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Insight into the valuable elements of Sistan local architecture in relation to climatic factors of sustainable architecture

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Abstract

In this study, part of the native Iranian architecture of the Sistan region in terms of climate issues, techniques used in the construction of buildings and difficult environmental (climatic) issues are studied. Today, in sustainable architecture, the greatest attention is paid to climatic, environmental and green architecture issues alongside matters related to traditional and old architecture on a local and global level. Advanced technologies in construction and use of new materials in architecture has, on the one hand, created the suitable conditions for realizing exotic ideas and projects for architects and designers. These challenges and the need for paying attention to valuable elements of local traditional architecture indicate the necessity of undertaking research on climatic conditions and sustainable architecture. This research deals with parts of traditional Iranian architecture in the Sistan region in terms of climate, the techniques used in construction and difficult environmental conditions (climate) based on modern theories of sustainable architecture.

The research question deals with the factors, climatic conditions and characteristics of architectural structures of Sistan region (indigenous and ancient) which can be utilized in modern Iranian architecture and be of use in contemporary design issues of climate architecture. The research methodology was based on two parts: a descriptive approach and field studies in part one and a comparison of the theoretical and climatic components of sustainable architecture with the structural elements of local Sistan architecture forms part two.

In traditional Iranian architecture, discussions always focus on valuable strategies and methods of providing adequate living conditions in buildings. Different and variable climatic and geographic conditions throughout this land have forced architects with their innovative principles to provide the best and most appropriate ways of buildings adapting to climatic conditions.

Since past-times, the use of natural and inexhaustible forces such as the sun and wind has commonly been used in Iran to improve the bio-thermal conditions of living spaces. These forces results in buildings saving fuel consumption and more importantly enhancing the quality, comfort and hygiene of residential environments.

The research results indicate that centuries-old use of Kharkhona, Dorche, Kolak, Surak were suitable climatic solutions that are defined as a component of indigenous architectural principles in this region to combat the harsh climate and facilitate good living conditions. With little change in the structure of contemporary architecture, these solutions can be used to achieve sustainable architecture.

Keywords

Sustainable architecture, Traditional architecture of Sistan, Kharkhona, Koulak, Sourak.

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Introduction

In Iranian local architecture, valuable methods and strategies have always been proposed to provide proper living conditions in buildings. Variety of different climatic and geographical conditions across the country have driven architects to employ innovative principles in order to provide the best and most appropriate ways of adapting to climate and proper use of climatic conditions. Today, these principles and patterns by proper integration with new technologies can be fitted into contemporary architectural structures and with its own identity provide new and stable architecture. Examining the valuable works of local Iranian architects in this vast territory and on different scales signifies a comprehensive and objective way of thinking in the use of climatic conditions in different buildings. This way of thinking identifies the appropriate use and blend of contemporary architectural principles and results in improving these architectural styles.

Architectural design as a solution that aims to create a safe shelter against natural hazards has attracted people's attention since the beginning of history. Over time, Iranian people, especially those living in hot and dry climates have devised suitable methods to deal with unbearable heat (Mahmoudi, 2008: 97). Private and public spaces, on micro and macro scales, with various uses such as mosques, bazaars, schools, caravanserais and the most widespread use of space, residential architecture, in different parts of Iran have provided the best comforts for users.

The use of natural and inexhaustible forces such as the sun and wind, has long been used in Iran to improve the bio-thermal conditions of living spaces. These forces results in buildings saving fuel consumption and more importantly enhancing the quality, comfort and hygiene of residential environments. (Mirlotfi, et al, 2012:39).

Currently, most types of new technologies related to buildings and the architecture industry are considered the main pollutants of the environment causing a lot of damage to people's health. Thus, exclusive emphasis on the use of new technology without considering old architectural patterns does not lead to good architectural structures in all fields.. Therefore, there is a need for an appropriate relationship between former architectural patterns and today's architectural needs along with new architectural structures. Based on this need, this article attempts to investigate the important climatic principles and guidelines governing South Eastern Iranian architecture, and extract the best results for use in Iranian architecture today.

Methodology

The method in this article consists of two sections based on descriptive methods and field studies along with a comparative approach. In the first section, library-based studies and documentation review are the main sources for expressing, analyzing, describing, and interpreting the materials in this article. This type of research allows researchers to interact with the research question. The second section contains a comparative analysis of the library-based findings in the first part with field studies and analyzes the circumstances leading to the results in this study.

Research Hypothesis

According to preliminary studies and an examination of library-based documents as well asattention to different views of Sistan architectural structures, this study's hypothesis is based on the grounds that the use of local agents in the area's architectural structures such as Kharkhaneh, Dorc h e, Koulak, Sourak are suitable climatic soluti o ns that have over the years been defined as a part o f the local architecture of this region to confront its harsh climate, provide comfort, and facilitate living conditions. These factors with slight cha n ges can be used in the structure of contempora r y architecture in order to achieve sustainable architecture. By identifying and properly exploring the p atterns and principles of past architecture from a climatic perspective and its proper combination with contemporary architecture, sustainable architecture and architecture with its own

identity can be achieved.

