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Principles of sustainable architecture extant in heart of desert areas of Iran

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Abstract

Climate has an important effect on operation of the traditional building architecture and its energy consumption in desert area of Iran. Absence of water and unpleasant climate of these regions compelled people to build their houses with some strategies based on effective energy expenditure. Therefore, builders try to use natural climatic strategies for confronting hard situations. Narrow and droughty streets, much lofty air traps, upland walls, big water reservoirs, and vaulted roofed chambers are the distinguished features of desert towns in Iran. Techniques and principles used in this architecture obviously have many new notions in themselves in sustainable architecture arena. Techniques and principles of this architecture show that considering the experiment in traditional architecture of desert regions is conceivable to create an ecological and sustainable architecture. The sustainable architecture that advances to a point in order to be permitted to attain its aims deems necessary the design of any building with the least detrimental effect on environment as well as the design compatible with nature. This study uses qualitative content analyzemethod and tries to extract features that have been used in Iranian traditional architecture in two different categories: urban texture and architecture. Iranian's Hot-Arid zones architecture includes numerous unique features which comprehend aesthetic exigencies and environmental capacity.

Keywords: *Sustainable architecture, Traditional strategies in Hot-Aid regions, Energy efficiency, Natural environment.*

1. Introduction

In the discussion of sustainable development and following it sustainable architecture, it is clear that each building should interact with its surrounding natural environment. The controversial and considerable part is how to interact and the type of intended measures. This sustainable architecture is something that was precisely used by Iranian architects many years ago. They have benefited from this architecture by presenting technologies and especial principles in regard to natural resources and optimal use of energies especially solar and wind energies, and in harmony with regional climate. But unfortunately, today it is forgotten and eradicated [1]. Energy is one of the highly important matters in today's life. Through the appropriate design of urban and residential spaces, energy expenditure could be minimized and at the same time, maximum use could be made of climatic factors. The significance benefit of this design could be seen in hard climatic situations. The central Plateau of Iran with hot and dry climate is one of those regions.

Due to hard climatic situation of desert region of central part of Iran such as low humidity, high temperature in summer, unnecessary solar radiation and high differences between temperatures in the days and nights, sandy wind, adoption of the houses with climate has become one of the important issues in designing.

Thus, traditional architects have utilized simple inactive strategies to provide comfort conditions in houses [2]. Builders tried to use natural climatic strategies for confronting with hard situations. These strategies include observing distances between buildings, layout orientation, building orientation and configuration, introversion, very dense texture, climatic elements such as indigenous material, Wind catcher, Eyvan (porch), central courtyard, subterranean (Qanat), and etc.

When sustainable design and construction strategies of Iran's traditional architecture are under investigation, then it is possible to observe how traditional buildings and the urban design in this hot and dry region were designed in harmony with the natural environment, topographical and climatic situations, and how their design and construction could be integrated in today's design methods [3]. Using natural factors in traditional architecture shows the compatibility of architectural design with natural environment. In traditional architecture of Iran, natural factors, climate and renewable energy resources have been used. It saves energy and is in accordance with the aims of sustainable architecture. Today, the designers are seeking for different methods to decrease the use of the renewable sources, and extending the natural environment in the

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residential complexes. In this study with qualitative content analyze method, the principles of sustainable architecture, and then climate strategies used in Iranian traditional architecture have been specifically studied in two different categories: urban texture and architecture. The existence of spaces such as particular residential spaces for summer and winter, optimal use of wind and solar energy and soil thermal capacity are significant characteristics of houses in different regions of Iran and it has been attempted briefly to investigate some elements and strategies used in construction and architecture of Iranian traditional houses in hot-arid zones and tries to make a connection between past, present and future.

