



## **Learned Lessons from Traditional Architecture in Yemen -Towards Sustainable Architecture**

Ahmed S. Attia

College of Architecture & Design, Jordan University of Science & Technology, Irbid 22110, Jordan

Corresponding Author Email: [asattia@just.edu.jo](mailto:asattia@just.edu.jo)

<https://doi.org/10.18280/ijstdp.170418>

### **ABSTRACT**

**Received:** 15 June 2022

**Accepted:** 13 July 2022

#### **Keywords:**

*traditional architecture, indigenous knowledge, Islamic perspective, tower house, Qamariya*

This paper explores the Learned Lessons from traditional Yemeni Architecture Towards Sustainable Architecture. It highlights how the local context influences the traditional architecture in Sanaa city and different regions of Yemen and Arab regions, according to nature, climatic conditions, culture, traditional values, and indigenous knowledge. Overview for sustainability during the twentieth century, sustainability and the Islam perspective in the Arab region, and selected the traditional architecture in Yemen as a case study. In addition to the analysis analyzed the city's urban form and the traditional house in Sana'a city, the design and elements of the house; spatial organization, construction systems and building materials, and window openings. Ornaments and sewerage systems. The study summarizes the aspects of sustainability in the traditional house in different regions in Yemen as an indigenous traditional knowledge for sustainable architecture. In conclusion, the traditional houses in the house in Yemen, designed according to the local context and indigenous traditional knowledge, have influenced traditional Yemeni architecture; the house elements and design fulfills sustainable requirements and positively impact the city's environmental, economic, and social aspects. Furthermore, it is considered a learned lesson from traditional architectural heritage and indigenous traditional knowledge toward sustainable architecture.

## **1. INTRODUCTION**

The research highlights lessons from traditional architecture in Yemen by studying the different architectural house designs in different Arab regions and Yemen, emphasizing the traditional house design (Tower House) in Sana'a city, and overview of Sustainability back to 1969, according to the mandates adopted by IUCN [1], where the concept was to achieve economic growth without damaging the environment. Moreover, international environmental policies at the United Nations Conference on Human Environment, known as the Stockholm conference, convened under the UN in 1972, was an essential turning point toward sustainability. Also, the research highlighted sustainability from the Islamic perspective, as many Arab regions have traditional architecture influenced by the local environment, which meets the Islamic teaching.

Furthermore, by analyzing the city's urban form and the house design, building materials and elements are considered a learned lesson towards sustainability as it fulfills the three dimensions of sustainability.

In addition, the study of some examples of the traditional houses in the Arab region and Yemen. A comparison of the house forms in different regions in Yemen found that the traditional architecture in Yemen fulfills the three dimensions of sustainability (environmental, social, and economic aspects). Also, it is considered a learned lesson toward sustainable architecture, where the indigenous traditional knowledge used in house design and construction is a lesson to be learned toward applying sustainability.

## **2. METHODOLOGY**

The research included an overview of sustainability from the Islam perspective in the Arab region and selected examples of the traditional houses in the Arab region and Yemeni architecture as a case study, which found that the house design differs from one region to another due to local context, surrounding nature, culture, climate, and local traditions.

Moreover, it started with studying the geographical location of Sana'a city, the urban city form, its parts, and the market area planning and architectural character. The survey and analytical study for the traditional house (Tower House) in Sanaa city included; the traditional house construction system, building materials, spatial organization, openings, windows, ornaments, and sewerage systems. Also, the house design in other regions found that city planning and architecture design are sustainable and influenced by local context, surrounding environment, climate, culture, and economic aspects. Moreover, study the recent attempts in the Arab region by applying traditional elements using modern techniques.

## **3. HISTORICAL OVERVIEW OF SUSTAINABILITY**

### **3.1 Sustainability during the twentieth century**

Sustainability started fifty-three years ago, during the mandates adopted by IUCN in 1969. The concept was to achieve economic growth without damaging the environment. Moreover, the new concept of sustainability consists of three

dimensions; environmental, social, and economical, and the IUCN Program 2005-2008 used the integration of the three pillars [1]. Also another essential turning point by developing environmental policies internationally at the United Nations Conference on Human Environment (known as the Stockholm Conference), which convened in 1972 [2]. Furthermore, the modern state of sustainability appeared in the Brundtland Report, titled "Our Common Future," published in 1987 by the United Nations [3].