Theoretical Foundations

An analysis of local architecture reveals that concepts such as identity, tradition, and structure are among the most significant issues raised in local architecture which are taken advantage of in contemporary architecture (Shahbazi &Torabi, 2014:35This paper, with an emphasis on valuable local architectural identity, has tried to extract elements in architectural technology which can be used in contemporary architecture. In other words, continuing the tradition both in the concept and the structure are the main components which form the theoretical basis of this research. This study considers the technical components forming the local architectural structure and the use of contemporary architecture in Iran (in Sistan region) along with a climatic approach to sustainable architecture. The main principles of this approach is discussed and studied in the following section.

The Concept of Sustainability in Architecture

The application of the concepts of sustainability and sustainable development goals to reduce energy wastage and environmental pollution in architecture has created a topic called "sustainable architecture". In this type of architecture, the building adapts not only to its local climatic conditions, but also establishes a reciprocal relationship with it. Thus, according to Richard Rodgers, "buildings are like the birds that in winter puff their feathers and adapt themselves to the environment's new conditions, and accordingly adjust their fuel and compromise."

Sustainable architecture has broad definitions and the significant issues in the field of sustainable design are wide-ranging. These issues involve matters related to human life, the environment, and even socio-cultural issues. Therefore, providing a definition which has sufficient flexibility and comprehensiveness becomes necessary. A brief definition that is worthy for this study could be that sustainable architecture is architecture where designer leads the architecture user toward the use of few non-renewable land resources and the design is compatible with the climate with minimum damage to the environment and land.

Design consistent with the environment in its physical-spatial aspect has no choice but to comply with the framework and conditions of sustainable development. As rural planning has to comply with the requirements of environment for the sustainable development of a village, correspondingly, the rural design has to comply with the ecosystem's principles and conditions (Habibi, et al, 2010: 7).

Amongst the most important factors affecting the formation of municipal bodies, weather conditions can be mentioned. These factors, along with other environmental factors, impact human possessions and distinguish the different texture of cities. Thus, paying attention to climatic conditions, besides other environmental factors both increases the durability of human construction and makes the potential environmental abilities tangible (Akhtarkavan, 2012:7).

The Concept of Local Architecture

Although local architecture has been subject to changing trends throughout history, it has well been able to maintain its special identity. In dealing with collections and units of architecture, natural and cultural environment influences manifest in a way that can be a good example for sustainability in their own time and place. In fact, sustainable architecture is field-depended architecture (Armaghan & Gorji Mahlabani, 2009:21).

Sustainable architecture approach is created in response to sustainable human survival and human environment that is dependent on the biological world's balance maintenance. Sustainable environment is environmental from ecological view in which original biological systems of environment are involved, and it has continuation (Asadi, 2007: 59). It is worth mentioning that the development and improvement of areas in each system has unique structural, physical, cultural, and social features, and

it is only through discovering the mechanism of these structures that a way to build sustainable environment can be found. An erroneous perspective often mentioned is that traditional design is considered as a local design, while local design is not a pictorial repetition of what has been in the past, but it may be possible to follow the processes of traditional architecture. Therefore, understanding the strategies of traditional and former architecture could be the first step towards the realization of architectural concepts and demands in contemporary regional and local architecture.

Review of Literature

Based on the main structure of this research, two topics of sustainable architecture and local architecture of Sistan are studied. In sustainability discussions, architecture has a significant position. Because of a lack of attention to climatic and design issues such as the design of building form, orientation, coverage, and appropriate materials cause energy waste and increase energy expenditure, and consequently cause harm to the environment and non-renewable natural resources (Al-Sallal, et al, 2013:1). On the other hand, some research has been conducted on the local architecture of Sistan region which has mainly examined structural elements of this architecture. In the last decade, with a global and national emphasis on sustainable architecture, some research have been carried out on the functional elements of Sistan's traditional architecture based on climatic indicators. The findings of these researches represent the need to put greater emphasis on this issue.

Given the importance of the elements used in this section of Iranian architecture, such as a comparative analysis of of the establishment of rural housing geographical directions and energy consumption in Sistan (Mirlotfi et al, 2012:2), considering Asbad (windmills) as the oldest wind mills in the world (Mahdavinezhad et al, 2011:3) Baloch local housing (Janeb-Allahi, 1996:4) and the use of wind energy in air conditioning of windy rural houses (Mirshekari, 2000:5) represents a part of previous researches in this area.

Compared with researches carried out in various parts of the architecture of the central regions of Iran, there was less research in Sistan architecture with an emphasis on climatic indicators in sustainable architecture, and in this article due to the importance of the fundamental components of the climate, the above factors are studied and investigated.

The scope of research: Sistan plain

According to the climatic statistics, one of the hot and dry provinces of Iran is Sistan and Baluchistan. This province comprises two quite distinct regions of Sistan and Baluchistan, which are different from historical, situational, social, and cultural aspects (Afshar Sistani, 2004:6). At first, Sistan was in the form of lands with hills of fluid sands and marine sediments that a part of it was located on the river path; reduction in river water led to the expansion of the surrounding lands and therefore a large village was formed (Malekzadeh, 2001:7).