2. Research Methodology

In a scientific research selecting a qualitative or quantitative research method differs from the technical and epistemological viewpoints. The technical viewpoint supposes that the research methodshould be formed according to the research question and the nature of the research. The epistemological viewpointsuggests a qualitative research method in order to find answers to more detailed and complex questions. Thebasic difference between qualitative and qualitative research methods is that in quantitative research interpretation is less emphasized compared with qualitative method and contingency is taken into consideration at different levels [4, 5]. In qualitative research method the basic concern is to deeply understand and interpret conditions without numerical data. The core of this research is based on totally understanding relations at different levels and interpreting outcomes. For this research the researchers has decided that the subject should be approached with critical thinking. Qualitative research method has been selected since it is a method enabling understanding of the context and architectural aspects of it. Qualitative research is a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data [6]. Inductive reasoning is reasoning from small observations to general principles or a larger theory. This method of inquiry generates rich, detailed comprehensive information [7].There are no standard methods used for analyzingdata collected in qualitative research. There are three approaches suggested by Wolcott to analyze data collected. First of them is to use a descriptive approach and present data by directly quoting individuals. Thesecond one is systematical analysis. To use this method after data used in the descriptive analyzes are presentedsome themes are defined and relationships between thesethemes are established. In the third method the researcherpresents his/her own interpretations basing them on the first and second methods. In this method the researchersteps forward with subjective and participative values.

Descriptive analyses method is composed of mainlythe first and to some extend the second method and content analyses method is composed of the second andthird methods. The basic goal of the content analysesmethod accepted by most of the researchers is to reachconcepts that can describe data collected and reach interrelations. For this at first data collected is conceptualized and similar data are gathered andorganized around defined themes. Content analysesrequire analyzing data collected in detail. This enablesbringing themes to light that were not clear at thebeginning and themes at different levels. For this reasonthe researcher has reached to a conclusion that it would be proper to analyze the data collected using the content analyzes method [8]. This research uses content analyze method.

3. Sustainable Architecture

‘Our common future’, the report released in 1987 by the World Commission on Environment and Development (WCED) chaired by Gro Harlem Brundtland, stated that development is only ‘sustainable’ if it ‘meets the needs of the present without compromising the ability of future generations to meet their own needs’ [9]. The concept of sustainable development was launched by the WCED as a ‘global objective’ to guide policies orientated to balance ‘economic and social systems and ecological conditions’. It is often represented with the ‘triple bottom line’ of economy, environment, and society [10, 11].

For classifying a building in the category of sustainable buildings, some principles should be observed as follows:

1. The first principle: energy conservation
2. The second principle: climate coordination
3. The third principle: to reduce use of new resources
4. The fourth principle: to meet residents needs
5. The fifth principle: coordination with site
6. The sixth principle: generalization [12]

Principals of sustainable urban design would placepriority on the conformity and re-use of existing building, infrastructures and roads, together with there-use of recycled building maters and components. Sustainability in any urban development is no damaging to the environment and contributes to the city’s ability to sustain its social and economic structures. According to an accepted definition of sustainable development, the objectives for an agenda of urban design in a regime of sustainable development would emphasize conservation of both the natural and built environments.

Sustainable development places a premium on the conservation of natural resources, wildlife, and habitat protection. It also resume high degrees of self-sufficiency a tall levels of settlement structure. Wherenew development is necessary, the pattern of such developmentanditsstructuresshouldminimizetheuse ofenergyconsumed intravelbetweennecessaryactivities andalsointheoperationofthebuildings.

- Reduction the Environmental Damage
- Reusing and Recycling
- Correct use and utilization of the wind of any climate in the ventilation

4. Features of Study Area

4.1. Climate conditions

Iran is situated in a high-altitude plateau surrounded by connected ranges of mountains .The well-known deserts of Iran are at two major regions: Dasht-e-Kavir, and Kavir-e-Lut. They are both some of the most arid and maybe the hottest areas of their kinds in the world. Kavir-e-Lut is the largest pit inside the Iranian plateau and probably one of the largest ones in the world. Kavir-e-Lut is a pit formed by broken layers of the earth .The maximum annual rainfall is about 100 mm there. The average height of this desert is almost 600 m above sea level (ASL). Dasht-e-Kavir is a geological pit almost at the north of Kavir-e-Lut. The minimum height of this desert is 400 m ASL. The main part of Dasht-e-Kavir is covered by sand and gravel and exposed to strong winds and storms that set salt-combined sand in motion like sea waves. At times, this phenomenon forms long sand hills of 40m high. The difference of temperature between days and nights during a year in Dasht-e-Kavir is between 0 and 70 degree C [13]. Hard and cold winters, warm and dry summers, air humidity, herbal cover, very low rate of rain, so much difference between day and night temperature in salt desert and salt-desert border regions, and the dusty winds are the outstanding climatic qualifications in this region. A large part of Iran suffers from hot and dry climate and the desert's climate has made a bunch of problems for its residents, but Iranians have overcome the harsh climate situation with their creativity and innovations, and have brought comfort for the residents even with the limitations in this area. For example, in a desert area, low humidity and high dry temperature must be considered to reach comfort zone condition. The most affordable way of dealing with such problems is constructing compatibly to the climatic condition to make it possible to reduce the inside-buildings' temperature by expending no money and energy.

