Original Article

Environmental and cultural sustainability of the architectural elements of two historical mosques in historic Jeddah

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Abstract
The research reviews the environmental and cultural sustainability of the architectural elements of two mosques in the historical area of Jeddah, Al-Shafi'i Mosque and Al-Mimar Mosque. Through the research methodology, the environmental and cultural sustainability of the two mosques in the historical Jeddah area were compared, as how they were treated and reused in different ways and the architectural elements were analyzed. The results of the research indicate that sustainability. The environment is rebuilding some walls, reducing waste by using existing walls, not using new materials as much as possible, and reducing the entry of solar radiation into the building through wooden windows (Roshan). As for cultural sustainability, it is through contributing to a pioneering project that achieves the rehabilitation of the mosque to increase the number of worshipers and its use by visitors and residents of the city of Jeddah to be a distinguished center for reviving the meetings of the people of old Jeddah and enriching the social environment. As for economic sustainability, it is through the financial return of commercial activities around the mosque, the creation of job opportunities for Saudi youth, and the work of a distinguished pioneering project to encourage government agencies and real estate owners in the historical area of Jeddah, to carry out similar projects that support the development and economic sustainability, and achieve the vision of the Kingdom of Saudi Arabia 2030, as the most important recommendation for research.

Keywords Al-Mimar mosque · Al-Shafi'i mosque · Cultural sustainability · Environmental sustainability · Historic buildings · Sustainability

JEL Classification R00 · R01

1 Introduction

One of the main pillars of civilized Islamic societies is preserving religious and cultural heritage. Islamic culture and the community has accepted these values, and year after year, the upcoming rulers and government took the norms of their customs, laws, control of mechanisms, and the behavior of individual of the locality. Religious values concertize architecture's sensitive and physical aspects, adopting the design according to Islamic principles, which follow privacy preservation. Avoid the construction of the tallest building in front of old cultural mosques or front of religious places. Religious values also concern profligacy and wastefulness in decorating buildings, places, and mosques, and architects focus more on simplicity and

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inattention. The provision of religious building construction for worship is to give material value [1].

In many Islamic cities, religious values are absent from their design and transfer the imitation of western architecture, which does not coincide with Islamic values [2]. Manifestation of religious values is the memorial, and the building is used as the Source of spiritual beauty and wonderful art philosophy that provides the soul's gracefulness and purity. The conservation of this construction is more important than converting it into the structure of modern entertainment, which is prohibited in Islam [3].

In 2014, the UNESCO world heritage site designated Jeddah as one of the historical heritage sites located on the red sea's eastern shore. Development of different spatial patterns of the old and the new Jeddah falls in a moderate zone, which shows the tremendous change in infrastructure because of intense rainstorms and sewerage network [4]. Jeddah represents the unique architectural platform which recalls the memoirs of the Kingdom of many empires which had ruled this place for many years [5].

Many southern parts of Arabia represent the Hijazi culture which has sustained its quality by durability, hardness, and strength of the construction. Engineering firms and the architectural platform have led too much concentration on the decorative element (wooden or glass curving/painting) of the doors and the walls of the building and the interior design management of the lighting of the building [6]. These decorative pattern examples exist in Egypt, Syria, and India [7, 8]. Al Qabala, Al-Banana, Al-Zahid Al Shaafi mosque, the Great Mosque, and the Mosque of Uthman Ibn Affan are well-known archeological buildings and historical mosques examples in the world [9, 10]. The sustainability of the heritage Hijazi architecture in the urban, social, and economic aspects has been compromised because the leading research problem lies in rehabilitating historical and technological mosques to meet the needs of society at the present time without affecting the present ability of future generations. Al-Murshid added that the concept of sustainable development expanded to include three main axes, the environmental, economic, and social ones [11–13], mentions that the Athens Charter—a charter for the Restoration of historical monuments—was issued by the first meeting of technical architects concerned with historical monuments in Athens in 1931 AD, and recommended in the second article the necessity and importance of preserving historical, archaeological buildings in a sustainable way, and the use of unused archaeological buildings, Taking into account the historical and technical characteristics of the building, the Venice Charter—an international charter for the preservation and Restoration of antiquities issued in 1964 AD in Venice [14, 15] recommended the need to use historic buildings to ensure their maintenance. Simple modifications can be made without changing the shape and plans of the building or the details of original decorations and inscriptions.

The present study aims to review the environmental and cultural sustainability of the architectural elements of two mosques in the historical area of Jeddah, Al-Shafi'i Mosque and Al-Mimar Mosque.