Politically, Sistan is divided between Afghanistan, Pakistan, and Iran. The part of Sistan which is larger and has water is located in the territory of Afghanistan. A small part of Sistan is situated in Pakistan territory and also a section is located in contemporary Iran with an area of 36,000 Km2 (Ibid, 2001:7).

At the Achaemenid time, Sistan was a region and based on Zoroastr i anism book Sistan was the eleventh country created by Ahura Mazda. The term Zaranj is the oldest name for Sistan and Zavelestan which is mentioned in the inscription of Darius with the same name. Sistan has been called by different names such as Sak e stan, Sajestan, and Sivestan. From east and south-eastern, Sistan is limited to Baba and Solomon mountain range in central Afghanistan, from north to Khorasan, from south to Baluchistan and King Black Mountains, and from the West to Loot Desert, and in general it is very similar to South Khorasan geographically and climatically.

The Climate of Sistan

• Sistan Winds

In Sistan, wind blows in all seasons; the 120-day winds of Sistan are resulted from Western high pressure masses which blow from the North West to the South East in summer. The maximum speed of these winds is 100 kilometers per hour in July which moves quicksand on its path and illustrate dunes, sandstorms, and sand barchans.

The most important local winds of Sistan region are :

- The Qousse wind which blows in December, causing a brief rainfall in the region.
-The seventh wind (black or Gav-kosh) which is among the cold winter winds and blows from the north.
- The Pelpelasy wind (Swallow) which starts from mid-March and its blowing marks the beginning of spring.
- The Qebleh Wind (West) which blows at different seasons from the West and Hamun Lake.
- The 120-day wind (Levar) (Master plan of Zabol, 2005).

According to Table 1, the following points are concluded:

- This region has desert and semi-desert climatic conditions
- This city is among the arid areas of the country.

The number of drought months with no rainfall is 7 months.

- Most of the rainfall is in winter and it is less than 30 mm.
- This city has 3 cold months, 6 warm months, and 3 moderate months (Ghafuri, 2011:13).

The distribution of pressure and the topographic features of the region is in a way that creates the 120-day winds of Sistan. These winds are considered as the followers of monsoon wind in India and after passing through low-lying areas in Afghanistan, it enters the East of Iran, and by turning on the Iranian plateau from the North West to the South East it enters Sistan plain. The period of 120-day winds has been cited from 15 June to 15 October (Saligheh, 2003:110). According to Fig. 1. these winds pass through the low-lying areas between the rough areas in the East of Iran with increasing speed. Their speed increasing, raise the climatic effects that creates two different climates depending on Hamun Lake in Zabul. In years full of water when the Hamun Lake has water at the pathway of 120-day winds appropriate air along with relative humidity are brought. In the years that Hamun is dry, the wind stream digs the bottom of the lake and carries dust and sand particles and contaminates the environment (Ibid:112);(Fig. 1).

Table 1. Statistics of Zabol weather station. Sistan and Baluchestan geography, 2011.

City	Zabol
Climate	Hot and dry
The annual temperature average in Celsius (C)	22/1
The annual rainfall average in Millimeters	61
The annual relative humidity average in percent	38
The annual number of frost days average	25

The people of Sistan consider wind as the mercy of God and believe that without this wind the life in Sistan is impossible, and on this basis for years they have different innovations for living in the wilderness areas and indigenous knowledge during different periods has achieved some appropriate options such as follows:

a) Windmills: invention of the first Asbad (windmill) in the world was reported to be from Sistan in which wind power was used for grinding wheat (Mahdavinezhadet al., 2011:45)

b) Using wind for sand removal

c) Using wind for drawing water from wells to irrigating agricultural lands.

d) Kharkhaneh: to escape from the severity of summer heat and the dust created by 120-day winds

e) Air trap: to cool the house and to escape from the summer heat and ventilation.

The Review of Sistan Architecture

Architecture in Sistan is based on the climatic conditions of the area, so that most of its homes are made of local materials including water, mud, and

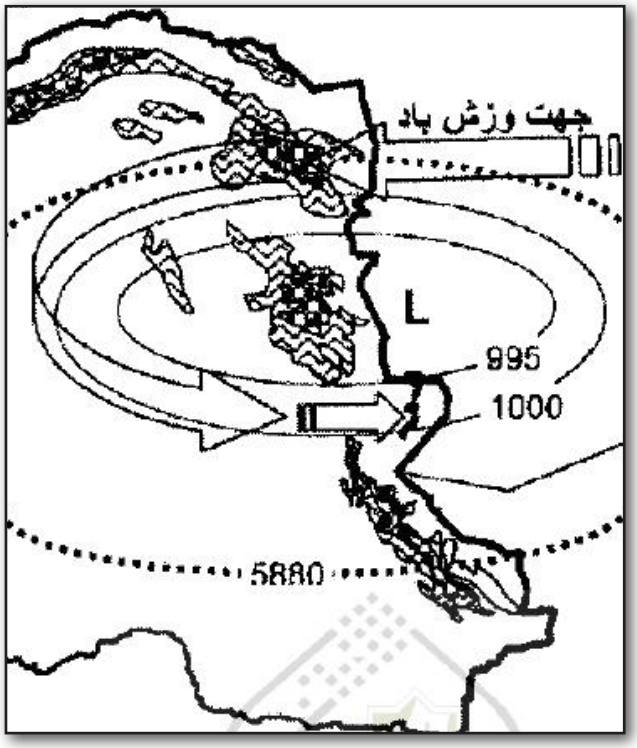

Fig. 1. The direction of Sistan's 120-day winds.
Source: Saligheh, 2003:113.