The early 20th century, due to the industrial revolution, led to a different view of the philosophy of architecture. The trends of organic architecture in the functional and international style emerged in Europe and the United States of America. In the 1960s, The Green Architecture was referred to by the architect Frank Lloyd Wright who raised Eco Awareness and called through his work the first definition of sustainability in 1987 in "the United Nations World Commission on Environment and Development in the Report Titled "Our Future," and also known as Brundtland report," where it based on the three pillars of sustainability; economy, sociology, and environment [4] (Figure 1) Moreover, the United Nations conferences on Environment and Development (UNCED), known as the "Earth Summit," was held in Rio de Janeiro, Brazil, in June 1992 [5].



**Figure 1.** Three main pillars of sustainability

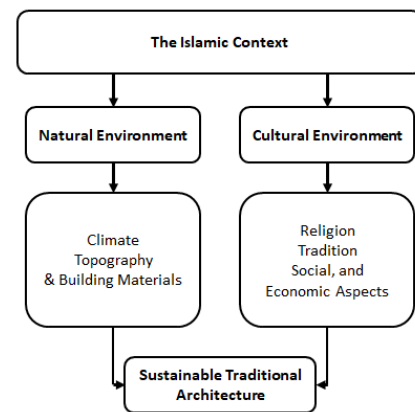
In the Arab region, some architects show interest in sustainable architecture during the same period. The Egyptian architect Hassan Fathy was one of those architects who applied the principles of sustainable architecture in the Village project of New Gournia in Nubia (Figure 2) [6]. Fathy used low technology in construction works and mud as a local building material. In addition to the architectural elements, domes, vaults, and courtyards. Fathy was later considered one of the first architects who applied sustainable architecture in the Arab Region.



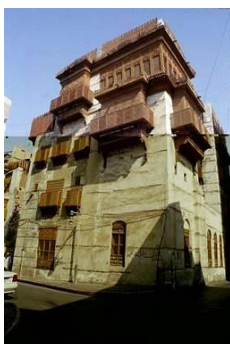
**Figure 2.** New Gournia Village. Architect: Hassan Fathy [6]

### 3.2 Sustainability and the Islamic perspective

"The idea of sustainability in Islam is not new"; it includes economic, social, environmental, ecological, biodiversity, and human values [4, 7]. Muslims are among their traditions associated with preserving the environment and nature through the creation of societies and social and economic activities, and the environment is similar to the three pillars of sustainability [6, 8]. Islam encourages social relations and establishes rules in dealing with them, social and economic growth through the teachings of Islam zakat, where Islamic economic rules which applied through the Qur'an. Figure 3. It shows the Islamic context and sustainability. (Figure 4. a, b, c) shows the traditional house elements in selected Arab cities, a. Jeddah, b. Cairo; Mashrabiyyah, which provide privacy and cool air for the house, and c. The windcatcher (Malkaf) in one of the traditional houses in Dubai provides cross ventilation.



**Figure 3.** The Islamic Context and Sustainability



**a.** Traditional House, Jeddah, Saudi Arab [9]



**b.** Gamal Al-Din Al-Zahabi House. In Old Fatimid City, Cairo, Egypt.



**c.** Wind Catcher (Malkaf), in a traditional house, Dubai, UAE [10]

**Figure 4.** Examples of traditional house architecture in Arab regions

#### 4. TRADITIONAL ARCHITECTURE IN YEMEN

#### 4.2 City of Sana'a

##### 4.1 The geographical location of Yemen

Yemen stands in the southern part of the Arab Peninsula. To the southwest and the south, it faces the Red Sea, Aden Gulf, and Indian Ocean. Yemen's geographical location provided an opportunity to contrast with surrounding countries (Figure 5). Because of geographical, natural, and climatic diversity in Yemen, building materials are also diverse, and this diversity has its bearing on urban and rural architecture (Figure 6. a, b, c).