4.2. Morphology and Urban texture

Iran's traditional architecture has been generated from the climate and the situation which it has grown on it. So that all the existing spaces of these regions such as urban spaces of passages, yards, and buildings are protected against the atmospheric factors especially unpleasant winds, and pleasant winds and the sun's radiation are used according to some special arrangements.

Spiral and narrow allies with high walls insides can reduce wind speed and provide shady areas in passages. Like allies, buildings have enclosures too. They are surrounded by upland walls which make them isolated from the outside environment. These walls perform as a shell, protecting the building from the intense sun ray and desert dust winds, and in cold seasons, they protect buildings from cold winds. There are few openings on the shells, and in many cases the only opening is the main entrance [14]. In hot-arid region architecture of Iran, the materials with heat capacity and resistance like mud, mud-brick and brick are used which are very effective in cooling and heating of internal spaces. These materials can be recycled thus, are very effective in the sustainability of Iranian architecture.

In very hot climatic conditions, the retardation is reached to infinity by constructing houses inside the hills or basements and by using this measure, the balanced thermal conditions of the depth of the land are used [15]. Thermal balance between body and surrounding temperature is an important human's health and comfort factor. The climate elements include sunlight, air temperature, humidity and airflow and considered as effective factors in desert architecture [16]. Urban texture in this climate has these factors:

1-Urban texture is very concentrative.

2- City spaces are completely surrounded.

3- Narrow irregular and some covered alleys.

4- Buildings are attached together.

5-Buildings have been located for using sunray and wind [14].

Climate design strategies in urban texture have been summarized in below table:

Table 1 Climate design strategies in urban texture

	Characteristics	Features	result
Urban Texture	Dense and very compact	Spaces are completely enclosed, buildings are closely stuck, facing the desired wind and opposing undesired one.	Thermal loss is lowered.
Urban Environment	Enclosed	City structure seems like a battlement fully enclosed from all directions, the inside of the city is wholly different from the outside facing.	Prevent high velocity winds and sand storms, Prevent the invasion of enemies from all side, Inside air is more static than the outside air.
Alleys	Narrow and irregular	Narrow and with many turns, surrounded by tall walls, have roofs, sabot, and ribs, seldom any windows opened to the alley.	Prevent receive sunshine for long hours of day, Make shelters for passersby, Resistant to the earthquakes, Make non boring features and give alleys special beauty.
Buildings' arrangement	Compressed to each other and have merged walls	Minimize the contact of wall surfaces with air, surrounded by high walls and isolated from the street, thick and heavy walls.	Less thermal exchange between inside and outside, Cool environment in summer and warm environment in winter.
Orientation &Configuration	Near to the orientation of north to south	Dividing house into a part in the north and a part in the south to use in different seasons, providing coolness and natural ventilation, making the spaces in the fond of earth.	Absorb the maximum of heating in winter as well as shadow in the summers, Reduce the fossil energy consummation.

[Authors]

4.3. Architectural design strategies

Nowadays, most of the houses are designed and constructed without enough respect to the both environmental and spiritual aspects of human being's life. Residential architecture of these regions is an expressive sample of ecological architecture. Old architecture in hot and dry region is in accordance with region and regional factors such as desired and undesired winds, humidity, sun, and etc. Planning each of the full and empty spaces like court yards with tall and shading walls, enclosed spaces, rooms in different directions, porches, wind-catchers and pond, basements, and roofs is for special hours of day and night of cold-average and hot seasons. As a result, people can change their living spaces in harmony with regional changes. Houses of court yards with indicators like thick walls, porches, underground, wind catcher, vault and dome, are clear examples of architect understanding of the environmental conditions. In fact, all traditional buildings of Iran, both in architectural and constructional fields, are planned in a way to have maximum of sun radiation during winter and maximum of shade during summer to use natural ventilation and to provide peace and comfort for the house residents.

