INTERNATIONAL ASSOCIATION FOR THE STUDY OF TRADITIONAL ENVIRONMENTS

WORKING PAPER SERIES

HOUSE FUNCTIONS

Nermine Aly Hany

Manar Bint Abdulaziz AlYabis, Mohammed Bin Saeed Al-Aisan Al-Ghamdi

Sima Tawakoli

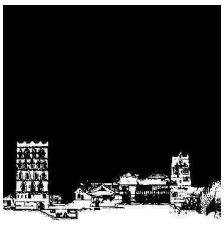
Majdi Faleh, Shams Alshamasi

2024
Volume 333

Volume Editors:
Mark Gillem
Hesham Issa
Adnya Sarasmita

207 East 5th Avenue
Eugene, OR 97401

tel: 541 712 7832
e: coordinator@iaste.org; www.iaste.org



TRADITIONAL DWELLINGS AND SETTLEMENTS WORKING PAPER SERIES

Volume 333
Contents

HOUSE FUNCTIONS

Traditional Dwellings and Settlements
Working Paper Series

RETROFITTING SCENARIOS PROPOSALS FOR NET-ZERO ENERGY NEIGHBORHOODS IN THE MEDITERRANEAN CLIMATE: A CASE STUDY OF A RESIDENTIAL COMPOUND IN ALEXANDRIA, EGYPT

Nermine Aly Hany

Volume 333
Pages 1-19
2024

RETROFITTING SCENARIOS PROPOSALS FOR NET-ZERO ENERGY NEIGHBORHOODS IN THE MEDITERRANEAN CLIMATE: A CASE STUDY OF A RESIDENTIAL COMPOUND IN ALEXANDRIA, EGYPT

◆ ◆ ◆

"Net-Zero Energy", is the flagship concept for the current world to achieve energy conservation and consequently reduce carbon dioxide emissions in the built environment. It has been widely used, considered and applied on the building scale for the last few decades, however, there are major advantages for transforming it to the community level by applying it to the neighborhood scale.

Therefore, several communities are eager to upgrade their neighborhoods into net-zero energy neighborhoods (NZEN) because of their potential to reduce energy demand and greenhouse gas (GHGs) emission. Although this concept has been implemented across different Mediterranean cities, this approach has not been applied in Egypt yet. Therefore, this paper aims to investigate the impact of various retrofit scenarios on the energy performance of an existing neighborhood in Alexandria, Egypt.

The investigated energy-efficiency measures (EEMs) are utilized for the reduction of the energy consumption, decreasing of greenhouse gas (GHGs) emission, and the generation of electricity using renewables. The investigated energy-efficiency measures (EEMs) are as the following; changing the type of windows' glazing; insulation of the walls and roof; use of LED lights; and solar PV panels. The suggested investigated scenarios were developed and simulated using Design-Builder V6.1 and Energy Plus 8.9.

The retrofitted neighborhood shows that changing the window glazing reduced the cooling and heating demand by around 2.5% and 0.6%, respectively. The insulation of the buildings' walls and roof reduced the cooling and heating demand by up to 43.7% and 40.7%, respectively. The LED lights reduced the cooling by 5.7%. However, LED lamps increased the heating demand by 10%. The energy generated from solar photovoltaics has been able to cover the monthly energy demand of the building if a battery is installed.

Finally, this paper demonstrates the challenges and obstacles for retrofitting a residential cluster into a net-zero energy neighborhood (NZEN) and consequently proposes guidelines and recommendations to facilitate the transition of the Mediterranean climate neighborhoods in Alexandria into net zero energy neighborhoods by considering the environment, energy and economy.

1. INTRODUCTION

The residential sector is one of the substantial concerns that hinder environmental sustainability. The housing industry consumes around 72.5% of the annual building energy consumption and is the third-largest energy consumer [1]. The residential sector is responsible for 27% of the total electricity consumption [1]. Building energy demand is expected to continue to rise annually [2]. This increase will pose a threat to energy security and will undermine any efforts to combat global climate change. Therefore, the NZE (net-zero energy) concept has emerged as a viable solution that uses active and passive energy-saving technologies to mitigate the conflict between diminishing fossil fuel supplies and rising energy demand. NZE will ensure a neutral (or positive) balance between energy consumption and GHG emissions[3].

The transition of the concept from NZEB (net-zero-energy building) to NZEN can enhance the scale of zero energy performance implementations while overcoming the constraints of single buildings concerning

building use, size, and on-site renewable energy [4,5,6,7,8]. Although the implementation of NZEN has been attracting researchers' attention for the last few decades, the absence of comprehensive and global frameworks to distinguish the NZEB and its requirements, particularly the performance standards and energy usage from renewable energy sources, is still notable.

Therefore, this paper aims to expand the concept of Zero or low-energy neighborhoods and investigate the impact of different energy-saving technologies on the energy performance of a neighborhood. This is carried out by:

1. Defining the available energy-saving retrofits
2. Identify the optimum design keys from the energy point of view
3. Identify the impact of each technology on the total annual energy consumption.

In order to achieve this aim, the paper is structured as follows:

Section 2 presents the research methodology and structure.
Section 3 presents a review of different retrofit and energy-saving technologies available in the literature.
Section 4 presents a review and analysis of the selected analytic examples.
Section 5 discusses in-depth the impact of the developed retrofit scenarios on the selected case study.
Section 6 presents a discussion and conclusions of the results are demonstrated in the final section

2. MATERIALS AND METHODS

A three-step methodology is adopted in this research. The first stage is to identify the different retrofit technologies and energy systems available in the literature. The second step is to review and analyse successful retrofit examples. This review will demonstrate the various retrofit scenarios, climatic conditions, and end-use energy and their impacts on the building's performance. Through the analytical examples, a set of retrofit scenarios will be developed and applied in the last step. The final step is to make a simulation model using Design Builder and Energy Plus to test and evaluate the impact of proposed retrofit scenarios on a case study in Alexandria, Egypt.

3. LITERURE REVIEW

There are several retrofitting technologies. These technologies can be grouped into three broad categories: Energy Efficiency Measures; Renewable Energy; Energy infrastructures [9]. The following section discusses the details of these categories.

3.1. Energy Efficiency Measures

Energy efficiency measures are widely employed frame for first lowering the building load and second for more effectively meeting the demand. Reducing energy loads combines methods like; improving the building envelope, layout, orientation, etc. Meanwhile Meeting the load demand requires the selection of highly efficient building systems (e.g., HVAC and DHW, and controls)[10].

3.2. Renewable Energy

Renewable energy is one of the main elements of achieving zero-low energy buildings. The category combines solar cells, wind turbines, and biomass, which are the most employed energy generation methods [11]. However, their installation is not always easy. Most of the time, solar or wind energy may be harvested locally, but when installation space is an issue, off-site sources are required. Setback requirements for wind turbine placements must be followed to reduce noise pollution and "shadow flicker" [12].

3.3. Energy Infrastructures

Energy infrastructure is one of the vital elements for achieving zero-energy building. Energy infrastructure resolves short-term disparities in renewable supply and building demand. Moreover, energy infrastructures store, export, and import excess renewable energy. These structures combine main energy facilities like electrical grids, gas pipe networks, etc [10, 13.]

From the above categories, you could identify the different retrofit technologies that could be applied to the building. However, identifying the retrofitting scenarios isn't simple. Therefore, the following section demonstrates successful retrofit examples to develop a coherent retrofitting framework that could be later applied to buildings.

4. ANALYTICAL EXAMPLES

This section discusses various successful NZEN retrofits that have been implemented in residential clusters across the Mediterranean cities. Different examples were viewed; however, only three were selected that met the required selection criteria discussed below.

4.1. Selection Criteria

The selection criteria and the applied methodology for the analysis of the example studies are presented as follows:

-The selected examples are either executed in real-life or designed and simulated to upgrade buildings' systems and reduce their energy consumption.

-The selected examples utilize different energy-saving technologies used for the adaptation of the buildings and their systems and renewable energy generation resources.
-The study provides a detailed numerical analysis of the energy performance of the settlements and the status of the achievement of NZE goals.

4.2. Selected Examples

Example 1: A Residential Area of a Settlement in Pieria, Greece

- Building Description

The study is located on the Pierian plain, between Mt. Olympus and the Thermaikos Gulf, at sea level. According to the Koppen climate classification, Katerini is in the Greek climatic zone G and has a traditional Mediterranean climate with warm-to-hot and dry summers and cool and wet winters. The coldest months are January and February, with average low air temperatures of 18°C, and the hottest months are July and August, with average high temperatures of 33°C. The Pierian plain tends to witness high temperatures in the spring and autumn that range from 15°C. (March to November) to 25°C. (May to October), and average low temperatures of 5°C. (March to November) and 12 °C. (May to October) [14].
The study area comprises ten different residential building typologies that are one or two stories, as illustrated in Figure. 1. Buildings with two stories typically accommodate large families, with a living room and kitchen, two bedrooms, and one bath on the ground floor. Meanwhile, the first combines two bedrooms and one bath. On the other hand, one-story houses typically include a spacious living area with a separate kitchen, two large bedrooms, and two bathrooms[14].

- Retrofit Approach

Four different retrofitting scenarios have been employed to reduce the energy consumption of the study area, which are presented as follows:

1. The installation of PV panels
2. The installation of a high-efficient HVAC system
3. Enhancements to the buildings envelops
4. Adoption of natural ventilation strategy during the night

- Findings and Results

The use of PV panels on the rooftops of the buildings reduced the electricity consumption by more than 70% for all buildings during the heating period. In the cooling season, the energy consumption was reduced by 45% to 70%. The highly efficient HVAC system reduced the heating energy consumption by 36% and the cooling energy consumption by 43%. Furthermore, enhancements were made to the buildings' envelopes, airtight windows, and controlled air change rates to reduce heating energy demand from 42% to 70% [15].

Fig 1: Overview of the studied area. (Source: Ascione, F., Bianco, N., de Masi, R. F, (2016).

Example 2: A residential neighbourhood in Granarolo dell 'Emilia, in Emilia Romagna, Italy

- Building Description

The pilot neighbourhood is part of a housing development area in Granarolo dell 'Emilia, in Emilia-Romagna, Italy, as shown in Figure. 2. The development has a moderate Mediterranean climate with an average of 2162 heating days and 110 cooling days. The neighbourhood combines one and two stories' residences[16].

Fig .2: Overview of the studied area. (Source: Mavrigiannaki, A., Gobakis, K., Kolokotsa, D., Santamouris, M, 2021).

-Retrofit Approach

Different retrofitting scenarios have been employed in order to reduce the energy consumption of the study area, which are presented as follows:

1. Area for outdoor overheating mitigation.
2. Insulation for energy conservation.
3. PV polycrystalline panel installation.
4. Energy management system.

-Findings and Results

Results show that the installation of PV polycrystalline panels could cover around 66% of the total energy consumption on an annual basis. In fact, in some months, the monthly production exceeds the total monthly consumption. These interventions allowed the neighborhood to perform as a positive energy neighborhood for the first five months of monitoring. However, due to the seasonal variation of the amount of energy produced by PV panels. The study area behaved as a near-zero energy neighborhood in the remaining monitoring months. Moreover, the energy-saving of the pilot ZEN for the monitored year was found to be 75.7 % in comparison to a typical neighborhood[15,16.]

Example 3: A residential NZES in Rimini, Italy

- Building Description

The study area consists of four single-family houses located in Rimini, Italy. Figure. 3 shows a prototype of the studied buildings. The buildings are built on the typical Italian construction typology and systems. The simulation was carried out on two typical summer and winter days. The 19th of July was chosen, with the highest summer temperature reaching 31°C and relative humidity of 36% and 54% when the air temperature is at its minimum and maximum, respectively. The winter temperature was simulated on the 3rd of January, with a mean temperature reaching 7.1°C. The relative humidity of the winter day ranges from 70% to 96% when the air temperature is at its minimum and maximum, respectively[17].

Fig.3: Prototype of studied buildings. (Source Castaldo, V. L., Pisello, A. L., Piselli, C., Fabiani, C., Cotana, F, (2018).

- Retrofit Approach

Different retrofitting scenarios have been employed to reduce the energy consumption of the study area, which are presented as follows:

1. Insulation of the building walls and the usage of highly reflective materials on roofs and walls.
2. Upgrading of the building envelope openings.
3. Installation of renewable resources (PV panels and wind turbines).
4. Upgrading the HVAC system to a more efficient one.

- Findings and Results

The installation of extruded polystyrene, the use of reflective material, and the re-placement of the windows with low-E double glass and PVC frames were found to lower the energy demand used for heating, ventilation, and HVAC systems by around 10 % compared to the base case. Meanwhile, the installation of renewable resources on the rooftops yielded an energy reduction of about 70% per building.

From the previous examples, it was concluded that several retrofits have a notable impact on the energy performance of the buildings, as noted in Table 1. Upgrades of the building's construction, more specifically the insulation of the walls and roof, are one of the main factors in reducing the energy demand of the building. Insulation reduces the solar gain of buildings and thus lowers their heat gain and loss. Retrofitting the building envelope also reduces energy consumption and enhances the performance of the HVAC system. Moreover, the employment of renewable energy is the main element in achieving the status of zero-energy neighborhoods. In fact, in most cases, PV panels reduce the energy demand by around 70%. Therefore, it could be concluded that to achieve the status of zero energy, three aspects have to be taken into consideration:

1. The utilization of the building's construction
2. Upgrading the building envelope.
3. The installation of renewable energy resources
4. Upgrading the building systems

LOCATION OF COMMUNITY	TYPE OF WORK	RETROFIT TECHNOLOGIES	KEY FEATURES AND PROSPECTS
A residential area of settlement in Pieria, Greece	Simulation using Energy Plus.	**Adaptation of the buildings:** •Arbor or wattle-covered roofs and terraces. •Windows with double clear glasses, argon filled cavity, and wooden frame. **Energy technologies:** •Hydronic air-conditioning system • Solar PV Panels	•Building envelope and windows allowed to reduce the heating and cooling energy demand up to 42–70% •The infiltration and the adaptation of ventilation rate were reduced to 0.2 ACH and 0.8 ACH respectively. • The overall reduction of energy demand was found up to 50–90%
A residential neighborhood in Granarolo dell'Emilia, in Emilia-Romagna, Italy	Simulation using Energy Plus & Monitoring using Web-GIS	**Adaptation of the buildings:** •XPS insulation for energy conservation. •Area for outdoor overheating mitigation. **Energy technologies:** •PV polycrystalline panel installation. •Energy management system.	• Renewable energy was able to cover 66% of the energy demand. • The neighborhood achieved the status of positive neighborhood for the first six month. • An overall decrease in the energy consumption up to 75.7 %.
A residential NZES in Rimini, Italy	Simulation by ENVI-met and Energy Plus	**Adaptation of the buildings:** • Extruded polystyrene insulation. • Highly reflective tiles for roof and external walls. •Low-e double glazing windows with PVC frames. **Energy technologies:** • High-efficiency heating, ventilation, and air conditioning (HVAC) system. • B-Type Wind Turbines. • Roof installed PV panels.	•The use of insulation, reflective material and upgraded windows reduced the energy demand be 10% •Up to 10% reduction in the energy demand could through the use of highly efficient HVAC system. •Overall, about 70% energy reduction per building was achieved through the PV panels and wind turbines.

Table 1. Summary of Analytical Examples

In order to achieve the three main retrofit aspects, a set of different retrofit scenarios, illustrated in Table 2, have been developed and implemented in an existing neighborhood.

	RETROFIT SCENARIOS
1	Upgrading of the windows glazing
2	Insulation of the external walls and roofs
3	The use of LED lights and light controls
4	Installation of solar PV panels

Table 2. Proposed retrofit scenarios

5. CASE STUDY

In order to investigate the impact of different retrofit scenarios on the energy performance of a neighborhood, a residential cluster located in Alexandria, Egypt, was selected to be retrofitted.

5.1. Building Description

The details of the proposed case study are discussed. The study area is located in Meroza compound in Alexandria, Egypt. The study area consists of 11 standalone villas. Each of the villas has a net area of 368.6 m². Each of the villas has three floors. Every floor has a net height of 3 meters and a total height of 9 meters. The ground floor consists of a reception and a kitchen. The second floor consists of four bedrooms, a bathroom, and a family room. The third floor has a guest bed-room, an office, a bathroom, and a lounge area. Figure. (4) shows the plans for one of the villas.

Fig. 4: Floor plans to the villas prototype. (Source: The researcher).

- Climatic Conditions

The typical climatic data of Alexandria is espoused according to the Köppen climate classification. Alexandria has a hot desert climate [18]. Table 3 presents the intensity of solar radiation and ambient air temperature, and humidity during heating and cooling seasons. From this table, it can be concluded that most of the summer days are moderately hot and can be very humid. July and August are the warmest and driest months of the year, with an average temperature of 30°C (86 °F). However, winter exhibits storms, rain, and occasionally sleet and hail. The coldest months are January and February, with maximum temperatures ranging from 12°C to 18°C.

Months Parameters	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average high temperature (◦C)	18.4	19.3	20.9	24	26.5	28.6	29.7	30.4	29.6	27.6	24.1	20.1
Average low temperature (◦C)	9.1	9.3	10.8	13.4	16.6	20.3	22.8	23.1	21.3	17.8	14.3	10.6
Humidity %	69	67	67	65	66	68	71	71	67	68	68	68

Table 3. Average temperature and humidity for Alexandria, Egypt

5.2. Simulation Tool

Design-Builder was chosen because of its adequacy for load and energy demand simulations. Design-Builder uses Energy Plus as a simulation engine for its energy analysis. The software and its engine are founded on dynamic load theory [19]. They also employ the response coefficient methodology to calculate and analyze energy loads and consumption [16.] Design builder has a built-in library of various building models, renewable energy, building systems, and emerging technologies. Design Builder's simulation of cooling and heating demands for all months of the year is considered.

- Base case configuration of the neighborhood (as built neighborhood)

Different input parameters for setting the existing building are espoused. For what concerns the building construction, the layer sequence and composition of the external and internal walls, the ground floor, repeated floors, and the roof are detailed in Figure 5. The thermal performance of the composition layers is illustrated in Tables 4-7. Concerning the transparent envelope, single-pane 3mm clear glass windows with PVC frames were used. Details for the construction of the windows are illustrated in Table 8.

(a) (b) (c) (d)

Figure. 5 Building Construction Layers. (a) Composition of the walls. (b) Composition of roof. (c) Composition of repeated floor. (d) Composition of the ground floor. (Source: The researcher).

Material Density	Thickness	Density [kg/m3]	Conductivity [W/m K]	Specific heat [J/kg K]
Plaster	2 cm	1050.00	0.2000	1500.00
Cement / Plaster Mortar	2 cm	1760.00	0.7200	840.00
Brick	12 cm for exterior walls 10 cm for interior walls	1920	0.7200	840.00

Table 4. The composition of the walls.