brick to keep the cold and heat in itself. Here, as in other hot and dry areas of the country, the housing texture is compressed and dense. The ceilings of buildings in these districts are in the form of rocking roofs (Yazdi cover) and dome roofs (Sistani). In this region, the passages orientation is done according to the wind direction in order to use the wind power to carry sand and particles. In this case, in the narrow passages with high surrounding buildings the wind intensity increases which can be annoying. In addition, the placement of passages perpendicular to the wind direction causes the accumulation of sand on the road and behind the wall. Such cases are rarely observed in local architecture. In these regions, generally the buildings have short height and building height restrictions on both sides of the passage have prevented the creation of a wind tunnel in the passages aligned with the wind.

In Fig. 2. the New Castle Village texture is shown as a sample. Most of the passages are in the direction of the prevailing wind and are moved from the northwest to southeast. Weak deviation from the wind direction

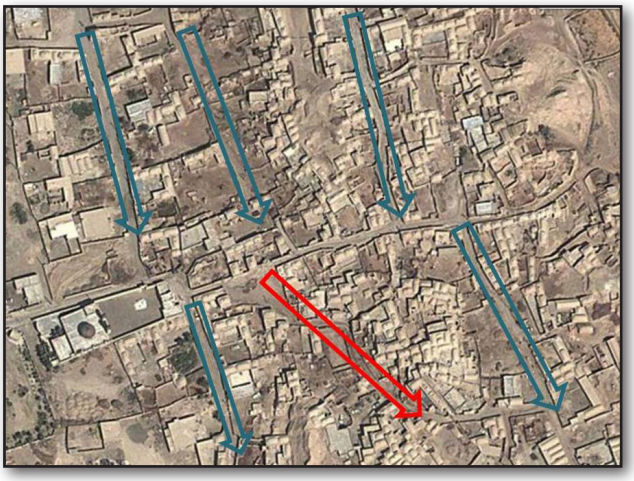

Fig. 2. New Castle Village passage network. Source: Google Earth.

has a positive effect on reduction of wind canalization. To create a secondary passage instead of creating a passage perpendicular to the wind direction, the continuous direction changes have been used, and the passages perpendicular to the wind are short and narrow to avoid creating the turbulence effect of air and soil obstruction in passage (Saligheh, 2003: 118). In the main route which usually leads to the mosque, creating spatial openness in large numbers along the way and interfering with the passages along with the wind will prevent the soil obstruction in passage.

In these areas, for reducing heat and ventilation in houses, structures such as "Koulak1", "Sourak2", "Dorche3", and "Kharkhaneh4" are used.

- **Sourak**

In the walls of Sistani houses, a window similar to the English letter S is located which is called Sourak. Souraks are combined in different ways on the buildings facade, and to some extent they are considered as simple decorations in the simple and flat adobe walls, Fig. 3.

The walls encompassing a Sourak have different functions. When Sourak is located in the wall facing the north wind, it is for air entry and if it is in other walls, it will be for air exit. Sourak structure is in a way that it limits having view into the space, prevents the arrival of the animals, and by reducing wind speed at its gorgeforces the dust in the air to settle. Sometimes, at the bottom of Sourak depressions are created so as to gather dust there.

- **Dorche**

Sometimes, on the northern part of domed ceilings, which is always in the shadow, some holes are embedded that are known as Dorche (valve). These Dorches are also visible in the wall behind the houses (facing the wind and the ever shadow part). The function of Dorche is moving the accumulated hot air under the ceiling and cooling the indoor air. Fig. 1-4 and 2-4 and 3-4.

- **Koulak**

On the roof of the houses some valves called "Koulak" or windward are embedded which are in the direction of the north and facing the northern and north-western winds.

As the wind is permanent and relatively tough in the Sistan region, there is no need to make tall windward like those in Yazd, and Koulak carries the wind into the indoor space in a simple way and causes temperature reduction and building ventilation. The hot indoor air is withdrawn through Sourak or the embedded holes in the top of the entrance.

Koulak is always made in the direction of the north wind, and at the time of construction it is noticed that the Koulaks of two neighboring buildings are not aligned so as to not block the wind movement to the next Koulak. On days when the weather is associated with dust, a lace is put in front of the Koulak's mouth and some wet thorn is put behind it. Fig. 5.

