World Academy of Science, Engineering and Technology
International Journal of Civil and Environmental Engineering
Vol:13, No:5, 2019

Traditional Sustainable Architecture Techniques and Its Applications in Contemporary Architecture: Case Studies of the Islamic House in Fatimid Cairo and Sana'a, Cities in Egypt and Yemen

Ahmed S. Attia

Open Science Index, Civil and Environmental Engineering Vol:13, No:5, 2019 publications.waset.org/10010369/pdf

Abstract**—**This paper includes a study of modern sustainable architectural techniques and elements that are originally found in vernacular and traditional architecture, particularly in the Arab region. Courtyards, Wind Catchers, and Mashrabiya, for example, are elements that have been developed in contemporary architecture using modern technology to create sustainable architecture designs. An analytical study of the topic will deal with some examples of the Islamic House in Fatimid Cairo city in Egypt, analyzing its elements and their relationship to the environment, in addition to the examples in southern Egypt (Nubba) of sustainable architecture systems, and traditional houses in Sana'a city, Yemen, using earth resources of mud bricks and other construction materials. In conclusion, a comparative study between traditional and contemporary techniques will be conducted to confirm that it is possible to achieve sustainable architecture through the use of low-technology in buildings in Arab regions.

Keywords**—**Islamic context, cultural environment, natural environment, Islamic House, low-technology, mud brick, vernacular and traditional architecture.

I. Introduction

IN the early 20th century, the impact of the industrial revolution led to the vision of different architectural philosophies of schools in both Europe and the United States; Functionalism, Organic Architecture, and International Style. The origin of green architecture is dated back to 1960, when Frank Lloyd Wright raised eco-awareness through his works with nature. In 1969, McHarg Literally wrote a book on green architecture called "Design with Nature" [1].

There was a very early attempt to apply sustainable designs by the Egyptian Architect Hassan Fathy in his project of Gourna village in Nubba region through the use of low technology and the traditional Egyptian Architecture elements; later on Fathy is considered one of the pioneers of sustainable architecture.

In 1988, the sustainable architecture codes began to be introduced at the Building Research Establishment in the United Kingdom (BREEAM). In 2014, the British government signed the codes for sustainable homes. These codes, they have become part of BREEAM family. [1]. In 1993, the United States Green Building Council (USGBC) founded, and controlled the Leadership in Energy and Environmental Standards (LEED) to encourage sustainable practices in design [2].

Ahmed S. Attia (Professor) is with the College of Architecture, and Design, Jordan University of Science & Technology, Irbid, Jordan and Emeritus Professor, Faculty of Engineering, Alexandria University, Egypt (phone: +962-796894341; e-mail: asattia@ just.edu.jo).

II. Architecture within the Islamic Context

The term context in scientific context is more universal and comprehensive than the function, technology and economic aspects in order to reach the best use of the space.

The architecture theories are closer to the mechanical context, while the term "context" includes social, economic and human needs.

As an Islamic architecture which is paired to Islamic values, and the formal values that are associated with local and cultural values of the region.

III. Traditional Architecture in Egypt

A. Islamic House and the Influence of Cultural and Natural Environments

Islamic architecture was formed by ecological civilization which is consists of both cultural and natural environments. The cultural environment consists of the local environment and traditions derived from the Islamic Sharia and Sunnah, and social and economic aspects, while the natural environment includes climate, topography, and available building materials. As an example, the traditional Islamic house in the Fatimid Cairo in Egypt, we can find several examples of which its designs have been influenced by cultural and natural environments. The court is considered the main element surrounded by the house elements; the main entrance is inclined in order to provide privacy.

The Qa'a at the second floor is separated from the other house elements, Mashrabiya, for climate and privacy purposes, wind catchers and Shukhshikhah (Skylight), have been provided for climate purposes and to provide the house with cross ventilation [3].

B. Fatimid Cairo City (Medieval Cairo)

Islamic Cairo City (Medieval Cairo) was founded in 969 A.D. as the Royal city for Fatimid Caliphs. The city was surrounded by walls and characterized by its compacted urban form and its unique architectural style including residential and religious buildings; mosques, mausoleums, fountain

Open Science Index, Civil and Environmental Engineering Vol:13, No:5, 2019 publications.waset.org/10010369/pdf

(Sabil) and school (kuttab), spiritual retreat (khanqahs), and Inn (Wakkalah) and commercial buildings. Fig. 1 shows Fatimid Cairo City Map.