The most important design parameters affecting indoor thermal comfort and energy conservation in building scale are distance between buildings, building form, building envelop, self-efficiency in building materials and optical and thermo-physical properties of the building envelope. All of these parameters are related to each other and the optimum values of each parameter should be determined depending on the values of the others and their optimum combination should be determined according to the climatic characteristic of the region.

4.3.1. Introversion and court yard

One of the Iranian people's beliefs is valuing private life and its sanctity; this fact has made Iran architecture, to some extent, introverted. Introversion is a concept which has existed in Iran architecture as a principle and is observable in various forms. In the warm and dry climate of Iran, this Introversion has shown itself in terms of central courtyard. Central courtyards can be introduced as a sign of sustainable architecture and as a proper pattern for this aim. In this hot and dry region the creation of court yard in the middle of building and preparing pond and flower-bed increase humidity in building environment. The mud brick and brick walls, which are made thick, due to heavy weight of arched and dome vaults, act like thermal condenser anddecrease the variance of temperature during the day and night. Creation of the court yard causes close relation between habitants and natural elements. Net counting the beauty it provides, by shading and increasing relative humidity it helps the comfort condition of yard and is one of the major elements of natural cooling system of the house. Presence of wind and sun radiation provides a convenient condition in different orientations in different seasons. Wind causes natural ventilation in hot seasons. Finally, by making all openings facing to relatively humid spaces of the yard and blocking external walls of building (except the entrance door), the internal and external space connections are cut as far as possible and a suitable microclimate is constructed for human comfort in hot arid region. Almost all of the houses in this hot and dry region have one courtyard or more, and the rooms and other spaces of the house take place around the courtyard and have openings to it. The courtyard is functioning as an element to unite the different space of the house [1].

Fig. 1. Courtyard in house of Kashan

Embedded spaces in the central courtyard building structure are very flexible, and it is compatible with the sustainable architect principles. Most of the traditional buildings have pools and areas for growing plants and trees.

Pools in the traditional houses had various shapes and forms; sometimes they were six-sided and sometimes twelve-sided, but most of the times they were rectangular. Pools were often constructed along one of the main axis of the house, in a way that the length of the pool is located along the length of the house [17]. In the warm climates, pools were often made in 2 sections and were located in the coming and going passages, so that the wind passing above the water of these pools may provide a cool and desired weather for the residents in the warm summer days. The sonic and aquatic properties of the water are other positive and effective aspects of the pools and in fact the existence of water in the pools acts as a hidden barrier and blocking against the sound passing inside and out-side the house [18] [19].

4.3.2. Four season housing

The optimization of energy consumption in residential buildings is the design of 4-season housing, the most obvious form of traditional buildings in consistency with climate which have been made in hot and dry regions. These buildings have particular residential spaces for summer and winter that are the best forms and possible combinations of components in a building for climate modification. Thus, north and sunny side of courtyard which was warmer, was used in winter and was famous as particular residential space for winter. Vice versa, south

side of courtyard and back to the sun was used in summer and known as particular residential space for summer [14]. There were below wind catcher spaces and throne room which had higher elevation and lighter volume than particular residential space for winter. This was because of using wind, air conditioning, better air circulation, and cooling this space in summer. Particular residential space for winter consists of a three-door room, a five-door room [1]. This seasonal movement occurring between spaces in the houses is one of the human responses to the climate condition. Houses in these regions are living places for all 4 seasons of the year. Occupants may move to a more suitable place when season changes in order to advantage a better situation

4.3.3. Wind catcher

Wind catcher is one of the other elements of hot and dry architecture which is used for cooling and ventilation of internal spaces. Traditional architects were obliged to rely on natural energies to render the inside condition of the buildings pleasant. Air trap was the specific feature of architecture in the majority of warm regions.

Air traps were normally in a suitable location in houses according to the size of the building, and the number of air traps that were necessary to cool the summer apartments. In cities, where suitable wind is blowing from a specific direction, the air trap is open at one direction and closed from the other three directions. Wind-catcher is a constant complex which acts both by sucking and pulling. The basis of these actions is that the blowing wind is used to suck the cold air inside the building and the reaction of it is used for sending out the hot and pollutant air from the inside of the buildings. Air trap is like a chimney whose end is in the underground and the top is set over a specific height on the roof. At the upper outlet many small openers or ducts are set. At the end of the air trap, at the bottom of the door, a pool whose water is provided by Qanats (aqueducts) is often set [16].