Sana'a city stands in the center of Yemen on a high plateau, about 2300 meters above sea level. In 2020 the population reached approximately 3,939,500 (Sana'a Governorate [14]). The population density amounts to 348 persons per km<sup>2</sup>, and its privilege is as early as the pre-Islamic period. The city is overgrowing, swallowing up the surrounding villages. The city is separated into three parts by a wall and gates until the revolution (Figures 7, 8), each with a distinctive architectural character and style.

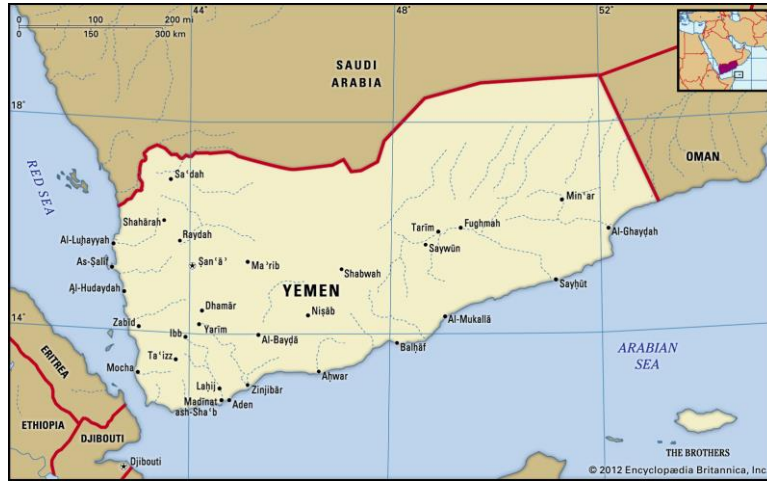


Figure 5. Yemen Geographical Location [11]



a. Reed huts in the Tehama region [12]



b. Stone house in Midlands



c. Mud walls house in the Eastern Plateau [13]

Figure 6. Different types of Yemeni houses

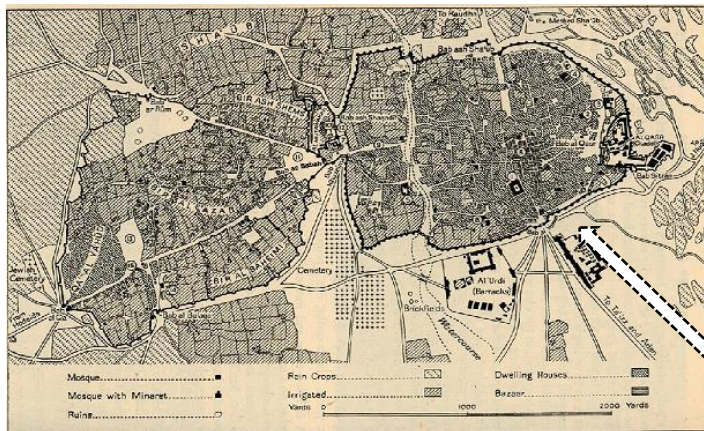


Figure 7. Map of Sana'a City, 1940, and its parts [15]

The three parts of Sana'a city:

- 8. The Eastern part., 11. Bir Al-Azab part, 15. Jewish quarter



Figure 8. Sana'a city gate



These sections are the eastern part of the city: the city's bulk comprises old residential areas and mosques, and the buildings of this part distinguish luxury, decoration, and height of buildings. Before the revolution, the middle part was called "Bir al-Azab" and contained a collection of gardens and orchards, including some of the imam's palaces. Their windows consist of decorative wood instead of windows, and the contracts (Qamariya) and decorated with colored stained glass. The third part was home to the Jewish residential area, including several brothers, narrow alleys, and a small market.

### 4.3 The urban structure of Sanaa's City

#### 4.3.1 The urban form

The city's urban form is compacted urban tissue combining rural and urban characteristics, similar to Yemen's other regions. Verticality features that houses consist of multiple floors with narrow pedestrian passages and public spaces. The streets and passages have front doors which are articulately designed and painted with white stucco and built of stone or brick (both crude or burnet) and sometimes of both, which gives an esthetic value.