Fig. 1 Fatimid Cairo City Map [4]

C. House of Zainab Khatoun (1784 AD)

The house is located in Fatimid Cairo City, adjacent to Al-Azhar mosque. The house was built in 1784 and consists of a central court yard, overlooked by the house elements, as shown in Fig. 2. The main house lounge for visitors (Al-Qa'a) is located at the first floor; and consists of a central space and two Iwans (rectangular space open on one side) for the living areas, finally topped by a wooden decorated roof that contains the Shukhshikhah (skylight) for lighting and ventilation (Fig. 3) and another lounge or court (Takhtaboush) located at the first floor to provide privacy for the family (Fig. 4). In addition, all openings are covered from the outside by Mashrabiya for climate and privacy purposes (Fig. 5) [6].

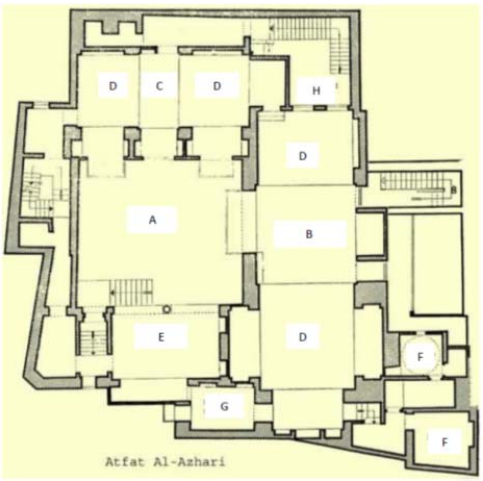


Fig. 2 House of Zainab Khatoun, Ground Floor Plan (1468 AD) [5]

Fig. 2 shows the house plans and the house elements overlooking the walled court yard [1].

A. Court Yard
B. Main Qa'a (for women)
C. Secondary Qa'a (for men)
D. Iwan (living area)
E. Takhtaboush (living area for family)
F. Hammam (bathroom)
G. Master's Quarter
H. Back Yard

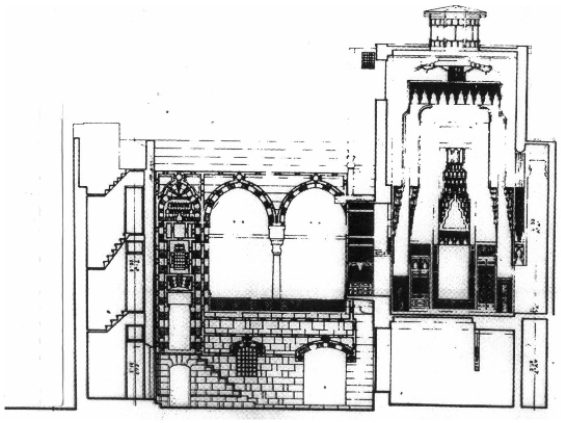


Fig. 3 House of Zainab Khatoun Façade (1468 AD)

The section shows the house main lounge (al-Qa'a) and the Shukhshikhah (skylight) at the top of roof to provide cross ventilation [6].



Fig. 4 The Courtyard

IV. Traditional Architecture in Yemen

According to the different climatic regions in Yemen, it is very obvious that each region is characterized by its unique architecture character and building materials suitable for the climate conditions. The architectural character in each part of the country is different according to the climate, topography, available building materials and traditions. The houses in Tihama, a coastal plain on the Arab Peninsular, are constructed of reeds and mud, because of the hot and humid

Open Science Index, Civil and Environmental Engineering Vol:13, No:5, 2019 publications.waset.org/10010369/pdf

climate, in addition to the influence of Somali traditions, since the area is fronting Somali on the Red Sea (Figs. 6 and 7).



Fig. 5 The Mashrabiya



Fig. 6 Mud and reed hut, Tihama, Yemen [7]



Fig. 7 Group of mud and reed huts, Tihama, Yemen [7]

A. Sana'a City, Yemen

Sana'a city is considered as a model of traditional architecture in the Arab Muslim cities by its coherent urban fabric including markets, mosques residential areas, and hotels (Caravansaries), surrounded by fences or walls. The city streets are characterized by their rich multi-story houses design. They are made of regular stone and mud and are decorated with white plaster motifs. Although mud and stone are often combined in construction for different effect, every part dealt with in a distinct way to expresses the architectural language of both stone and mud in a harmonious way (Fig. 8) [8].

The ground floor contains the main entrance, the living room for guests and a store for seeds and a water well. The top floor contains a second guest room following a rectangular shape; its dimensions vary from 3x7 m to 4x8 m and are used for social gatherings, such as gat (a native flowering plant used as a stimulant) meetings.

Traditional House in Sana'a City, Yemen

A traditional house in Sana'a city is considered unique from other parts of the country, and is characterized by its multiple floors which could reach from 5 to 7 floors in most cases, and are either constructed from stone or of a mixture of both stone and mud brick (Figs. 9 and 10).



