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Assessment of the Sustainable Design Principle of Mushrabiyah in the Building Design of Suakin Inland, Port-Sudan Sudan.

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ABSTRACT

This study assessed sustainable principles based on LEEDS approach with Mushrabiyah in Suakin Inland historical building city in Port Sudan, Sudan. The location was borne out of the fact that the city is an historical building city with phenomenal environmental deterioration as well as heatwaves and its capability of reflecting the architectural and cultural attributes of this region. Systematic random sampling was used in selecting two hundred and ten houses and observation formed the basic instruments for data collection on the physical characteristics of the Mushrabiyah in the building design, mechanisms used for natural ventilation as well as buildings' aesthetic with natural ventilation in the houses. This was further complemented with LEEDS Sustainable Building Principle to measure the efficiency of mushrobiyah in relation to window types, locations and openings of the houses. Thematic analysis was employed in the presentation of the findings and to analyze the data obtained from case studies analysis. This research explores the integration of sustainable architecture with Mashrabiya shading devices, showcasing its ability to reduce energy consumption while enhancing building aesthetics. Key findings reveal improved indoor air quality and energy efficiency in Suakin city, underscoring the importance of transparent sustainability strategies for a healthier, more serene built environment.

Key words: Building Design, LEEDS check-list, Mushrabiyah, Sustainable Building Principle, Suakin Inland.

INTRODUCTION

In hot coastal region climates, Suakin inland port-Sudan, where scorching temperatures and limited clean water resources pose significant challenges, the design of buildings plays a critical role in achieving thermal comfort for occupants while minimizing energy consumption for cooling. Sustainable design principles offer a holistic approach to address these challenges by leveraging natural resources, natural building material (coral stones) passive design strategies, and innovative technologies to create buildings that are environmentally responsible, energy-efficient, and comfortable to inhabit.

The integration of sustainable design principles into buildings in hot coastal region climates, Suakin inland, Port-Sudan requires careful consideration of several factors, including climate conditions, site characteristics, building orientation, materials selection, and HVAC (heating, ventilation, and air conditioning) systems. By adopting a comprehensive LEEDS approach that combines passive design strategies with active technologies, architects and designers can create buildings that optimize energy performance, enhance occupant comfort, and reduce environmental impact.

This research sets the stage for exploring the complex interplay between sustainable design principles and the unique environmental and Islamic traditional element of Mashrobiyah in hot coastal regions.

In the Islamic world and beyond, a mashrabiya, also known as mashrabiyya (Arabic: **مشربية**), is an architectural element that is considered traditional (Petersen, 1996; Fathy, 2018). This kind of projecting oriel window, which is sometimes enhanced with stained glass, is found on the upper floors of buildings and is surrounded by carved wood latticework. It was historically used for passive cooling and wind collection (Fathy, 1986). It can be used inside on the sahn (courtyard) side of the building, but it is most frequently used on the street side (Mohamed, 2015).

Mashrabiya, sometimes referred to as "shanshul" or "rushan," are a type of projecting oriel windows made of wooden lattice that are typically seen in traditional buildings. It is a feature of traditional Arabic architecture that dates back to the middle of the Middle Ages and the middle of the 20th century. It alludes to a method of turning wood that is used to fashion screens that resemble lattices to adorn windows in classic residential architecture. The Arabic verb shariba, which means "to drink," is the root of the Egyptian word mashrabiyya, which originally denoted a location for drinking. There has also been a suggestion that the term comes from the word Musharrafiya, which refers to the area where women look out. Lane EW (1954) defined a mashrabiyya as a piece of latticework from which small sections projected; these sections were used to put and cool earthen water drinking bottles by exposing them to airflow (Fathy H 1986) (Behrens-Abouseif D 1991). Usually visible from the street side of the building's exterior facade is Mashrabiya. It could also be integrated into the structure on the inside face, which is typically facing the courtyard. Informally, this style is referred to as an English "harem window" (https://www.hisour.com/mashrabiya).

Although the history of mashrabiya is unknown, the earliest known instances of the practice date to the Abbasid era in Baghdad in the 12th century (Abdullah, 2001).