#### 4.3.2 The market area

There are two market systems in Yemen open urban markets, which are always adjacent to the large mosque, and there is a clear separation between the housing and market areas by gates (Figures 9, 10, 11). In addition a clear distinction between the productions, area, and trade with the presence of areas reserved for agricultural products. However, the workshops located outside the market center and the general urban fabric of the old market area contain a building lower than the rest of the city [13].

It has a one-story shop and brokerage buildings serving as a khan (small hotel). It consists of two floors and rest places such as cafes, restaurants, artisan workshops, public bath buildings, public bathrooms scattered throughout the market area, and the weekly rural market network, including market buildings, shops, and inns buildings. The marketplace location in the south-eastern part of the city is adjacent to the Great Mosque. It contains two main streets from the south to the north (from Bab Al-Yemen to Bab Sho'uob) and the second from east to west (Bab al-Qasr) penetrating the Cow market to Bab Sana'a), and is characterized by its urban composition and their central location in the surrounding residential area.

In addition, there are public baths close to mosques and used for ablution, cafes, restaurants, and workshops. The significant small mosques and their minarets were built of bricks and decorated with white stucco in geometrical shapes and seen through spaces and passages and combined with the city skyline giving a unique characteristic to the city (Figure 12).

The market area contains a network of narrow intercepted passages used as a means of transport in the past and as spaces for children's play and social activities such as wedding celebrations, several store buildings, cargo warehouses, and brokerage buildings.

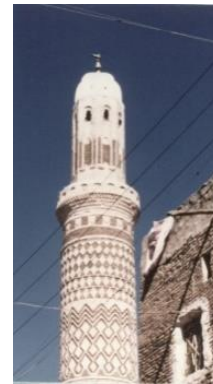


Figure 11. Mosques Minarets

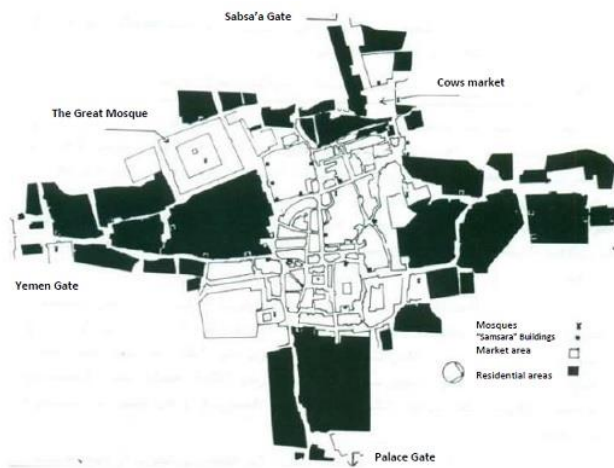
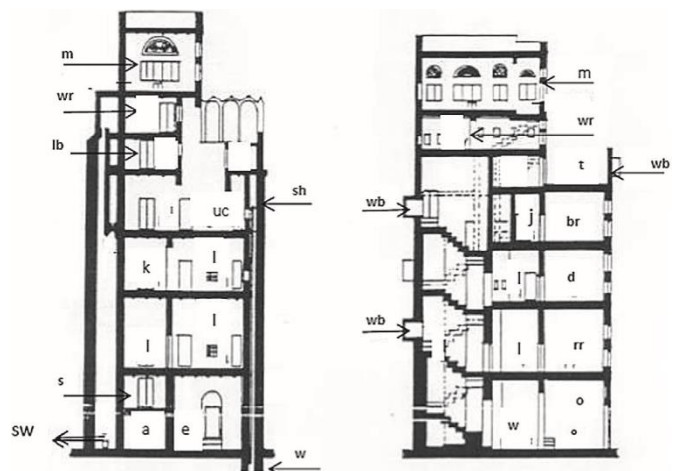


Figure 9. Old Suqs (Market) area in Sana'a city [13]