2 Literature review

2.1 Environmental sustainability

Environmental sustainable development, dimensions including economic, social, and environmental, together with higher preferences for peace and security, are more in the shape of independent action. Environmental sustainability identifies the real potential within the limits of the resources available in the community. It makes good use of them to ensure the achievement of development goals while maintaining the morphological, climatic, geological, and urban balances that preserve the ecological balance for future generations. Environmental sustainability improves the living conditions of the population. It raises the standard of living using suitable environmental methods [16] and the characteristics that formed its environmental uniqueness and its impact on development activities, wealth, and capabilities available in society. Heritage traditional values are challenging the socio-cultural public perception with ecological pressures which are natural (floods, earthquakes), social (improper plant growth and visitor control or looting), Political influence (colonial heritage assets or dictatorship) for protection and preservation activities and have expression towards religious heritage assets.

2.2 Cultural sustainability

The cultural and civilizational heritage are focused keenly on developmental dimensions related to the community's culture and human aspects. Programs must be compatible with the local cultural context and distinguish it from unique human characteristics, social relations, and prevailing customs and traditions. It is necessary to properly employ this heritage with the aim of sustainable development and promoting environmental solutions. It led to the close relationship between the natural and built environments, where Arab-Islamic architecture and decoration reflected many elements of nature, such as plants, flowers, colors, and an integrated cosmic system [17].

The integration of nature with urbanization inside the house through the yard and gardens or the roofs of buildings and their use as an extension of the living spaces. The

overlap of the building with nature within the urban environment forms an integrated unit and balanced ecological and organic systems. This led to taking into account the heritage environment of the relationship between the city on the one hand and nature, whether agricultural lands or green spaces and natural oases. On the other hand, both the built environment and the natural environment have a clear field that does not dominate one over the other. All of this aims to benefit from the culture of sustainability upon which this civilization was built. It intends to create a degree of cultural and environmental balance in the contemporary environment in the face of the culture of consumption and globalization that prevails in all aspects of urban, architectural, and cultural production [17].

3 Methods

The research designed the comparative analytical approach by studying the design of two mosques in the old Jeddah historical area. Architectural sustainability, which the historical places face for the survival of customs of Muslims since their existence. The sustainable elements in mosques are: 1- courtyard and prayer area, 2- walls, 3- windows and openings, which are the essential parts of the mosques for the visitors to attract, and the place location faces many environmental regional challenges with time. The project for this study was Masjid Al Mimar and Al-Shafi'i Mosque. These two are considered one cultural world heritage, and the strategic evidence proves their existence for more than 150 years [18].

4 Analysis and results

4.1 Architectural background of Masjid Al Mimar (Masjid Al-Ma'amar)

4.1.1 Location

This mosque is near the Makkah gate, which lies at the center of the old Jeddah wall. This area is underprivileged because of the stronghold of tribes (Bayt Noorwali and Bayt Naseef). Mode of transportation is primarily accessible by foot and random by car. This area's construction date is almost unknown, preceding about 1824–1825, in old Jeddah, Saudi Arabia. This area is known as the old souk in Mazloum quarter, along Souk al Alawo. The location of Al Mimar masjid is shown in Fig. 1.

Fig. 1 Location of Al Mimar masjid

4.1.2 Foundation

This mosque is built at the slope edge of the hill and in the historic city's center. This evidence was given by French traveler Tamisier. The basement of the mosque was divided into three naves and on praying hall with six square pillars at the top. The height identifies the sixth floor of the building to reach the prayer area. The uniqueness and the remarkable attraction point of this was similar to the Prophet's Mosque in Madinah, particularly the wooden ceilings mosque (Fig. 2). Source: [19, 20].

4.1.3 Hijazi style

Al-Mimar Mosque is an archaeological and historical landmark. It was built in a Hijazi style and incorporated traditional Ottoman architecture (Fig. 3).

Fig. 2 Comparative view of Al Mimar Masjid and Madina Mock model

Fig. 3 Hijazi style of the mosque

4.1.4 Rawshan

The largest area of Jeddah architecture is the rawshan which covers the building's facade. A large wooden structure with prominent latticed components. Some buildings are characterized by vertical rawshan that extends to 3–4 stores, while some buildings contain horizontal ones. Their projection is about 60 cm and is fixed with a wooden cantilever (Fig. 4) [21].

