EQA - International Journal of Environmental Quality
ISSN 2281-4485 - Vol. 39 (2020): 32-51
Journal homepage: https://eqa.unibo.it/

published by

Eco-adaptive architecture through the bioclimatic design in historical Arab regions

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Article info
Received 6/2/2019; received in revised form 26/3/2020; accepted 15/4/2020.
DOI: 10.6092/issn.2281-4485/10484

Abstract
Since ancient ages, humans sought to find a shelter. They started a long way of creating, modifying, and developing their shelters. During the continuous seek for luxury, he ignored architecture designs that respects the surrounding environment and climate. This type of architecture represented our historical roots that presents the local culture and environment of any country; and it is the result of creative interacts of humans and the nature. The aim of bioclimatic architecture is to create urban areas and buildings that are designed to fully cover their energy requirements without induce environmental damage. this study focuses the traditional /historical architecture in Arab countries, especially the natural conditions that influence the architectural decisions of sustainability, that could be used as a new vision for eco- adaptive architecture. In addition, it encourages analyzing and taking advantage of environmental conditions around buildings to maintain ideal living conditions through minimal consumption of energy, to achieve sustainability that recently has become a philosophy of architecture.

Keywords
eco-adaptive architecture, bioclimatism, historical architecture, sustainability and Arab regions

Introduction

Since ancient ages, humans sought to find a shelter. Starting with a cave, they started a very long way of creating, modifying, and developing their shelters. During the continuous seek for luxury and welfare, human started to add appliances and materials that makes his life easier ignoring the surrounding environment. Moreover, he ignored a kind of architecture that once respected the surrounding environment and climate (Talib, 1984).

This kind of architecture represented our historical roots, the great lessons that identified the genius link between humans and their mother nature, as without it we will never get future. So historical Architecture is the main root that presents the local culture and environment of any country; it is the result of creative interacts of humans and their nature with all of their aspects avoiding any harmful impacts (Ahmadreza and Fergus, 2008). On the other hand, the aim of bioclimatic architecture is to create urban areas and buildings that are designed without inducing environmental damage. Bioclimatic architecture is the kind of architecture that takes into account the analysis of the climate and environmental characteristics where the building is situated, achieving comfort conditions and maintaining reduction in energy consumption (Nuno et al., 2011).

The case studies chosen here are from traditional / historical architecture in Arab countries, with a focus on the natural conditions that influence the architectural decisions of sustainability. This study encourages analyzing and taking advantage of environmental conditions around buildings to maintain ideal living conditions within the buildings through minimal consumption of energy, and to achieve sustainability that has become a philosophy of the present and future architecture.

DOI: 10.6092/issn.2281-4485/10484

The study presents an overarching goal to achieve an Approach for Integrating Traditional Architectural, environmental practices, thermal solutions and their structure materials and techniques to contemporary settings. Through this vision, it is a new methodology towards the integration of bio-climatic design concepts of nativity into modern practices as a solution to the current climatic issues and Energy problems; it also embraces traditional techniques for energy efficiency in buildings in Arab countries.

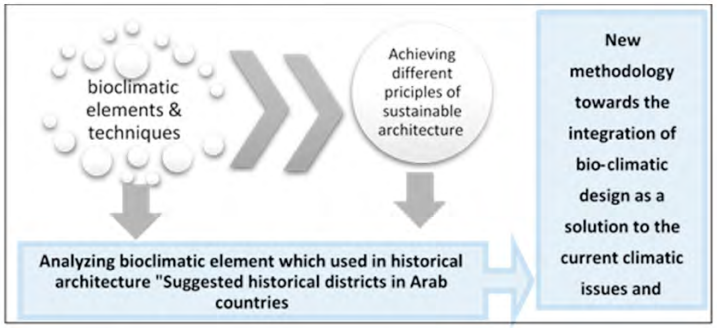


Figure 1. *The scope of the study, (Source: Authors)*

Scoping and limitation

This is not about going back to historical visions of design or copying from the past, but it is all about acquiring historical practices and techniques to modern buildings while satisfying current needs. Our Historical building environmental practices starts with site considerations, soil, physical, and climate considerations, that merging with techniques and materials available etc., it is collectively a perfect passive designing system with climatic loads and energy consideration.

So, the scope and limitations that are used to define this study focus on inferring the relationship between different elements & techniques of bioclimatic architecture especially in historical architecture as a promising way to achieve sustainability, as shown in figure 1.

This study is in fact of the quantitative type, and the strategy is inferential, through tangible methods; the data is collected, analyzed and developed. Then, this study is presented through the descriptive approach including summarization and classification of data collection through producing and regulating the tables and graphs as well as evaluation. See the chart figure 2.

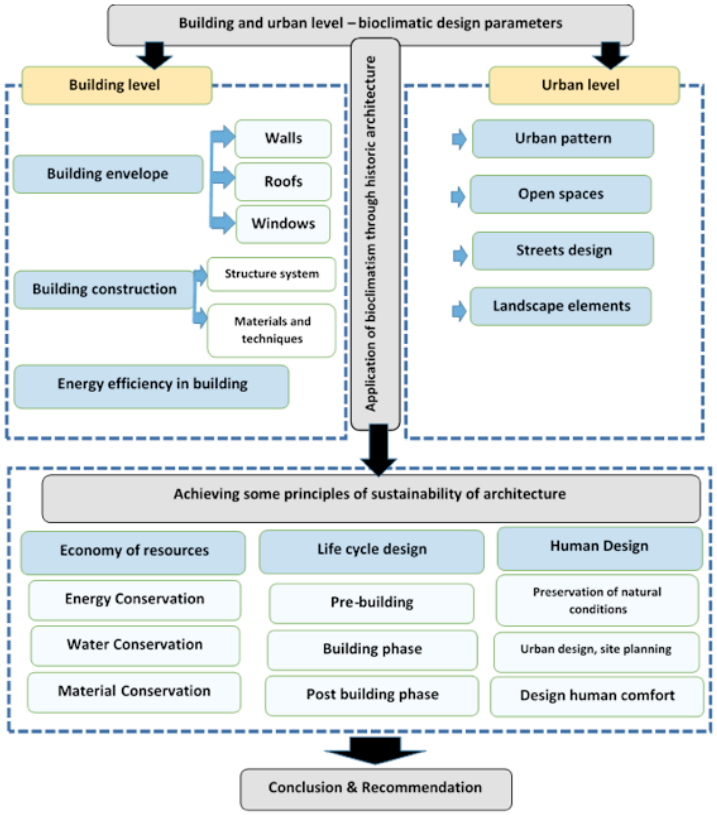


Figure 2. *The proposed chart for the methodology of study (Source: Authors)*

Research Questions and Objectives

In Arab countries, we have a wide range of knowledge and practices with respect to build environments through our historical architecture, but how it works in different scales to design modern architecture, using natural ventilation, passive solar design, sustainable materials, and many other traditional and historical specific techniques. Therefore, to answer this question we must answer subsequent inquiries:

- What are the main elements of bioclimatic architecture, which offer thermal comfort, and efficient energy consumption when natural resources are taken into account?
- How can the principles of sustainability be achieved through the bioclimatic outcomes that could be abstracted from historical architecture?

To achieve answers for these questions, this study will discuss the following points:

- analyzing the bioclimatic roles and conditions of Arab region;
- clarify the main elements and techniques of bioclimatic architecture through integrating design concepts of natural cooling, ventilation and

DOI: 10.6092/issn.2281-4485/10484

lighting techniques through historical architecture to contemporary practices;
- analyze and describe the chosen case studies in Arab countries like in Egypt, Saudi Arabia and Dubai, according to the aforementioned methodology;
- evaluate and give opinions about potential indicators for achieving different principles of sustainability in historical architecture based on bioclimatic elements and techniques to suggest new methodology of sustainability.

Background

Bioclimatic architecture

Basic concept of bioclimatic architecture. The mission of architecture has always been the main protection from the exterior environment. So, bioclimatic architecture is one of the major factors of ecological architecture, which deals with the control of environmental considerations in building units' level that takes into account the requirements of ecology and sustainability. Moreover, it attempts to achieve human thermal comfort by interacting energetically with the exterior climate (Widera, 2015; Manzano-Agugliaroa, 2015).