Material Density	**Thickness**	**Density [kg/m3]**	**Conductivity [W/m K]**	**Specific heat [J/kg K]**
Reinforced Concrete with 2%	15 cm	2400.00	2.5000	1000.00
Bitumen insulation	2 cm	1100.00	0.2300	1000.00
Cast Concrete	10 cm	2000.00	1.1300	1000.00
Sand	6 cm	2200.00	1.8300	712.00
Mortar	2 cm	2800.00	0.8800	896.00
Ceramic / Porcelain	2 cm	2300.00	1.3000	840.00

Table 5. The composition of the ground floor.

Material Density	**Thickness**	**Density [kg/m3]**	**Conductivity [W/m K]**	**Specific heat [J/kg K]**
Reinforced Concrete with 2%	15 cm	2400.00	2.5000	1000.00
Sand	6 cm	2200.00	1.8300	712.00
Mortar	2 cm	2800.00	0.8800	896.00
Ceramic / Porcelain	2 cm	2300.00	1.3000	840.00

Table 6. The composition of the repeated floor.

Material Density	**Thickness**	**Density [kg/m3]**	**Conductivity [W/m K]**	**Specific heat [J/kg K]**
Reinforced Concrete with 2%	15 cm	2400.00	2.5000	1000.00
Bitumen insulation	2 cm	1100.00	0.2300	1000.00
Cast Concrete	10 cm	2000.00	1.1300	1000.00
Sand	6 cm	2200.00	1.8300	712.00
Mortar	2 cm	2800.00	0.8800	896.00
Ceramic / Porcelain	2 cm	2300.00	1.3000	840.00

Table 7. The composition of the roof.

Material Density	**Thickness**	**Density [kg/m3]**	**Conductivity [W/m K]**	**Specific heat [J/kg K]**
Single Pane Clear Glass	3 mm	2400.00	2.5000	1000.00

Table 8. The composition of windows.

- Simulation Verification

The simulation of the building's energy has been validated. The model was created according to the parameters mentioned in the previous section. The simulation for the electricity consumption of the model starting from the 24th of March till the 15th of May to compare it to the actual electricity consumption of the study area has been done. The simulated electricity consumption was 13207.12 kWh, meaning that the usage per unit was 1200.64 kWh. The simulated result was compared with the actual electricity consumption in the same period. The deviation between both results was 2%, as shown in Table (9). Therefore, the simulation model was considered valid for future investigation.

	Actual electricity consumption (kWh)	Simulated energy consumption (kWh)	Error
Data	12938.23	13207.12	2%

Table 9. Electricity Consumption Record between actual and simulated electricity consumption

5.3. Simulation Results and Discussion

This section discusses the results of the retrofit scenarios previously presented in Table (2), to reduce the energy demand to achieve NZEN. A design-builder model was developed, and its cooling and heating demands were simulated using Energy Plus. The preliminary cooling and heating demand for the model was 130808 kWh and 43260.85 kWh, respectively. Figure. 6 shows the monthly cooling and heating demand of the proposed study area. The simulation model shows that most of the energy demand is because of the high solar gain from windows, poor insulation, and infiltration of the building, as in most of the buildings in Egypt. The impact of energy-saving technologies is demonstrated in the following section. The results of using each of the tested scenarios are compared to the preliminary case and its former technology.

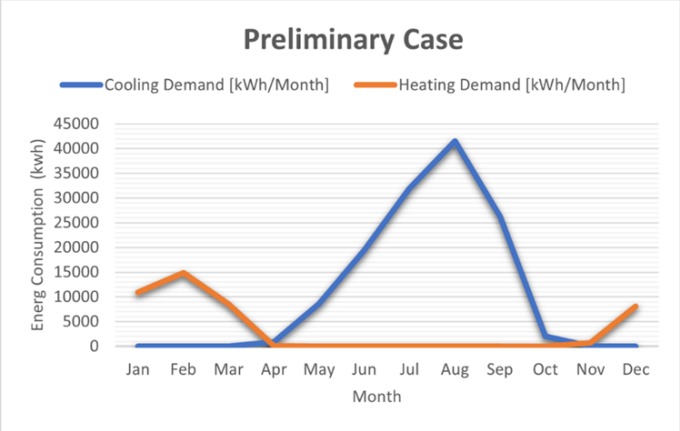
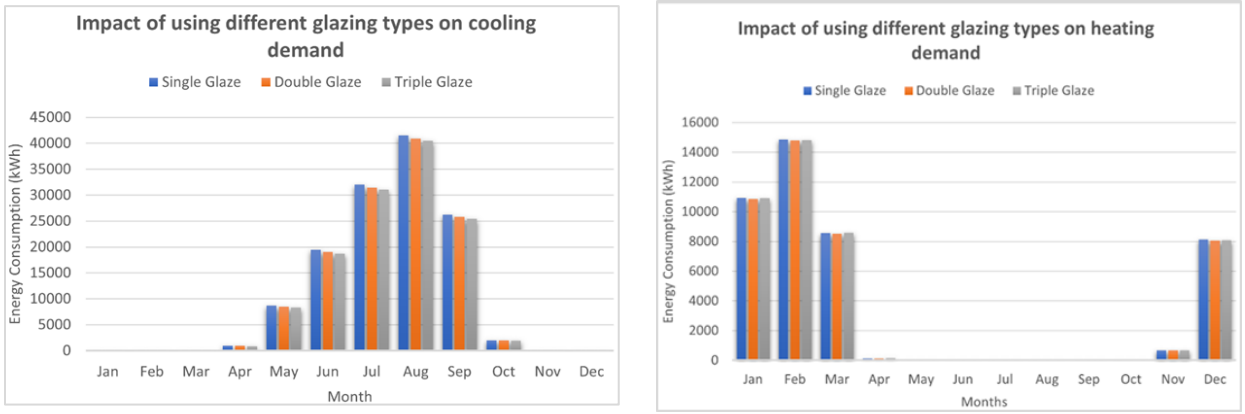


Figure. 6 Monthly variation of the preliminary energy demand. (Source: The researcher).

5.1. The Impact of Using Different Types of Glazing

Changing the type of window glazing has a positive impact on energy demand. Table 9 demonstrates the construction and thermal details of the tested glazing. The results showed that double glazing reduced the cooling energy demand by 2.5%. As for the heating demand, double-glazed windows reduced the energy consumption by 0.6%. Using triple glazing reduced the cooling consumption by 3.2%. As for the heating demand, triple glazing lowered the energy demand by 0.2%. The reason behind this slight decrease in the heating demand compared to the cooling one is that double and triple glazing have low solar heat gain, so the room requires more energy to reach the optimal temperature during the heating season. Using double-glazed windows would be a choice if we considered the pricing of both options. Figure. 7 shows the monthly variations of cooling and heating demand using different types of glazing.



(a) (b)

Figure. 7. Impact of using double and triple glazing on (a) cooling demand (b) heating demand. (Source: The researcher).

5.2. The Impact of Insulating the External Walls and the Roof

Insulation of the buildings' external walls has a significant impact their thermal performance. In this scenario the impact of insulating the external walls and roof using fiber glass is illustrated. Changes made to the construction of walls and roof are illustrated in Figure. 8. The thermal properties of the insulation tested materials is illustrated in Table 10. Results show that the insulation of the walls reduced the cooling consumption by 10.32% compared to the double-glazed case. The insulation of the walls reduced the heating energy by 10.6% and 10% compared to the base case and double-glazed case, respectively. Changing the construction of the roofs along the walls, as illustrated in Figure. 7, reduced the cooling demand by 43.7% and 42.75%, respectively, when compared to the base case and double-glazed case, respectively. In terms of heating demand, the insulation of the walls and roof reduced the heating demand by 40.7% and 33.6% when

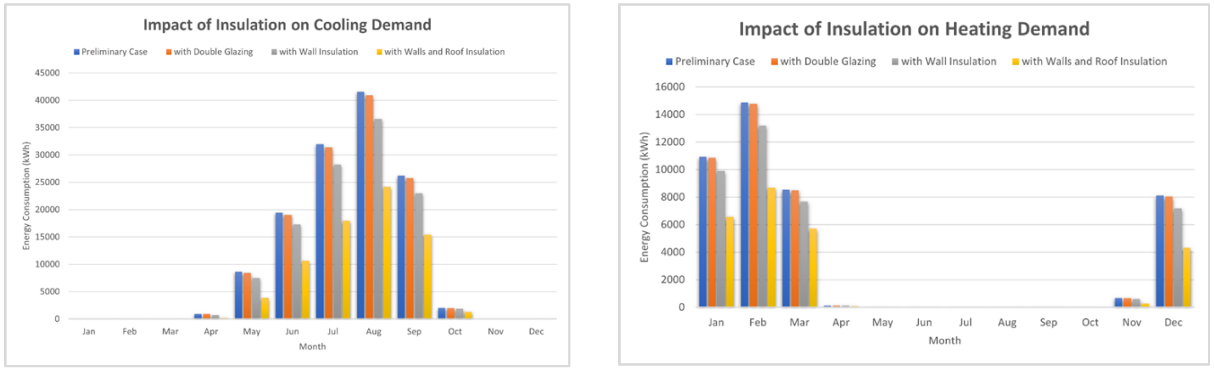
compared to the base case double glaze case, respectively. Figure. 9 shows the monthly variations of the cooling and heating demands after insulation.

	Thickness	Conductivity	Specific Heat
Fiber Glass Board	2 cm	0.036	840
Fibre Glass Slab	5 cm	0.035	1000

Table 10. Thermal Properties of the insulation material

(a) (b)

Fig.8: The thermal properties of the insulation tested materials (a) walls & (b)roofs. (Source: The researcher).



(a) (b)

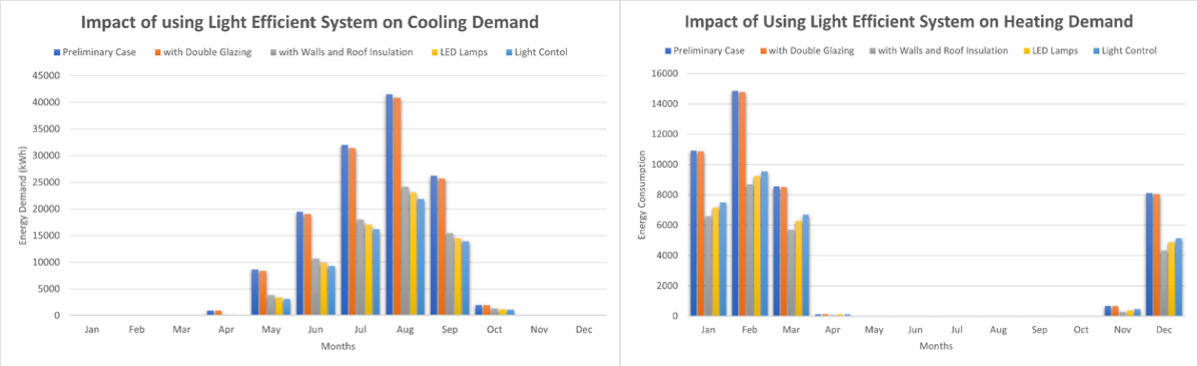
Fig.9: Impact of walls and roof insulation on (a) cooling demand (b) heating demand. (Source: The researcher).

5.3. The Impact of Using Efficient Lightning System

LED lamps and light control systems have a positive impact on energy consumption. Figure.10 shows variation of cooling and heating energies after changing the lighting system. Using LED lamps and the previous energy-saving measures has reduced the cooling energy consumption by 47% compared to the

preliminary case. Meanwhile, LED lights reduced the cooling consumption by 5.7% compared to the insulated buildings. In terms of heating demand, combining LED lamps with other technologies reduced the heating demand by 35% compared to the preliminary results. However, it in-creased the heating demand by around 10%. This rise is due to the low heat emitted by LED lamps compared to normal ones.

Installing a light control system decreases the energy required for cooling by 5.2%. Light control systems and the tested technologies decreased the cooling energy consumption by around 50%. In terms of heating energy, light control systems with other technologies decreased the overall energy demand by 31.8%. Meanwhile, it increased the heating demand by 5% for the previously discussed reason. The rise of heating energy could be overlooked in the Mediterranean climate, where the climatic conditions witness severe cold.



(a) (b)

Fig.10: Impact of using light efficient system on (a) cooling demand (b) heating demand for each month. (Source: The researcher).

5.4. Impact of Using Solar Photovoltaics

The use of solar photovoltaics is one of the key elements to changing the status of the investigated area to NZEN. A 10 watts (W) photovoltaic panel with a total area of 78.75 m² has been installed on the top of each one of the buildings. However, due to the large amount of data to be processed all at once, each building is simulated alone. The results are then summed up and presented in Figure. 11. The results showed the total electricity generated from photovoltaics was 181014 kWh which exceeds the annual electricity demand of the investigated area by 7%. However, during cooling season insufficient energy is produced to meet the required energy. In order to solve this problem, a battery should be installed to store excessive energy.

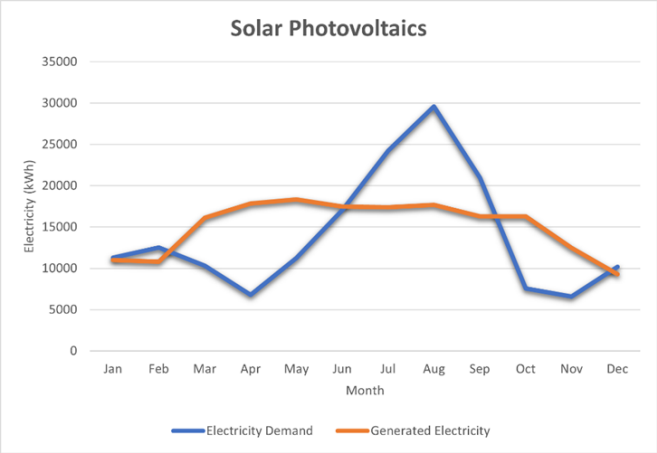


Fig.11: Monthly variation of the electricity generated from photovoltaics. (Source: The researcher).

5.5. Discussion

Results show that the adopted technologies could successfully change the status of the study area to positive energy building. the adopted measures could expand the use of energy retrofit technologies and be implemented in other residential areas to achieve NZEBs. Given that all information on renewable energy resources, building envelope and construction material, building energy systems, are all commercially accessible options. Energy-saving practices are also widely adopted and are simple to implement So, the framework can be used as a guideline for architects and researchers in their energy renovation practices.

5.6. Present Challenges, and Scope of Further Studies for the NZEN

Even though this study has successfully reduced the energy demand, it has been subjected to a lot of limitations. This study only investigated the most common energy-saving practices and overlook the impact of the rest energy-saving technologies. One of the main limitations of this study is inability to test the generation of solar PV because of the large data to be simulated. The tested PV panels was only limited to the roof area due to the unavailability of space. Furthermore, this study could not test another off-site renewable energy technology e.g., wind turbines for the same reason. As wind turbines has to be placed away from the site to reduce the noise transmission to the site. Moreover, this study does not consider the cost assessment of the proposed scenarios which could significantly impact the retrofitting decision.

In terms of future implementations, we suggest that future research take a closer look on the less investigated energy-saving measures. Furthermore, it's important to con-sider the feasibility and economic value of the investigated measures which could facilitate or hinder its implementation. Furthermore, a real-life implementation and monitor of these measures should be taken into consideration as most of current research depend only on simulation tools.

6. CONCLUSIONS

Buildings with Zero-Low Energy are now regarded as one of the most important solutions to rising energy demand and GHGs emission. This study has contributed to decreasing the energy consumption of a residential cluster in Alexandria, Egypt. A series of retrofit scenarios, including upgrading the buildings' glazing; insulation of external walls and roof; use of highly efficient lighting systems; and installation of solar photovoltaic, have been developed to reduce the energy demand. The proposed scenarios were tested and developed using Design Builder v6.1 and Energy Plus 8.9. The preliminary results of the investigated area showed that its cooling and heating demands are 130808 kWh and 43260.85 kWh, respectively. The combination of the energy-efficient technologies reduced the cooling and heating demand of the base case by around 50% and 32%, respectively. Finally, the results highlighted that installing PV panels on the roofs could meet and cover the remaining energy demand of the building.

NOTES AND REFERENCES

[1] I.E. Agency, Energy Technology Perspectives , 2017.

[2] Harkouss, F., Fardoun, F., & Biwole, P. H. (2018). Multi-objective optimization methodology for net zero energy buildings. Journal of Building Engineering, 16, 57–71. https://doi.org/10.1016/j.jobe.2017.12.003

[3] KAZANCI, S., & SAMANCI, A. (2021). Overview a nearly zero energy building. International Journal of Energy Applica-tions and Technologies, 8(3), 154–168. https://doi.org/10.31593/ijeat.927678

[4] Butera, F. M. (2013). Zero-energy buildings: the challenges. Advances in Building Energy Research, 7(1), 51–65. https://doi.org/10.1080/17512549.2012.756430

[5] P. Torcellini, D.B. Crawley, Understanding zero-energy buildings, ASHRAE J (2006).

[6] Marique, A. F., & Reiter, S. (2014). A simplified framework to assess the feasibility of zero-energy at the neighbour-hood/community scale. Energy and Buildings, 82, 114–122. https://doi.org/10.1016/j.enbuild.2014.07.006

[7] Mittal, A., Krejci, C. C., Dorneich, M. C., & Fickes, D. (2019). An agent-based approach to modeling zero energy communi-ties. Solar Energy, 191, 193–204. https://doi.org/10.1016/j.solener.2019.08.040

[8] Hledik, B. Tsuchida, J. Palfreyman, Beyond Zero Net Energy? Alternative Approaches to Enhance Consumer and Envi-ronmental Outcomes, 2018.

[9] Wu, W., & Skye, H. M. (2021). Residential net-zero energy buildings: Review and perspective. Renewable and Sustainable Energy Reviews, 142, 110859. https://doi.org/10.1016/j.rser.2021.110859

[10] Zhou Z, et al. "The operational performance of 'net zero energy building': a study in China. Appl Energy 2016;177:716–28. https://doi.org/10.1016/J. APENERGY.2016.05.093.

[11] DOE. "United States office of energy efficiency & renewable energy - wind energy technologies office - frequently asked questions about wind energy. ": Department of Energy; 2019. http://energy.gov/eere/wind/frequently-asked-questions-about -wind-energy. [Accessed 17 March 20].