The Rawshan performs many functions, like protecting from extremely hot hard climates and heat stroke. The lower and upper stripes are fixed wooden panels for ventilation and to protect privacy values. Another ornated projection of Rawshan is Rafaf which helps in the projection to caste shade on the higher section. It is the most flexible space to be added to the adjacent room. The uniqueness of Rawshan is the endless varieties of sizes, shapes, treatments, and organizations [21].

4.1.5 Shurbah

This is group identified place where cool water is collected in pottery, and the water remains cool due to the passage of air.

Fig. 4 Examples of Rawshan

4.1.6 Ghulam

One of the latticed components is hanging over the lower half of the window, which is covered with shutters [22]. The construction of the building material uses masonry walls, which are made of stone, brick, adobe, and rubble [23, 24]. The category of assembling modality of the structural materials [23] determines its structural behavior [24]. The preservation and conservation of cultural architectural and structural engineering fields' heritage are complex challenges [25–28]. Structural evaluation of buildings [29] and stone conservation techniques and strategies [30–32] require an interdisciplinary approach based on scientific assessment. Preservation of such buildings requires the availability of knowledge in building techniques, precise documentation of dimensions and elevations, structural stability analysis, and materials characterization [33]. It is also required for their conservation assessment for safe use guidelines.

4.1.7 Restoration of Masjid Al Mimar

King Abdullah bin Abdulaziz Charitable Foundation is one of the well-known recognized as part of a program for reconstructing many historical mosques in the Kingdom. Similarly, in 2018 Al Mimar Mosque was rebuilt at the expense of the king's charity to save the preservation of religious heritage and then opened its doors to believers [34].

4.2 Architectural background of Al-Shafi'i mosque

4.2.1 Location

Al-Shafi'i mosque is the ancient and oldest mosque in Jeddah. It is one of the city's most important, beautiful, hypostyle mosques. It is located in the two main East–west commercial areas of Suqal Jumah. The main southern entrance and the western side of the mosque face the clothing market of a bedouin. The main area is Harrah al-Mazlum (al-Mazlum quarter) [35].

4.2.2 Foundation

Much evidence proves that this mosque was established initially by King al-Muzaffar Sulayman of Yemen in 1250. He followed the Shafi'i school of jurisprudence (law). Al-Shafi'i Mosque was named after Imam Muhammad ibn Idris Al-Shafi'i, one of the four imams of Islam born in

Fig. 5 Qiblah of Al Shafi'I Mosque

767. Islamic civilization followed a similar mosque architecture after this establishment.

The mosque was completed in 1539 by an Indian merchant named Khawaja Muhammad Ali, who used the finest timber and carved wooden columns for minaret construction. Later this mosque was reconstructed during the rule of the late Saudi King Abdullah.

4.2.3 Design of the mosque

This mosque was constructed with the basic concept of the Yeman architectural style. The building was built with coral stone (Manqabi) and wood. The prayer hall was supported by columns and adopted the style of a hypostyle hall, and the inner courtyard was engraved with white marble slabs. Every courtyard has four sides. The column indicated the qiblah direction to separate the prayer area and the courtyard. The coral stones line was used to discriminate. From this, the concept of construction the architectural construction of the mihrab and minbar toward the qiblah was introduced (Fig. 5) [36].

A network of wooden beams was used to support the mosques' infrastructure.

- *Mihrab*: it was the slightly raised gable roof on the top of the mosque. The raised area had many perforated windows to supply natural light and air. The area of the mihrab is decorated using combinations of different calligraphic styles, geometric patterns, and floral designs.
- *Inner courtyard*: The wooden roof of the inner yard was supported by three tall columns of six wooden beams to support the infrastructure strongly. The wooden col-