Objectives of bioclimatic architecture. The bioclimatic architecture aims to protect the environment and natural resources avoiding complete dependence on mechanical systems. So, the main objective of bioclimatic architecture is modifying the final effect of building to be safe and comfortable and contributes to its health and enriched biodiversity through taking advantage of local bioclimatic conditions with the benefit of the natural and built environment. Bioclimatic architecture deals exclusively with building design and materials to achieve energy efficiency (Tsioroli and Ioannou, 2016).
Principles of bioclimatic architecture. In particular, the basic principles of bioclimatic design related to the architectural structure and orientation of the building and its surroundings, (Tsioroli and Ioannou, 2016) , as the following:
- Architecture building structure: Typology, building materials& construction techniques, form, walls, openings
- Orientation
- Surrounding area: microclimate, the vegetation

Elements of bioclimatic architecture. Basic elements of bioclimatic design are passive systems, which are components of a building. Passive systems operate without mechanical parts or additional power supply and naturally heat, and cool buildings (Tsioroli and Ioannou, 2016). They include the following categories:
- Passive and active solar heating systems
- Passive and natural cooling techniques
- Systems and day lighting techniques

Sustainable architecture

Basic concept of sustainable architecture. Sustainability is defined as meeting the needs of the current generation without compromising the ability of future generations to meet their own needs (Bennetts et al., 2003).

Objectives of sustainable architecture. The principles of sustainability aim to address environmental problems and improve the quality of life, by supporting sustainable development economically and socially and providing a stable and healthy environment in the long term (Sassi, 2006), this is found in vernacular architecture.

The principles of Sustainable design. There are six principles of sustainable design. Each principle embodies a unique set of strategies. Which could be applied to reduce the environmental impact of buildings. The principles of sustainable design as the following (Lányi, 2007; Esmaeili and Litkouhi, 2013):
- *the first principle: Energy conservation*. Where energy consumption is improved and renewable energy resources are utilized; such as solar, wind and so on
- *the second principle: Indoor environment quality.* Enhance the quality of the interior environment, by designing the building in accordance with the environment-controlled ventilation and humidity as well as improve the thermal and acoustic performance of the building and urban design.
the third principle: Use environmentally and friendly building materials. Conservation of materials through the reuse and recycling of natural resources used in the building.
- *the fourth principle: Meeting the resident's needs.* Respect their psychological and physiological needs by improving the environmental and social performance of urban design.
- *the fifth principle: Efficient use of space.* Through the integration of the site with the design of the building to achieve sustainability and harmony
- *the sixth principle: Generalization and inclusiveness* (Seghezzo, 2009).

DOI: 10.6092/issn.2281-4485/10484

Traditional architecture

Basic concept of traditional architecture. Traditional architecture offers the best potential for the improvement of a reasonable contemporary regionalism of reliable top notch, equipped for accommodating many structure types (Abel, 2000). Buildings created in response to real needs, fitted into environment by individuals who knew better how to fit them to it with native feeling. The traditional architecture contains numerous values of how individuals lived in their environment and interprets their necessities in a unique character. Therefore, these lessons should be studied, handled, preserved, and enhanced in modern planning policies and building practice (Bukhash, 2000).

Objectives of traditional architecture. Climatic conditions: Arabian residential architecture has always taken procedures to protect the inhabitants from the overpowering heat of summer. This led to thick walls for thermal insulation, with few windows and with devices such as the wind tower designed to take advantage of any potentially cooling breeze (Johnson, 1995).
Culture and customs: Religion and custom have also affected the domestic architecture as Islamic teaching promotes privacy and modesty (Abdulac, 1982).
Materials: Traditional materials of construction are taken from surrounding sites, these materials have very low thermal conductivity and were therefore ideally suited for the hot and humid environment, (Majid, 1987).

Bioclimatic elements & principles of traditional architecture. Traditional architecture in the Arab World was a natural product of interaction between environmental factors (site, geography, topography, and climate), social and cultural values (religion, traditions, norms, and cultural background).
Analyzing principles of sustainability in traditional architecture is a call for an adoption of a new way of thinking and acting responsibly towards the surrounding environment and the creation of new environments. These principles are: compact urban planning, site planning, design philosophy, building envelope and materials, natural ventilation

Presentation of the suggested historical case studies in Arab region

The Case studies that have been chose from different types of traditional architecture of (Egypt – Kingdom Saudi Arabia – United Arab Emirates) form the initial basis of scientific knowledge, which can lead to further hypothesis for investigation. So, the purpose of the analytical study is to present the standard features of three case studies of historical Arab regions « in Egypt, Saudi Arabia and Dubai « to develop a criteria check-list in order to evaluate achieving sustainability and create comfort buildings.

SIWA, EGYPT

Site Characteristics. Siwa Oasis is located in the northwest of Egypt at the northern edge of the Western Desert; it is about 80 km from the Egyptian border with Libya and 300 km south of the city of Mersa Matruh, which is overlooking the Mediterranean Sea. The oasis is located at 25.5 degrees' east longitude and 29 degrees' north latitude (Fig. 3) (Masoud and Koike, 2006).
The deepest part of the oasis has salt lakes with salt deposits that are used in building houses (Karshef). (Farrag et al., 2016). It is a material made of a mixture of hardness of sodium chloride and potassium (75-85%), quartz and calcite molecules found on the shore of the lakes, it is a strong sediment extracted from lakes" (Siwa Oasis Egypt -May 2016). Siwa Oasis covers an area of about 1088 square kilometers, the oasis has a unique environment that combines cultivated areas with desert landscapes, and contains more than 300 freshwater fountains. It is inhabited by eleven tribes with a total population of about 20,000 people. (Ahmed, 2014).

Climatic Characteristics, (Hot-dry tropical). Siwa Oasis has a hot and dry climate in summer while its climate is cold in winter, where the air temperature in the hot summer is about 39 °c while it reaches about 5 °c in winter. (Ahmed, 2014). The absolute maximum temperatures reach 50 ° C while the minimum temperature is 4 ° C, the average monthly relative humidity ranges from 30% to 58% (Masoud and Koike, 2006). The climate is also very dry from April to November with very low rainfall from December to March (average 10 mm / year). Siwa is located on two huge groundwater reservoirs.

Bioclimatic Design Parameters for Urban Level. The urban planning of Siwa is divided into several phases: (Neveen, 2004). The phase of the village (Sidi Muslim): It is the beginning of the urban presence in Siwa. The old town phase (Shali): It is the first direction of the ascension of the mountain for the purpose of

DOI: 10.6092/issn.2281-4485/10484

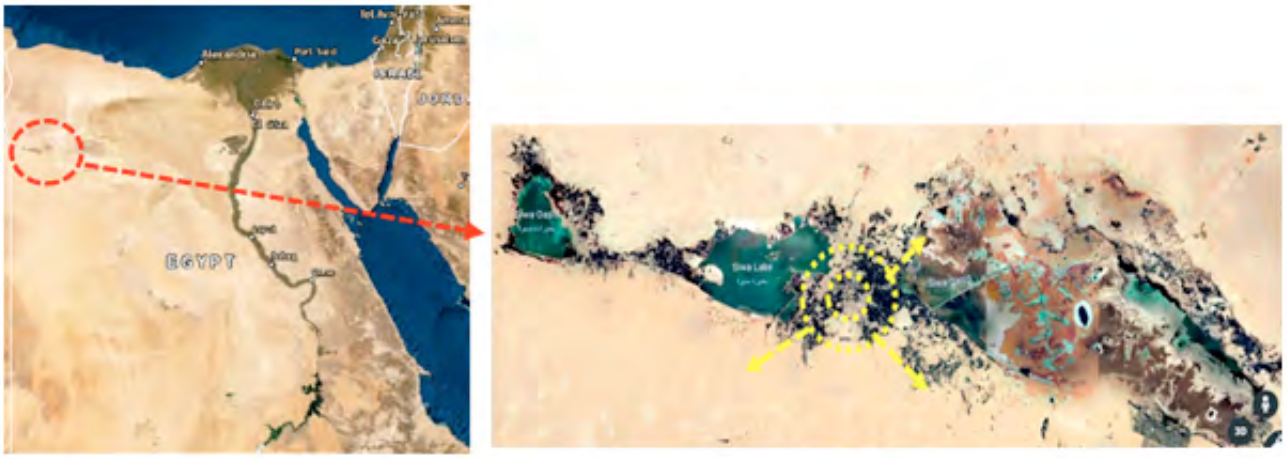


Figure 3. *Location of Siwa oasis in Egypt (Google earth)*

residential, protection and safety. The phase of descent from the mountain to the plain: a natural extension of urbanism. Urban Extension (Current Siwa): This is the last phase of the town's extension. Urbanization was influenced by different geographical and demographic factors in each of these stages, but the planning thought was one and derived from the thought and character of the desert Arab city, the oasis includes a main road that flows directly into the main square and the mosque and represents the hallmark of the entrance to the city. This square includes most of the commercial, social and political activities.

Urban pattern: Siwa is one of the few Egyptian oasis communities that has managed to retain most of its traditional characteristics. The urban fabric of the old city buildings is a compact fabric, where buildings clustered together to protect against exposure to solar radiation, which begins to decrease as we move toward the plain (Ahmed, 2014) (Fig. 4), but Siwa still maintains a narrow, irregular pattern of fabric that allows for a pleasant pedestrian environment, while restricting vehicle movement (Hanafi and Rashed, 2004; Rovero et al., 2009).