[12] Ohene, E., Chan, A. P., & Darko, A. (2022). Review of global research advances towards net-zero emissions buildings. En-ergy and Buildings, 266, 112142. https://doi.org/10.1016/j.enbuild.2022.112142

[13] Pless S, Torcellini P. Net-zero energy buildings: a classification system based on renewable energy supply options (NREL/TP-550-44586). 2010

[14] Ascione, F., Bianco, N., de Masi, R. F., Dousi, M., Hionidis, S., Kaliakos, S., Mastrapostoli, E., Nomikos, M., Santamouris, M., Synnefa, A., Vanoli, G. P., & Vassilakopoulou, K. (2016). Design and performance analysis of a zero-energy settlement in Greece. International Journal of Low-Carbon Technologies, 12(2), 141–161. https://doi.org/10.1093/ijlct/ctw003

[15] Ullah, K. R., Prodanovic, V., Pignatta, G., Deletic, A., & Santamouris, M. (2021). Technological advancements towards the net-zero energy communities: A review on 23 case studies around the Globe. Solar Energy, 224, 1107–1126. https://doi.org/10.1016/j.solener.2021.06.056

[16] Mavrigiannaki, A., Gobakis, K., Kolokotsa, D., Kalaitzakis, K., Pisello, A. L., Piselli, C., Laskari, M., Saliari, M., Assima-kopoulos, M.-N., Pignatta, G., Synnefa, A., & Santamouris, M. (2021). Zero energy concept at neighborhood level: A case study analysis. Solar Energy Advances, 1, 100002. https://doi.org/10.1016/j.seja.2021.100002

[17] Castaldo, V. L., Pisello, A. L., Piselli, C., Fabiani, C., Cotana, F., & Santamouris, M. (2018). How outdoor microclimate mitigation affects building thermal-energy performance: A new design-stage method for energy saving in residential near-zero energy settlements in Italy. Renewable Energy, 127, 920–935. https://doi.org/10.1016/j.renene.2018.04.090

[18] Wikipedia contributors. (2012, June 30). Alexandria. Wikipedia. Retrieved May 10, 2022, from https://en.wikipedia.org/wiki/Alexandria

[19] Janzadeh, A., & Zandieh, M. (2020). Design feasibility of a net-zero energy neighborhood in Qazvin. Energy Efficiency, 14(1). https://doi.org/10.1007/s12053-020-09909-w

Traditional Dwellings and Settlements

Working Paper Series

EVALUATION OF THE "VISITOR EXPERIENCE" AT SAUDI ARABIAN CULTURAL HERITAGE SITES
CASE STUDY: THE DIRIYAH MUSEUM IN THE HISTORIC DISTRICT OF TARIF

Manar Bint Abdulaziz AlYabis, Mohammed Bin Saeed Al-Aisan Al-Ghamdi

Volume 333

Pages 20-37

2024

EVALUATION OF "VISITOR EXPERIENCE" AT SAUDI ARABIAN CULTURAL HERITAGE SITES
CASE STUDY: THE DIRIYAH MUSEUM IN THE HISTORIC DISTRICT OF TARIF

◆ ◆ ◆

This study argued that museums of cultural heritage sites in Saudi Arabia are designed to provide a pleasant visit but fail to project the main themes and cultural values. Researchers have adopted the Museum Exhibition User Experience model to examine the visitor experience of the Diriyah Museum in the Alturief district, one of the most important UNESCO heritage sites in the kingdom.

The theoretical and empirical framework of the study demonstrated the significance of building museums of heritage sites to enhance the visitor experience and make their visit not only pleasant but also informative. The study suggests a continuous evaluation of visitor experience and using their feedback for developing museum context.

1. INTRODUCTION

To revive the cultural past, consolidate national identity, and introduce future generations to its glorious history, there has been an increased interest in developing the museum sector, and many contemporary and local museums have been established in Saudi Arabia's archaeological areas. Visiting museums and heritage sites creates awareness, interest, and education about the past, and is one of the most significant tourist attractions for people of all ages [1]. Therefore, museum designers should develop methods to attract visitors and enhance their educational, entertainment, and cultural encounters.

In the Kingdom of Saudi Arabia, museum administrations lack the basic foundation to ensure the success of museum design in achieving its mission and objectives, which is to evaluate visitors' experience to ensure that museums effectively communicate their mission, achieve their objectives, and enrich such experience. This research examines the visitor experience of the Diriyah Museum, which is one of the seven museums established in historical palaces in the Tarif district of Diriyah. The other six museums are the Social Life Museum, Military Museum, Arabian Horse Museum, Bait Al-Mal Museum, Sabalah Moudi Museum, and the Museum of Traditional Architecture. In addition to presenting the history and antiquities of the Kingdom of Saudi Arabia, each of these seven museums aims to emphasize local archaeological regions. This study will be conducted in two phases; the first phase will focus on reviewing concepts such as "experience in museums" and "satisfying experiences," followed by a listing of globally accepted models for evaluating the visitor's experience in museums. The second stage consists of selecting a tool to measure visitor experience and distributing it to visitors of the Diriyah Museum, the subject of this research and study, to determine the extent to which visitors comprehend the scientific and cultural value of the museum. It is anticipated that

This study proposes a model for evaluating museums and providing recommendations that can contribute to enhancing the visitor experience in those museums; additionally, it urges the community to preserve its past, understand its history, and disseminate museum culture.

2. LITERATURE REVIEW

According to the World Tourism Organization [2], heritage tourism has steadily increased in recent years and now accounts for 40% of global travel. Heritage tourism is defined as "the provision of goods and services that come from or are related to the past in some way" [3]. Museums are a part of the tourism industry and, thus, have evolved to connect the past with the present without compromising cultural value. This may have been accomplished by museums, but the following questions must be addressed perpetually: What does "museum experience" mean, and who are its audiences? How can we maximize the outstanding quality of the "museum visitor experience"? This will be covered in the subsequent paragraphs.

2.1. Defining "Experience in Museums"

Visiting a museum involves different dimensions of the visitor's life, including physical, intellectual, social, and emotional. To clarify these dimensions more precisely, the meaning of the phrase "experiences in museums" must be described.

Roberts [4] defines the "visitor experience" as the primary categorization of social connection, memories, imagination, and interpersonal engagement. As for Annis [5] who identified three distinct types of symbolic association in the museum, the term "dream space" was coined to describe this area (the area of interaction between the suggestion of emotional objects and the viewer's subconscious), the space (the field of activity in which being physical, not things, has meaning), and the "cognitive space" (the domain that corresponds to thought and rational order) as multidimensional experience. Falk and Dirking [6] submitted a clear definition of "visitor experience"; it is the intersection of three interrelated factors: an individual's motivations, expectations, and background knowledge, the influence of group dynamics and broader cultural contexts, and the visitor's immediate physical surroundings.

Graburn [7] argues that people visit museums not only to have educational experiences to help "understand the world" but also to have reverential experiences of something "out of the ordinary," such as experiences in social signs and rituals in family life. According to Foley, Malcolm and McPherson [8], museums are an important part of the entertainment sector. Cultural tourists and locals looking for fun comprise a large part of the crowd. While Stepen believes that the "expectation of a pleasant experience" draws people to museums

as a form of pleasure, visitors attend museums not only to gain knowledge but also to accumulate knowledge as much as to accumulate experiences [9].

Although "experience" has been proposed as a concept that transcends the conflict between education and entertainment by Falk and Dierking [10], some people still treat it as separate from learning. To provide an "experience" as much as an opportunity to learn, modern galleries aim to highlight the visitor's "emotion and amazement," says Beier-de Haan[11]. However, there is a strong line of thought in museology that does not separate experience from learning, but instead emphasizes the role of direct experience in education and its contribution to the satisfaction of visitors.

2.2. Museum Visitor Satisfaction

By the 1990s, the Smithsonian Institution's Office of Institutional Studies began conducting new research on museums and their visitors to find out the latter's point of view regarding the experiences that they value most. In this regard, Pekarik, Doering & Karns (1999), introduced the idea of "satisfying experiences" based on many years of museum visitor research at the Smithsonian Institution. They created a list of such experiences that currently includes 14 items and classified these into four clusters based on various multidimensional analyses and use it as an effective tool for identifying visitor experiences. The first cluster is "object experiences," which highlight "something external to the visitor," such as the object's authenticity, value, and attractiveness, the desire to own the object, and professional development. The second cluster is "cognitive experiences," which provide intellectual stimulation to analyze and integrate the exhibit's cognitive content to learn or improve comprehension. The third cluster is "introspective experiences"; the reactions are triggered by the object or exhibition, causing one to look inward and have a personal, private experience by imagining other times, reflecting on the meaning, recalling personal memories, feeling a spiritual connection or connectedness, and so on. Furthermore, the fourth group comprises "social experiences," that is, spending time with friends or family or observing children learn at the exhibition[12].

In addition to Doering, Pekarik, and Karns (1999) and De Rojas and Camarero (2006) explained the concept of satisfaction as a product of experience and expectation. Two effective statues—pleasure and mood (or state of mind)—are already present for the visitor. "Pleasure" is a self-referential emotional component that increases the visitor's initial satisfaction when they evaluate the experience in relation to one's expectations. An increase in satisfaction (from either confirmation or positive disconfirmation) is encouraged by a positive pleasure factor. An individual's unhappiness will be amplified when presented with a negative "displeasure" component in addition to disconfirmation. The exhibition visitor also brings their own "state of mind" or "mood" to the show, which may be affected by variables such as illness, exhaustion, stress, heat, and noise.

De Rojas and Camarero (2006) also found that an individual's degree of happiness correlates with their capacity to assimilate information, pick good or negative data, and recall positive or negative experiences[13].

2.3. Models To Understand Visitor Experience

Many models depict visitor experience such as, most notably, the interactive experience model (Falk & Dirking, 2016) and the visitor experience model (Bakker & Ballantine, 2016). Falk and Dirking's model identifies three important contexts for the visitor's museum experience: a) the personal context, which includes the visitor's prior knowledge and experience about the museum's content and design, b) the social context of those who visit the museum (e.g., if the visit is with a group or an individual visit, or through visitors' communication with other visitors or museum staff), and c) the visitor's perspective toward the architectural design of the building and the museum design of the exhibits and antiquities and their reaction, actions, observations and memories through their interactions with those physical features of the museum. These three contexts come together to form the "interactive experience" model[14] (Fig.1).

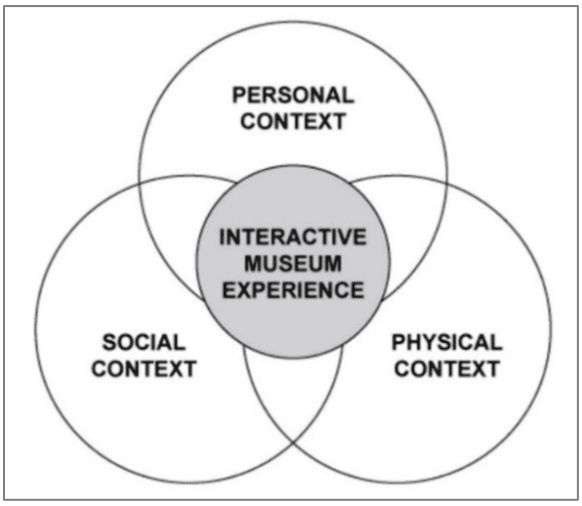


Fig. 1: A three-context model for evaluating the visitor experience for museums (Source: Falk & Dierking, 2016).

Baker and Ballantine (2016) believe that the visitor experience is a multi-faceted experience that includes areas classified as "external," which are the moments that the visitor cannot be directly affected by or are not personal; this applies to planning and implementation or the impact of news and publications in public networks on people or social groups. The middle region refers to the "current experience" or "subjective experience," which explains the impact of the visitor's personal expectations, interests and motives (e.g., high excitement, positive stimulation or social interaction, and others during the current visit that may produce a

conscious personal experience); therefore, it is multi-faceted, and all these elements are linked to each other, which overlap and ultimately shape the visitor experience[15] (Fig.2).

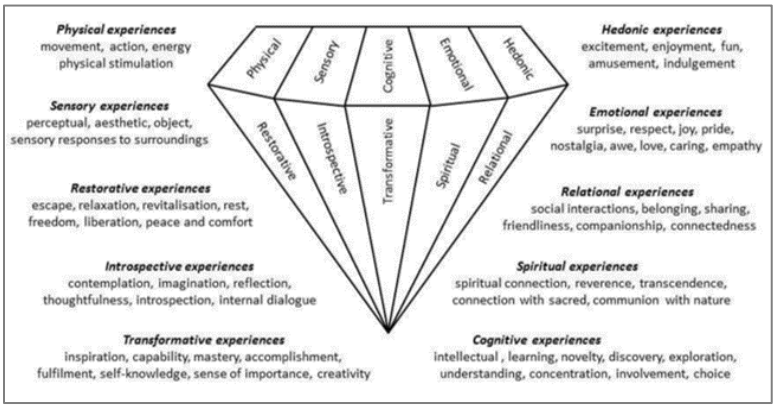


Fig. 2: A multi-faceted model for assessing the visitor experience (Source: Packer & Ballantyn, 2016).

The previous two models shed light on understanding the visitor's experience, respectively, from three and several aspects; however, no link exists between understanding the visitor's experience and how to develop museum content to enrich that experience of exhibits, collections, information, and activities. How can museum content be developed in an innovative and interesting way to enrich the visitor's experience? Therefore, the museum sector must better understand the visitors to develop museum components and contents; this will allow visitors to better comprehend the cultural themes and the authorities to use these ideas for further continuous development.

2.4. Creating Meaningful Museum: A Model for The Museum Gallery User Experience

This study introduces one of the models for creating a successful user experience—the Hassenzahl (2003) model (Fig.3)—and introduces a new model by integrating existing knowledge of the visitor experience of the Oxford University Museum of Natural History (OUMNH) with its principles of user experience. This model depicts the experience of a museum exhibition from the perspectives of the institution and the visitor through research interviews and surveys with museum professionals in the UK for the OUMNH and, then, investigates it as a method for assessing the visitor's tourism experience at the museum. A discrepancy was found between the preferences of the museum and those of the visitor for the visit and the results that arise from the visits when comparing the results with those of the employees. The hedonistic aspects and realistic qualities of the exhibition can be used to visualize the visitor experience by integrating the theoretical Museum Exhibition User Experience (MEUX) model into museum practice and developing evaluation tools

(Fig.4). This approach properly assesses how museum development decisions affect visitor experiences by identifying institutional and tourism preferences[16].

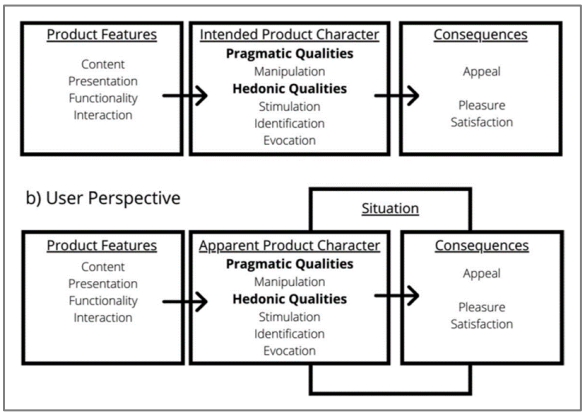


Fig. 3: The user experience (UX) paradigm, adapted from Hassenzahl (2003).

The paradigm has been divided into "design perspective" and "user perspective." This distinction highlights the essential element of user experience; that is, there is no guarantee that the user will interact with the product in the way the designer intended, and, therefore, the personality of the product can only be "intentional." Moreover, the user's state is always added from the "user perspective," which leads to unpredictable interactions (Fig. 3).

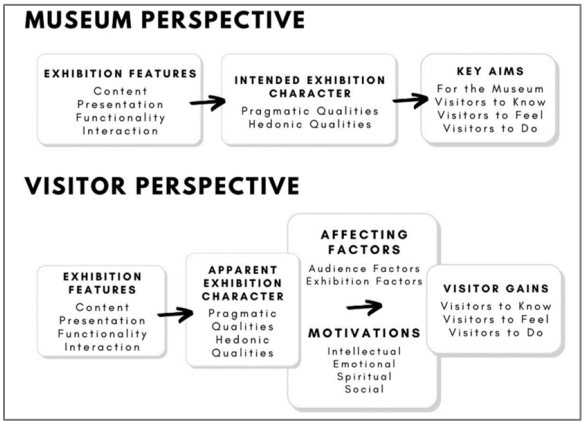


Fig. 4: The developed MEUX model adapted from Hassenzahl (2003).

The MEUX model distinguishes between the perspectives of the museum and visitors. From a museum's perspective, "exhibition" refers to its character, as the museum shows what it aims to achieve through the exhibition. The visitor interacts with the exhibition according to their motives for visiting, and the influencing factors provide them with benefits. While understanding visitors increases the likelihood of this happening,

there is no guarantee that visitors will understand, interpret, and interact with the exhibit in the way the museum intends (Fig. 4).

2.5. The Application of the Integrated and Developed Meux Model to Evaluate the Experience of Visitors to the "Diriyah Museum"

The MEUX model (Fig. 4) was used to assess the experience of visitors to the Oxford University Museum of Natural History (OUMNH) after it was developed and combined with the Hassenzahl (2003) model and to evaluate the experience of visitors to the Diriyah Museum. This is because of its method and accuracy in collecting data and ability not only to visualize the visitor's experience but also to evaluate the visitor's experience after completing the visit to the museum.

2.6. Description of the Case Study: Diriyah Museum

The Diriyah Museum is located in Salwa Palace, built by Imam Abdulaziz bin Saud in 1765. The palace is located in the historical Turaif neighborhood in the city of Diriyah in Riyadh, covering an area of 10,000 square meters. The Diriyah Museum presents the stages of development of the first Saudi state, the history of its imams, and its political achievements, which collectively form its main theme. As for the museum's secondary themes, it displays the historical depth of Najd architecture in the city of Diriyah. Since the founding of the first Saudi state 300 years ago, Diriyah has served as the state's political, economic, religious, and social administration center. The city of Diriyah is also considered a pillar and a starting point for achieving unity, security, and stability on the Arabian Peninsula. Thus, the museum was named the “Salwa Palace,” which means comfort, and conferred the title "Palace of Power" due to its stability and durability. Imam Muhammad bin Saud, Imam Abdul Aziz bin Muhammad bin Saud, Imam Saud Al-Kabeer bin Abdulaziz bin Muhammad bin Saud, and Imam Abdullah bin Saud Al-Kabir bin Abdulaziz all resided at the Salwa Palace (Fig. 5).