Figure 10. Gates separate between market and residential areas and Mosques Minarets



- e: entrance
- a: animal's stalls
- s: store
- SWR: sanitary waste room
- w: water well
- d: dewan
- k: kitchen
- uc: upper court
- lb: lavatory/bathroom
- wr: women's room
- m: mafraj
- o: loading mounting animals
- rr: reception room & business
- br: bedroom
- t: terrace
- j: grain and fruit store
- wb: window box (Mashrabiyyah)

Figure 12. Spatial organization of the Traditional multi-story house (Tower House) in Sana'a [13]

## 5. THE TRADITIONAL HOUSE (TOWER HOUSE) in SANA'A CITY

The multi-story houses (Tower House) characterize the city of Sanaa as in other cities and some rural areas, where the multi-story house are considered the forms of residential communities in Sanaa city similar to other traditional Islamic towns [16].

### 5.1 Spatial organization of the traditional house (the tower house)

The house's main entrance is a wooden door, richly decorated, and consists of multiple floors containing the "Diwan," a reception, and the private rooms, including the living, dining, and bedrooms. The "Mafraj" lies on the house roof and serves as a reception place for close friends of the landlord (Figures 12, 13). Moreover, the spatial organization of the Yemeni house secures strict privacy and segregation for women and men, according to Islamic traditions. Each house contains a manual mill, a well, and a complete sewage system, where separating the liquid from solid waste is collected and dried to serve as fuel for the public baths or even as fertilizers [17].



**Figure 13.** The Traditional House (Tower House) in Sana'a City

### 5.2 Construction system and building materials

The house usually was constructed on a solid foundation of basalt stone at a depth of half a meter and a meter from the land surface. The external walls of the first two floors consist of courses of limestone with some black stone inlaid at the wall corners (Figure 14 a, b). The upper floors consist of burnt mud bricks, the ceilings consist of wooden beams, and above it, perpendicular steams of lesser size and covered with clay mixed with straw as a concrete mortar secure bond.

### 5.3 Openings, widows, and ornaments

The decorations characterize the Yemeni house of different arches, "Qamariya," in different shapes surrounded by white stucco, and used projected windows to cool water pottery

vessels and provide privacy for the house residents (Figure 15 a, b).



(a)

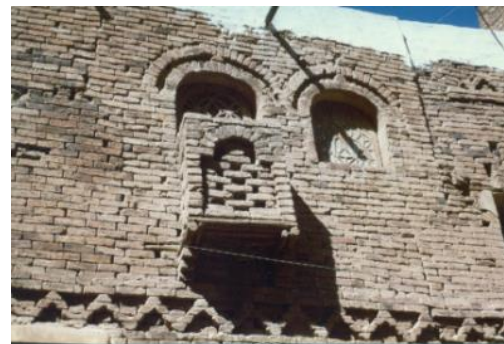


(b)

**Figure 14.** Different building materials are used in the Traditional multi-story house (Tower House) in Sana'a city



(a)







(b)

**Figure 15.** Different types of window openings and the Mashrabiya in the traditional house (Tower House) in Sana'a city

### 5.4 Sewerage system

The liquid drainage goes on the outer wall isolated by lime paint after being separated from solids and the solid waste material used as fuel for public baths.

**Table 1.** Aspects of sustainability in the traditional Yemeni house in different regions

#	Region	Construction System & Building Materials	Indoor environment quality	Energy Efficiency	Water Efficiency	House form
1	Tehama Coast	Mud & Plant Reeds	Use of small window openings	Use of mud thick walls and ceiling from reeds	Water basin to collect rainwater	 Source: [12]
2	Midlands	Stone walls	Use of windows and Qamariya	Use of stone walls	Water basin to collect rainwater	
3	Highlands (Sana'a city)	Stone & Mud Bricks	Use Mashrabiyyah and Qamariya	Use of stone-bearing walls and mud-brick	Water well to collect rainwater	
4	Eastern Plateau	Mud walls	Use of window openings and Qamariya	Use of mud walls	Water basin to collect rainwater	 Source: [13]

## 6. TRADITIONAL ARCHITECTURE IN YEMEN AND SUSTAINABILITY

Local context influences the Traditional architecture in Yemen surrounding nature, culture, tradition, and climate. The house's design and architecture are different in each region and constructed according to; topography and the local building materials. On the Tehama coast, the houses build material from mud and reeds; on high lands built from stones, mud bricks, and mud walls on the eastern plateau (Table 1). The house's spatial organization and design provide privacy for residents and the architectural elements; windows, Qamariya, and Mashrabiyyah provide natural lighting, ventilation, and privacy.