Open Spaces: Urban spaces are classified into three levels (public spaces - semi-public spaces – semi private spaces) The public Market space: It is a large area that is directly connected to the open space that connects the north and south of Siwa, and allows air to enter the urban areas. The Semi-public spaces: are found at each urban section (East - West). They are spaces that commensurate with human standards. They are semi-enclosed with buildings, which allow heat exchange with open spaces**.** The semi-private spaces: are found inside the neighborhoods and are of human scale and the degree of containment and high closure, they are common in most of the spaces of ancient Siwa.

Streets design: The streets in Siwa are characterized by their gradation, which is divided into:

- Highways: The road that connects Siwa to the outside and linking the north and south of Siwa.
- Semi-public roads: linking areas with each other and the highway, as well as linking residential areas, gardens and agricultural land.
- Semi-private roads: linking residential units, with a specific entrance through the convergence of upper floors.

Figure 4. *The Siwa oasis urban planning (Neveen, 2004) (Google earth)*

DOI: 10.6092/issn.2281-4485/10484

Figure 5. *The street shading in Siwa oasis (Neveen, 2004)*

Most of the streets in the old Siwa are narrow, in addition to the use of "EL Sabat" (A type of street shading in which every two buildings on the two opposite sides of a road have a floor connecting them over the canyon). This can provide shading and protection from storms (Fig. 5), while upright streets in the extension areas descending to the plain (Farrag et al., 2016).

Landscape elements: The oasis is characterized by natural plants and fountains as well as beautiful scenery, palm trees and olive trees (El-Shafie, 2010; Nofal, 2011).

Bioclimatic design parameters for building level. The buildings are characterized by the simple style and building materials. The most important types of buildings are the mosque and the housing of the Siwa. The design of the dwelling at the top of the oasis is based on the vertical extension, while the horizontal extension when descending to the plain.

Building form: The oasis houses are similar in shape and building materials. They are one or two floors at most. In case using modern building materials the architectural style is preserved, so that the facades are made in the same form using the "Karshef" material, with the same heights. The shape of the house in Siwa is characterized by the presence of the internal courtyards or backyards that allow many activities within it as shown in (Fig. 6) (Neveen, 2004).

Building orientation: The inhabitants of Siwa have shown an early adaptation to the environment and coping with climate change, through the distribution of housing. The kitchen is in the south; the house has an outdoor rooftop for sleeping where it is up to two meters with openings worked out. Their houses also feature inward oriented where the courtyard, which is protected from extreme heat in summer and cold in winter (Petruccioli and Montalbano, 2011).

Building envelope "walls-roofs & openings":
Walls: The walls take curved spontaneous forms and may be built perpendicular to each other. They are thick walls of 60-80 cm and this thickness is reduced in the upper floors where up to 30-40 cm , of local building materials from (karshef) mixed with clay as materials of low heat conduction, which works as a thermal insulation between the outside and inside (Petruccioli and Montalbano, 2011). The surface of the walls is smooth and works against the sun's rays of the same color as the natural soil (Abo-elazm and Ali, 2017).
Roofs: The ceilings are flat, of which with two types, simple and mounted, according to the size of the space. Simple ceilings are used for roofing spaces of limited dimensions, from longitudinal palm trees filled with fibers and covered with 10 cm layer of (karshef) (Neveen, 2004). However, composite ceilings are in the case of roofing spaces of 4-5 meters wide, and rely on providing the roof with beams of semi-palm trunks, on which palm trunks stacked above it adjacent to each other and then covered with (karshef) (Ahmed, 2014).
Windows: The windows are designed to be narrow and opposite to increase the speed of air flow inside the

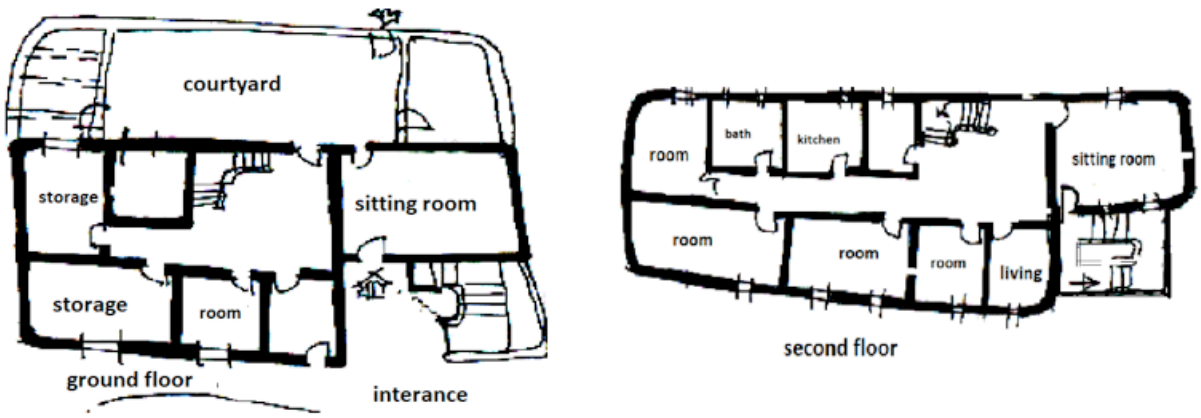


Figure 6. *An example of a house in Siwa (Neveen, 2004)*

DOI: 10.6092/issn.2281-4485/10484

dwelling. They are a few rectangular windows on the outside walls (Farrag et al., 2016). While Most of them always open to the courtyard as in Siwa's homes and in The Adrere Amellal Hotel. Another natural technique was used to cool the air by using the ladder tower as a tower for passive ventilation (Ahmed, 2014).

Building materials and construction techniques: The buildings in Siwa Oasis are characterized using Karshef material in the building. Wood is also used in construction to improve the linkage between the exterior and interior. The roofs are made from palm tree trunks that are compatible with Karshef as an environmentally friendly material that does not emit carbon dioxide, as shown in (Fig.7) (Farrag et al., 2016).
As for the methods of construction, the ancient buildings of Siwa were built with load-bearing walls from karshef, and limestone was used to make foundations with a depth of 50-100 cm. Palm trunks were used for roofing as a grip to carry the roof, and cut into longitudinal slats to be used as adjacent slabs to form the roof of the building and then covered with a layer of karshef (Ahmed, 2014).

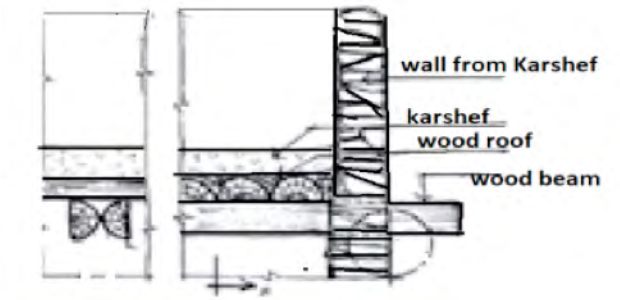


Figure 7. *Section in Siwa building (Neveen, 2004)*

Energy efficiency in building: Positive effect of clay material on the building thermal effect during summer and winter. The heat energy gained from the sun during the day is stored in it and then slowly re-released into the building at another time for thermal comfort. Passive cooling by separating the building narrow paths to create wind movement, as well as cross ventilation that replaces the use of air conditioners. (Ahmed, 2014). Achieving traditional elements of climate control, which saves energy consumption.

Daylight strategies: Some oasis houses used the wind tower as a lighting tube, where natural light is reflected through the mirrors to let the sunlight to enter into the interior as in some Siwa houses (Ahmed, 2014).
Relying on natural light in hotels lighting, which appears in Adrar Amlal hotel, which do not use electricity in lighting.

JEDDAH, SAUDI ARABIA

Site Characteristics. Jeddah City is the second largest city in Saudi Arabia after the capital city; Riyadh and it has the largest sea port of the Red Sea, it is also the largest city in Makkah province. Geographical location: Jeddah is situated to the south of the tropic of cancer on middle point on the western coastal plains of Saudi Arabia (latitude 29.21 north & longitude 39.7 east) (Jeddah Municipality 2013). The City is placed in the west side of Hijaz region, through a coastline on the Red Sea. The City is valuable that because it is the welcoming port to the two holy cities "Madinah and Makkah" of Islam as shown in figure 8.