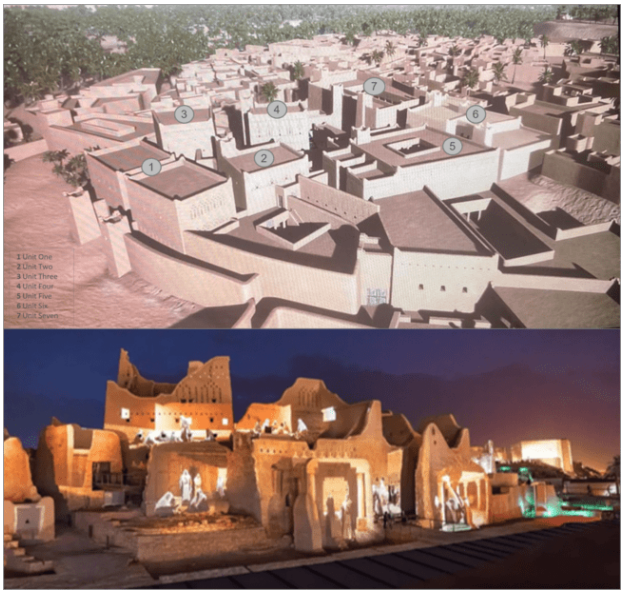


Fig. 5: Above: the seven units of the Diriyah museum; below: the Diriyah museum in Salwa Palace, located in the historic Turaif district of Diriyah.

The museum consists of seven galleries, The first and second ones are the Salwa Palace and the Dirriyah Gallery attached to the palace, respectively. The other five galleries are scattered apart at different locations in the Turaif district and can be reached through an open path between the ruins of buildings (Fig. 5).

As for the seventh unit, it consists of two parts, and its area is about 1,100 square meters. This unit includes the residences of the wives of Imam Saud bin Abdulaziz and his sons and a large hall with pillars in which a school has been established. The attached gallery at the Salwa Palace offers a journey through time and displays a model of the ruling family tree that begins with the founder of Diriyah, "Mana al-Baridi" (Fig. 6). The tree is not displayed in its entirety but rather in five stages completed at the end of the museum. The attached gallery at the Salwa Palace is divided into two parts; the first part is related to the first Saudi state and includes historic and geographic information about the Diriyah site and Wadi Hanifa (Fig. 6). Also displayed in this first part are the sample of Abd al-Wahab books about Faith and Sharia. It also presents the expansion and the fall of the first Saudi state, starting with Imam Muhammad bin Saud until the six-month Siege of Diriyah at the hands of Toson Pasha, during which wells and palm trees were dug and, then, burned.[17].

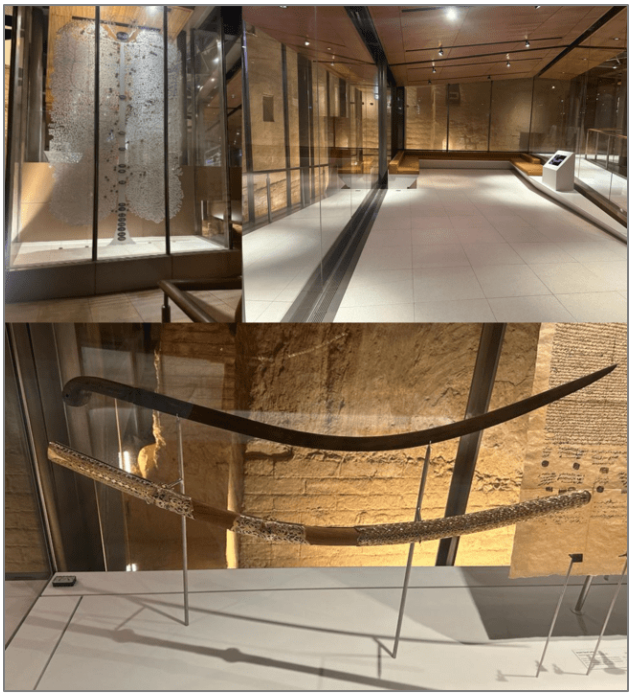


Fig. 6: Top left: the dynasty tree at the beginning of the interior museum; top right: a resting area with an interactive screen showing information about Wadi Hanifa and Al Yamama; below: an exhibit of a copy of Seif Suleiman Pasha.

To move to the second Saudi state, the visitor must cross a narrow corridor (about two meters wide) divided into seven steps representing the seven-year gap between the first and the second Saudi state. Among the most prominent things that are shown in the second part is a copy of Al-Saif Al-Ajrab, followed by a display of the fourth tree and a pause equipped with screens to display the rest of the branches of the ruling family tree and equipped with hearing aids. Screens on the walls display the development of the Kingdom of Saudi Arabia, including old pictures of the building, King Abdulaziz, and its economic development. This is followed by a display of King Abdulaziz's letters, and the visit ends with the presentation of the fifth tree, which represents more than seven thousand members of the royal family. The display and its reflection distinguish the interior museum as a public aspect by making visitors wander through the glass corridors and see the ruins of Salwa Palace under their feet. The museum has activated two languages for Arabic and English display, in addition to the tour guides who speak several languages such as French, Spanish, Korean, Japanese, Russian, German, as well as sign language (Fig. 7).

Fig. 7: Top left: seven-year-long corridor separating the first and second Saudi states; top right: displays of the Alsayf alajrab sword; below left: view of the final tree; below center: exhibition concept for the interior museum; below right: glass floor to see the archaeology under the structure.

Outside the Salwa Palace, another five galleries can be visited. The first gallery was constructed in the eighteenth century on a rocky incline at the bend of Wadi Hanifa on stone foundations. It is approximately 690 square meters in size and has multiple apertures. The entrance can be found on the southwest side. This unit comprises two structures. Each structure contains a central hall surrounded by three rooms. A staircase leads to both the second floor and the tower on the palace's eastern side. The walls were constructed with clay. The thatch is sourced from the local environment, whose mud walls are up to 1 meter thick and are decorated with openings that serve as windows to enable air and light to enter.

The second unit consists of two entrances and is approximately 785 square meters in size. The first entrance is to the north and leads to the portico, while the second entrance is to the east and is ornamented with notched balconies. Each floor of the second unit, which represents the Tarif Mosque of Imam Muhammad bin Saud, was constructed to reflect traditional characteristics. The first unit was connected to the second unit by a series of columns, and the second unit was connected to the Tarif Mosque (T) by an overhead bridge. The entrance to the third unit overlooks the eastern side of Salwa Palace and leads to three rooms covering approximately 245 square meters on three levels. As is the case with other units, Imam Abdul Aziz constructed multi-story structures with ceilings protected by a layer of mud plaster. This unit features a balcony that is accessible from the rear. During the reign of Saud the Great, it was protected by earth plaster and a curved wall from the east. Imam Saud Al-Kabeer's inner council met there to receive his visitors.

The fourth unit is located in this unit's eastern corner, and its entrance is on the eastern side. It has an area of approximately 445 square meters, and three floors, with the first floor containing three rooms; all of its corners have been decorated. Imam Saud Al-Kabeer added a fourth unit with multiple stories connected to the other units by terraces and columns, and the western side was replaced by the small Imam Saud Mosque, which contains a water well and ablution basin.

The fifth and final unit is distinguished by its construction quality and architectural form; its area is approximately 720 square meters, and it contains three residences, each with its own entrance. It is situated on the western side of the palace and has been transformed into three distinct homes. This unit performed an indispensable role in the palace. Some remnants of the original wall and the T-shaped superstructure facing north are visible (Fig. 5).

3. RESEARCH METHOD

The research is conducted in two phases using an analytical descriptive method. The first part entails searching the literature for the terms "user experience" and "satisfying experience" and compiling a list of models that have been internationally approved for evaluating the visitor experience of archaeological museums in order to select the most appropriate model. The second stage involves using a weighted model to administer a questionnaire and evaluate the experiences of visitors to the Diriyah Museum.

4. RESEARCH RESULTS

The results of the study include visitors to the "Diriyah Museum" in the historical district of Tarif in the city of Diriyah in Riyadh; it consisted of a sample of 100 visitors who were chosen by the "random sample" method, indicating equal opportunity and the same degree of probability for any member of the research community; a trained team was used to randomly select the sample and provide the selected visitors with a QR code to evaluate their experience after visiting the museum.

One hundred questionnaires were collected, and none were excluded. As for the analysis of visitor arrival patterns, the data showed that most of the visitors were in the family category, and this may be due to the time of distribution of the questionnaire, which was during the weekend. Family is the most common group of visitors (45%), followed by the categories of friends (23%) and couples (22%); individual visits represent 8%, and the least common groups of visitors— school and sister groups—were equally represented (1%) (Fig. 8). The figure shows that most museum visitors wander in groups; thus, it is necessary to design the main traffic lines and axes of movement, such as the corridors that connect the hall to the other, the sub-axes,

the stairs and the slopes that connect several levels to accommodate the passage of groups of visitors, and the ease of their movement between the different spaces to avoid forming crowds.

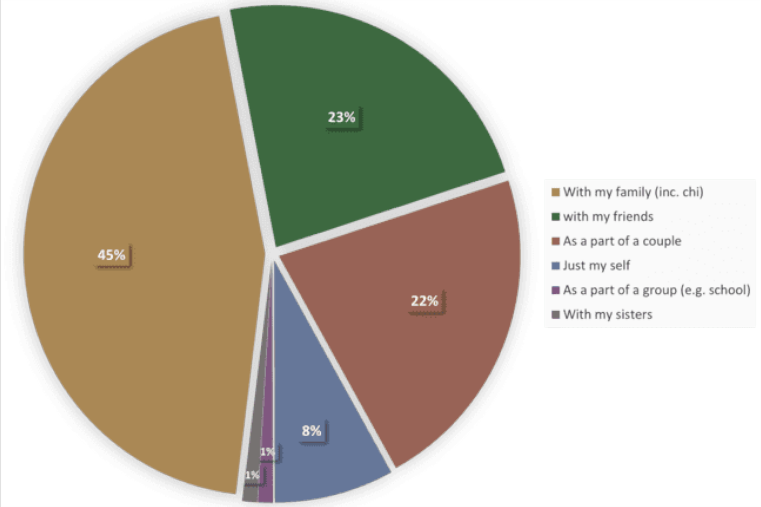


Fig. 8: Graph showing visitor arrival pattern.

The number of female respondents was three times higher than that of male respondents (76% versus 24%) (Fig. 9). The smaller number of male visitors compared to female visitors may be due to their preoccupation with the responsibilities and requirements of life. The largest age group was 45–36 (48%), followed by the age groups 26–35 (24%) and 46–55 (19%), respectively. The least responsive age group was 65+ (2%), followed by the age group 18–25 (4%), which is lower than the age group 56–65 (5%) (Fig. 10), meaning that visitors from the age of 26–55 years represent 91%, which might have been due to the stability of financial or family income for this age group. Sample analysis indicates that male and female general education students represent a small percentage of visitors (1%) because the largest part of the museum, which is the external museum and includes five units, does not open its doors until after sunset, because its displays depend on technologies such as light and laser, and the indoor museum is available during the morning. In addition, the percentage of the elderly (aged 56–65) (5%) is very low, although this age group mostly comprises free-timers. However, the low percentage of this group may be due to the lack of motor corridors and the difficulty of moving due to the type of floors used, which may hinder the walking stick or the absence of vehicular lanes in areas of different latitude levels.

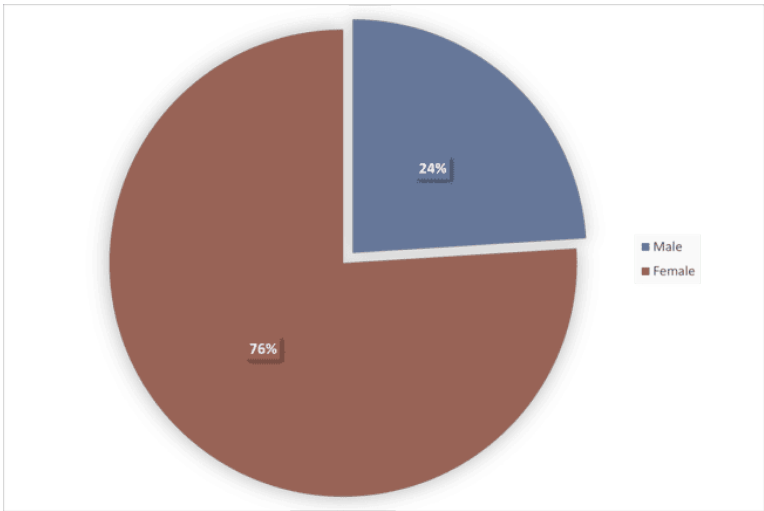


Fig. 9: Graph showing the percentage of female visitors compared to male visitors.

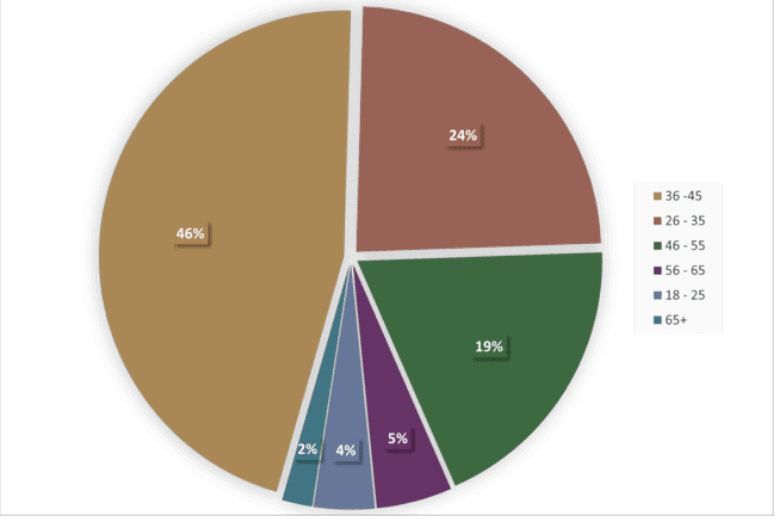


Fig. 10: Graph showing the ages of visitors to the museum.

4.1. Analyzing the Results of Answering the First Question: What Did You Benefit From Your Visit to the Museum Today?

For the first question, the visitors selected the five most important motives and gains for their visit. Table 1 presents the number of repeat visitors and the percentage of respondents from visitors in descending order.

Visitor Motivations: "Why have you visited the exhibition/ galleries today?"		**Visitor Gains:** "What did you get out of your visit today?"	
Concept	N (%)	**Concept**	N (%)
Entertainment	84%	Escape everyday experience	66%
See something new	72%	Enjoyment	62%
Cultural and social status	70%	Identity	61%
Interested in topic	48%	Experience	54%
Facilitates social engagement	46%	Good use of time	46%
To learn	43%	Return	39%
Good day out	34%	Emotional response	38%
Escape the everyday	23%	Engage with concept	36%
Relaxation	23%	Social engagement	35%
Word of mouth	23%	Memories	29%
Leisure time	20%	Understanding of concept	28%
Inspiration	12%	Intellectual response	23%
Safe space	10%	Empowered	18%
		Relevance	15%
		Learn more	13%
		Further action	5%
		Improve social relationships	5%
Other			
Nothing			
	1%	I felt distracted and unable to figure out the details	1%
The museum is great, and I recommend it to parents with children who are old enough to learn about their country's history.	1%	Discover the place	1%
Concepts are ordered from most to least popular, based on the number of times they were selected by participants. Frequency and percentages are given.			

Table 1. The results of analyzing the gains and motives of visiting the Diriyah Museum are arranged according to the largest.

The abovementioned data showed that the visitor's experience was satisfactory and distinctive by (66%) and that 84% enjoyed their visit to the museum. This means that the Diriyah Museum is performing its work to the fullest.

The results presented in Table 1 demonstrated the observed gains; 98 responses from visitors were collected, and 2 visitors mentioned other gains. In all, 66% of the respondents expressed that the experience was unique, while the second and third highest percentage gains were after the distinctive experience—enjoyment and a sense of identity (62% and 61%, respectively). Some of the respondents gained experience from their visit to the museum (54%), and 46% of the respondents benefited from their time during their visit to the museum. Moreover, 39% wanted to repeat this visit or visit another museum. Responding emotionally to museum exhibits (38%) and understanding the ideas that were presented (36%) were close. In all, 35% of the respondents engaged in social participation with friends or family. Moreover, 29% formed memories of the museum through visiting it. For understanding ideas, mental response, and perception of exhibits, the

percentages were somewhat close (28%, 23%, and 18%, respectively). While some felt attached to the museum (15%), others had a desire to know more about the idea of the museum (13%). In terms of changing behavior and making decisions after visiting the museum and improving social relations as a result of the visit, the percentage among the sample was equal (5%).

In general, it is clear that visitors' experience of the museum is positive and that the pleasure aspect of the visit is the first benefit. However, shortcomings exist in communicating the knowledge and cultural aspects of museums to members of society.

4.2. Analyzing the Result of Answering the Second Question: Why Did You Visit the Museum Today?

The answers to the second question were arranged according to the following: 84% of the respondents had visited the museum for enjoyment, while the motives for seeing something new and feeling the cultural and social status of the respondents were similar (72% and 70%, respectively). Some of the respondents expressed their interest in the displayed items in the museum, were motivated to participate in the community with the family or cultural groups, and showed their love for learning; the percentages were close to some extent (48%, 46%, and 43%). The weather was good; thus, 34% of the respondents went out and visited the museum. While escaping from the daily routine, feeling comfortable and verbal recommendations were equal, and each represented 23% of the respondents. Moreover, 20% of the respondents expressed a sense of emptiness, which prompted them to visit the museum. As for the motive for the museum to be a source of inspiration (12%) and a sense of safety (10%), the result was close. Two more motives were added to the sample, and one was excluded for not mentioning the motive. One visitor stated that one of the motives was to allow children to understand the nation's history by bringing them to visit the museum. Visitors felt that these other motivations and benefits were not covered by the concepts presented in the survey but could be integrated into existing categories; therefore, no further data were required.

4.3. Results

This study aimed to measure the extent of the visitor's knowledge of the scientific theses and exhibits presented by a museum by evaluating their experience with museum performance and finding out the appropriateness of architectural planning to meet the visitor's desires. Methods were used to activate and develop the experience of visitors using the MEUX questionnaire model approved by Oxford University; through this form, it is possible to measure the knowledge of visitors to the museum and verify their desires by analyzing the information resulting from this questionnaire. The results of this study can be summarized by looking at the basic theme of the "Diriyah Museum", which is to show the political aspect, the establishment of the first Saudi state, the history of the imams and their achievements, and display the stages

of development of the Saudi state. We find that only 28% of the respondents understood the ideas that were presented. Moreover, 18% of the respondents were able to understand the exhibits, while 82% did not. As for one of the museum's sub-themes—the reason for naming it the "Salwa Palace," that is, the feeling of comfort—, we find that only 23% of the respondents had realized this. The respondents' main purpose of visiting the museum was to enjoy, representing the highest percentage (84%). Notably, the museum's design is not suitable for older people and those with disabilities, as evident from the results of the age group of the visit.

5. CONCLUSION AND RECOMMENDATIONS

In general, the research proved the importance of focusing on evaluating visitor experience and its impact on the development of historical museums. The theoretical and field framework of the research showed the importance of understanding the gains and motives of the museum visitors to achieve its goals and develop such experiences. To reach a distinctive museum experience, there is a need to evaluate the experience of museum visitors because of their ability to change the way museums deal with them.