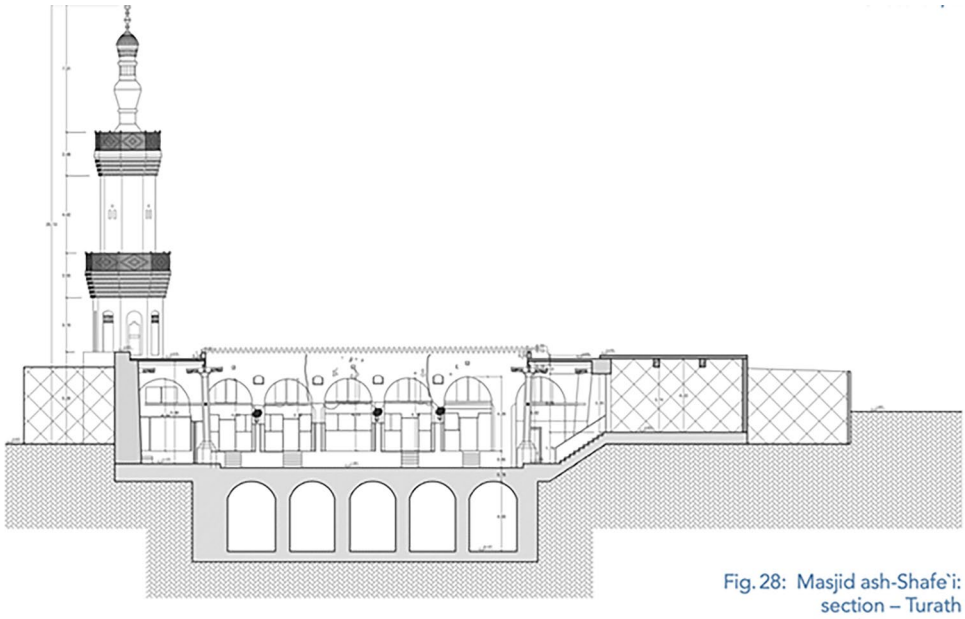


Fig. 6 Model structure of Masjid Al Shafi'i

umns had the additional support of the roof, which are flat wooden corbels.

- *Decorative elements on wooden columns*: Al Shafi'i mosque thoroughly elaborated the concept of beautifully wooden carved working with high quality. Khawaja Muhammad Ali rebuilt it and worked on the carving of the wooden column, which reflects the distinctive Indian character. The mosque has two full partial arcades, and its pier and column are plastered with coral stones.
- *Outer Infrastructure of the Mosque*: The mosque consists of many sections. One of the sections is dedicated to the woman under veiled design for Jummah and Ramzan prayers, and men use other sections. Some of the mosques are also used for residential purposes.

The mosque's walls are crenelated more than one meter thick, and the windows are fitted into the arched ceiling. The mosque represents six minarets, four minarets with three balconies, and two minarets with two balconies. This mosque is the complete transparency of the Ottoman influencer in the case of mosque construction. The environment of this mosque is always simple with its natural adornment. The Ottoman effects represent the executive presence and architectural proclivities (Fig. 6) [37].

The mosque's architecture represents the friendly and harmonious coexistence between the architectural expressions and functions of houses and mosques in the city. The mosque has four entrances and one of the small entrances for women at the back. The main entrance on the southern side is massive and includes elaborate geometric and floral designs for decoration purposes. With the wall of a mosque on this south side, some shops constituted part of an endowment for the mosque and were part of the mosque's self-sufficiency drive. The mosque's ablution area and toilets are entirely separated from the mosque proper. They are on the northern side. The mosque also caters to the needs of disabled persons, such as wheelchairs. Their adequate facilities are provided at one of the entrances of the north.

4.2.4 Water reservoir

The mosque had a huge water reservoir constructed by King al-Muzaffar Sulayman himself. It was in operation well into the last century. Indeed, overly stereotyping and even stigmatizing tradition; failing to shrewdly connect either with tradition or modernity and failing to see how the two can amalgamate and form a holistic model; having recourse to imposing sheer mechanization and artificial solutions on whatever does not fit the modern-day tastes and molds; etc. – none of these are the steps in the right direction [37].

4.2.5 Unique construction

The building's unique construction was rectangular, open yard and four marble columns topped with pointed arches parallel to its Qibla (prayer direction) wall. Sea

Fig. 7 Present the renovation of Masjid Al Shafi'I (outer view)

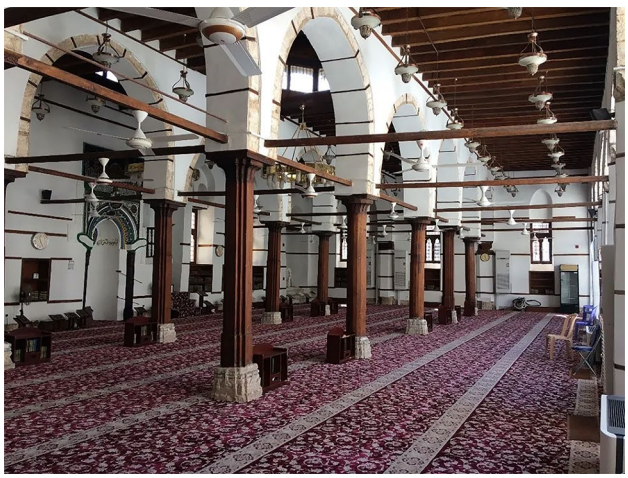


Fig. 8 Present the renovation of Masjid Al Shafi'I (inner view)

mud, brick, stone, and wood were used to build the mosque (Figs. 7 and 8) [38].