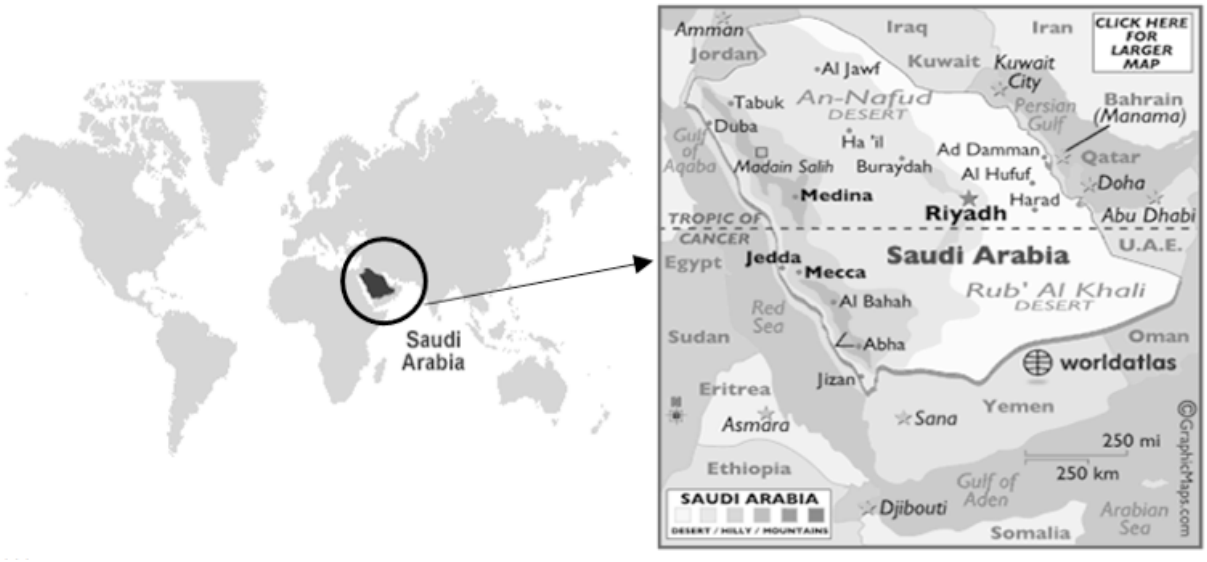


Figure 8. *Location of Jeddah (Adapted from Google earth)*

DOI: 10.6092/issn.2281-4485/10484

Climatic Characteristics, (Hot-dry tropical). Jeddah is situated within a dry climate zone characterized by high temperatures, humidity during the summer, minimal vegetation cover and lack of rainfall (Jeddah Municipality 2013). The temperature hovers around 40oC at the time, and the low seasonal zone with a solid and warm air mass influences the city. Humidity reaches its highest level in the summer because of the high temperature of sea water (Jeddah Annual Report 2016–2017).

Bioclimatic Design Parameters for Urban Level. Jeddah has a very long history dates back to more than 3000 years ago and the Old City contains a lot of historic buildings "around 350", which have been built for more than 350 years ago with special characters that exhibit the very culture of the nation, (Jeddah Annual Report 2016–2017). Specific, Old Jeddah has several monuments and heritage buildings of archaeological interest, including the Old Jeddah wall and its historical open squares, as shown in the following figure 9 these squares include the following quarters:

Haret Al Mazloom: The quarter is located in the northeastern part of the old district to the north of Al Alawi Street inside the wall.

Haret Al-Sham: The quarter is located inside the northern part of the fence, in the direction of the Levant.

Haret Al Yemin: Located in the southern part of Al Alawi Street inside the wall.

Haret Al Bahr: Located in the southwestern part of Old Jeddah, it overlooks the Red Sea.

Urban pattern: Jeddah remains the largest urban area in Makkah Province. It has expanded from 30,000 inhabitants in 1932 to over 3 million in 2010. It has always stood on the primary routes taken by Muslim pilgrims travelling to the twin holy cities Makkah (Mecca) and Medina (Mandeli, 2017). The urban fabric of Jeddah during the period until 1945 remained traditional in character, organic fabric, urban compactness shaped by narrow zigzagged alleys see figure 9, Mixed land uses, narrow streets. The city had four main gates. The architecture was vernacular and multi-story (4-7 stories) built with local materials (coral stone) walls, wooden lattice (mashrabia) covered openings. These were highly adaptive to the environment and climate (Mandeli, 2017). Jeddah was one of the first cities in the Kingdom to benefit from the flourishing economy after the Second World War (post 1945). Therefore, the second five-year plan was easy to designate it as: A center of Sea, air and land communication ii) Commercial and business center iii) Second diplomatic city of the Kingdom iv) Hajj and Umrah reception center for non-Saudis v) An educational health and cultural center. (Osra and Jones, 2018). So, in figure shows the difference between the urban fabric of the old city and new city.

Open Spaces: Currently, the amount of public open space provided in Jeddah is less than 2 m2 per person in the entire city and less than 1 m^2 per person more than of Jeddah›s planned residential districts. Therefore, Jeddah like the rest of traditional Islamic Arabic cities include different forms of functional public open spaces. These forms can be classified into five groups as the following see figure:

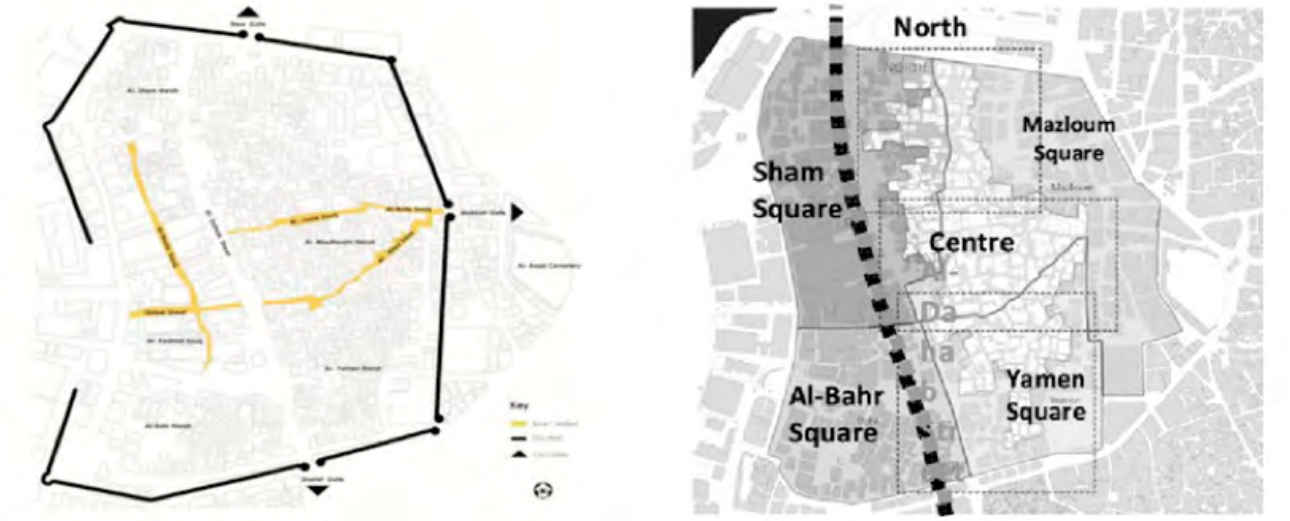


Figure 9. *The fourth quarters of old Jeddah and the main gates (Adapted from: Jeddah Annual Report 2016–2017)*

DOI: 10.6092/issn.2281-4485/10484

The first: is the religious public open spaces which consists of the mosque courtyards Like the waterfront squares which was in close proximity to the custom building; the Akash mosque square, the central square and the nearby Makkah gate square (Pesce, 1974), and the Musalla outside the city walls which was then integrated into the modern fabric of the city .
The second: is the commercial public open spaces which can be seen in squares adjacent to markets, the Bat›ha and the commercial streets. These forms were used for trading purposes, but also provided opportunities for social interaction.
The third group can be described as residential public open spaces. The important form of them was known as the communal plaza or squares most often, a communal plaza took the form of a relatively wide area along the street of an intersection of two streets or alleys, or an area of buildings set back from the street frontage. The plaza might also be found at the end of dead-end streets (cul-de-sacs) which were formed by a group of residential buildings, the only form of public open spaces used of passive and active recreation within the city. (Alhajaj, 2014), as shown in figure 10 that clarifies the form of Open spaces of social quality.
The fourth form: is the ceremonial public open spaces that includes squares within the Kasbah area.
The last form: can be referred to as «green» public open spaces that exists in the form of public gardens within parts of the city and may be used for passive recreation. However, Traditional Middle Eastern Islamic Arabic cities didn›t include specific.