One of the fundamental characteristics of Islamic architecture that has gained a distinct reputation in the modern world is "mashrabiya." (Abdulraheem Olakanbi and Osama Rayis 2016). The application of Mashrabiya has mainly been associated with the façade that also gives an identity to the building. Over time, Mashrabiya's image has evolved from a conventional window screen with patterns to a cutting-edge climate-responsive shading system (Abdulraheem Olakanbi and Osama Rayis 2016). In certain instances, it has been improved even more and utilized as a standout feature that covers the building's whole exterior. Many architects around the world have created a large number of buildings that use a significant amount of energy, mostly because of the air

conditioning loads. This has led to an overuse of natural resources. Understanding the importance of energy conservation, attention has shifted to finding ways to cut energy use, which has made it necessary to build energy-efficient buildings without sacrificing aesthetics. It becomes vitally important to lower a building's air conditioning loads in arid and coastal countries with harsh sunlight and extreme climate conditions. Hence, this research tends to assess how can sustainable design principles be integrated into buildings in hot arid climates to minimize energy consumption for cooling while maintaining thermal comfort for occupants? This paper focuses on the role of the Mashrabiya, a well-known shading device that can dramatically reduce energy consumption while also greatly improving the building's aesthetic appeal. By examining the Sustainable Design principle of Mushrabiyah in the Building Design in historical city of Suakin Inland, Port-Sudan Sudan and its innovative design solutions, this study aims to identify effective strategies for minimizing energy consumption for cooling while maintaining thermal comfort in buildings in hot coastal climates. Through this research and knowledge exchange, architects, engineers, policymakers, and stakeholders can work together to advance sustainable design practices and create a built environment that is resilient, resource-efficient, and conducive to human well-being.

MATERIAL AND METHODOLOGY

The study employed a qualitative research method employing a case study approach. An observation guide and qualitative photo production checklist were used to elucidate data from buildings. An observation guide was used to document some features that are used in the study based on LEEDS sustainable building principle. In the end, some results were presented in tables.

STUDY AREA

Suakin or **Sawakin** (Arabic: سواكن, romanized: *Sawākin*, Beja: *Oosook*) is a port city in northeastern Sudan, on the west coast of the Red Sea. It was formerly the region's chief port, but is now secondary to Port Sudan, about 50 kilometers (30 mile) north.

Once regarded as the pinnacle of Red Sea Medieval luxury, Suakin is now a ruin, its ancient coral city. The population of the nearby historic mainland town, known as the Geyf, was estimated to be 43,337 in 2009, up from 18,030 in 1983 (World Gazeteer, 2012). In Saudi Arabia, there are daily ferries from Suakin to Jeddah.

Suakin experiences extremely hot summers that are humid but dry, as well as extremely warm winters due to its extreme hot desert climate (Köppen BWh). Rainfall is scarce, with the exception of October through December, when easterly winds may produce sporadic downpours. November 1965 saw as much as 445 millimeters (17.5 in) of rain, but from July 1981 to June 1982, there was only 3 millimeters of rain in the entire year (0.1 in) was recorded (Weatherbase, 2011).

Climate data for Suakin (Sawakin) [hide]													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean daily maximum °C (°F)	26 (79)	26 (79)	27 (81)	30 (86)	33 (91)	38 (100)	42 (108)	41 (106)	37 (99)	33 (91)	30 (86)	27 (81)	32 (90)
Mean daily minimum °C (°F)	19 (66)	19 (66)	20 (68)	21 (70)	24 (75)	25 (77)	28 (82)	29 (84)	26 (79)	25 (77)	23 (73)	21 (70)	23 (73)
Average rainfall mm (inches)	8 (0.3)	2 (0.1)	1 (0.0)	1 (0.0)	1 (0.0)	0 (0)	8 (0.3)	6 (0.2)	0 (0)	16 (0.6)	54 (2.1)	28 (1.1)	125 (4.7)

Figure 1: Suakin climatic data Source: ("Weatherbase: Historical Weather for Sawakin, 2011)

Background Information

This city was initially occupied under the colony of the Turkish emperor, Suakin and was managed by turkey kingdom for the owners, together with Ottoman Empire at Jeddah in kingdom of Saudi Arabia. As a result of disagreement between both parties, the historical city emperor had to quit, then, Anglo-Egyptian government emperors were invited to manage the city, thereby changing the unique sustainable principle to the contemporary principle that led to the absorption of diverse architectural styles and that ruin and deteriorate the city. However, the earliest history of Suakin city was constructed between 2000 and 3000 BC. It was earlier used to the Kingdom of girl (Punt) in the East Africa to hunt Elephants. It was also used in terrain, for the prophet Sulaimon prison in Suakina but was officially became occupied territory on the 5th of Centuries, Suakin have been the Roman port of Evangelon Portus used by Ptolemy. Suakin established itself as an Arab trading hub in the tenth and eleventh centuries. Following the introduction of Islam, Suakin gained prominence and rose to the top of Africa's ports of call for pilgrims making their way to Medina and Mecca, the sacred cities. Venetian and Indian traders began to come to Mamluk Egypt in the fifteenth century, and they remained there until the Ottoman invasion of 1517, when it became a major commercial hub. And from then on into the 19th century, many of the characteristic Coral Buildings were constructed during the Ottoman occupation, and by the time the Port of Sudan opened at Sheikh Al Bargath in 1922, Suakin had become a ruin (Olakanbi R. 2016).