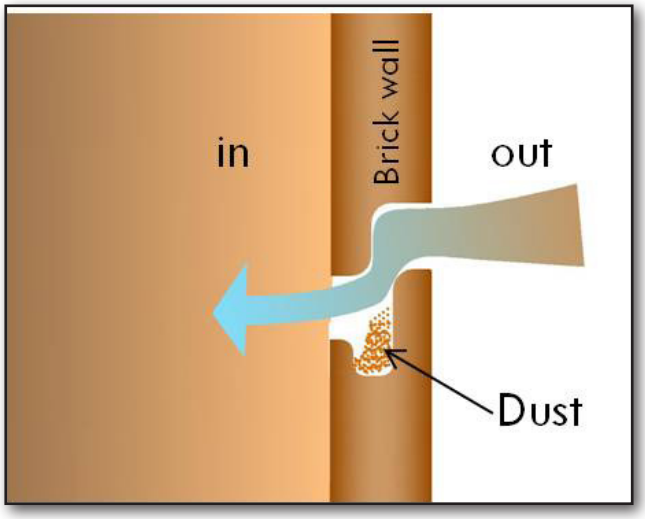

Fig. 3. Sourak performance with depressions. Source: authors.

Fig. 4-1. The Ceiling Dorche. Source: http://www.cloob.com/sistan

Fig. 4-2. The Ceiling Dorche. Source: Bazr-Afkan, 2013.

Fig. 4-3. The Ceiling Dorche. Source: Bazr-Afkan, 2013.

• **Kharkhaneh**

In Sistan in order to be able to turn the warm temperate into the moist air, houses called Kharkhaneh or in the local language "Kharkhona" are used. Beyhaghi history book refers to Kharkhaneh which the son of Sultan Mahmoud of Ghazni had in his villa. As Beyhaghi said "the secretary accumulated thorns and gradually flowed water on them, and the air flow caused cool air to enter into the building." Sistan'sKharkhaneh, which is built for summer residence, is called "Khishkhaneh" in Borhan-e Qate and it is known to be specific of Sistan.

Of course Kharkhaneh does not just belong to Sistan but it is for all desert districts and only the names are different. For instance, in Afghanistan like Sistan it is called Kharkhaneh, in Baluchistan Ahtekan5, in Kerman Yax Dekan6, and in Bandar Abbas Adorband7.

Thorn bushes are put behind the north facing valves that are embedded on the back of houses in Sistan, and occasionally water is sprayed on them. When hot air passes through these thorns, the absorbing moisture turns into humid and cool air. This is called Kharkhaneh. Fig. 6.

Another example of Kharkhaneh that was prevalent in Sistan has a simpler design, and had been used in every location (including the shed, the adobe and mud houses and temporary residences, etc.). This kind of Kharkhaneh has been used mostly by agricultural land guardians; they put several pieces of wood to lean on and stabilized the thorns behind the sheds' windows, and sprayed water on thorns every 10 to 20 minutes for ventilating the air (Fig. 7). The important thing is that the thorns do not need to be replaced because of the lack of sun and not dry up to 20 days to 1 month and after that they should be changed, and the other thing is that the lack of breeze, increases the air humidity in the room (in Sistani dialect the air becomes Tafo8) and makes the living conditions more difficult.

In another example, in a Kharkhaneh, a room is built with walls made of compressed thorns where some containers are installed on its roof . The containers are filled with water, water pours down through pipes from the thorny walls which prevents dust from local hot winds passing through .it. The heat is reduced significantly and relative cool air blows into the Kharkhaneh, and as a result a significant temperature difference between the inside and outside of Kharkhaneh is created.

"YaxDekan" is the same as Kharkhaneh and it functions exactly like a cooler; the only difference is that you should sit in it not beside it. It is made of two parallel walls which are three meters in height and three meter of space, one roof, and one hatchway covered with alhagi (camel thorn), trunk and palm branches. In summer water is poured on thorns, when the air passes through the wet thorns, it cools YaxDekan's inner space. Fig.8.

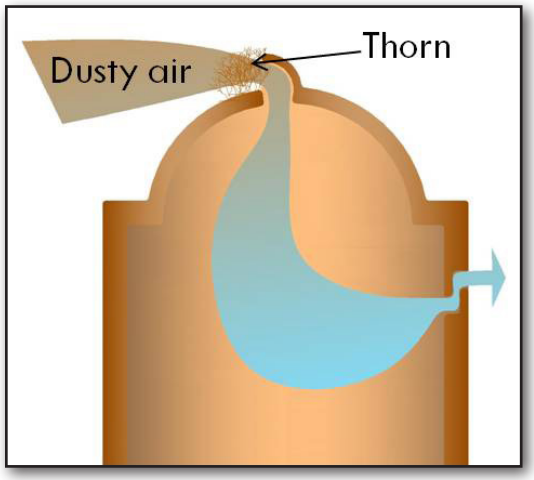

Fig. 5. Koulak function in dusty atmosphere. Source: authors.