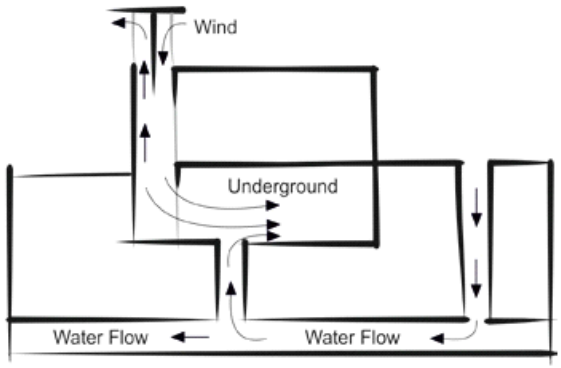

Fig. 2. The function of a wind catcher. Design by Author

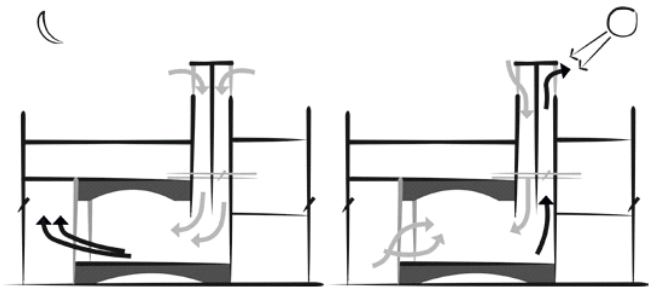

Fig. 3. Wind catcher function during day and night

Once the wind comes in contact with the walls of the internal wings of wind-catcher, it descends and enters the building space inevitably; on the other hand, the holes or vents of wind-catcher on the opposite side of wind suck and blow the hot and pollutant air of building to the wind. In ancient times and in traditional buildings in arid and dry regions, the air trap functioned like the present modern air conditioning system. They cause a balance of temperature at night and bestow the attracted warmth to the cold night air. They are built with their long ventilation shafts positioned to catch any hint of a passing breeze to channel down into the houses.

For traditional architects, the wind is an important factor in the design of a building. They consider the wind's effect on the thermal comfort through convection or ventilation and the penetration of air in interior spaces. This wind tower catches cool winds at a higher level, in all directions, and leads them into the interior spaces.

Wind tower influences on creating natural cooling in 2 ways: air movement and displacement or evaporative cooling in an overall classification. In warm and dry regions, besides warm weather, dryness and low rate of moisture are among those factors that endanger the thermal convenience. Thus, the wind towers in these regions try to optimize the cooling operation by evaporative cooling. The evaporation phenomenon takes place in the wind towers when the water surface is under the wind flow. As the water turn from liquid state to gas state, it attracts a remarkable rate of heat from its around environment and in this way it helps to the environment cooling [20][21].

Fig. 4. Wind catchers

Wind towers in the warm and dry climates can be seen in the Iranian architecture face in vertical element. This architectural element shows the compatibility of architectural design with natural environment.

Design of wind towers depends on the shape of building, speed and direction of wind, height of wind tower, air passing section, and wind tower location. The most important advantage of wind towers is the air conditioning and air cooling without any use of electrical energy [22]. These elements lead a desired wind to the inner spaces of the construction through their vertical pores, and apply the stable energy of the environment by connecting the architecture to its around environment and entering a dynamic and environment-based flow into the construction. Natural ventilation has become an attractive technique and important method for reducing energy consumption and cost. This environmental technique also helps traditional architect to provide acceptable indoor environmental quality and maintain a healthy, comfortable and productive indoor climate without using mechanical ventilation [23]. Wind catchers have been used in different residential, religious, and service buildings and the remains still stand in hot and dry regions of Iran in central and southern cities like Yazd, Esfahan, Kashan, Boushehr, Gheshm Island, and etc.