Fig. 8 Map of Old Sana'a City, Yemen [9]



Fig. 9 Traditional house in Sana'a city (mud bricks construction)



Fig. 10 Traditional house in Sana'a city (stone construction)

Open Science Index, Civil and Environmental Engineering Vol:13, No:5, 2019 publications.waset.org/10010369/pdf

The house design is considered a sustainable design as it was constructed according to the climate conditions, and the available building materials of stone and mud. The building facades contain ornaments, although it is not similar but it forms harmonious masses overlooking the narrow paths from both sides, each house contains a back yard as a small farm to provide vegetables for the family.

Window openings are covered from the outside by Mashrabiya which are composed of stone or wood to provide ventilation, block out sunlight and to provide privacy for the people inside the house (Fig. 11). In addition, the windows have mounting semi-circular slots (Qamariya) made of white gypsum and stained colored glass in geometric shapes [10].

V. Early Attempts of Sustainable Architecture at the Start of the 20th Century

While some states in the Arab World were impressed with the modern architectural trends, it was Egyptian Architect Hassan Fathy (1900-1989), who applied sustainable design through traditional architecture and low-technology.

The continuous development of sustainable architecture was due to the impact of technological developments and the damage that appeared in the environment and their climate.

At a later stage, the approach of sustainable architecture has been developed and applied, with the objective to lower the negative impact of buildings on the environment [10].

Hassan Fathy Works

The design of the New Gourna village in Upper Egypt reflects Fatty's philosophy which is targeted as architecture for the people. He applied the principles of Egyptian Vernacular, traditional architecture, and low technology through the use of mud that is the most available building material. The court yard, the domes and vaults were examples of traditional architecture elements. In addition, there were small openings to adopt environmental conditions and are considered sustainable (Fig. 12).



Fig. 12 The New Gourna Village, Nubba, Egypt [11]

Wind Catchers in Dubai

The wind catchers found in the traditional house in Dubai is considered one of the main architectural elements of homes in other Arab regions. Fig. 13 shows the wind catcher in a house in Dubai.



Fig. 13 Wind Catchers in Dubai [12]

VI. The Use of Traditional Elements in Modern Architecture

A. The American University in Cairo (AUC), New Campus

The planning and design of the American University new campus, which is located in the New Cairo Community, and designed by Architect Abdel Halim Ibrahim, opened its doors for the first classes stated in the fall of 2018. The new 260-acre campus was planned and designed as "City of Learning" to serve 7,000 students. The plan contains several elements from local Islamic architecture in Egypt, such as court yards, wind catchers (Malkaf), which work as a cooling element and provide continuous cross ventilation, as well as the Mashrabiya that provide both ventilation and privacy, which combined reflect the local and traditional architecture in a modern way (Fig. 14) [12].



Fig. 14 American University Campus, New Cairo [13]

B. Qatar University, Doha, Qatar

The University of Qatar in Doha, which was established in 1973, started with one college of a total number of 150 students, and by the year 2006 had reached 7,660 students and a new campus on 2,000 acres.

The campus design and planning has followed Islamic traditional architecture, where the overall design contains covered court yards and wind catchers (Malkaf), which have been used for cooling and ventilation (Fig. 15) [14].

Open Science Index, Civil and Environmental Engineering Vol:13, No:5, 2019 publications.waset.org/10010369/pdf