Figure 10. *An example of dead-end street or cul-de sac in traditional, (Adapted from: Hisham, 2014)*

Moreover, the urban open spaces of the traditional district acquired a specific character that distinguished them from other urban spaces in other Islamic cities. For example, the courtyard usually located in the middle of the house was replaced by open spaces in the upper levels, while the main open space was located on the roof of the house. However, the urban public spaces of Jeddah did not witness any major changes as they were derived from surrounding Islamic principles, environmental circumstances, and the local socio-cultural values of the residents (Alhajaj, 2014). So open spaces appeared in the upper levels of the traditional district with different forms based on the required degree of residents' privacy. Space, movement, and heritage planning of the historic cities in Islamic; societies: Learning from the Old City of Jeddah, Saudi Arabia.

Streets design: In the late of 19th century, Jeddah's streets were described as narrow pedestrian ways, open tracks with quite spacious, not too neglected, and intimate spaces where the built environment is opening from time to time on large and well-aerated squares, which are the lungs of the city. (Mandeli, 2017). So, the street configuration is mainly depending on creating shadows and allowing the passage of air, as shown in figure 11. Which is fabric helps in providing shade and minimizes direct exposure to sunlight that in turn helped in reducing the air temperature and increased circulation of air currents " air wind pattern" (Rashid and Ali, 2015).
Landscape elements: In terms of Jeddah green cover and vegetation, the city had no forms of urban vegetation except for spares desert shrubs in close proximity to the southern gate and a single tree in the middle of the city in front of the historic Nassif's house (Alhajaj, 2014).

DOI: 10.6092/issn.2281-4485/10484

Figure 11. *hading the external surfaces in streets of old Jeddah, (Adapted from: Hisham, 2014)*

Bioclimatic design parameters for building level. Current old houses of Jeddah are a reflection of the Mamluki era, during which the Rowashan appeared as a major façade element. Besides, Egyptian Ottoman influence is evident in the spatial distribution and gypsum and wooden decorations of Jeddah houses.

Building form: Beginning with external form is described thus: a cubical mass of 2-5 floors without major projection, Skeleton of four sides that entirely opened, but covered with wooden elements (rowshans, mashrabiays, and windows in between), the only projections or breaks are the rowshans and mashrabiays, emphasizing the shading along the elevations such as Nasif house which it merged between a typical Hijazi architecture and the Egyptian Ottoman era (Alrashed, and Alsulimani 2015).

Then for the building heights; The High-rise of earlier buildings were 2-3 floors. But late 19th and early 20th centuries, tendency for higher buildings (6-7 floors) was necessary due to limitation of land for construction within the walled city, where figure 12 clarified the common height of typical houses in old Jeddah (Hisham, 2014).

Spatial Distribution and Use; High- and low-rise dwellings share similarities in spatial use and each floor has a specific function, almost. Ground floor, more public and used to receiving male guests in Maqa'ad and has servants' and storing spaces. It starts with a corridor (Dahliz) that precedes the entrance (1 or 2, depending on residents' economic conditions). First floor is also for receiving male guests and has cooking spaces. Second floor, more private, and used mostly for sleeping (mabitat) and receiving female guests. Upper floors (3rd-5ht, etc.) have majalis or salons for all members of the family and room number varied according to economic conditions of residents (Alhajaj, 2014).

Building orientation: Because there is no interior courtyard in the buildings of old Jeddah, therefore, the basic dependence of the orientation on the outside (Alhajaj, 2014).

Building envelope "walls-roofs & openings". Walls: the external walls made of coral stone in 50-60 cm. thick

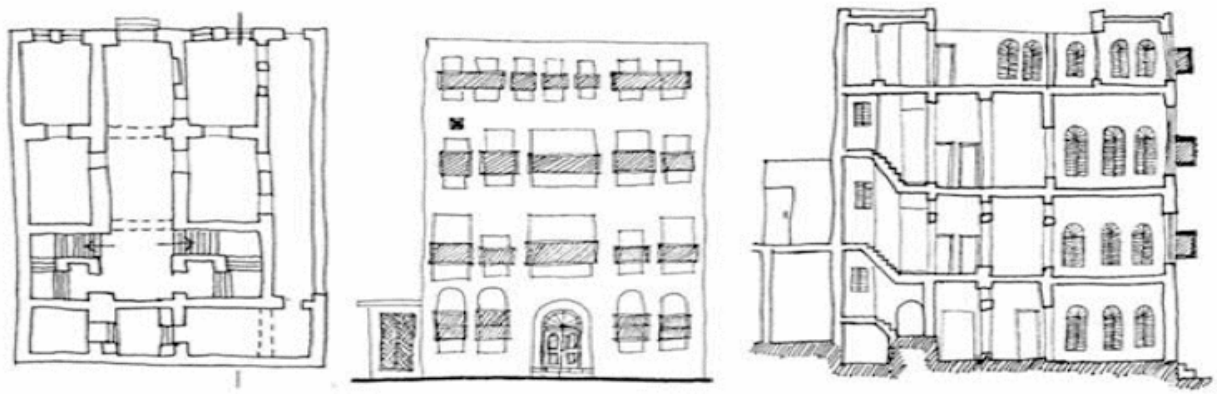


Figure 12. *The height of a typical house in Jeddah, (Talib, 1984)*

DOI: 10.6092/issn.2281-4485/10484

because of the coral stone wall at the lower floors provide a considerable resistance to the passage of heat due to the low thermal conductivity of the material. Based on the considerable thickness of the construction is capable of absorbing heat and delaying its passage to the interior. Roofs: As for Roofs, they were constructed in a similar way of flooring which consists of timber boarding laid on timber joists, but with an addition of a thick bed of limestone below the wet earth layer, and water-resistant lime plaster on the top. Windows: The most common types of opening which are used; Rowshans and Mashrabia. Rowshans are 60-90 cm projected wooden skeleton covered with decorative covered with decorative wooden panels and screens. It covers the entire elevation of the upper floors this type helps for Ventilation (middle panels are slid able and with louvers) also for Sitting/sleeping, in addition to achieve Thermal insulation, solar rays' reduction, and sandy air filtration. The second type is Mashrabia which is considered an artistic elegance adds to the building and it's different from Rowshan in terms of size, location and function. There are Pots of water are placed on its base to cool the air passing by it. These types of opening help to improve the air beside the function for achieving more privacy. Whilst Doors are massive, usually consists of two panels of tek wood with heavy metallic nails and knockers with highly decorated with deep engravings. All rowshans, mashrabiyas, windows and doors mostly imported in large quantities. See figure 13.

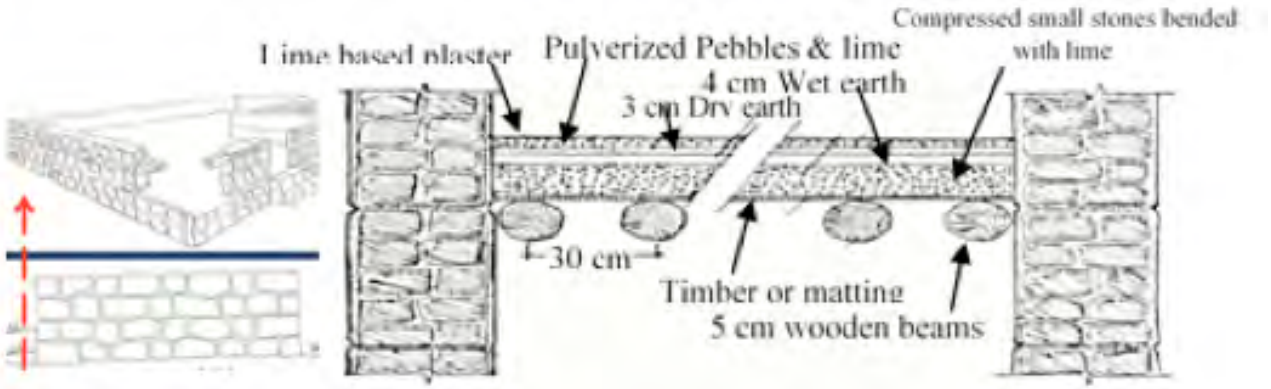


Figure 13. *The common Method of building external walls and ceilings, (Adapted from: Hisham, 2014)*

Building materials & construction techniques. The construction materials used in the houses of Jeddah indicate the ability of residents to integrate with the surrounding environment. The most common materials used are Coral stone, Wood and Gypsum. Where coral stone is characterized by lightness and non-durability but it was protected from humidity and air salinity with a thick layer of lime plaster (nora), and wooden pieces (ganadel) that absorbed cracks resulted from stone size reduction after drying. This has maintained the survival of buildings for more than 400 years (Hisham, 2014). As for using wood, the construction of the building was largely dependent on it in ceilings, walls, ganalde from tek to prevent walls from collapsing if exposed to salinity and humidity, also for staircase steps and use in rowshans, mashrabiyas. But Gypsum mostly used in decorating facades, framing doors and windows also it used for Painting in white color as a protection from climatic conditions (Alrashed, 2015).