4.3.4. Roof (dome & arched roofs instead flat roofs)

In hot and dry region to structured reasons, the dome shape roofing of buildings has some thermo-physical reasons. The domes, which were used as covering roof for mosques, water reservoirs and Bazar (shopping center), are another type of roof in hot and dry regions. Due to having convex and unbalanced surface, the impact angle of sunbeam on dome and arched roof is different from one point to another, and a part of it always remains in shade during morning and afternoon times. For this reason, the curved shape is suitable for releasing and emitting sunbeams and waves during night and it helps to the night cooling. If the flat roofs are used in hot and dry regions, it is usually paved with square shape bricks called paved bricks. These bricks receive the most radiations of sun. Early morning, it starts to increase, and late afternoon it decreases gradually. This action causes the change in sun radiation intensity and radiation angle.

Fig. 5. The dome roof

4.3.5. Porch (eyvan)

Porch (Eyvan), semi-open areas, is used to create shaded and cool living spaces during the day. The Eyvan, three side closed passageway in front of the ‘‘rooms’’, permits a common life inside. Usually they are oriented to the south [3]. Especially south and east oriented porches are very cool and shady places for summer afternoons. The porch semi-open colonnade arranged in the courtyard always provides shady areas. Use of additional elements such as porches and sunshades along with vertical or horizontal sunlight controller blades, curtains, and latticed windows with colored glasses are the ways to control the depth and amount of sunlight into the buildings in summers and winters based on resident needs to solar energy. While, the proper angle of solar radiation in winter makes the penetration of sunlight possible into the building in the best way.

Fig. 6. hot-dry regions windows

Fig. 7. Porch & pool in hot-dry regions houses

4.3.6. The indigenous materials consistent with climate

The use of local materials to reduce energy expenditure during the occupation is a wise decision since it will also reduce the initial embodied energy as well as the cost, especially transportation cost [24]. Those materials which are labor intensive rather than energy intensive in their extraction, dressing and erection being more environmentally friendly and equitable in terms of the distribution of resources, are more acceptable for purposes of sustainability. The used materials such as clay and mud in this region require only man's efforts to make a structure from them. Due to very hot temperatures, the building materials absorb heat from the sun and make it available later when the sun goes down. In other words, this energy is retained in the walls about 8 hours and the other parts of the building envelope and is gradually transferred to the inner compartments. In cold seasons, the absorbed temperature serves as an isolation barrier which protects the inside air from being affected by the chilly winter desert climate specially at nights, because during the daytime the temperature is absorbed by the walls and the building and although the air is cold outside, the inside of the house remains warm. Building from earth does least damage the environment; it is close to the building site and so does not involve transport energy costs. Moreover, when no longer required, the building decomposes naturally and without pollution, return to the earth from where it comes before. Nevertheless, it can stimulate the imagination as an analogy for sustainable development.

Fig. 8. Material in desert architecture

Indigenous material selection, compatibility, embodied energy, application of passive energy and design environmental strategies in waste and technology management concerning the impacts in the environment are all concepts that are part of sustainable building design [25].

4.3.7. Aqueducts (qanats)

The most important problem in the desert, as we all know, is water. So, people had to find a way to bring water to the city, without any kind of modern technology or pumping system. A passive system "Qanat" was used there.

A mother-well was dug in a place far from the city where theycouldreachtothewatertablemaybe100meters underground; they dug other wells to direct water toward the city, with minimum possible gradient. There are thousands of water wells connected together by Qanats. Using the slope of the earth, they could bring water close to the surface in the city [26]. At the present time, although the Qanats have been replaced by the modern deep wells, the agricultural lands of many Iranian cities in the central part of Iran such as Yazd, Kerman, Naein, Kashan, Shiraz, and Isfahan still benefit from the Qanats. Many residential

buildings, bazaars, schools and mosques have also been connected to the network of Qanats by gutters, grooves, rivulets and ponds. Also, these urban facilities arethemainwater resourceforirrigationoftheagronomicallandsofthecity and neighboring areas. In addition, some people also used to take advantages of the water of Qanats for their personal use such as drinking, cleaning and irrigating their small gardens.