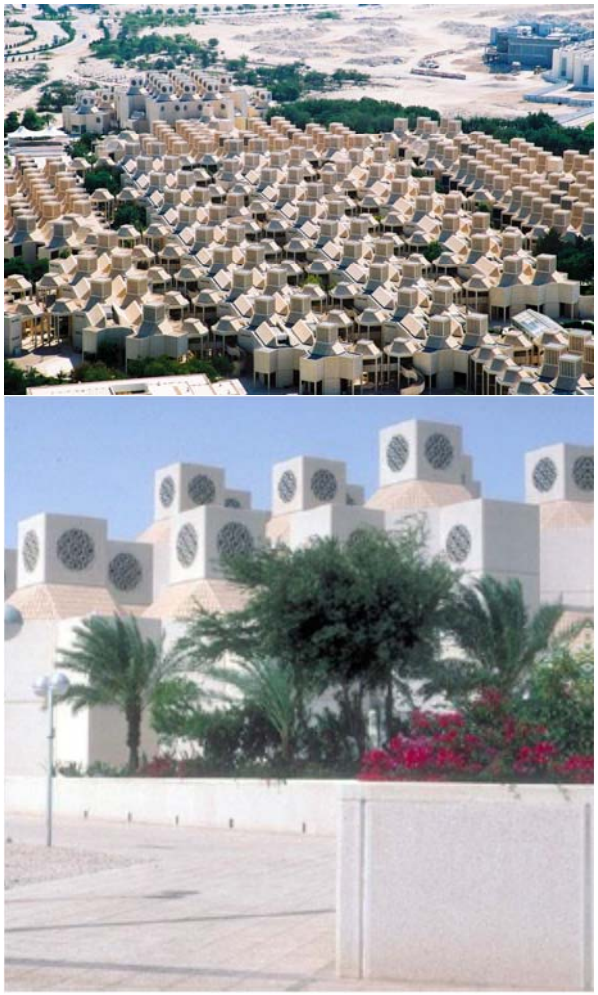


Fig. 15 Wind Catchers (Malkaf), Qatar University Campus, Doha [15]

Masdar City, Dubai, UAE

Masdar City in Dubai, design and plan covers an area of around 17 km^2, and is considered as a sustainable mixed-use development. The design applies several Islamic architectural elements to suit the local climate; the buildings include window openings similar to the Mashrabiya, in addition to a double skin to protect the facades from sun, and wind catchers (Malkaf) for cooling. Moreover, some of the external yards were covered to provide shade from the sun (Figs. 16 and 17). The Incubator Building is also home to the first LEED CI-certified office in Abu Dhabi [16].

VII. Conclusion

The selected Islamic traditional architecture examples presented in this study from constructions in Egypt, Yemen and Dubai show that the used elements in these buildings; courts wind catchers, and Mashrabiya, are used in contemporary sustainable designs by employing advanced technology.

International interest in sustainable designs has begun to be essential since the establishment of the Building Research Environmental Assessment Method (BREEAM) in 1988, in the United Kingdom, and the Leadership in Energy and Environmental Design (LEED) in 1993, in the United States. Meanwhile, there was an early attempt for sustainable architecture applications in 1946 by Hassan Fathy in the design of New Gourna Village, in Upper Egypt, and in 1960, by Frank Lloyd Wright when he raised eco-awareness through his works with nature.



Fig. 16 Widows Opening, Masdar City, Dubai [16]



Fig. 17 External Yards, Masdar City, Dubai [16]

References

[1] BREEAM hhttp://www.greenbooklive.com/search/scheme.jsp?id=8.
[2] Green Architecture: Past, Present and Future. https://recyclenation.com/2015/06/green-architecture- Past-present and future/Sustainable Development Goals.
[3] Mustafa, S. L. (1984). Islamic Architectural Heritage in Egypt. Dar Al-Nahda Al-Arabia, (In Arabic).
[4] Fatimid Cairo Map https://www.google.com/search?source=hp&ei=E1aZXJmoCIbNwQK7uIXQBg&q=fATIMID+cAIRO+MAP&btnK=Google+Search&oq=fATIM.
[5] Zainab Khatoun House, Plan https://www.google.com/search?q=zainab+khatoun+house+plans+cairo&tbm=isch&source=.
[6] The Basic for Architectural Design and Urban Planning. The Centre of Planning and Architectural Studies and Centre for Revival of Islamic Architectural Heritage for the Organization of Islamic Capitals and Cities. (1990).
[7] Traditional Houses in Tihama Yemen https://www.google.com/search?q=The+reed+houses+in+tihama+yemen&tbm=isch&source=iu&ictx=1&fir=43Qs-.
[8] Ahmed S. Attia, "Traditional Architecture in Yemen", Published and presented, The International Conference & Exhibition on Architecture,

of Cities, Calcutta, India, 16-20 November, 1990.
[9] Plan of old Sana'a City, Yemen https://www.google.com/search?q=old+sanaa+city+map&tbm=isch&source=.
[10] Veranda, F. (1981). Art of Buildings in Yemen. MIT Press, USA.
[11] Fathy, H. (1987). Architecture for the Poor. University of Chicago Press, Chicago, IL, USA.
[12] Wind Catchers of Dubai https://www.google.com/search?q=traditional+windcatchers&tbm=
[13] American University, New Campus, Cairo, Egypt. https://www.fluor.com/projects/cairo-egypt-university-project-management.
[14] Salama, A. (2014). Interrogating the Practice of Image Making in a Building Context. Archnet-IJAR, Volume 8 – Issue 3 – November 2014 – (74-94).
[15] Qatar University Campus https://archnet.org/sites/288/media_contents/11150.
[16] Masdar City, Dubai https://www.google.com/search?q=masdar+city&tbm=isch&source=iu&ictx=1&fir.

Open Science Index, Civil and Environmental Engineering Vol:13, No:5, 2019 publications.waset.org/10010369/pdf