Location

The historical city Suakin is found at the north-eastern tip of the Arabian-African Coastal Region, bordered by Saudi Arabia to the north across the Red Sea and Sudan to the north and west across an oval-shaped island. It is a nearly completely level desert plain that is about 750 meters long and less than 500 meters wide. (Olakanbi R. 2016)

Building Structure and description

According to several references, Qezar, et al (2013), Dirar (1981), Salim (1997), Salim (2015), Mallison (2007), and Olakanbi (2016) The first impression of historical city Suakin is that of a truncated Mushrabiyah frustum appeared in the whole inland. However, it would be more

appropriate to interpret the structure as a distinctive Coral Building punctured by Mushrabiyah. This sustainable architectural system developed a distinctive art and architectural style, which was applied throughout the Arab coastal region (one of the largest in the Africa and Arab Muslim world at that time). Over a long period of time, between (3000 – 2000 BC) – (20th 21th AD), It shares specific culture, social and environmental values which are embedded in their everyday system of social organization, also had its influence on their architecture as well.

The location of the Mushrabiyah, living hall (Salamatik), kitchen and Diwan is in the Majlis extending further from the main Mushrabiyah. As Salaamlik entails a large reception-room (Diwan with mats or carpets of varying qualities and designs are placed), smaller adjoining room, latrine and store there in. The Harim entails a series of suites or sitting-rooms each called a majlis linking main Mushrabiyah. These often had a smaller room, called the khazana, adjoining the larger and linking it, cooking area, washing –space, a latrine, and a store. As result of the shape of the main Mushrabiyah, the Majlis were staggered horizontally cantilevered on opening of each window to get equal room and corridor spaces for natural air quality and visual. Moreover, this sustainable factor in the building space allowed for single loaded corridors with clean air quality spaces in between them which form a court yard round the whole city. The courtyard is housed by the building in a manner that it forms an atrium. More also, the courtyard is divided into two parts by mostly a 3-5- story which houses the shaft. The most important part of the architectural building is the main hall for Salaamlik therefore women are prohibited therein except in courtyard which most indoor activities were held. In the hot Season, usually mats made from palm leaves are used to cover the floor, but in the cold Seasons, for the rich people (merchants) of the Suakin, the halls are fully carpeted. In the contemporary period, the latter practice is not confined to those Seasons only (Olakanbi, 2016).

Suakin Architecture

The Suakin inland's design is based on an oval round grid. The structural elements of the city were also based on square grid which forms a structural unit. These structural units' form rooms, and the size of these rooms depends on the number of units used. The main hall for reception and entertainment of quest, called salaamlik in Turkish, the harim, the house which is occupied by the family, the women, and children, majlis (plural majalis) (family sitting-rooms), khazana (servicing-area), kharjah (terrace outside on the roof), dihlis (an entrance-lobby)which sometimes had diwan (an imposing reception end), maga'ad (reception platform-Seats), Mushrabiyah (roshan),remains virtually unaltered, there evolved in the cause of time, certain features that were incorporated with the main Suakin architecture (Greenlaw, 1976).

Construction and Materials of Suakin Architecture

The on-site construction technique was predominantly adopted in the historical city building. This was due to the building's form, which did not allow for pre-fabrication of most parts of the building. Consequently, Coral stone was used extensively as a construction material. Suakin Architecture is

instantly recognizable in the view of its largely predictable standardized, modular and symmetrical nature of Coral stone. The most important legacy of Suakin is in its unique architecture that implements most of the rules of architecture, relying on local materials like locally available coral stones, recycled panel timber and reefs paved with white lime. Suakin employed these coral stones in the burn modular unit, giving it the form and shade of white that perfectly capture the exquisite beauty of the wood arrangement. The building's external finishes are primarily beige, with coral tiles and polka dots on a 2.5 cm main finish. These tiles were widely used in the lower levels of the Suakin building and in the accommodation structure of the maga'ad (reception platform-seats) (Olakanbi, 2016).