Energy efficiency in building. The uses of wind catcher that is mostly covers the stair underneath for ventilation and thermal comfort. As well as the staircase creates an airflow pattern that ventilates the spaces around based on using rowshans and mashrabiays, beside the height of the building enhances such pattern as shown in figure 14 (Alrashed, 2015).

Daylight strategies. Although windows –whether Rowshans or Mashrabia - are considered major architectural elements in old Jeddah buildings that have many advantages, as providing daylight and ventilation in interior spaces, which has a great impact on occupants' comfort (Alhajaj, 2014). Also, distance between buildings has major impact on daylight especially in compacted buildings like the fabric of old Jeddah.

AL BASTAKIA, DUBAI

Site Characteristics. The Bastakia, "Fareej Al Bastakiya" on the southern side of Dubai Creek "old souk". Basically, it was residential with some commercial elements (shops& storages). It was built during 1890-1950 by some Iranian Builders named "ustadh" that

DOI: 10.6092/issn.2281-4485/10484

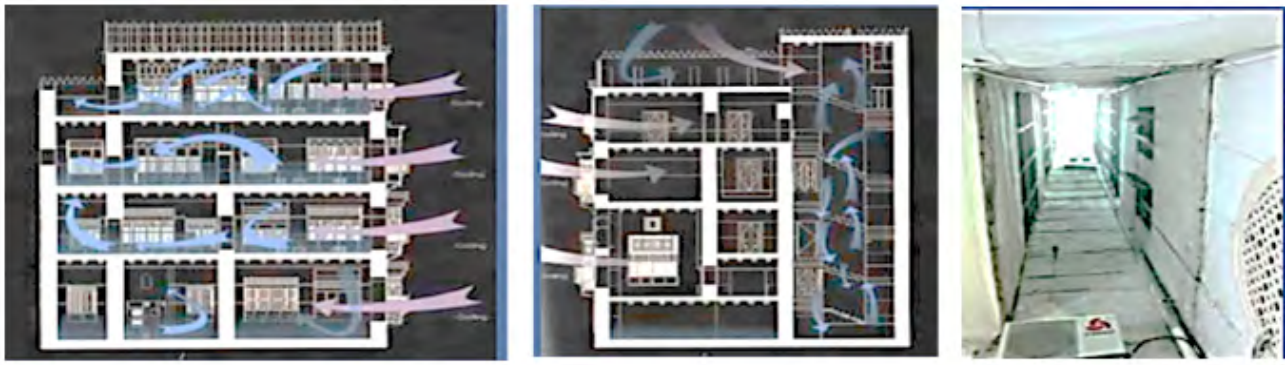


Figure 14. *Achieving natural ventilation through using a wind catcher covers the stair underneath, adapted from (Hisham, 2014)*

migrated from Bastak village in the south of Iran to settle in Dubai (Heard-Bey, 1996; Salama, 2015). Those people originated from *Bastak* district in a sub-province of Lar in the Fars Province. Trade particularly the import of wood, took place between Dubai and the port of Khamir. Bastak people were allocated a land parcel east of Fahidi Port to build houses for their families. This was a great location given its access to the creek and near the *Suq* of Dubai. This district was called *Bastakia* (Frauke, 1996) see figure 15.

Figure 15. *The location of the UAE and the emirate of Dubai (http://www.lonelyplanet.com/maps/middle-east/united-arab-emirates/)*

Climatic Characteristics, (Hot-dry tropical). UAE lies between 22°50' and 26° north latitude and between 51° and 56°25' east longitude, so that most of its land is located in a sub-tropical area while Cancer latitude (23° 5") crosses over its southern third part. It is exposed to vertical sun during the summer time and most of the autumn and spring seasons. Thus, the climate of the area could be classified as Hot Arid, except the coastal strip, with the lack of significant precipitation. The hottest months are July and August, when average maximum temperatures reach above 48° C on the coastal plain, these coastal areas suffer from the highest level of humidity that reaches to approx. 100% during some periods in summer. The temperature reaches to an average of 40 C among seaside, (Abdelmonem and Loehlein, 2007). In winter the temperature average 20 C & 35 C which is very comfortable climate for living in the Middle East.

Bioclimatic design parameters for urban level. A sequence of external landscaped open-air spaces (Sahas) as gathering places were created for pleasant out door environment. Then in 1795; there were almost 50 wind-tower houses built of solid coral stone. Bastakia was characterizes by a dense pattern of one- or two-story courtyard dwellings that planned to form a compact layout. Despite the level of deconstruction that occurred during the 1960s and 1970s, there still remains a number of houses capable of retaining a distractive identity image and the most importantly that maintain the physical characteristics of a traditional urban settlement (Salama, 2015).

Urban pattern. Bastakia urban planning is compact Organic urban planning form, building shading building, shaded walkways. Protection from direct solar radiation & hot wind. The district is arranged in two directions parallel to the creek as well as a perpendicular alignment. The *sikkas* (alleyways) have an average width of 2-3m. An array of open-air public spaces is distributed across the district allowing space for socializing. The outdoor areas are often additional shaded by native trees and shrubs which make it into a visual pleasant environment. The geographical position of the creek also enables the use of the breeze to and from the water to be creating a cool breeze that goes through the *sikkas* (narrow streets), (Abdelmonem and Loehlein, 2007), as shown in figure 16.

DOI: 10.6092/issn.2281-4485/10484

Figure 16. *Urban pattern (Google maps)*

Open Spaces. Bastakia houses were laid out to enable direct access to the creek, by producing streets or axes perpendicular to the creek. This being its dependence on trade coming from and leaving to the sea, (Hadjri, 2014). The entrances to the residential districts usually were located on the main streets of the souqs, where in between shops a gate would lead into a district. The residential clusters were made up of a maze of winding alleyways leading to cul-de-sac dead-ends. Doors to various dwellings would open up into these cul-de-sacs, forming a small neighborhood sometimes even marked with a gate. Hence, one would move horizontally through a sequence of spaces varying in levels of privacy, each change marked with a distinct threshold, (Al-Zubaidi, 2007).

Streets design. Axes of movement for transportation of goods had to link the creek to the inland. These axes were in fact the generators of the built form of Bastakia. It is claimed that the first houses were built on the edge of the creek and later more houses were added following the axes, as more land was made available for construction. Smaller and less important streets parallel to the creek link the main streets. The intersection of these streets sometimes results in the creation of small squares. These squares did not have an urban function but rather the result of unplanned growth, or to allow the continuity of a main street when its linearity is broken, (Hadjri, 2014), see figure 17.

Figure 17. *Street in Al Bastakia (Google maps)*

Landscape elements. The photosynthesis strategy of plants reduces the heat gain on the roads, which reduces the temperature of immediate microclimate, also are very effective as shading elements, (Ali et al., 2014).

Bioclimatic design parameters for building level.

Building form. Due to climate of UAE, builders designed houses that accommodated to the long hot summer months and their solution was based on that fact, (Heard-Bey, 1996). Accordingly, building mass was solid, exterior openings were very small protecting the interior spaces from this harsh climate. Aligned with that, traditions and social values were of great effect on size, numbers, and location of openings in building external treatments, see figure 18.

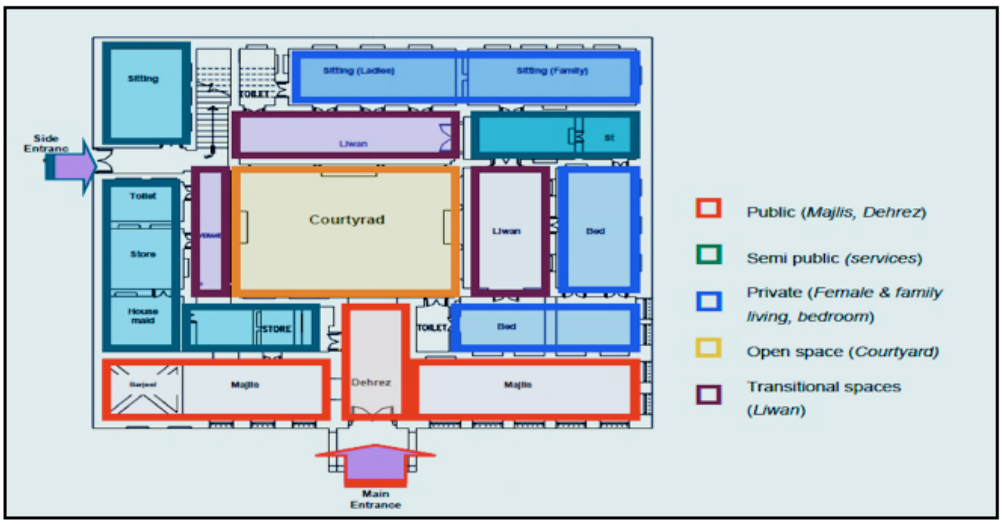


Figure 18. *(a, b) Solid building mass with small openings to eliminate sun exposure Schematic, (c) analysis for space organization in a traditional house in the UAE (Al-Zubaidi, 2007)*

DOI: 10.6092/issn.2281-4485/10484

Building orientation. Building oriented N-S for min. solar radiation and max. Exposure to wind & cross ventilation. Evaporative cooling from creek. This feature helps in alignments with courtyards, which are generally small, partially shaded most of the time and help air cool down before entering indoors. Wells in courtyard help evaporative cooling. See figure19.

