniya, is "human properties"; meaning "being designed according to human scales"; this item not only is crucial in transportation and material usage; but also in cooling and heating the space [12].

Using insulators is another method of solving the climatic issues. Dr. Pirniya declares that all the roof coverings, regardless of being level or curve, are

double-shelled. Being double-shelled, in addition to decreasing the roof's weight, prevents thermal conductions between outdoors and indoors [14].

Generally, with reanalysis and polishing up such samples of Iran's traditional architecture, we can reach answers towards executing a kind of architecture which is compatible with its geographical context and progresses along with today's issues.

Table 1: Comparing the manners to response to the climatic issues in the warm and dry, and cold climates [Authors]

The hot and dry climate	The cold climate
Materials have high heat capacity.	Materials have high heat capacity and strength.
Indigenous materials are applied.	Indigenous materials are applied.
The plans are compact.	The plans are compact.
Buildings sink into the soil, in order to be able of using the soil's thermal capacity.	Buildings sink into the soil, in order to be able of using the soil's thermal capacity.
The types of the roofs are vaults and domes with two shells.	The types of the roofs are flat and steep.
According to the sunlight, the orientation of buildings is south to southeast.	According to the sunlight, the orientation of buildings is southeast to southwest.
The number of windows is few and their area is little.	The number of windows is few and their area is little.
Natural ventilation is used at low level.	Natural ventilation is used at low level.
The context of the set of constructions is compact.	The context of the set of constructions is compact.
The color of the outside aspects of the building is light and clear.	The color of the outside aspects of the building is dark.

Table 2: Comparing the details of the ways of responding to climatic issues in Iran's traditional and contemporary architecture: [Authors]

Era / Subject	Traditional architecture	Contemporary architecture
Water	Primarily provided from the earth, water is returned to the water cycle with a lower quality.	Water is being provided from distant sources, causing high expenses, and then it is returned to the water cycle with a lower quality.
Solar Energy	In every climate, traditional architecture is formed according to the solar energy.	Using of this given energy towards sustainability concepts can be more than what it currently is.
Materials	According to the durability of the traditional buildings' materials, such as bricks, and their capability of being reused, we can say that Iran's traditional architecture has been close to sustainability from this aspect.	Harmful materials to the environment are used very frequently, and they are majorly unrecoverable and of low life expectancy; as a result, today's architecture doesn't make that much steps toward sustainability.
Wind	The traditional architecture has benefitted from the wind for ventilation and cooling.	Can play an important role in sustainable energy production (more than the role it currently has).
Form	Structural forms of traditional architecture have been created in harmony with the climate.	Has nothing to do with the climate.

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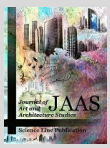

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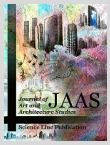

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