Moshrobiyahs Across the Suakin Historical city-A Panorama Inland Survey

It is noteworthy that no part of the building's main features has assumed such a transformation as the Mushrabiyah. The various shapes it assumed range from cylindrical to square and octagonal types. Balconies of Mushrabiyah equally assumed diverse patterns. Below is a selection of some of the Mushrabiyah across the city.

1. The Ali Shawish Building (two octagonal three-balcony Mushrabiyah) is documented in (figure 1)
2. The Shinnawi-bey new (the ancient three-balcony Moshrobiya) is documented in (figure 1)
3. The Shinnawi-bey old Building (detached two-balcony cylindrical Mushrabiyah) is documented in (figure 1)
4. The Omer Affendi Building (four-balcony square, octagonal and two upper concave balconies with motifs is documented in (figure 1)
5. Sharifa Mariam 1 (detached two-balcony cylindrical Mushrabiyah) is documented in (figure 1)
6. Sharifa Mariam 2 Building (Single balcony Mushrabiyah with elaborate Qur'anic calligraphy) is documented in (figure 1)
7. Beit Shams building (two-balcony square Mushrabiyah) is documented in (figure 2)
8. The Beit Sayd-safi Building (four cylindrical two-balcony curved Mushrabiyah). This is the first curved Mushrabiyah built in Suakin is documented in (figure 2)
9. The khorsheid Afendi Building (squared two-balcony Turkish Mushrabiyah). This is the only oldest building in the Suakin with Mushrabiyah is documented in (Plate 5)
10. The Beit Basha Building (two-balcony square Mushrabiyah styled on Jeddah and Mecca architectural design. Photo by the Author) is documented in (Plate 8)

11. The Ali Shawish Building ultra-historic one-balcony cylindrical Mushrabiyah (photo by the Author) is documented in (figure 2)

12. The Beit Siam Building detached two-balcony octagonal Mushrabiyah in plot 273 - 274 – 275 is documented in (figure 2) (courtesy of Dirar (1981))

There were three waves of architectural influences on the Suakin city. These were the Turkey, the British or (Anglo-Egyptian) and Islamic influences ever since Islam's founding. The first two influences were on limited scales. The last category of influences had greater effects due to the advent and closeness of Islam as more reliable lifestyle. Newly generated buildings sprang all over Suakin beginning with the pioneer Suakin Island City Building which some researcher tagged as departure from traditional style. Subsequent generations of buildings in Suakin Island, as well as in the other surrounding cities, were generally constructed on the rectangular Hypostyle Hall (or the Arab Plan) type, but with certain modifications, took various forms in Suakin in particular, and in coastal region, in general (Abdulraheem Olakanbi and Osama Rayis 2016).

All this generation of buildings can be summarized as the use of existing references as a basis to create an enduring structure that allows for growth under a set of guidelines. The Qibla axis is understood both as a physical artifact and a compositional frame work. In the urban context of the Suakin, the backbone of the urban structure was an organic grid matted that branched off to create a grid of lots, adjusted to the topography toward the Red sea. This lot formed a self-supported basic unit that allowed houses to be built independently. Traditional and vernacular house types were referenced in the house design, interpreted and modified to create house types suitable for modern lifestyles. These types provided a structure that allowed different houses to be built and expanded to adjust themselves to the needs of their inhabitants and users. The next chapter uses a shape grammar, knowledge-based system, and optimization of Suakin to explain how the house types and urban context of the Suakin were encoded by a set of rules for formal and functional composition (Mattew) (Greenlaw 1976) (Salim 1997), (Salim 2015), (Mallison 2007), and (Olakanbi 2016).

The variety and unity of the urban landscape is documented in Figure 1, the spots from which the photos were taken are shown in Figure 2 & 3

Figure 1 showing: Ali Shawish Building, Shinnawi-bey new building, Shinnawi-bey old Building, Omer Affendi Building, Sharifa Mariam 1, Sharifa Mariam 2 (two octagonal three-balcony Mushrabiyah).