Previous literature and the visitor experience questionnaire show the scarcity of studies related to evaluating the experience of museum visitors and that museums seek to create a rich and meaningful educational experience in their exhibitions but do not consider the desires and understanding of their visitors; in addition to that, they face difficulties in knowing what the visitors will gain from it. Finally, most of the visitors are women and their age group ranges between 25–55 years; the rest are aged under 25 and over 60, and they mostly come to the museum in groups except for the group of male and female students of public education schools and universities. Most of them had an enjoyable time, but they did not grasp the ideas that were presented and perceived them in the way the museum aspired to.

Therefore, the study summarizes recommendations that must be implemented, which is the interest in evaluating the experience of visitors to museums belonging to archaeological sites by the Museums Authority. It is good to use modern technology in museum display systems, but it must be studied to suit the visiting times of one of the most important target age groups, that is, students from schools and universities. It is also necessary to spread the museum culture and develop the experience of its visitors by benefiting from the global experiences of museums in evaluating visitor experience and building effective strategies to do the same. It also requires museums to link and enhance the visitor experience with the way the exhibits are presented to achieve a distinctive experience and create interactive presentation methods. Special attention must be paid to older people and those with disabilities in choosing floors, designing traffic, and ensuring ease of movement to suit their health capabilities. This category can also be expanded by establishing

activities that suit their abilities, integrating them with other age groups of tourists, and making them part of society. Officials must also consider the impressions and desires of visitors to historical museums, take into account the results of the questionnaire, and make decisions to develop the visitor's experience of the historical "Diriyah Museum".

NOTES AND REFERENCES

[1] Timoney, Steven. "'We should all know where we came from. 'Identity and personal experiences at heritage sites." *Journal of Heritage Tourism* 15, no. 4 (2020): 424-437.
[2] WTO. *Tourism Market Trends 2004-Europe (English version)*. World Tourism Organization, 2005.
[3] Ashworth, Gregory John, and J. E. Tunbridge. *A geography of heritage: Power, culture, and economy*. Arnold, 2000.
[4] Roberts, Lisa C. *From knowledge to narrative: Educators and the changing museum*. Smithsonian Institution, 1997.
[5] Annis, Sheldon. "The museum as a symbolic experience." *Unpublished doctoral dissertation, University of Chicago* (1974).
[6] Falk, J.H., & Dierking, L.D. (2013). The Museum Experience Revisited (1st ed.). Routledge. https://doi.org/10.4324/9781315417851.
[7] Graburn, Nelson. "The museum and the visitor experience." *Roundtable reports* (1977): 1-5.
[8] Foley, Malcolm, and Gayle McPherson. "Museums as leisure." *International Journal of Heritage Studies* 6, no. 2 (2000): 161-174.
[9] Stephen, Awoniyi. "The contemporary museum and leisure: Recreation as a museum function." *Museum Management and Curatorship* 19, no. 3 (2001): 297-308.
[10] Falk, John H., and Lynn D. Dierking. "Learning from museums: Visitor Experiences and the Making of Meaning. Walnut Creek." (2000).
[11] Beier-de Haan, Rosmarie. "Re-staging Histories and Identities." *A companion to museum studies* (2006): 186-197.
[12] Pekarik, Andrew J., Zahava D. Doering, and David A. Karns. "Exploring satisfying experiences in museums." *Curator: The Museum Journal* 42, no. 2 (1999): 152-173.
[13] Rojas, María del Carmen de, and María del Carmen Camarero. "Experience and satisfaction of visitors to museums and cultural exhibitions." *International Review on Public and Non Profit Marketing* 3 (2006): 49-65.
[14] Harada, Tazuru, Yanagisawa Hideyoshi, Eric Gressier-Soudan, and Camille Jean. "Museum experience design based on multi-sensory transformation approach." In *DS 92: Proceedings of the DESIGN 2018 15th international design conference*, pp. 2221-2228. 2018.
[15] Von Georgi, R. "Eventerleben als psychologisches Konstrukt und dessen Messung." *von Georgi, R.; Wünsch, U.: Erlebnis Messe. Dimensionen des Erlebens, ihre Wahrnehmung und Hinweise zu ihrer Inszenierung (= gizeh-letters, Band 8), Berlin* (2001): 32-113.
[16] King, Ellie, M. Paul Smith, Paul F. Wilson, Janet Stott, and Mark A. Williams. "Creating Meaningful Museums: A Model for Museum Exhibition User Experience." *Visitor Studies* 26, no. 1 (2023): 59-81.
[17] Author name. "n.d." "The educational film displayed on the museum screens". Month Day, year." n.d." (00:06:27), URL." n.d."

WORK OF HIRE
Graduate/ PhD program at the college of Architecture and Planning at King Saud University.

Traditional Dwellings and Settlements
Working Paper Series

LIGHTING SILHOUETTES AS AN ELEMENT IN VERNACULAR ARCHITECTURE: INSPIRATIONS FOR CONTEMPORARY DESIGN

Sima Tawakoli

Volume 333
Pages 38-50
2024

LIGHTING SILHOUETTES AS AN ELEMENT IN VERNACULAR ARCHITECTURE: INSPIRATIONS FOR CONTEMPORARY DESIGN

◆ ◆ ◆

This paper proposes to investigate the role that lighting place in giving vernacular architecture, some of its unique qualities. This may include for example how a beam of light may dictate the location of a window in relationship to the functions of a house or a shop that makes it stand out as different both aesthetically and functionally in a manner that defines specific traditional practice in selected regional and climatic contexts.

If we assume the main goal of tradition is to celebrate the highest achievement of the past and use of it as an inspiration for the present and for the future, we might need to dive deeper into the forms and practices of natural lighting as means to understand its contribution to the unique qualities of the vernacular.

1. INTRODUCTION

The study of natural and artificial lighting has always been an important component of contemporary architectural design. Such studies show the importance of light in dictating the actual experience in both the domestic spaces of dwelling as well as the commercial spaces of the public sphere. Yet, the study of lighting, particularly natural daylighting, in the context of vernacular architecture and traditional settlements has not received any serious attention from scholars of architecture or architectural history.

This paper will present selected case studies of natural lighting in different vernacular contexts from different regional and geographic locations. This paper examines the tole of lighting in two different buildings: Golshan Laleh Hotel in Yazd, Iran and Sheikh Lutfullah Mosque in Isfahan, Iran.

1.1. Tracing the Development of Lighting Techniques Across Different Architectural Styles

As Le Corbusier says, "the history of architecture is the history of the struggle for light[1]". The architects in each historical era and geographical area approached and proceeded with this struggle differently.

In ancient civilization such as Egypt, Mesopotamian, and Iran most windows were simply a skylight opening on top of the structure, however as architectural style shifted there was a profound transformation in lighting techniques and we can see its result in different regions differently.

In this paper we focus on the structural and playfulness of a window role in two Iranian vernacular building examples: Sheikh LotfAllah Mosque in Isfahan, Iran and Golshan's House in Yazd, Iran.

A. Sheikh Lotf Allah Mosque was built in 1619 Safavid Period in Isfahan Iran. This mosque is categorized as in smaller size of royal mosques located in Isfahan's Citadel across Naghsh- E- Jahan Squre in Isfahan which was the capital of Safavid dynasty at the time.

Sheikh LotfAllah Mosque is a unique mosque in term of design and functionality; Unlike other mosques Sheikh Lotfollah mosque doesn't have minaret, iwan, and courtyard; And its entrance and gheblah aren't aligned. This building is the first in the series of buildings that was built in the center of municipal of Isfahan during Shah Abba's time. Shah Abbas's wanted this building to be built in honor of his father-in-law Sheikh Lotfollah. Shah and his immediate family were using this mosque since Shah Abbas decided it is not appropriate for him and his family especially female members of the family to go to Shah's Mosque for their prayers 5 times a day.

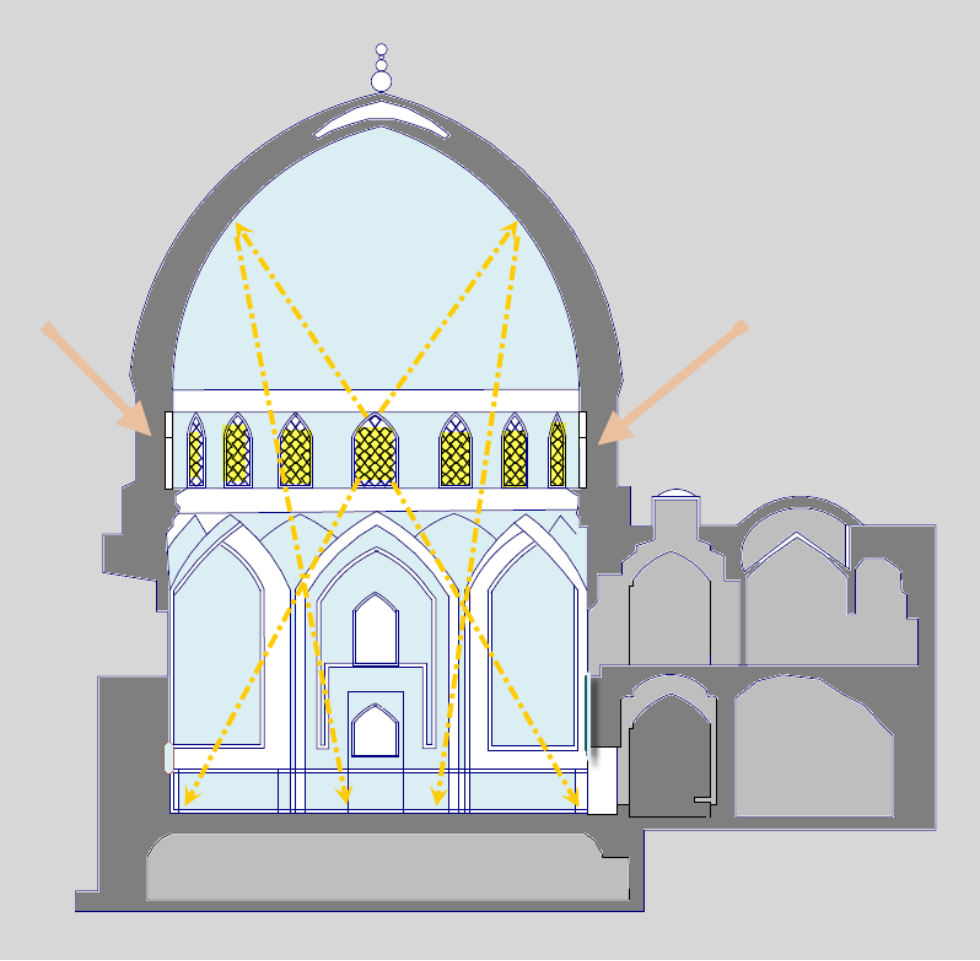


Fig 1. Sheikh Lotfollah Mosque direct and indirect light in the main hall, section, no scale by author.

The prominent architect of Safavid era, Reza Isfahani took responsibility for the design and build of this masterpiece in the eastern side of Naghsh-e-Jahan square. The building layout is a 5-sided geometrical shape, the dome height is 32 meters high, and its diameter is 22 meters.

Sheikh Lotfollah Mosque is located across Naghsh-e-Jahan square from Ali Ghapo palace and it is connected to the palace through an underground tunnel for private access of the royal family to the mosque. The mosque access from Naghsh-e-Jahan square is a relatively small entrance compared to Grand Bazar's or Shah's Mosque entrance (located on the northern and southern sides of the square) with the shape of a half dome ceiling decorated with Quran's verses in marble and tiles.

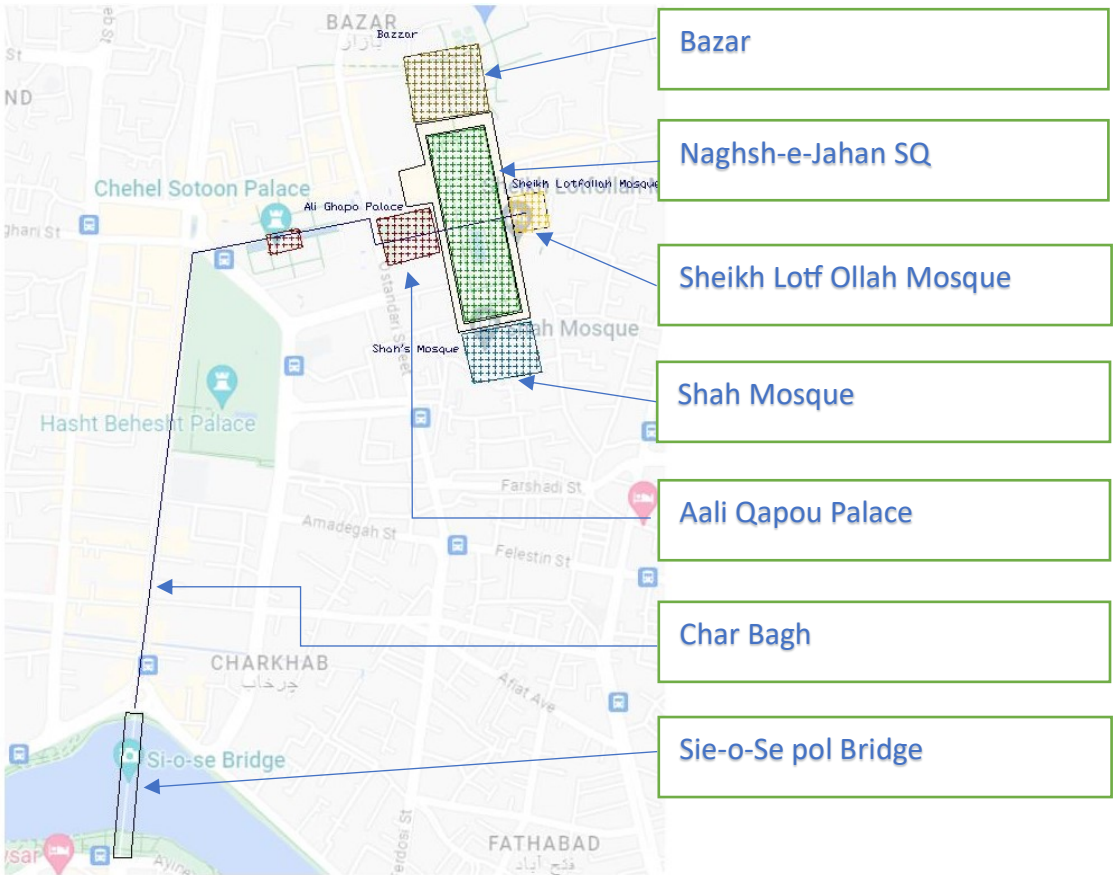


Fig.2: Naghsh-e-Jahan Square, and placement of Sheikh Lotfollah Mosque, Ali Ghapoo Palace, Bazar, and Shah Mosque. Drawing based on google map 2023.

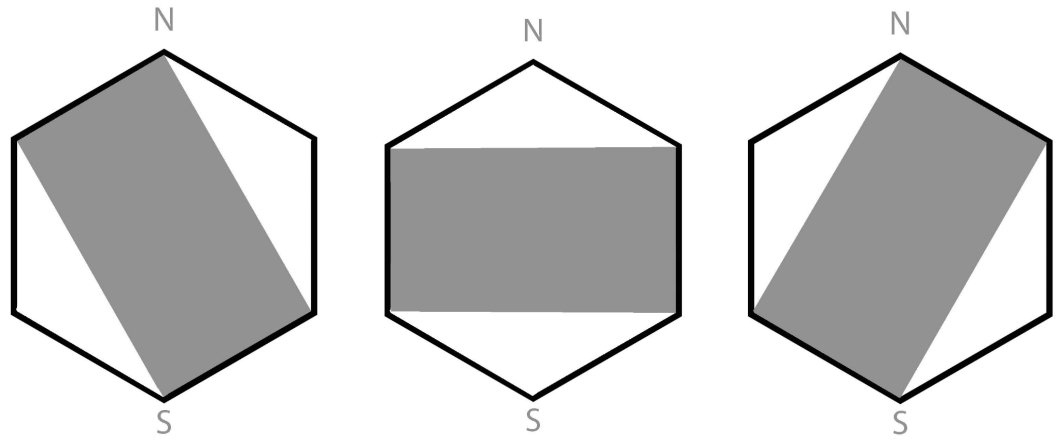

Fig 3, left. Sheikh Lotfollah Mosque entrance, Source: Iran Tourism and Touring Organization, 2018.
Fig 4, right. Sheikh Lotfollah Mosque entrance, source: Wikimedia.org.

To have a better understanding of the placement of the windows in Iranian traditional architecture in general and in our two examples in particular we need to familiarize ourselves with an architectural vocabulary that has been in use vastly since Pahlavi period: Architectural Roon.

Architectural Roon refers to the orientation of the cities and buildings. There are three Roons introduced by Architect Pirnia: Roon Isfahan, Roon Kerman, and Roon Rasteh. The practicality and the design intention of these Roons(orientations) are to maximize day light harvesting and wind harvesting for natural air circulation was helpful with regulating the indoor temperature, light, and enhances the air flow in the buildings and the cities; Similarly, skylights were often incorporated into the design to let additional light and additional light and air circulations enters from above.

The placement of the buildings was summarized and categorized in there different category to make the neighborhoods more uniform in term of main blocks being directed in the same direction and maximized the usage of natural resources such as sun and wind (air circulation) in any structure and urban design.

Below we can see the orientation of any structure in each Roons.



Roon Isfahan Roon Kerman Roon Rasteh

Fig 5: Roon Memari: Direction of the building placements on any property was called Roon. Mimars(traditional architects) in Iran were using three Roons for the footprint of their buildings' layouts: Roon Rasteh direction is Northeast- Southwest, Isfahan Roon's direction is northwest- southeast, and Kerman Roon's direction is west- east.

Naghshe-e-Jahan square and all buildings around it are following Roon Isfahan which is Northwest-Southeast directed. This orientation facilitates natural light harvesting and natural air conditioning in the open public space and buildings sustainable, healthy, and efficient.

In regard to design Sheokh Lorfollah mosque in the east side of Naghsh-e-Jahan square the architect needed to solve a problem with the 45 degree angle difference between the direction of ghebleh(Mecca) and Naghsh-e-Jahan square.

Architect Isfahani remedied the situation with a 45-degree rotation in the access hall and a corridor on two sides of the main hall which added to the charm of the structure.