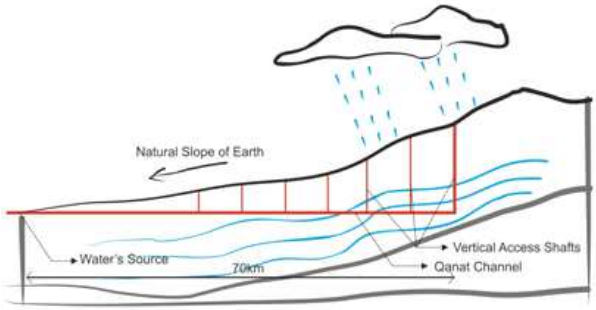

Fig. 9. Qanat's system
Design by Author

Fig. 10. Shafts, Manholes and Tunnel of Qanat

7.8. Water reservoirs

Freezing places and cisterns (water reservoirs) are among other urban elements which are often seen in desert cities. Major parts of structures of the cisterns are: [27]

1. Water reservoirs, all or a part of them are built underground, because it first adds to the resistance of walls, and the soil, as the natural insulation around the reservoirs, prevents the temperature penetration.

2. Reservoirs coating: Major coating of cisterns is dome shape so the heat ascends and the reservoir side is kept cool. On the other hand, in most hours of day, one side of the dome is in the shadow.

3. Ventilation and wind catcher: they discharge the hot water below cisterns dome and establish air flow to keep the water healthy and cool.

4. Staircase and water foots.

5. Decorative threshold.

As summarize below table shows traditional sustainable strategies, their results and also their classification upon three sustainable dimensions:

Fig. 11. six wind catcher Abanbar in Yazd

Fig. 12. Yakhchal (ice maker)

Fig. 13. Abanbar

Table 2 Traditional sustainable strategies and three sustainable dimensions

Strategy	Result	social	Environmental	financial
Court yard	Increase humidityand shadow		■	
	Increase close relation between habitants and natural elements	■		■
	Unite the different space of the house	■		
	Make pleasure views with pools, plants and trees		■	
	Make a silent private space for habitants	■		
	Four season housing for habitants	■		

Wind catcher	Natural cooling and ventilation of internal spaces	
	Balance of temperature at night and day	
	Make different impact angle of sunbeam on dome and arched roof	
Dome & arched roofs	Remain some parts of roof always in shade	
	Releasing and emitting sunbeams and waves during night	
Porch	Make a local identity	
	Make cool and shady places for summer afternoons	
Indigenous materials	Reduce the initial embodied energy	
	Reduce the cost (especially transportation cost)	
	Make an environment-friendly character	
	Make decomposing buildings naturally and without pollution	
Aqueducts (Qanats)	Make a local identity for each city	
	Bring water to the cityclosetoits surface	
Water reservoirs	Reserve water and make a freezing place	

[Authors]

5. Conclusion: Past, Present and Conclusions for a Better Future

Today, the urban population increased industrialization and construction process in order to meet the housing needs cause more disharmony between the built and the environment and the principles of sustainability in their traditional architecture is very far.The fact is that the most of modernists forgot by making the no time and no locality spaces.

By examining and comparing main components of sustainability with the architecture of traditional houses, it was clarified that the architecture of these houses are in full compliance with the principles of sustainable architecture. Lack of attention to sustainability foundations of traditional Iranian architecture and the factors affecting on it; have shown an unstable condition in existing architectural structure. Forgotten solutions in design of sustainable residential space should be identified and updated regarding to available technology and used in design of buildings. Sustainable strategies which gained from simultaneous intelligent design of climate and architecture are valuable from aspect of sustainability. In fact, the ecology of building emphasizes on its ability to combine with climatic factors and transform it into spatial qualities and comfort form. Using these strategies and solutions in architecture not only is a major step toward sustainable development but also will largely restore and strengthen the lost architectural and urban native structures.

Table 3 Past, Present and Conclusions for a better future

Past	Present
• There is a direct relationship between building and site. (environment) • Buildings energy use based on the nature. Such good use of the wind in the air conditioning that reducing the environmental damage caused by burning fossil fuels. • Climatic parameters in terms of building, so that makes harmony whit the environment and thus reduces the energy consumption. • The use of local and recycled materials in the building. • The flexibility and reuse of buildings.	• Building regardless of the site and its surroundings and thus create disharmony between the site and the building and often create a deal between them. • The indiscriminate use of fossil fuels and renewable and thereby causing irreparable environmental damage. • Construction, regardless of regional climate and thus create major problems in air conditioning and heating and cooling systems in buildings which is indiscriminate use of energy. • Materials use inconsistent whit the interests of regional climate. (Such as the construction of stone buildings in hot and dry areas.) • Being inflexible buildings and therefore can't reuse them. Buildings are destroyed after a time and replace it with a new building is constructed with a new user.

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