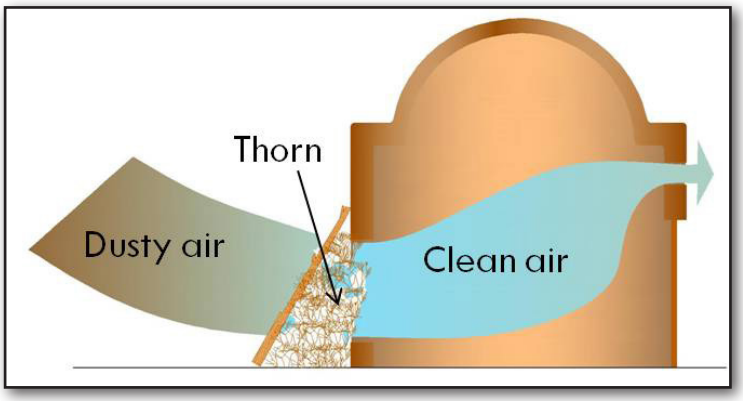

Fig. 6. Kharkhaneh. Source: Authors.

Fig. 7. Kharkhaneh. Source: Bazr-Afkan, 2013.

- **Ahtekan**

A research on analyzing Balouch domicile, introduced Ahtekan as one of the house attachments which its skeleton is something like shed that is surrounded by a pit filled with water and water is being splashed on camel thorns from the pit. Fig. 9. In some points the columns are vertical and horizontal and have cavity walls. First of all it is tied with 5 or 6 "Tioor" which is made of two or three tied branches, and then they put woods which are called "Tekye" horizontally on them so it is resistant to strong winds and then they will put thorns between "Tekye", they will consider at least 2 to 3 Tekye for the thorns in order not to scatter with wind, they will tie these Tekyes with Tioor and so Ehtaken's wall has a slope (Janeb-Allahi, 1996:107).

Kharkhaneh construction in Afghanistan is like a passageway on the north side of the house in which they put camel thorns inside it and by spraying water on it every 20 to 30 minutes, they try to temper the weather (Fig. 10).

In some places it is difficult to obtain camel thorn or there is not vast coverage; this especially occurs, in

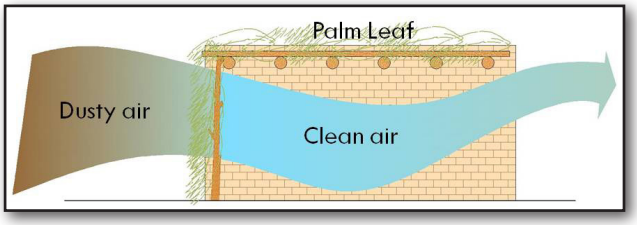

Fig. 8. YaxDekan. Source: authors.

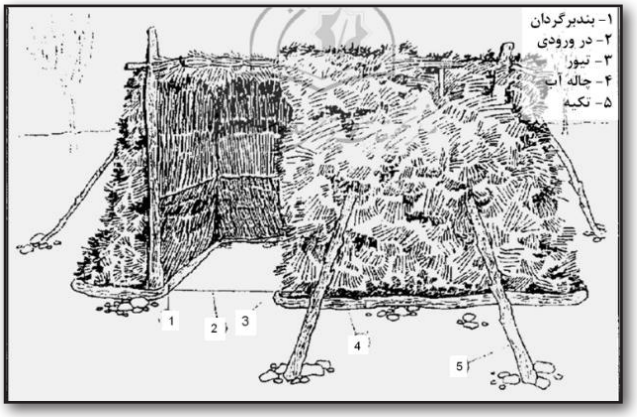

Fig. 9. Ahtekan or Adorband. Source: Janeb-Allahi, 1996:107.

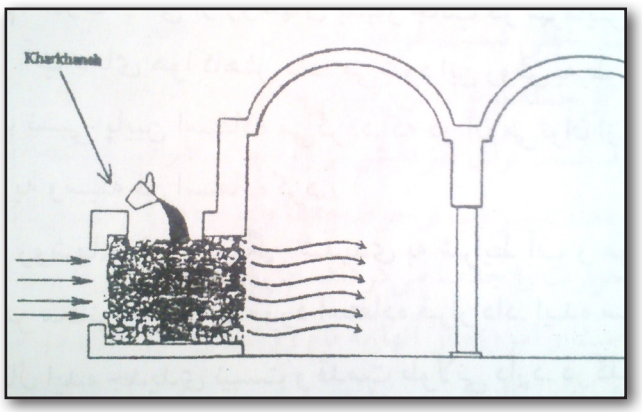

Fig. 10. Kharkhaneh in Afghanistan. Source: Mirshekari, 2000.