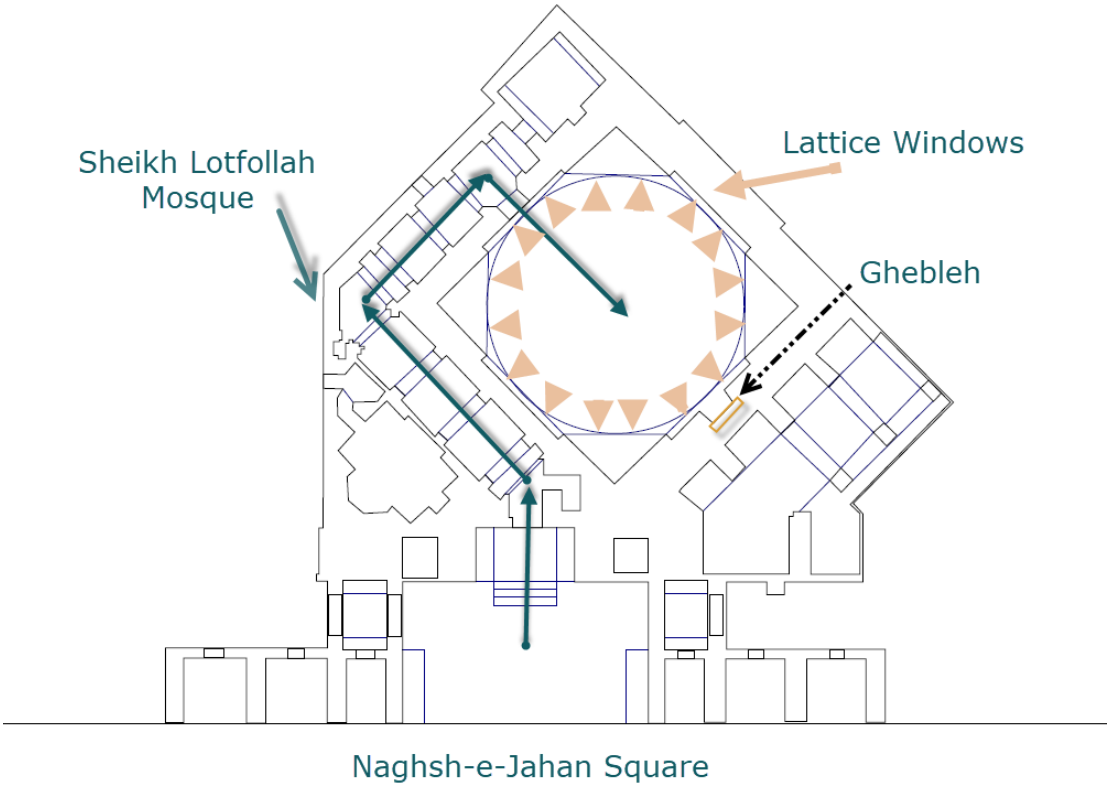


Fig 6. Sheikh Lotfollah Mosque plan view, first floor, by author, no scale, 2023.

Sheikh lotfollah mosque main hall has 16 lattice windows that soften the light as it can be harsh during the spring and summer. The lattice pattern is dictated from the intricate tile panel and is in harmony with the tranquility of the rest of the building in terms of color, tiles and brick. The light that passes through is never static, in the course of the days, weeks, and seasons the light is animated by changing its color and intensity and creates the patterns wandering across the floor, walls, and dome.

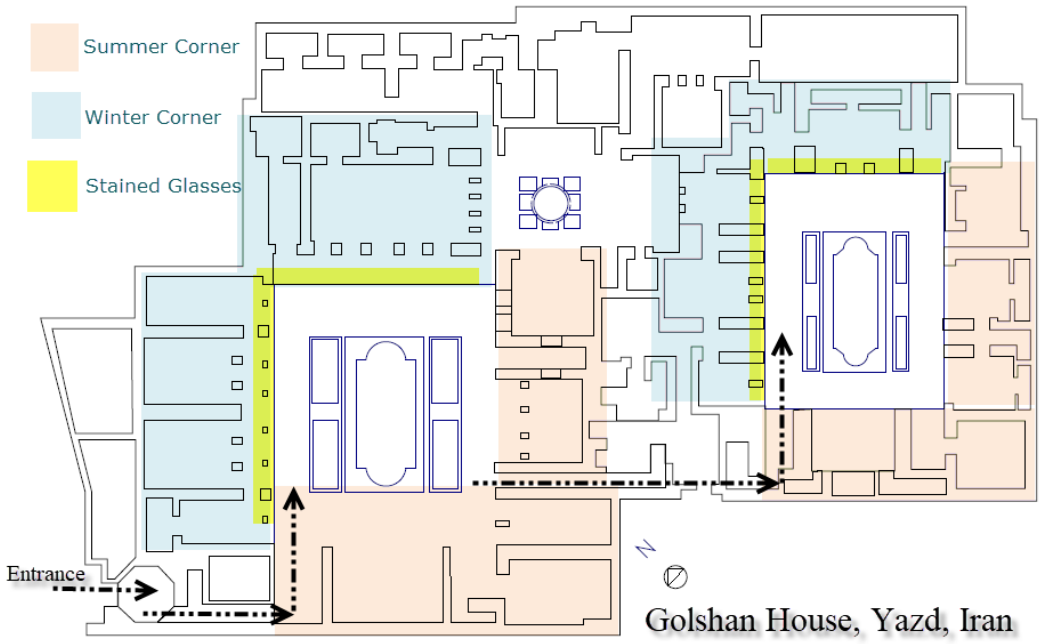
The history of lattice work in windows is back to Middle Ages and is an often underestimated technical and artistic achievement. Lattice work has been one of the most advanced form of design tools that Memar's (traditional architects) such as architect Isfahani were deigning and making it with so much detail work to decorate it with Gol-o-Morgh, Flower and Birds tiles, which was a common design in Safavid era and way before that.

Fig 7. Main Hall and Mehrab, Sheikh Lotfollah Mosque, Isfahan, Yazd, Source: Wikimedia

B. Golshans House, Yazd, Iran was built around 1900 by Haj Aliakbar who was a famous merchant in Yazd. Later his daughter Bibi Fatemeh and her husband Haji Golshan inherited the house. They bought two attached properties and added it to their property. This mansion has three courtyard: Birooni(Guest courtyard), Andaroni(family courtyard), and Narnjestan(private courtyard). The architectural style of the house is Ghajari and its orientation is Roon Isfahan.

Each courtyard has rooms shaped around the open space in the middle. Usually, two sides of the courtyard are designated for residing in the hot seasons and two sides of the courtyard are designated for cold seasons respectively.

Summer residences have a large open patio for the evenings and the main living room locates in the basement.



Winter wings are located in north and west side of the courtyards therefore they can have maximum access to the south light in the limited hour of daylight in the winters. These rooms have stained glass windows, which are made of small pieces of colorful glass arranged and framed within the windows. The usage of colorful glasses gives the opportunity to fill a room with natural light.

The ability of certain elements to absorb light and give color is used to great effect in stained glass windows. These colors of course were discovered by ancient through trial and error. The variety of colors, effects, arrangement, and the design in these windows is incredible and the result of these design with uneven handmade glass distorts the light, giving a natural organic quality with bubbles trapped forever in the heart of the colorful glasses.

Fig 9. Golshans House, Seh Daari (three doors room), Yazd, Iran.

Fig 10. Golshans House, Andarooni courtyard, Part of the summer and winter residences, Yazd, Iran. Source: Wikimedia.

Fig 11. The impact of colorful stained glasses on interior lighting. the white color of light Nasir-o-Moluk Mosque, Shiraz, Iran. Source: Atlasobscura

2. EVOLUTION OF NATURAL ARCHITECTURAL LIGHTING IN RELATION TO CULTURE

In both buildings: Sheikh LotfAllah mosque and Golshans house it obvious that the lighting techniques have evolved in response to the cultural, technological, and artistic needs of the society, resulting in a various and more sophisticated natural architectural lighting design.

In most geographical regions the key idea behind architectural lighting in vernacular architecture is maximizing daylight harvesting during specific times of the day and year.

The other key factor that plays a vital role in vernacular architecture in general and in our discussed examples in specific is the cultural significance of these structures. Both structures reflect people's belief, lifestyle, community importance, and culture.

The design intention for above mentioned buildings is to maintain residences' privacy and protecting them from harsh desert climate, respecting their privacy and their connection to their community at the same time.

For example: In Golshans house architectural layout is designed to serve three different group of people: Birooni Courtyard which serves the visitors and guests, Andarooni Courtyard which serves the family

members, and Narenjestan which is more for female members of the family. We see a decrease in the size of the windows and an increase in the decorations and ornaments when we move from Birroni to Andarooni.

The bride's room in Andarooni has large size windows but the design of the stained glasses is so profoundly arranged that nobody can see inside the room from outside, but the residents of that room can see the courtyard thoroughly. It provides them with maximum privacy and the colorful light illuminated the room magically.

On the other hand, Sheikh Lotfollah mosque is designed for a very specific small group of people, royal family, therefore, the layout is simple and transparent from inside and an opaque and enclosed envelop from outside. It is obvious that privacy and spiritual flow are the main intention of this building therefore every element of design plays a vital role in serving this purpose: Flow and reuniting with higher power.

The lighting design in Sheikh Lotfollah Mosque incorporated symbolic lighting elements that carry cultural and religious meanings with illuminating the space from above with direct and indirect light that creates a divine space. The lattice windows soften and carry the indirect light inside to provide a uniform lighting level in the main area.

It is amazing how the designer was in control of all aspects of their design and how comfortable they were with using light as a material in the design of this building. They precisely calculated the reflected light on the interior dome to create a silhouette of a peacock's tail inside the dome. The clever design shows the head and body of a peacock in the center of the dome, but they had a clever idea for the bird's tail: The arrays of sunlight were intended to illuminate part of the tile work as the most magnificent tail for the bird.

As we see, this integration of symbolism in lighting design not only enhances the aesthetic quality of vernacular architecture but also reinforces the cultural identity of the community it belongs to.

3. CONCLUSION

Element of Lighting in traditional architecture has played a role in buildings which is as important as its role in contemporary architecture. Modern architecture is increasingly recognizing the value of incorporating traditional lighting design techniques, cultural sensitivity, and sustainability which will result in fostering sense of identity and belonging within the built environment; And with studying and examining the successful solutions of the past it would be possible to learn, update, adapt, and apply those lessons to the contemporary architectural lighting for a successful approach to sustainable design.

NOTES AND REFERENCES

Nick Baker, Koen Steemers, 2014, Daylight Design of Buildings, A Handbook for Architects and Engineers, Taylor & Francis.

Ali Sayigh, 2019, Sustaniable Vernacular Architecture, how the past enriches the future, Springer.

Traditional Dwellings and Settlements

Working Paper Series

LEARNING FROM TRADITION IN THE FACE OF GLOBALIZATION: A COMPARATIVE STUDY OF VERNACULAR AND MODERN HOUSING IN THE OASES OF TUNISIA AND SAUDI ARABIA

Majdi Faleh, Shams Alshamasi

Volume 333

Pages 51-72

2024

LEARNING FROM TRADITION IN THE FACE OF GLOBALIZATION: A COMPARATIVE STUDY OF VERNACULAR AND MODERN HOUSING IN THE OASES OF TUNISIA AND SAUDI ARABIA

◆ ◆ ◆

In traditional cities of the Islamic World, the forces of globalization, neoliberalism, oil, and over commercialization have shaped the built environment and the relationships between the creation of space and socio-spatial practices. The architecture and planning of cities and neighborhoods have become less informed by the roots of vernacular architecture. The influence of global forces and contexts have facilitated development and diversity. On the other hand, the urban and architectural patterns and typologies in the Islamic world have become largely "Westernized." Postmodern construction styles that are glitzy and primarily imported have been linked to a new consumerism culture that promises development and sustainability. To examine the roots of metamorphosis in the built environment, this study examines two oases' towns, one from the Middle East, Qatif in Eastern Saudi Arabia, and one from North Africa, the Island of Djerba in the southern part of the country.

As it will involve literature from architecture, planning, philosophy, and religious studies, the research will be cross-disciplinary. It challenges academics and professionals in the field of architecture to consider how modern architecture in the Islamic World is being challenged by several internal and external forces. The entire study's goal is not to offer technical answers; rather, it stems from the necessity for architects and intellectuals in the Muslim world, notably in Tunisia and Saudi Arabia, to reconsider the idea of identity and to express an architectural concern. The paper will conclude by articulating the importance of learning from vernacular architecture and understanding its values for modern housing patterns.

1. INTRODUCTION

The Island of Djerba, home to several ethnic groups and diverse typologies of buildings, has seen several changes in the past decades. The typical Menzel, or traditional habitat of Djerba, has been affected by abandonment, decay, and disinvestment. This housing typology comes with a variety of morphologies located within fields and palm trees, which constitute a typical landscape of the Island and define a typical mode of expression of the Djerbian urban landscape. The Menzel is composed of different elements, the main ones being the house or 'the Houch', the workplace or the workshop, the place of worship and culture which is the mosque and 'the Medressa', the garden or the 'Jenen', and the secluded guest house or Makhzen Eddiyaf. While the Djerbian Menzel stands as a strong element that supports the environment around it as well as the multiple daily life activities, the modern housing patterns of Djerba seem to abandon this system and create gated and independent villas as objects, with foreign materials, dissociating themselves from the culture of the Island and engaging only at times with the local. This marginalization of vernacular housing cannot be seen only in North Africa but also in the Arabian Peninsula. In Qatif in the Eastern Province of Saudi Arabia, the research explores the interactions between the modern urban form and modern dwelling form in relation to climatic and socio-cultural aspects. Using a macro-scale of the suburban design and a micro-scale of the housing arrangement, a comparison of the traditional town and the modern suburban layout is made. The study's goal is to comprehend

how modernization processes have altered the traditional household environment's economy and cultural balance, and to what degree these changes may be blamed for the shortcomings of current planning.

2. THE ISLAND OF DJERBA: HISTORICAL AND GEOGRAPHICAL BACKGROUNDS

Tunisian philosopher, sociologist and historian, IIbn Khaldūn (1331-1406) explained that the name Djerba refers to an Amazigh branch and tribe of Lemaya. Situated at the intersection of several routes on the southern shores of the Mediterranean, in the Gulf of Gabes Tunisia and close to Libya, the Island of Djerba is connected by a four-mile causeway built by the Romans. It is 17 miles long and 6 miles wide. Originally settled by the Romans, the Island has been a crossroad of many civilisations including Phoenicians, Romans, Byzantine, and was conquered by the Arabs in the seventh century. Power was passed back and forth between the Ottomans, Hafsids, Normans, and Sicilians. In September 2023, the committee of the UNESCO member states that met in Riyadh approved including Djerba and its heritage on the World Heritage List. The heritage of the island, both tangible and intangible, contributed to these efforts to demonstrate the universal value of Djerba, as a human settlement that preserved its heritage and the authentic characteristics of its architecture. Based on UNESCO's statement, Djerba is a testimony to a settlement pattern in an island territory, and is described as follows:

> "This serial property is a testimony to a settlement pattern that developed on the island of Djerba around the 9th century CE amidst the semi-dry and water-scarce environment. Low-density was its key characteristic: it involved the division of the island into neighbourhoods, clustered together, that were economically self-sustainable, connected to each other and to the religious and trading places of the island, through a complex network of roads. Resulting from a mixture of environmental, socio-cultural, and economic factors, the distinctive human settlement of Djerba demonstrates the way local people adapted their lifestyle to the conditions of their water-scarce natural environment".
>
> The United Nations Educational, Scientific and Cultural Organization.[1]

The Island of Djerba developed a unique settlement pattern in the 9th century CE given the climatic conditions of the place. The distinctive pattern of occupying the land in Djerba shows how its people adapted their lifestyle to the challenges faced due to the water-scarce natural environment. The above-mentioned quote highlights the importance of architectural adaptation of housing to the specific environmental conditions of the region. In Djerba, people organized their living spaces to make the most of limited water resources in a low-density clustering of neighbourhoods and a network of unpaved roads. Globally, the adaptation to water-scarce environments is a common theme in traditional housing which are closely connected to the natural environments, reflecting a symbiotic relationship between humans and their environment. Djerba Island exemplifies the ingenuity of traditional housing in addressing the challenges posed by local ecological factors.

3. LAND ACROSS THE ISLAND OF DJERBA: THE GROUPED AND THE DISPERSED

Across its 514 km² (miles), the Island of Djerba, as many parts of the southern parts of Tunisia, relies on the sources of water. Habitats are grouped together in locations where water sources are rare, and other habitats are dispersed across the land reflecting the idea of the abundance of water. The island's UNESCO status came to light thanks to factor V of the Convention which states that a settlement has "to be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change".[2] The island dossier was in fact supported by its universal value seen through its Menzels, Houchs, Mosques, Foundouks, and oil mills.

Historically, the slow and methodical organisation of space by Djerbians shaped the landscape of the island and created unique social relationships and a specific way of life. Due to continuous attacks from the sea, its people moved away from the shores and dispersed into the interiors of the island. With its many mosques (around 300), the insular space of the island creates a sense of attachment between the population and religious spaces. Buildings are isolated and scattered across its territory. This dispersion of housing is overlaid with a hierarchical organisation of the insular space in nested levels, starting with the "Menzel," which is the basic unit of the island's spatial organization, and where social, cultural, and even economic activities are generated. It is the 'nuclei' of the Djerbian lifestyle.

The inhabited areas of the island are divided into cells organized into a beehive; that is to say, the spaces that surround them are brought together by proximity. This organization is first and foremost topological in nature, meaning that it is independent of shape and size.[3] The organic evolution of the territory infers the additive evolution rather than a pre-established planning based on an abstract geometry. The built environment is generally isolated and dispersed, and the plots of land, mostly not clearly delimited, reflect the complexity of the roads. Alleys, paths and cul-de-sacs established by transfer or right-of-way. Similar to the Medina of Tunis or Islamic cities, where roads gradually connect public and private spaces,[4] Djerba's pathways, typically sandy, gradually help the transition from mosques and souks to houma, to menzel, and then to houch.[5]

In Djerba, families are clustered based on social and religious precepts, where Muslims, and Ibadhi Muslims are scattered across the island closer to agricultural activities, and Jews live in the Hara Sghira and Kbira closer to urban activities and commerce. Through its specific mode of occupation, this territory constituted as a whole a social living environment on a family scale, organized into clans, and following religious precepts that guaranteed their cohesion in diversity.[6] The "menzels" are residential and functional spaces in which families live and organise themselves. The term "menzel," meaning the house, refers to the living area of a family. It

consists of one or more "houch" (housing units) and elements of economic life, including orchards, fields, as well as a weaving workshop, granaries, wells, and the essential cistern for family life. The "menzel" integrates its population with its agricultural surroundings and is organised as a defensive site, surrounded by "tabias" (earth hedges bristling with agaves, aloes, and prickly pear cacti, bordering paths and roads and enclosing properties).[7]

4. THE MORPHOLOGICAL CHARACTER OF HOUSING IN THE ISLAND OF DJERBA: THE MENZELS OR MNEZEL

Menzels or Mnezel, in the local Djerbian accent, are rarely understood by foreigners. These traditional housing components of the Djerbian rural landscape do not reflect a group of families, tribes or people, but express the originality and mixture found on the Island. In an interview conducted with Djerbian architect Anouar Ben Maiz he describes the character of these neighbourhoods stating that

> "The Houma is a set Mnezel stuck to each other, however, the land occupied by one Menzel generally ranges from 1 to 5 hectares and sometimes larger. The Menzel of 5 hectares or less are usually fenced by an embankment berm that separates them from pathways and other properties. For example, a planted berm (Tabia) separates Menzel Ben Youssef from Menzel Ben Maiz or Menzel Khirouni and to reach these houses you follow pathways known as Jedda. Within the Menzel we can find the Houche (a patio house) which is the main and major component, we can also find a Bir (water well) among the watering system besides the Jabya, as well as storage premises and local stores such as hay, textile and barns, and the threshing around slab (Rayyah) to thresh barley and lentils. Additionally, in most houses we can find Fsegui (plural of Fesguia which is an underground drinking water tank) built at the boundary of the Menzel for passers-by (Sbil) to allow them to drink fresh water".
>
> Anouar Ben Maiz, Personal communication, 2022.