4.2.6 Restoration

The late King Abdullah renovated the mosque very efficiently. The mosque was restored with key features left intact, such as the 900-year-old minaret and the old piping system covering 1700 square meters. King Salman bin Abdulaziz visited the mosque in 2014 and ordered further restoration work [39].

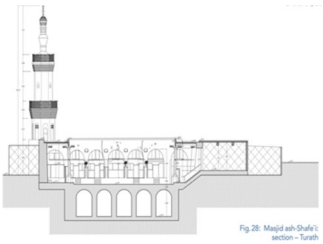
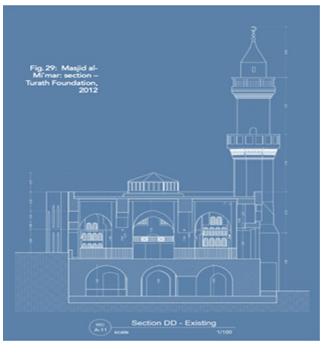
4.3 Strategic development

The model of strategic design level of action strategic design levels includes design operations to establish an organization capable of providing added value to the area itself and the people living in it. The three cultural tools for cultural heritage design used in design for cultural heritage and material culture mainly emphasize creating new products, services, and strategies.

5 Discussion

This paper presents an integrated scientific methodology for the assessment and material diagnostic procedures of a complex historic building which combines a field survey, microstructure analysis of the brick and stone-masonry walls, and materials characterization along with historical information. The combination of results obtained from different approaches produces more precise information and allows the identification of construction materials and masonry patterns in the studied building. This information is essential for improving an integrated multidisciplinary assessment strategy to investigate the safety margins and deterioration rates of historic buildings, under their present conditions, against environmental (i.e., weathering), using complementary analysis techniques. The current comprehensive methodology utilized an integrated study to select the most suitable repair material and strategies for the intended intervention process. Al-Shafi'i Mosque is a crucial component of a World Heritage Site.

Table 1 Comparative analysis of the two historic mosques in old Jeddah

Projects	Pictures	Cultural sustainability	Environmental sustainability
Al Shafi'i Mosque		•••••Reflects the architectural design mode of Yamen architecture •••••Preservation of mosque in the different time period maintain the legality and gracefulness of the cultural heritage mosque	•••••Maintenance of the sea mud, brick and the fine wood which was used still need renovation but it did not affect the base of the mosque
Al Mimar Mosque		•••••It follows the ottoman architectural design with the Hijazi style consisting of rawshan, shurbah •••••Infrastructure of the mosque is simple and follow the regional tradition	•••••According to the location and the people the the construction material which is used is durable like use of mansory bricks,wood and marble slab •••••This enhance the purity and the significance of the architecture and maintain the temperature and infrastructure of the mosque

Therefore, historical Jeddah represents a unique model of comprehensive urban configuration(Farsi,)when left untouched homes, mosques and palaces, has spread narrow the streets and separated the dense blocks of buildings [40–44]. It took into account that the architects—in the interior design of their homes—care to be included amenities depending on the standards of society and culture, environmental and climatic factors, and human nature [45–52]. The comparative analysis of two historical mosques of old Jeddah is shown in Table 1.

5.1 Financial of the conservation projects in historical jeddah

Conservation projects in historic jeddah are financed by the Kingdom, represented by the Ministry of Culture and the Jeddah Municipality. The financing is through loans granted by the government to owners for restoring their homes under the supervision of the Ministry, and the municipality [53] and special grants offered as a grant from His Highness the Crown Prince to repair 56 homes, estimated at 50 million Saudi riyals [54, 55]. Some self-efforts are working on fixing the region's property, and the state covers the costs of region-wide conservation projects for squares and roads [56].

6 Conclusion

The sustainability of heritage conservation depends on the development of three main factors in the heritage environment: the local community, the economy, and the local environment [54]. The development processes should deal with the sustainability level at which the building must be dealt with so that the intervention does not depend on Restoration. However, Architectural and urban heritage contains many cultural, aesthetic, and social values whose economic value is difficult to estimate according to market requirements. Economic returns can be defined as the society-wide gains from the project compared to the situation that would prevail if the project were not undertaken.

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Availability of data and materials Available upon reasonable request.

Declarations

Conflict of interest The author declares no competing interest.

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