The construction system used is bearing walls that protect the house from the hot and cold climate and ensure energy saving. The window openings are topped by "Qamariya" and provide adequate natural lighting and ventilation, and the "Mashrabiyyah" provides ventilation and privacy according to the traditions. Moreover, in most of the city's houses, there is a water well, a backyard "Bustan" for agricultural vegetables, and in villages, a water basin to collect rainwater from re-using it in agriculture. Furthermore, the sewerage system and its waste as a fuel for public baths preserve the environment from pollution.

Furthermore, the houses in Sana'a contain water well, while in rural areas, it contains a basin to collect rainwater and use it in agriculture [18]. Also, use the sewerage waste as fuel for public baths and natural fertilizers. The house architecture elements, building material, and openings significantly impact energy saving and efficiency [19]. It was evident from studying that local context and indigenous traditional knowledge have influenced traditional Yemeni architecture [20, 21].

## 7. SUSTAINABLE ARCHITECTURE APPLICATIONS IN THE ARAB REGION

### 7.1 European influence on Arab regional architecture

While European architecture influenced the Arab region's architecture during the twentieth and the beginning of the twenty-first centuries through the application of the International style of the glass skyscrapers (Figure 16) Dubai tower, which led the Arab cities to lose their identity, many Arab architects' moved toward new modern approaches that integrated the building and environment towards sustainability.



**Figure 16.** Doha City center and skyscrapers [22]

### 7.2 Application of traditional architectural elements and techniques

7.2.1 American University New Campus, New Cairo, Egypt  
The American University's New Campus in Cairo which designed by the Egyptian architect Abd Al-Halim Ibrahim and opened in 2018. The university buildings contain much



traditional Islamic architecture; stone walls provide temperature insulation, Mashrabiya for privacy and cross ventilation, and courtyards provide social interaction and shade (Figure 17) [23].

### 7.2.2 Qatar University, Doha

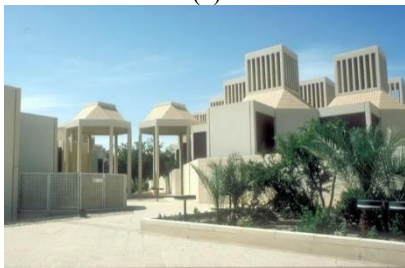
In 1973 the university was established following the planning and design of traditional Islamic architecture buildings, which contain internal courtyards and wind catchers (Malkaf), (Figure 18 a, b) that provide continuous ventilation and ventilation. Techniques [24].



**Figure 17.** American University, New Campus, New Cairo [23]



(a)



(b)

**Figure 18.** The wind catchers (Malkaf) and courts, Qatar University Campus, Doha [25]

## 8. CONCLUSION

It is concluded from the previous study that the traditional house architecture in Yemen and other Arab regions has been influenced by the Islamic context, cultural and natural environment also, while international architecture schools have influenced the contemporary architecture in the Arab region in both Europe and the United States, the International style and skyscrapers glass boxes. It is evident that by the end of the twentieth century and the beginning of the twenty-first century, some Arab Architects applied the principles of the

traditional architectural elements using modern techniques, economy, sociology, and environmental aspects, which fulfills the sustainable architecture requirements regarding economic, sociology and environmental aspects.

In conclusion, traditional architecture in Yemen and other Arab regions has rich indigenous knowledge of sustainable architecture and contains the three pillars of sustainability; environment, social, and economic. Similar to the synth of sustainable definitions set by international organizations, and is considered a lesson to be learned toward sustainable architecture.