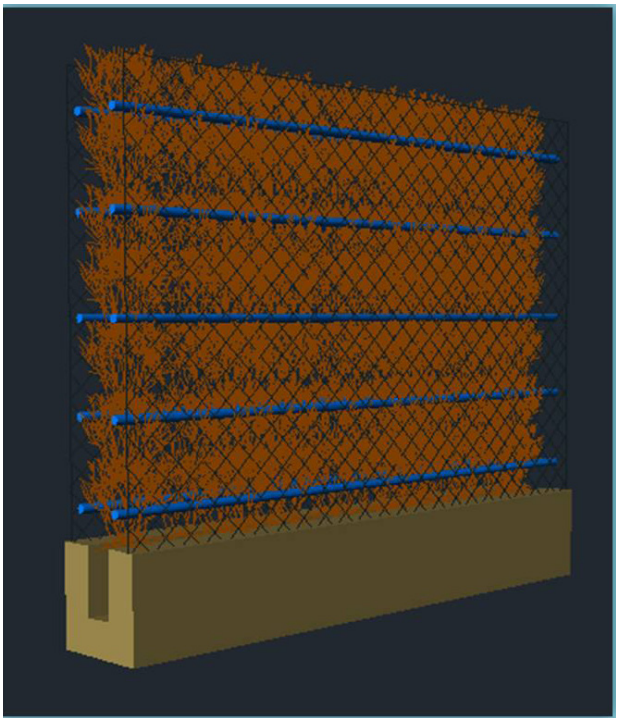

Fig. 11. The new Kharkhaneh of Baghiyatollah Complex. Source: authors.

parts of Iran where people use other plants like palm leaves which are more abundant than camel thorns.
Currently the electrification of different urban and rustic areas causes decrease in using this method and it is limited to agricultural lands and gardens. Recently in Zabol's "Baghiyatollah" Complex located in ChahNimeh, some Kharkhaneh with simple changes in older models were built. Fig. 11. In these Kharkhanehs two checked networks are connected together with metal wires and are filled with thorns. Some cellular pipes are passed through the thorns which temper the thorns consistently. There is a canal at the bottom of the wall to collect extra water. This Kharkhanehis used as an assembly or a place for pray.

Discussion

Due to the finite nature of non-renewable resources, it is necessary to pay much more serious attention than that paid in the past to the scientific use of natural renewable energy and look for new projects, especially in the construction industry. The more the amount of energy consumption in buildings is reduced, the more movement towards sustainability is made, and while meeting the needs of today's generation, the needs of future generations can also be considered (Sayadi & Madahi, 2012: 97).
The main question covered by this research is formed based on the hypothesis that the use of local architectural structural features such as Kharkhaneh, Dorche, Koulak, Sourak, are useful and the methods employed in building them are consistent with the climate which has over the years defined local architecture of the region in order to combat its harsh climate and to provide comfort and good living conditions.
Research results represent that in Sistan district, people could overcome the environmental problems and continental inconsistencies using cheap local materials with free and clean power. Along with domestication and using less fossil energy, these domestic technologies should be known and with transforming them to newer technologies -while having peace and suitable circumstances- cause the slightest harm to the environment. In other words, creating a stable architecture based on local and older architecture patterns.

Conclusion

Based on the understanding of the ancient architecture of this region and considering the structure of these elements, and based on the hypothesis made at the beginning of the article, in the structure of contemporary architecture and the issue of climatic architecture, the results can be classified as follows:
1. Sistan architecture is derived from the climatic conditions of the area in a way that most of the houses are built with local materials including water, mud, and clay which retain heat and cold in themselves. In contemporary architecture and according to the National Building Regulations, standards issues of Engineering Construction and Housing Foundation, a combination of these materials along with new materials can be used. It should be noted that the localization of materials is among the most significant issues considered at the National Building Regulations State that a lot of emphasis has been put on it.
2. Here, as in other hot and dry areas of the country, residential texture is compressed and dense. This case will be used as a pattern in passages networking in the form of detailed plans, in districts division, and in residential texture in the construction of new towns and cities. Constructing new towns is in the development program of most major cities, and in the main cities of Sistan, the consistent pattern with the old texture can be used as a valuable strategy in contemporary urbanization.
3. The ceilings of buildings in these districts are in the form of rocking roofs (Yazdi cover) and dome roofs (Sistani). Today, this model can also be used in new architectural designs. This kind of design, in addition

to considering climatic issues, is also noticeable in terms of aesthetics and building facade geometry. In this section, paying attention to the authentic identity of the local architecture and extending the past patterns in the contemporary era is a significant strategy in identification and in today's architectural identity. In other words, using this kind of ceilings besides climatic and structural issues has an identification function as well.

4.In this region, the passages orientation is done according to the wind direction in order to use the wind power to carry sand and particles. In this case, in the narrow passages with high surrounding buildings the wind intensity increases which can be annoying. In addition, the placement of passages perpendicular to the wind direction causes the accumulation of sand on the road and behind the wall. Such problems are rarely observed in local architecture. Therefore, in the details of the establishment of housing units and other municipal functions, this type of buildings orientation can be noted.

5.In these regions, generally the buildings have short height and building height restrictions on both sides of the passage have prevented the creation of a wind tunnel in the passages aligned with the wind. Height restriction factor as one of the main factors in municipal regulations and building engineering system will be used for designing new buildings.

6. On the roof of the old houses some valves called "Koulak" or windward are embedded which arein the direction of the north and facing the northern and north-western winds. With slight changes according to the number of floors in modern buildings, Koulak can be used in a modern way. Even by preformation and mass production of this valuable element of local architecture with modern materials, an appropriate integration of local architecture and contemporary architecture can be created.