According to Hassan Boubakri (1985), "houma" is an ethno-spatial term denoting a kind of local area composed of dwellings, cultivated plots, wells, and a social space, with the mosque as the unifying element. Traditions vary in each "houma," and families live in relative isolation within their "houma," creating a sort of island within the island.[8] In the Island of Djerba, the hierarchy of a dense network of pathways serves the habitat and its surrounding: main paths for long distances, secondary paths serving the "houmas" and connecting some of them, passages serving a cluster of "menzels," and passages serving each "menzel" individually. Thanks to this precise organisation of their territory, the people of Djerba, whose agricultural resources are insufficient compared to their needs, can migrate safely. Families are organised in such a way that the absence of men does not endanger the functioning of the "menzel." Wives work in the immediate vicinity of the house, raise their children, and are constantly under the guidance of their extended family. This extended family serves as a source of trust for the migrant, making long stays away from home possible.[9] As complex as it seems to be, the Menzel and the Houma surrounding it constitute an important core within the Djerbian urban landscape.

The Housh represents a multifaceted entity that mirrors the profound interconnections within the Djerbian family and underscores the lifestyle as well as the environmental adaptability of the island's inhabitants. The term 'houche' is inextricably linked to the broader rural framework, consistently situated along with its associated components within the 'menzel,' with which it shares an intimate connection in terms of both its purpose and its harmonious integration into the natural landscape. These 'houche' spaces are distinctly demarcated and structured to align with the extended family unit, primarily composed of the father and his married sons. Functioning as a communal living area, it accommodates a wide array of both individual and collective group activities. The arrangement of each observed 'houche' (Fig. 1) showcases the presence of various specialized subspaces, each tailored to accommodate the diverse activities indispensable to communal life.

Fig. 1: Model of the Djerbian Menzel at the Djerba Museum of Traditional Heritage. (Source: Mathilde Bielawski, 2018).

Upon entering this space, one immediately notices a mezzanine on the right, separable by a partition or left open. This elevated area is well-lit with exterior windows, providing ventilation and a comfortable spot for resting and observing surroundings, especially in hot weather. Below the mezzanine, there's a space for ablutions called the 'mustham' with a water dispensing mechanism for convenience. The 'bit' primarily serves the core couple, and its specific spaces are the alcove, mezzanine, and 'mustham.' The transitional area between the mezzanine and alcove employs a simple, cost-effective design. The 'houche' architecture comprises distinct volumetric fragments, each with a specific purpose, and chimneys' bases are integrated, signifying the hearth's presence while enhancing the architectural aesthetics.[10] These codes are based on the ergonomics of the body, the construction system, the nature of the activity, and its symbolic interpretation. It is with the help of this encoding that the segmentation of the 'Houche' is systematically achieved. The architecture of the Housh is legible and clearly communicable creating a subtle visual rhetoric. With the very clear and sober volumetric configuration, each form becomes distinguished within the overall landscape reflecting simplicity, cost-effectiveness, and human craftsmanship in the making. The Menzel becomes some sort of a white monument in the periphery of the land, and connected to different sources of life (water, animals), becomes a central

element for family members. As seen in Fig. 2, the Housh of Dar Ben Younes reflects the minimalism and the human character of the Djerbian architecture. Small openings on white facades, seating surrounding it, and a main entry marked by an arch and decorated tiles surrounding it, define the minimal volumetry of the Djerbian house. From the inside out, one can observe how the human scale is fitted to the scale of the Menzel and how each volume serves a purpose within the habitat.

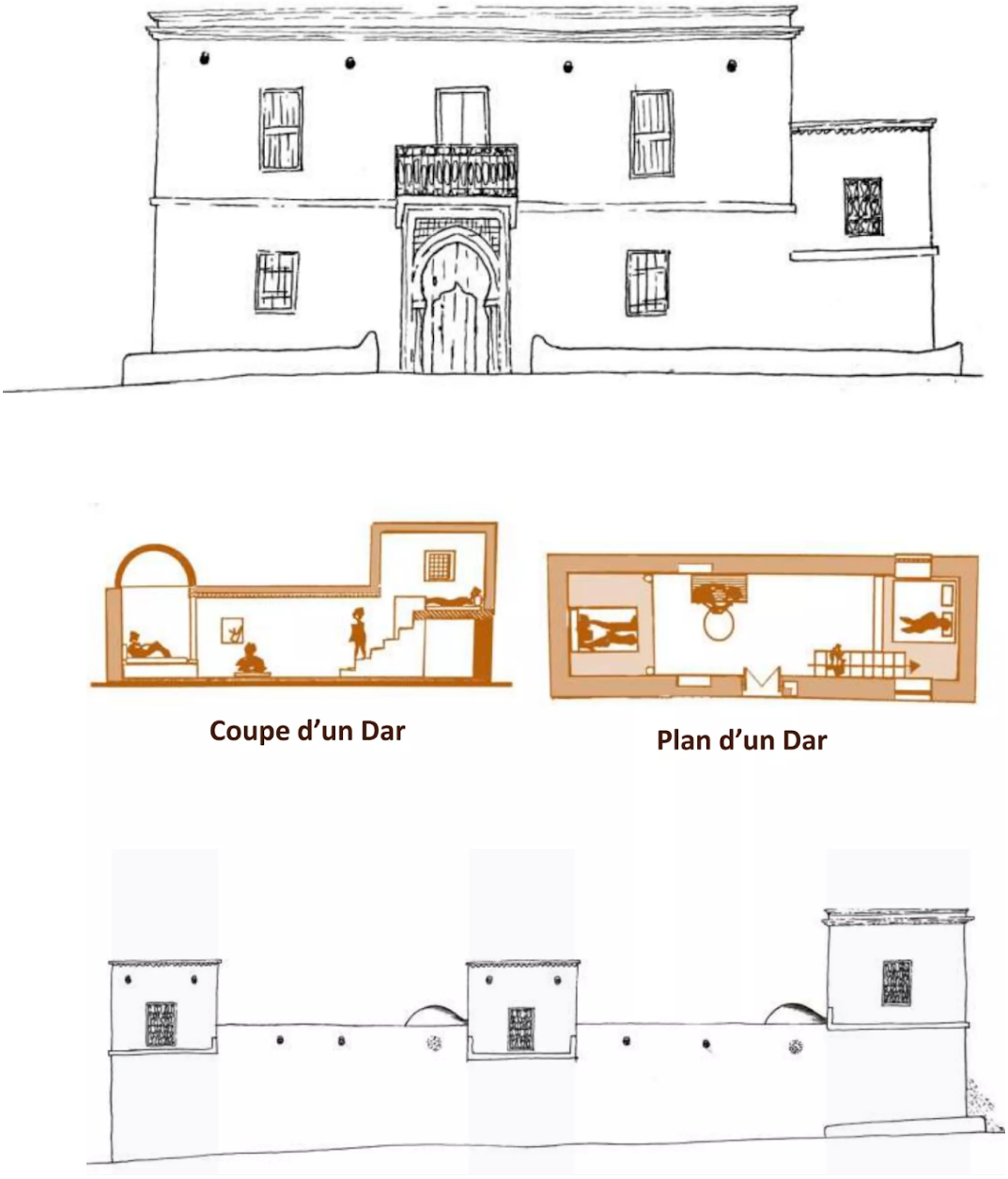


Fig. 2: Houch Ben Younes. (Source: Maher Ben Younes, 2016).

In conclusion, Menzels are intricate and often misunderstood elements of the Djerbian rural landscape. They symbolize the island's unique blend of diversity, which emphasizes the interconnectedness of these neighborhoods, particularly the 'houma,' and the self-sustaining micro-communities they create. The network of pathways in Djerba supports safe migration, while extended families ensure continuity during absences. The 'houche' architecture within the 'houma' harmonizes functionality and aesthetics, reflecting simplicity, cost-effectiveness, and human craftsmanship. The Menzel stands as a central symbol of family life and resource connection in the Djerbian urban landscape, embodying the island's rich cultural and architectural heritage.

5. SOCIO-CULTURAL AND SPATIAL RESPONSES ACROSS THE ISLAND

Fig. 3: Menzel Bayahia. (Source: Ghada Ayari, 2019)

The Menzels of Djerba, with their Housh in the Middle and other components (fields, tabia, well, etc) are a reflection of socio-cultural and economic incubators and link it to the idea of Azzaba System. Moncef Barbou, academic at the Higher Institute of Human Sciences in Medenine, stated that the Houma system, a lifestyle or pattern of scattered dwellings, appeared during the Hafsid period beginning the 13th century (Personal Communication, 2022). In fact, the architecture of Djerba and the planning of its territories is unique based on an ingenious and original layout made up mainly of "houem" (plural of houma) - neighbourhoods made up of a series of menzels that form the basic unit of land use and where daily activities happen - living activities and daily agricultural activities, and two urban cores such as Houmt-Souk (the quarter of the market), an economic and commercial urban core, and Hara Sghira, the Jewish neighbourhood with its peculiar layout.

Additionally, Djerba's architecture was largely influenced by the invasions and military expeditions including the Military assault of Ferdinand II of Aragon in 1510 or the 1560 Battle of Djerba where Ottomans Piyale

Pasha overwhelmed a large Christian Alliance. Not only mosques or caravanserais had imposing shapes but also houses. The architecture of Djerba has been deeply influenced by the long periods of insecurity it has experienced. The massive forms of the Houch buried behind hedges on the slope (Tabia) and olive groves, the absence of openings to the outside, and the towers flanking them at the corners, making them resemble real fortresses, are all indications of this need for protection. Similarly, the imposing, closed, and introverted form of the caravanserais of Houmt-Souk is clearly linked to the instinct for defense of the islanders.[11]

The community-based system, informed by how large families constitute the backbone of the Island, informs the socio-spatial organisation within the island. White volumes of houses/menzels scattered across the island, more or less isolated, and separated by sandy pathways define plot division and the rural fabric. Menzels are an expression of an egalitarian community, where religious codes and the principles of Fiqh can be seen through the facades. In fact, both privacy and reducing or rejecting excess are at the heart of the architecture of Muslims, particularly in Tunisia, and that could be seen on the white facades with small openings.[12]

6. CHALLENGES OF MODERN CONSTRUCTIONS IN THE ISLAND

With the influx of mass tourism in Tunisia and Djerba in the 1960s, the territory of Djerba was largely affected by the influx of people and constructions. The tourism development approach of the country was mostly Eurocentric.[13] Djerba's beach tourism has been a product for the whole country, and the island became one of the most important Tunisian destinations.[14] Tourism, and more precisely overtourism, has had significant impacts on the island. The overload of tourist traffic in Djerba and related problems) water stress, excess of waste, shoreline developments) led to the deterioration of the natural environment and society.[15] The urban and architectural landscapes of the island have gradually changed[16] due to the construction of large resorts and mass tourism.

Djerba's population also grew from 51.277 in 1936 to 150.000 in the year 2000, and with that the number of migrants residing in the Island grew faster. People moved there either to work in the tourism industry or develop new projects. From a legislative point of view, Menzels are defined according to the definition of article 2 of the Heritage Code cultural sites.[17] After the creation and delimitation of the cultural site by a joint order of the minister responsible for heritage, the work undertaken within the limits have been submitted to prior ministerial authorisation. The protection and development plan include the zone plan and regulatory provisions which define in particular the authorized activities and the easements to be respected. In the meantime, some Menzels remain under threat from the expansion, sometimes illegal, of housing in rural areas.[18]
In an interview conducted with Moncef Barbou, he explains that 'this retreat (receding), and the displacement of construction from the coasts to the interior took substantial time that continued for centuries but gradually

and cumulatively, and this first form of reconstruction based in cities replaced another form of construction which was based on residential dispersal. From this point, we start witnessing the arrival of Muslims in the 7th century CE, the beginning of dispersed settlements, and we have clear proof, based on the names of these places, about this scattered housing system.'

Natural and cultural heritage of the Island is now being threatened and the vernacular housing that long existed as part of its natural and urban fabrics is facing marginalisation. Threatened with depletion and even disappearance, due to continuous socio-economic 'progresses', and continuous human activities, the future of the Island, as a UNESCO World Heritage, needs to be reconsidered and reassessed.

In Djerbi's view, we can distill several key principles from the way people interact on the island of Djerba. First, the entire inhabited area reflects a self-sufficient production system, making the most of the island's natural resources and promoting essential trades and communal support. Everything created in this system is born from a minimalistic approach and a tradition refined through experience. Moreover, each place inhabited on the island is like a building block contributing to the island's overall structure. This structure is shaped by both the island's natural features and the closely-knit social relationships. It's evenly distributed, following an organic pattern.[19] The design of any structure in Djerba tells a story. It reflects the practical aspects like measurements and materials used but also carries deep symbolic values that inspire these creations. Ultimately, the architecture in Djerba is guided by principles like simplicity, modesty, and efficiency. It embodies the island's way of life and its harmonious relationship with the environment. Marginalization of vernacular habitat is not only seen in North Africa but also across the Arabian Peninsula and Gulf countries, including Saudi Arabia.

7. THE CASE OF SAUDI ARABIA: QATIF HISTORICAL BACKGROUND

Qatif is one of the oldest historical towns in this region. The name Qatif city refers to the whole area which includes many rural areas besides Tarut Island. Its history is estimated to extend back at least 5000 years.[20] Due to its location on the Gulf coast, Qatif has witnessed the passage of many civilizations including the Sasanian Empire. Shapur I, the founder of the Sasanian Empire, took this area as a military base where he built a fortified city in 226-241 AD, which is believed to be Qatif's traditional town *AlQala'a*.[21] It was built on an elevated plateau of land surrounded by a lofty rampart that contained three large main gates with nine watch towers to protect it from enemies (Fig. 4). In fact, Fortified cities were the main characteristics founded in other traditional Islamic cities such as Cairo, Damascus and Tunisia. The central area of the citadel was occupied by the royal family. It was filled with gardens, watered by canals penetrating the *AlQala'a* ramparts. After the fall of the Sasanian Empire, the fortified city was then used in the Islamic era as a depot for goods like perfumes and spices coming from Tarut Island, as Qatif was closer to the central market. Then it was finally used as a

residential area when it was colonized by the Ottoman Turks in 1871 AD and incorporated into the Ottoman Empire.[22] It was under the Ottoman Empire until the First World War when the forces of Al-Saud recaptured the country, with the support of the British, who were at war with Turkey's ally the German Empire and the Ottomans evacuated.[23]

In the early 1900s, after the Arabian Peninsula was united under the ruler King Abdulaziz Ibn Saud, it was renamed Saudi Arabia. From that time onwards, Qatif was ruled by the house of Al Saud. King Abdulaziz Ibn Saud brought foreign experts to search for oil. The economic growth started immediately after the Second World War following the discovery of vast reserves of oil in the Eastern Province of Saudi Arabia in 1938. Since then many sites have been found and this has further propelled economic growth. The wealth from the revenues accruing from the discovery of oil has brought about a radical change to the country in all aspects of life. One of the obvious transformations has been the change of the physical built environment.[24] Since the 1950s modernization the inevitable companion of advanced industrialization, has spread all over Saudi Arabia. Qatif was no exception to this change and the city of Qatif has expanded in both its commercial and residential districts as a result of the population growth and wealth that accompanied the oil revenues. The expansion caused change which started with the demolition of the *AlQala'a* walls to accommodate the growing population numbers.[25] New suburban planning and a new housing image have been introduced to Qatif, as in the rest of the country, but without adequate concern for climatic and cultural responses that should be offered by the built environment.

Fig. 4: The northern wall of Qatif's traditional town in 1945 before its demolition. The town is bordered with palm trees farms. (Source: View of a fort or ... – Pitt Rivers Museum Prints (prmprints.com).

8. URBAN GROWTH

Qatif's population was about 12,000 prior to the expansion of the Saudi oil industry.[26] In 2004 the population reached 473,454.[27] In 2010 Qatif's population was estimated to be 559,263 with a compounded annual growth rate of about 2% every year and approximately 10% every five years.[28] In 2015 it reached 599,117 in 2020 the population reached 659,941, and it is expected to reach 711,398 by 2025.[29] This rapid growth rate puts severe pressure on the area to accommodate the growing population and this has had a negative impact on the area especially compounded by inappropriate urban planning that does not consider the local environmental conditions. This seems to be a significant problem for cities along the Gulf sea shore as Khan and Kumar state:

> "Saudi Arabia along with other Arabian Gulf countries has undergone rapid development in infrastructure following the discovery of oil in 1930's. The coastal cities have seen major expansion resulting in land reclamation and dredging of the adjacent coastal areas. In the Gulf states such activities started in 1960 and are still continuing with the major impact on the coastal areas adjacent to Arabian Gulf Coast.".[30]

Qatif is one of the coastal cities that have been impacted by development. Changes in construction practice and new forms of inhabitation responding to growing population needs have caused many problems for the natural environment in Qatif. According to Alhammad, desertification covers approximately 31% of Qatif's land. This is a consequence of the deforestation and construction activities which have caused destruction to the natural life and ecological balance.[31] On the basis of current growth being sustained into the future that is, if no serious action were to be taken it is predicted that within one to two decades the green land will disappear completely. In the ten years between 1989 and 1998 the farming land in Qatif was reduced significantly from 7319 hectares to 7020, and in 2002 reduced to less than half the area in comparison to 1998.[32]

Another environmental problem associated with population growth and inhabitation pattern is the loss of mangrove trees along the coastal area. Urban development in Qatif has extended to the Gulf sea for reclamation activities.[33] A common practice is to fill the sea in order to have more land to build residential areas whereas there is a vast area on the western side of Qatif where residential suburbs could be built.[34] Destroying the green land and filling the sea contribute significantly to increasing heat levels in the area; thus, contributing to further reliance on mechanical cooling. Consequently, this practice contributes to global warming as well. Thus, there is an urgent need to focus on creating a sustainable built environment without contributing to an increase in the urban heat.