## REFERENCES

- [1] Adams, W.M. (2006). The future of sustainability: Rethinking environment and development in the twenty-first century. Report of the IUCN Renowned Thinkers Meeting, pp. 29-31. <https://portals.iucn.org/library/node/12635>.
- [2] UNESCO. (1972). Convention concerning the protection of the world cultural and natural heritage. The General Conference at its Seventeenth Session Paris. <https://whc.unesco.org/archive/convention-en.pdf>.
- [3] WCED. (1987). World commission on environment and development. Our Common Future. Oxford University Press, New York. <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>, accessed on March 10, 2022.
- [4] Brundtland Report. (1987). <https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html>, accessed on March 10, 2022.
- [5] United Nations Conference on Environment and Development-UNCED. (1992). <https://www.unsystem.org/content/unitednations-conference-environment-and-development-unced-1992>, accessed on March 10, 2022.
- [6] New Gournia Village. [www.bing.com/images/search?view=detailV2&ccid=abBRz7DP&id=DF68E08CBF22E342350CB5C8616DD5AD5D15B985&thid=](http://www.bing.com/images/search?view=detailV2&ccid=abBRz7DP&id=DF68E08CBF22E342350CB5C8616DD5AD5D15B985&thid=), accessed on March 10, 2022.
- [7] Abdussamad, S. (2021). Islamic perspectives: An Alternative to the existing model of social sustainability in architecture. Astrolabe: A CIS Student in Research Engineering Journal. <https://www.hbku.edu.qa/sites/default/files/islamicperspectivearchitecture.pdf>.
- [8] Sarkawi, A., Abdullah, A., Dali, N.M. (2016). The concept of Sustainability from Islamic Perspectives. International Journal of Business and Law, 9(5). <https://www.semanticscholar.org/paper/The-concept-of-sustainability-from-the-Islamic-Sarkawi-Abdullah/7d6fb3c376b2afbee8098f33bd0f77cec326720>
- [9] Traditional House, Jeddah, Saudi Arabia. [www.bing.com/images/search?view=detailV2&ccid=ZtkD7CWs&id=354413B64240B23DBFDDDBE1CFB337871F2A50AC&thid=OIP.ZtkD7CWszexUnom3mJ6bcwHaJQ&mediaurl=https%3a%2f%2fi.pinimg.com%2f736x%2f31%2f24%2f0](http://www.bing.com/images/search?view=detailV2&ccid=ZtkD7CWs&id=354413B64240B23DBFDDDBE1CFB337871F2A50AC&thid=OIP.ZtkD7CWszexUnom3mJ6bcwHaJQ&mediaurl=https%3a%2f%2fi.pinimg.com%2f736x%2f31%2f24%2f0), accessed on March 10, 2022.
- [10] Wind Catcher (Malkaf). [www.bing.com/images/search?view=detailV2&ccid=3uNM8hAe&id=6AB9441E55D1AE4A38F28DED15C88](http://www.bing.com/images/search?view=detailV2&ccid=3uNM8hAe&id=6AB9441E55D1AE4A38F28DED15C88)