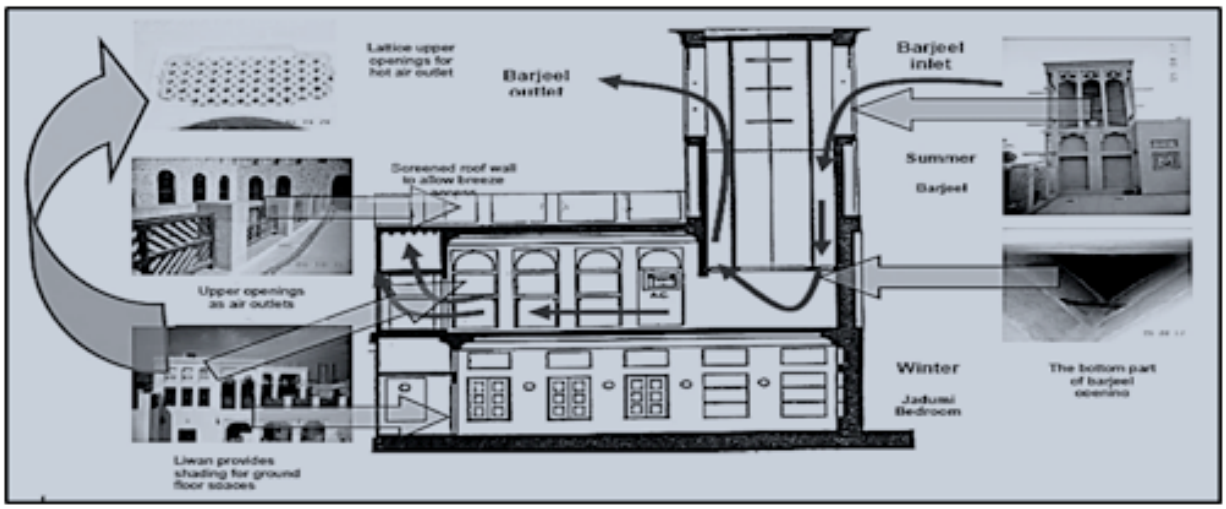


Figure 19. *Natural ventilation through upper spaces in a traditional house in the UAE (Al-Zubaidi, 2007)*

Building envelope "walls-roofs & openings" (Ali et al., 2014)
- Walls: solid walls & minimum openings on the western and southern façades to delay & reduce solar gain.
- Roofs: Thermal mass of thick (0.30 m to 0.70 m).
- Windows: Using high windows that work as air fan, since lighter warm air rises up and escapes through high openings, allowing cooler air to enter the room from below

Building materials & construction techniques. The construction material was invented from primitive mud soil available at the deserts, while, the settlers utilized the use of coral stones distributed along the beaches in Dubai and coastal regions to replace the usage of unbaked bricks as main structure component for load bearing walls. That structural system withstands loads until 3 stories high. Roofs and slabs are built out of available timber and trees branches that work as beams covered with layer of palm leaves. Basic spaces are located in ground floor, minor and additional spaces located in first floor. Through analysis to these building materials:
- Walls: Walls of mud blocks, coral stone, palm trunks and straws act as very good insulators. Poured in mud, or sun-dried mud blocks of rough texture. A variety of interior materials helps diffuse sunlight.
- Roof: Roof consisting of mud, palm trunks, bamboo, mangrove wood and palm leaves provide good thermal insulation.
- Floor: Mostly earth over compacted sand. Some exterior ones were of rough-cut stone. Mud kept floor cool.

Energy efficiency in building: Bastakia houses had a difference of 2.7°C between outer and inner surfaces of exterior wall: •1-outer 35°C, •2-inner 32.3°C, (Ali et al., 2014):
- wall thickness gives high thermal mass to the building; thereby reducing and delaying heat gain inside (Fig. 18). Fursh coral, 0.07 m thick, was used with mud for infill panels between piers and for partitions;
- shading of walls, openings, courtyards, *liwans* is the most effective strategy to keep interiors cooler, (Boussaa, 2014). This also helps in circulation of warmer air outwards;
- wind Towers brings in cooler air from higher up that circulates through interior spaces; sometimes water is sprinkled in the surrounding walls to cool the air more.

Daylight strategies: There are diverse types of daylight openings found in the indigenous buildings of the UAE. A regular window is by far the most common one, while the wind tower (*barjeel*) and air pullers (*masgat*) are another category of daylight opening, *(*ALNuaimi, 2007):
- windows in they do not have glazing; but are always open to the exterior environment. Due to the high temperature of the region this characteristic served well in promoting natural ventilation through the space;

DOI: 10.6092/issn.2281-4485/10484

- the wind tower; referred to as *barjeel* is the most distinctive architectural element. It consists of four open sides, each of which is hollowed into a concave V shape that deflects the wind down, cooling the rooms below. Water thrown on the floor beneath the tower cools the house as the water evaporate.
- the air puller (*masgat*) is a type of opening primarily used for circulation zones as well as common rooms.

The analysis of historical case studies based on bioclimatic design parameters

The following tables illustrate the three-case study analysis according to bioclimatic design parameters whether for urban level or building level and the crucial role for achieving different types of building comfort, besides achieving the three pillars of sustainability in architecture.
Therefore, this paper suggests that the proposed historical case studies represent an important research track in achieving different principles of sustainability in architecture in order to achieve different types of comfortable buildings especially visual and thermal comfort. Where this analysis will highlight particular issues and constraints relating to the importance of historical districts and its effects for increase health and wellbeing, see table 1& 2.

Results

This study found that the traditional wisdom of historical architecture plays an important role in using: natural ventilation, passive solar design, sustainable materials, and many other traditional and historical specific techniques.
This study through its analytical case studies have concluded the main criteria for urban and architectural through traditional districts of the hot-dry climate in Arab countries, in terms of passive cooling
As a result, paying attention to the bioclimatic design parameters of historical, social, cultural and climatic contexts through suggested case studies " Siwa in Egypt, Jeddah in Saudi Arabia and Albastakia in Dubahi, and they play important role to achieve different principles strategies, materials and methods of sustainable construction architecture.

Conclusions

Through sustainable design, architecture does not oppose the environment, but it constructs and design by interacting with the environment, by recognizing the specific features of the contexts which are considered in the suggested case studies.

The importance of understanding the context of any districts as did before in the historical districts at the start of the design process is very important for achieving sustainable architecture and create comfortable buildings.
The traditional thoughts could be the main focal to emerge new methodologies that will help cool passively and thus save energy.

Social Patterns must be respected and taken into considerations, because they the are one of the main factors while designing a sustainable model through urban and architectural design.

The study has reached the following diagram figure 20, that illustrates the proposed methodology for how to analyze any historical context and measure its achievement of sustainable principles.

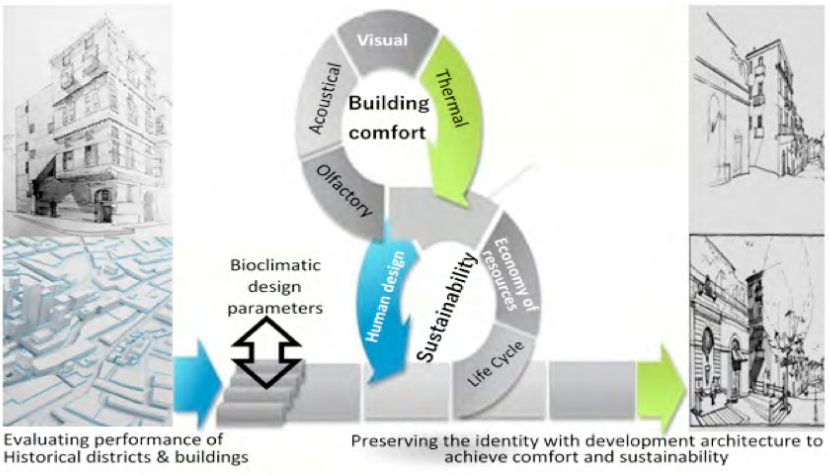
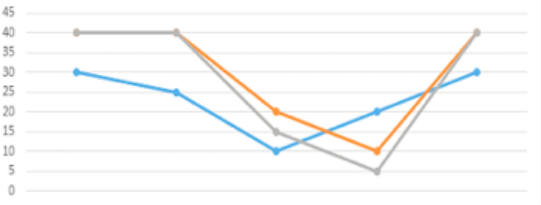