Figure 2: Beit Shams building, Beit Sayd-safi Building, Ali Shawish Building, Beit Siam Building **(regenerated by Olakanbi 2016)**

Figure 3: **the spots from Saukin urban landscape (regenerated by Olakanbi 2016)**

RESULTS AND DISCUSSION

VARIABLES OF THE STUDY BASED ON LEEDS SUSTAINABLE BUILDING PRINCIPLE

The basic principles of eco-friendly architecture were adopted as variables for the study. These variables include

i. Energy efficiency: Focus on reducing energy consumption within the Saukin city by incorporating features such as high-performance windows, energy efficient lighting, and renewable energy.

ii. Material and resources: Sustainable materials, recycled content, and materials with low environmental impact.

iii. Indoor Environmental quality: This includes proper ventilation, low-emission building materials, low VOC materials

iv. Sustainable site: Sustainable land use planning that minimizes disruption to natural environment.

v. Water efficiency: installing dual flush toilets, rainwater harvesting systems, low-flow fixtures, and effective irrigation techniques.

DATA ANALYSIS

Based on the description of the observed features, data from case studies and observation will both be analyzed using thematic analysis which will include the use of plates and figures that clearly depict what is being described. To get a better perspective of the facilities for more effective assessment, account of variables, and assessment of green building strategies based on LEEDS Sustainable Building Principle will be employed. Also tables will be utilized to provide comparative analysis of information.

This study employed thematic analysis to analyze the data obtained from case studies. This will be used to identify common themes and patterns in the data from observations, and architectural document.

Table 1: Variable to generate green building strategies based on LEEDS Sustainable Building Principle and analysis

S/No	Green Building Strategies	Requirements
1	Energy Efficiency	• Optimize passive solar orientation • Use of high performance passive ventilation • Use of Energy Star certified energy efficient appliance • Use of energy efficient bulbs
2	Materials for Construction	• Optimize the use of green building materials • Identify ways to use high recycled content materials • Use of locally available materials.
3	Indoor Environmental Quality	• Use building materials, adhesives, sealants, finishes and furniture which do not generate of release any gaseous contaminants. • Use of operable window to provide natural ventilation, day lighting to maximize users comfort and performance.
4	Land Usage and Site	• Make more efficient use of spaces In the building • Use of landscape design to preserve and restore the region's original habitat. • Use of permeable pavement for walkways.
5	Water quality and Conservation	• Make us of water saving fixtures and technologies • Use of on-site storm water treatment • Rain water harvesting system

Sustainable principles adopted in the design and construction of Historical city Suakin

Energy Efficiency:

- Use of high efficient windows: Windows and Double Cantilevered Wall Systems was used to minimize solar heat gains while also allowing for natural light.
- Use of energy-efficient wooding like Shababik (opening): The interior space is lit up with Shababik during the night which comes in different forms and colors and are energy-efficient, long-lasting, and emit less heat.
- Use of high efficient windows: Large energy efficient windows which allows for natural lighting and ventilation while also connecting guest to the outdoors.

Water Efficiency:

- Use of on-site storm water treatment: the historical city building employed a non-potable water source for plant irrigation. The historical city building made use of ring road for walkways also planted local, adaptable plants around which work to absorb storm water.
- Water saving fixtures and technologies: Drinking water is perhaps the biggest challenge facing the historical city building. it uses low-flush toilets and low-flow sink faucets. According to (1976) the implementation of water conservation measures has reduced demand percent compared to water usage at other coastal region Red sea zone.
- Water Efficient Landscaping: Soft landscape features like shrubs were planted all around. The hotel also made use of impervious pavement.

Material Conservation

- Use of green building materials: Suakin use Materials such as coral stones cement and wood, were used in the construction of the building.
- Use of recycled materials: Over 75 percent of construction waste was recycled, diverting it from package woods.
- Use of locally available materials: It was estimated that 100 percent of the total building materials is sourced from local coral.
- Reduction and Recycling of Waste
- Storage and collection of Recyclable: The hotel provides recyclable bin in every unit for easy collection of recyclables like plastic bottles etc.

Indoor Environmental Quality

- Use of low VOC materials: The mat Carpeting use in the spaces have low levels of volatile organic compounds (VOCs),
- Use of operable windows for increased natural ventilation: double cantilevered window was used to improve Natural lighting and ventilation while reducing UV radiation.
- Interior Lighting: The interior space is lit by allowing natural light through the window. It also makes use open grilled shababik which is currently one of the most efficient and rapidly and developing lighting technologies.
- View to outside: Mushrabiyah large energy-efficient “operable” windows in the rooms connects guests to the outdoors by achieving a direct line of sight to the outdoor environment for more than 97% of all regularly occupied spaces.

Land usage and site

- Efficient utilization of space: The site was planned in such a way that it reduces environmental impact.

- Solar orientation of the building: The layout of the building is such that the longer side faces the north-south direction, taking advantage of glare reduction that the layout provides.