- E4BF5EE8A9E&thid=OIP.3uNM8hAegtG3i3ERzu0cAgHaFj&mediainurl=https%3A%2F%2Fstaticflickr.com%2F6%2F5613%2F1, accessed on March 10, 2022.
- [11] Yemen. Map. Encyclopedia Britannica. (2021). [www.britannica.com/place/Yemen](http://www.britannica.com/place/Yemen), accessed on March 10, 2022.
- [12] Geography of Yemen. (2009). Reed Huts in Tehama Coast. [www.bing.com/images/search?view=detailV2&ccid=k7YkD0j9&id=12D6F32F905CC9666F7ED6112CB72E32B89C0C5D&thid=OIP.k7YkD0j9kHyk5uqHi5tIoAHaDt&mediainurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.93b6240f48fd907ca4e6ea87](http://www.bing.com/images/search?view=detailV2&ccid=k7YkD0j9&id=12D6F32F905CC9666F7ED6112CB72E32B89C0C5D&thid=OIP.k7YkD0j9kHyk5uqHi5tIoAHaDt&mediainurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.93b6240f48fd907ca4e6ea87), accessed on March 10, 2022.
- [13] Veranda, F. (1982). *Art of Buildings in Yemen*. Massachusetts Institute of Technology. Cambridge, Massachusetts. The MIT Press.
- [14] Sana'a Governorate. (2020). [www.google.com/search?q=sanaa+governorate+population&source=hp&ei=vC2zYaKnCIekUJrj\\_AC&ifsig=ALs-](http://www.google.com/search?q=sanaa+governorate+population&source=hp&ei=vC2zYaKnCIekUJrj_AC&ifsig=ALs-), accessed on March 10, 2022.
- [15] Sanaa city map. (2020). [www.bing.com/images/search?view=detailV2&ccid=LMasONO2&id=CD062EB4FB26B161626439A07674D6C99C5639DF&thid=OIP.LMasONO2HK314rUuyOj-](http://www.bing.com/images/search?view=detailV2&ccid=LMasONO2&id=CD062EB4FB26B161626439A07674D6C99C5639DF&thid=OIP.LMasONO2HK314rUuyOj-), accessed on March 10, 2022.
- [16] Attia, A.S. (2020). Traditional multi-story (Tower House) in Sana'a City, Yemen. An example of sustainable architecture. *Alexandria Engineering Journal*, 59(1): 381-387. <https://doi.org/10.1016/j.aej.2020.01.001>
- [17] Serjant, R.B., Lewcock, R. (1983). *Sanaa' an Arabian Islamic City*. World of Islam Festival Trust, London, Pinehurst Press Ltd.
- [18] Alabsi, A.A.N. (2013). The application of traditional building technologies in contemporary architecture in Yemen. Tongji University in conformity with Master of Architecture, China. <https://doi.org/10.13140/RG.2.2.23979.39202>
- [19] Abdallah, M.R., Hassan, H.A., Abbas al-Olofi, A. (2020). Traditional Yemeni architecture and its impact on energy efficiency. *International Journal of Engineering Research and Technology*, 13(8): 2014-2022. <https://doi.org/10.37624/IJERT/13.8.2020.2014-2022>
- [20] BREEM History. <https://en.wikipedia.org/wiki/BREEAM>, accessed on March 10, 2022.
- [21] Attia, A.S. (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. *World Academy of Science, Engineering and Technology, International Journal of Civil and Environmental Engineering*, 13(5): 266-271. [www.researchgate.net/publication/333175533\\_](http://www.researchgate.net/publication/333175533_), accessed on March 10, 2022.
- [22] Doha city center skyscrapers. [www.bing.com/images/search?view=detailV2&ccid=nc3hwmC4&id=4EBD79BE97B9B9B2A0BFCAD0072B642530D971D8&thid=OIP.nc3hwmC4GPUUZNY5LSdynAHaE7&mediainurl=https%3A%2F%2Fthumbs.dreamstime.com%2Fb%2Fview-city-center-skyscrapers-other-side-sea-Doha-Qatar-](http://www.bing.com/images/search?view=detailV2&ccid=nc3hwmC4&id=4EBD79BE97B9B9B2A0BFCAD0072B642530D971D8&thid=OIP.nc3hwmC4GPUUZNY5LSdynAHaE7&mediainurl=https%3A%2F%2Fthumbs.dreamstime.com%2Fb%2Fview-city-center-skyscrapers-other-side-sea-Doha-Qatar-), accessed on March 10, 2022.
- [23] American University New Campus, New Cairo, Egypt. <https://www.fluor.com/projects/cairo-Egypt-university-project-management>, accessed on March 10, 2022.
- [24] Qatar University Campus. [www.archnet.org/sites/288?media\\_content\\_id=25264](http://www.archnet.org/sites/288?media_content_id=25264), accessed on March 10, 2022.
- [25] Qatar University - Wind Catchers. [www.archnet.org/sites/288?media\\_content\\_id=11159](http://www.archnet.org/sites/288?media_content_id=11159), accessed on March 10, 2022.