Figure 20. *The proposed methodology for evaluating historical districts through bioclimatic design parameters to achieve comfort and sustainability (by authors).*

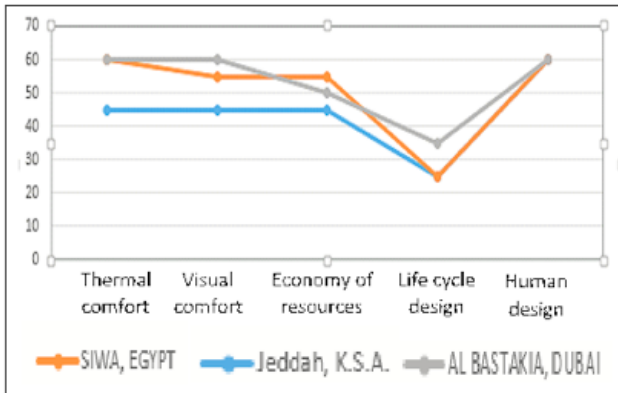
DOI: 10.6092/issn.2281-4485/10484



		Thermal comfort	Visual comfort	Economy of resources: Energy conservation	Economy of resources: Water conservation	Economy of resources: Material conservation	Life cycle design: Pre-building	Life cycle design: Building phase	Life cycle design: Post building Phase	Human design: Preservation of natural conditions	Human design: Urban design, site planning	Human design: Design human comfort
SIWA, EGYPT	Urban pattern											
	Compact fabric where adjacent buildings are protected from solar radiation, where small and narrow paths of movement	●	●	●			◒				●	
	Open spaces											
	Gradation urban spaces where they take into account human standards.	●	●	○			○				●	
	Streets design											
	- The streets are characterized by their gradation -Most of the streets are narrow and shaded with palm.	●	●	◒			◒				●	
	Landscape elements											
	Natural plants and fountains plus the spread of palm	●	●	◒			○				●	
Total evaluation for the first case study		40	40	20			10				40	
Jeddah, K.S.A.	Urban pattern											
	Organic Fabric to minimize direct exposure to sunlight and increased circulation of air currents, urban Compactness shaped and narrow Zigzagged alleys	●	◒	◒			●				●	
	Open spaces											
	The diversity of open spaces, the plaza found at the end of dead-end streets (cul-de-sacs) and public green gardens are not existed in specific.	●	●	○			●				●	
	Streets design											
	Narrow pedestrian ways, Open tracks with quite spacious and intimate spaces and well-aerated squares, which are the lungs of the city.	●	●	◒			○				●	
	Landscape elements											
	The city had no forms of urban vegetation except for spares desert shrubs and a single tree	○	○	○			○				○	
Total evaluation for the second case study		30	25	10			20				30	
AL bastakia , Dubai	Urban pattern											
	Compact Organic urban planning, Protection from direct solar radiation & hot wind- it is arranged in two directions parallel & a perpendicular alignment. The sikkas (alleyways)	●	●	◒			◒				●	
	Open spaces											
	- The residential clusters were made up of a maze of winding alleyways leading to cul-de-sac dead-ends - move horizontally through a sequence of spaces varying in levels of privacy	●	●	○			○				●	
	Streets design											
	Axes of movement for transportation goods had to link the creek to the inland - Smaller and less important streets parallel to the creek link the main streets	●	●	◒			○				●	
	Landscape elements											
	The photosynthesis strategy of plants reduces the heat gain & temperature of immediate microclimate	●	●	◒			○				●	
Total evaluation for the third case study		40	40	15			5				40	
Highly achieved = 10 ●		Moderate achieved = 5 ◒					Rarely achieved= 0 ○					

Table 1. *Bioclimatic design parameters for urban level of the historical case studies to achieve building comfort and sustainability, (by authors)*

DOI: 10.6092/issn.2281-4485/10484



		Thermal comfort	Visual comfort	Economy of resources: Energy conservation	Economy of resources: Water conservation	Economy of resources: Material conservation	Life cycle design: Pre-building	Life cycle design: Building phase	Life cycle design: Post building Phase	Human design: Preservation of natural conditions	Human design: Urban design, site planning	Human design: Design human comfort
SIWA, EGYPT	Building form - Most of the buildings are one or two floors, from Karshef or covered by it to preserve the architectural character.	●	●	●			◒			●		
	Building orientation The orientation to the interior where the inner courtyard, which the various elements of the building are directed -The direction of outside windows it is in the direction of the favorite wind	●	●	◒			○			●		
	Building envelope "walls-roofs & windows" The walls are thick of 60-80 cm and this thickness is reduced in the upper floors to 30-40 cm, of local building materials from (karshef). -The ceilings are flat. -The windows are designed to be narrow to increase the speed of air flow and shading inside the dwelling, most of them always open to the courtyard.	●	●	●			◒			●		
	Building materials & construction techniques - The buildings in Siwa Oasis feature Karshef -Salt mud is included in the construction process, while the roof design is trunks from palm trees. The city had no forms of urban vegetation except for spares desert shrubs and a single tree.	●	●	●			◒			●		
	Energy efficiency in building Positive effect of clay material on the building thermal effect during summer and winter -Passive cooling by separating the building narrow paths to create wind movement	●	◒	●				◒		●		
	Daylight strategies Some oasis houses used the wind tower as a lighting tube, in addition, relying on natural light in some buildings and hotels	●	●	●			◒			●		
Total evaluation for the first case study		**60**	**55**	**55**			**25**			**60**		
Jeddah, K.S.A.	Building form - it has a cubical mass of 2-5 floors, Skeleton of four sides that entirely opened, covered with wooden elements (rowshans, mashrabiays, and windows in between), earlier buildings were 2-3 floors, late 19th and early 20th centuries, the high of the buildings become (6-7 floors). High- and low-rise dwellings share similarities in spatial use and each floor has a specific function, almost.	○	◒	●			◒			●		
	Building orientation -The basic dependence of the orientation on the outside.	◒	◒	◒			○			●		
	Building envelope "walls-roofs & windows" Narrow pedestrian ways, Open tracks with quite spacious and intimate spaces and well-aerated squares, which are the lungs of the city.	●	●	●			●			●		
	Building materials & construction techniques The used construction materials indicate the ability of residents to integrate with the surrounding environment - the most common materials used are Coral stone, Wood and Gypsum.	●	●	●			●			●		

Table 2. *Bioclimatic design parameters for building level of the historical case studies to achieve building comfort and sustainability, (by authors)*

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	Energy efficiency in building - The uses of wind catcher, it covers the stair underneath for ventilation and thermal comfort. the staircase creates an airflow pattern that ventilates the spaces around based on using rowshans and mashrabiays. Daylight strategies - Rowshans and Mashrabia are providing daylight and ventilation in interior spaces. - the distance between buildings has impact on daylight especially in compacted buildings like the fabric of old Jeddah	● ●	◒ ●	◒ ◒	○ ○	● ●
Total evaluation for the second case study		**45**	**45**	**45**	**25**	**60**
AL bastakia, Dubai	Building form Building mass was solid, exterior openings were very small protecting the interior spaces from harsh climate. Aligned with traditions and social values	●	●	●	◒	●
	Building orientation - Building oriented N-S for min. solar radiation and max. Exposure to wind & cross ventilation. Evaporative cooling from creek	●	●	◒	○	●
	Building envelope "walls-roofs & windows" Walls: solid walls & minimum openings- Roofs: Thermal mass of thick (0.30m to 0.70m) - Windows: Using high windows	●	●	◒	●	●
	Building materials & construction techniques construction material: Walls of mud blocks, coral stone, palm trunks and straws act as very good insulators- Roof consisting of mud, palm trunks, bamboo, mangrove wood and palm leaves provide good thermal insulation - Floor: Mostly earth over compacted sand. Structural system withstands loads until 3 stories high.	●	●	●	●	●
	Energy efficiency in building Wall thickness gives high thermal mass to the building; thereby reducing and delaying heat gain inside - Shading of walls, openings, courtyards, liwans - Wind Towers Brings in cooler air from higher up	●	●	●	◒	●
	Daylight strategies Windows in they do not have glazing- The wind tower; referred to as barjeel- The air puller (masgat)	●	●	●	◒	●
Total evaluation for the third case study		**60**	**60**	**50**	**35**	**60**
Highly achieved = 10 ●	**Moderate achieved = 5** ◒			**Rarely achieved= 0** ○		

Table 3. *Follow Bioclimatic design parameters for building level of the historical case studies to achieve building comfort and sustainability, (by authors)*

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