7. On the northern part of domed ceilings, which is always in the shadow, some holes are embedded that are known as Dorche (valve). These Dorches are also visible in the wall behind the houses (facing the wind and the ever shadow part). The function of Dorche is moving the accumulated hot air under the ceiling and cooling the indoor air. Using Dorche nowadays is not only functional in residential buildings but also it can be used in other functions such as commercial and administrative ones.

8. In Sistan, in order to be able to turn the warm temperate into moist air, houses called Kharkhaneh or in the local language "Kharkhona" are used. A room is built with walls made of compressed thorns with containers on the roof filled with water. The water pours down through pipes from the thorny walls which prevents dust from local hot winds passing through .it. The heat is reduced significantly and relative cool air blows into the Kharkhaneh, and as a result a significant temperature difference between the inside and outside of Kharkhaneh is created.

Endnotes

1. Koulak
2. Sourak
3. Dorche
4. Kharkhona
5. Ahtekan
6. Yaxdekan
7. Adorband
8. Tafo

Reference list

- Akhtar, K. M. (2012).*Tanzimsharayethamsazba bum vaeghlim Iran* [Setting conditions consistent with the ecological and climatic conditions of Iran].Tehran: Kalhor Publication.
- Armaghan, M. & Gorji-Mahlabani, Y. (2009). Arzeshhaye me'mari bumi Irani dar rabete ba ruikard me'maripaidar

(Iranian local architecture values in relation to sustainable architectural approach).*Journal of Housing and Rural Environment*, (126): 20-35.
• Asadi, A. (2007). *Dar jost-va-juyeme'maripaidarIrani* [In search of sustainable architecture in Iran]. Unpublished Master's Thesis. Islamic Azad University of Mashhad: Faculty of Arts and Architecture.
• Afshar-Sistani, I. (2004). *Negahi be sistan-va-baluchistan* [Taking a look at Sistan and Baluchistan]. Tehran: Mahtab Publication.
• Bazr-Afkan, N. (2014). *Me'mari bumi va eqlimi sistan* [Local and climatic architecture of Sistan]. Architecture consistent with climate, Sanandaj: University of Kurdistan.
• Janeb Allahi, M. S. (1996). Masaken bumi baluch [Baluch's local residence]. *Journal of Geographical Research*, (43): 92-118.
• Habibi, M., et al. (2010). Tarahirustaei, Mosharekatvatose'yepaidar [Rural designing. Participation and Sustainable Development]. *Housing and Rural Environment,* (132): 3-16.
• *Daftarche tarh jame' Zabol* [Zabol Master Plan Booklet]. (2005). Zabol master plan. Tash Company, Zabol.
• Saligheh, M. (2003).Tavajoh be bad dar sakht kalbod phiziki shahr zabol [Considering the wind in the construction of the physical body of Zabol city]. *Journal of Geography and Development,* (2): 109-122.
• Shahbazi, M., & Torabi, Z. (2014). Moqayese bazta'rif va baz be kar giri sonat darme'mari mo'aser Iran vaorupa [Comparing the redefinition and re-use of tradition in contemporary architecture in Iran and Europe]. *Journal of Town's Identity*, (19): 35-48.
• Sayadi, S. E., & Madahi, S. M. (2012). *Me'mari Paydar* [Sustainable Architecture]. Tehran: Lutus Publication.
• Ghafouri, M. H. (2011). *Majmu'e farhangi touristi kuh- e Khajeh* [Khajeh Mountain'scultural tourism complex]. UnpublishedMaster's Thesis. Zabol University: Faculty of Arts and Architecture.
• Mahmoudi, M. (2008). Fanavari badger dar Iran [Windward technology in Iran]. *Journal of Architecture and Building*, (16): 97-101.
• Malekzadeh, M. (2001). Negahi gozara bar tarikh va bastanshenasi sistan [A quick glance at the history and archeology of Sistan]. *Asar Journal*, (2): 7-11.
• Mahdavinezhad, M. J., Bemaniyan, M. R., & Mashayekhi, M. (2011). Asbadha ghadimitarin asyahaye badi dar jahan [Asbad:the oldest windmills in the world].*The World Magazine*, (2): 43-54.
• Mirshekari, G.R. (2000). Estefadehazenerzhi bad dartahviyematbu' khaneha- ye rustaeimanategh badkhiz [The use of wind energy in air conditioning of rural houses in windy districts]. *Conference Proceeding of the Fourth National Conference on Rural and Energy*. Sistan and Baluchistan Province, Chabahar.
• Mirlotfi, M. R., Tavakoli, M., & Bandani, M. (2012). Barresi- ye tatbighi vaz'iyat- e steghrar jahat joghrafiyaei maskan rustaei va masraf- e enerzhi dar mantaghe sistan [A comparative study of the Settlementstatus of geographic directions of rural housing and energy consumption in Sistan region]. *Journal of Housing and Rural Environment,* (138): 39-52.
• Al-Sallal, K., Al-Rais, L., & Dalmouk, M. (2013). Designing a sustainable house in the desert of Abu Dhabi. *Renewable Energy*, (49):80-84.