SUMMARY

Various sustainable building principles adopted in Suakin city can be categorized under the following variable: Energy efficiency, Water efficiency, Material conservation, Indoor environmental Quality, Waste Management, Sustainable site planning. Energy efficiency includes the use of Mushrabiyah, Window openings, for natural lighting of the spaces as well as ventilation. Indoor environmental quality includes the use of Low VOC materials, daylighting, and ventilation. Material conservation includes the use of locally available materials and materials with recycled content. The construction of a ring road is part of waste management to ensure proper disposal of waste inside cities. Using water-saving fixtures and rainwater harvesting systems are examples of water efficiency. Sustainable site planning minimizes the building's environmental impact by carefully designing and landscaping the site and orienting the building toward the sun.

Table 2: Buildings in Suakin Inland Features of Moshrobiya, Sustainability building strategies

	SITE	**MOSHROBIYAH FEATURES** Single/Double/Balcony/ Square/Cylindrical	**SUSTAINABILITY BUILDING STRATEGIES VARIABLE**				
			Energy Efficiency	Materials for Construction	Indoor Environmental Quality	Land Usage and Site	Water quality and Conservation
1	Beitsiam	8	✓	✓	✓		✓
2	Beit-Alishawish	Two one-balcony cylindrical	✓	✓	✓		✓
3	Beit-Basha	Single-big balcony square	✓	✓	✓	✓	✓
4	Original type building	Single-balcony cylindrical	✓	✓	✓	✓	✓
5	Khorsheid Effendi	Single three-balcony cylindrical	✓		✓	✓	✓
6	Beit-Shinnawibey	Two single-balcony of lower cylindrical and upper square	✓		✓		✓
7	Beit-Sharifa Mariam	Two three-balcony cylindrical	✓		✓		✓
8	Beit-Omer Affendi&Obeid	Two one-balcony cylindrical	✓	✓	✓		✓
9	Beit shams	9		✓	✓		✓
10	Beit-safi	Two one-balcony cylindrical	✓	✓	✓		✓
11	Beitgedid	7	✓	✓	✓	✓	
12	Bayt Adoud	Without Mushrabiyah	✓	✓	✓		

							✓
13	Beit-Muhammad Ahmed	Without Mushrabiyah	✓	✓	✓	✓	✓
14	Shinnawi New Building	Without Mushrabiyah	✓	✓	✓	✓	✓
15	Sharifa Mariam 2	18	✓	✓	✓	✓	✓
16	No 55 building	Two single-balcony of lower cylindrical and upper square	✓	✓	✓	✓	✓
17	No 225 building	Two three balcony cylindrical	✓	✓	✓	✓	✓
18	No 25 building	Two single-balcony cylindrical	✓	✓	✓	✓	✓
19	No 132 building	Single two-balcony square	✓	✓	✓	✓	✓
20	No 86 building	Single two-balcony cylindrical	✓	✓	✓	✓	✓
21	No 63 building	Single two-balcony square	✓	✓	✓	✓	✓
22	No 102 building	Two two-balcony cylindrical	✓	✓	✓	✓	✓
23	No 163 building	Two three-balcony cylindrical	✓	✓	✓	✓	✓
24	No 220 building	Single square	✓	✓	✓	✓	✓
25	Muhafaza	Single one-balcony cylindrical	✓	✓	✓	✓	✓
26	No 1 building	single open balcony cylindrical	✓	✓	✓	✓	✓

CONCLUSION AND RECOMMENDATION

In summary, this study has shed light on the relationship between sustainable architecture and the role of the Mashrabiya, a well-known shading element that can dramatically reduce energy use while also greatly improving the building's aesthetic appeal. After a thorough analysis of green building strategies and their consequences, a number of important conclusions have been drawn. The study's conclusions make it clear that the building's adoption of green building practices has improved a number of the structure's design elements. The Suakin city's overall sustainability, energy efficiency, and indoor air quality have all improved as a result of these tactics. Suakina have spoken well of their stays, citing comfort and a feeling of wellbeing as highlights of the eco-friendly architecture and operations of the city.

The study also emphasizes how crucial it is to be transparent when designing and communicating a building's commitment to sustainability and functionality. As a result, it was suggested that other Port Sudan and the Sudanese community adopt the integrated sustainability strategy, which is employed by the historic city of Suakin, in order to create a built environment that is both efficient and sustainable and promotes a calm and healthy atmosphere.

Furthermore, studies have shown the role that environmental consciousness and historical heritage awareness play.

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