9. THE MORPHOLOGICAL CHARACTER OF THE OLD TOWN IN QATIF

Qatif's traditional town was a fortified walled city fortified walled city bounded by a green area of palm groves. Similar to other oriental Islamic cities,[35] [36] [37]the traditional town of Qatif was characterised by a morphology consisting of a clustering of irregular courtyard houses. The same pattern has been found in other traditional cities with a similar climate of long hot seasons in North Africa, Syria, Iraq and Egypt. This traditional form was a moderate dense settlement with narrow winding shaded streets (Fig. 5).

Fig. 5: Dense settlement of the traditional walled fortified town of Qatif located on the sea front and bounded by palm groves from the other sides. (Source: Arabian Anthropology (arabian-anthropology.blogspot.com)

The town was characterised by open courts of different sizes in a clustering of at least 24 houses comprising the residential neighbourhoods. The largest court was located in the northern part of the town. It contained the main mosque and a public bath (*hammam*). However, there were also small mosques in each neighbourhood. The market (*souq*) was located to the southwest outside the wall. There were also some small suburbs outside the traditional town occupied by farmers and fishermen (Fig. 6).[38] [39]

However, these characteristics are not limited to this region. There have been markedly different traditional housing typologies found in Saudi Arabia that possess a different climate to Qatif. This suggests that climate had a major impact on the formation of the traditional settlements, even if the culture was a common factor. However, settlements are the product of interrelated cultural and climatic factors.[40] [41]Rapoport states that socio-

cultural forces are primary factors, while other factors are secondary in generating the built form. However, he believes that climatic conditions play a main role in generating the house form in the absence of technology.[42] Therefore, it is important to understand the interrelation of both factors to be able to extract lessons from the past. The following explains how both factors worked to generate the physical environment in Qatif.

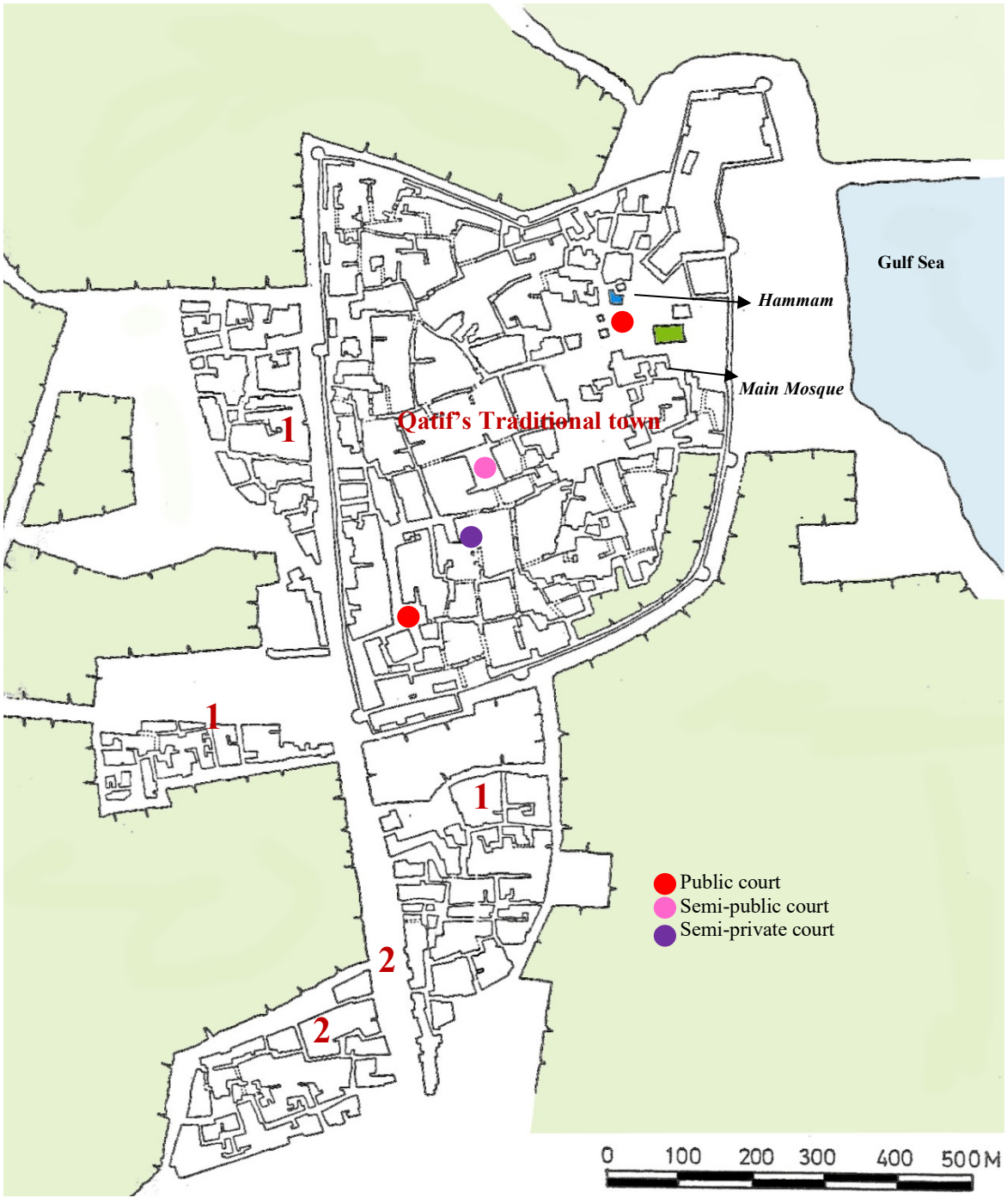


Fig. 6: Qatif's traditional town showing different urban court sizes which created hierarchy in the urban space. Plan adapted by the author from Winterhalter 1989.

10. SOCIO-CULTURAL SPECIAL RESPONSE OF THE URBAN SPACES

For centuries, socio-cultural norms and climatic factors evolved to produce the organic physical form of the old town of Qatif. The organic, urban spatial configurations were organised in a social and climatic hierarchy that is evident in the order of the town's physical configurations. This urban form can be associated with meanings generated from the pattern of use of space and the social network existing within the town's public, semi-public and private spaces. [43] [44] This is similar to other vernacular Islamic cities with a similar climate such as Baghdad, Damascus, Tunisia and Morocco. [45] [46]

Public areas such as the town's main court were spaces where locals from different neighbourhoods would traditionally meet and, due to its large size, was the most exposed urban space to weather conditions. This court included public areas, for example, the market, mosques and main public streets were considered as public urban spaces where culturally significance gathering took place. Strangers were expected to be seen in these areas. In Qatif, like other traditional Saudi towns, there was a graduation from public to private space. Thus, in the residential quarter the streets and lanes became more private and spaces gradually became semi-private, more protected from climatic conditions, fewer strangers were expected and familiar faces of residents living in the same neighbourhood were seen. Because these streets were shared only by residents in the same neighbourhood there would have been a greater sense of privacy and safety. Thus, according to the resident,[1] in these more private streets, a characteristic form of social behaviour was observed in which the neighbourhood children played in front of the houses and residents sat and chatted in the morning or in the afternoons. This pattern of social behaviour was described by Ragette in his study on the Middle-eastern traditional towns as "the balance between segregation and togetherness".[47]

This hierarchy, as described by Habraken, is the result of the act of inhabitation which creates what he calls a deep territorial structure. This territorial structure developed in the traditional Middle Eastern towns, such as those found in Tunisia, in a "bottom-up growth", as it started growing from the dwelling unit, then gradually generates the urban hierarchy when the density increases.[48] Bianca shares Habraken's viewpoint, adding that the absence of "formal civic institutions" and the complete control in the hands of the residents has resulted in "organic" growth characterised by physical order (hierarchy) of space.[49]

11. THE CULTURAL AND CLIMATIC RESPONSE OF THE TRADITIONAL HOUSE

As noted above, the traditional house organisation in thisregion was influenced by the local cultural values as well as climatic factors. Gender segregation has influenced the Saudi house for centuries. Rapoport argues that

[1] Former resident was interviewed by the author.

"building a house is a cultural phenomenon, its form and organization are greatly influenced by the cultural milieu to which it belongs." .[50] Traditional houses in the Islamic world were significantly influenced by the Islamic rules. According to traditional Islamic customs in this region, women should be separated from males when not with the family. Bahammam notes, in this regard, that according to such values "the Muslim woman is not allowed to reveal her figure to anybody other than her husband, family members, and/or close women friends".[51] As a consequence, gender segregation has helped shape the physical environment. The need for privacy and gender separation has been spatially translated in the arrangement of the house zones. According to Bahammam, two types of privacy have influenced the Saudi traditional house: female privacy and familial privacy.[52] Therefore, the house was physically divided into two domains: family and male guests. Thus, there were two transitional areas connected to the main entrance that led to each domain. One was called *dehleeze* which was used by the family members and it led to the private family domain. The main function of the *dehleeze* was to preserve the family privacy from the street and from pedestrians' sight. The other transitional zone was a hall that led to the male's domain. Male strangers are not allowed to enter the family domain. Instead, in the traditional house, they had their special zone called *Almajlis* which, in the traditional Saudi house in Qatif, was usually located on the first floor with windows facing the street. Houses were built in such a way that non-familial males could pass through the house to *Almajlis* without interfering with or exposing the family zone. They entered the house from the main entrance door and walked through a transitional hall to the upper floor where *Almajlis* was located. *Almajlis* was the only room that was always considered to be located in the prevailing cooling wind direction. Welcoming guests was and still is one of the most appreciated customs in Saudi Arabian society. Therefore, the best and the largest place used to be assigned at the very early stages of the house construction.[2] This was combined with the cultural values of the spatial segregation of non-familial males and preservation of the family privacy. Therefore, the room was located facing the northern direction on the first floor, with direct access from the entrance door by means of a staircase into the male guest room. In addition, this room had a direct stair case access to the roof, as the roof could be used as a warm place in winter to sit with guests (Fig. 7).[3]

All rooms in the house other than the *Almajlis* hall and *Almajlis* were considered to be a private family domain. In order to maintain familial privacy, most of the courtyard houses in this area did not have exterior openings on the ground floor (Fig. 8). If there were any exterior openings they were small and were located above the pedestrians' eye level. Another socio-cultural aspect of the houses in this region is that they were usually

[2] Decorating the interior of the reception room (*almajlis*) and the main house entrance door also was one of the obvious characteristics of the houses in this region to reflect guests welcoming and status. This also was found in the western and southern region of Saudi Arabia.

[3] The plan shown here is a representative of Qatif's traditional houses.

occupied by an extended family of up to four generations.[4] Talib notes that "an Arab house is never complete" [53] as the house has the flexibility and the potential to expand, adding rooms around two to three courtyards, to accommodate the growing number of family members. The house usually started with a single storey with a courtyard and the rooms surrounding it. However, the future expansion was always considered in the construction phases. For example, the wooden beams used to construct the house ceilings were always left extended to the outside, in provision for future expansion, when they would be connected to the new beams. Also, the ground floor walls were always thicker than the other floors to carry the loads when floors were added. Therefore, the final house size was not able to be predicted at the early stages of occupancy. However, the final size reflects the family size.

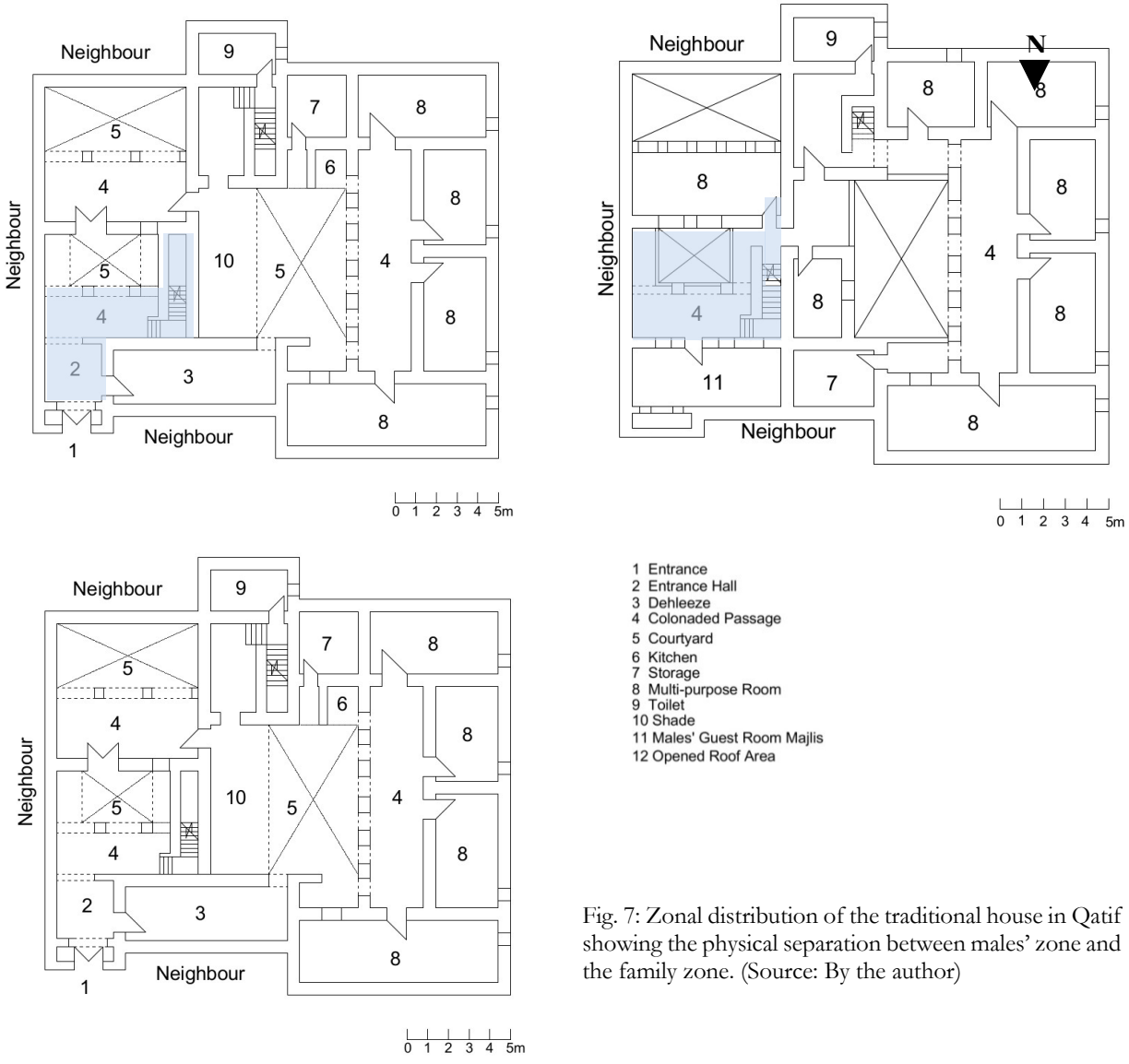


Fig. 7: Zonal distribution of the traditional house in Qatif showing the physical separation between males' zone and the family zone. (Source: By the author)

[4] An extended family is a family that consists of nuclear families. When the sons get married they stay with their wives and children with their parents. One house could be occupied by fifty family members. Each nuclear family stays in one room with their children. When the children grow up they are separated according to their gender, male and female.

Fig. 8: Openings above eye level on the exterior façade to preserve privacy while allowing cross ventilation. (Source: Fieldwork by the author)

12. HOUSE FORM

In Qatif's hot climate protection from the hot, humid summer conditions outweighs the need to protect against the winter climate. Therefore, the principle of a climatic hierarchy consisting of a variety of ventilated shaded and open spaces was applied inside the house and affected its physical form. Firstly, there was always a central open courtyard, open to the sky and completely exposed to the weather conditions (Fig. 9). Secondly, the semi-open spaces provided partial shade and shelter from the weather conditions by forming a colonnaded passage in front of the rooms. Finally, enclosed full shade interior spaces adapted to weather conditions by opening or closing windows and doors in order to achieve internal comfort (Fig. 10). In addition, these rooms which were deeply embedded in the plan, were surrounded by shading, and were enclosed by thick insulative walls. These factors made the rooms the coolest zones in the houses. The spatial order gave the occupants flexibility in adjusting to and tolerating different weather conditions.

The courtyard has always been used as a passive cooling strategy in hot climates. The wind condition inside a courtyard is determined by the proportion of the width to the height of the building.[54] In this respect, the courtyards in this town were usually square and their sizes varied from 4 to 6 meters square with H/W= 2/1.[5] This indicates that such a dimension would optimise solar protection by maximising shade. Also, this courtyard proportion allowed the effect of stack ventilation. Such a central open space was needed on hot humid days to

[5] Observations made by author during fieldwork survey.

encourage air movement when the sun struck the courtyard floor, as the air close to the floor surface heated up and it started to raise the cool air, creating air movement. The rooms surrounding the courtyard got benefit from the cool air when it escaped into the rooms. In winter the courtyard acted as a sun collector, the solar heat gain helping to warm the surrounding rooms (Fig. 11).

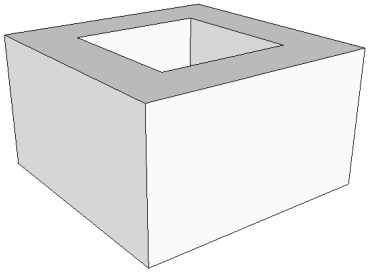


Fig. 9: A courtyard surrounded by rooms is the basic form of traditional houses in Qatif. (Source: by the author)

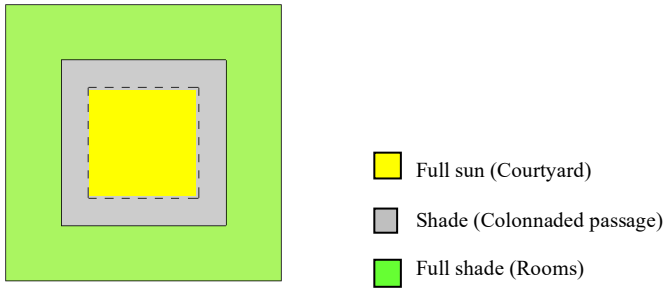


Fig. 10: Order of spaces from full-sun to full shade gave occupants options to tolerate the weather. (Source: By the author)

Fig. 11: The stack ventilation effect created by the courtyard form and the openings. (Source: By the author)

12. DJERBA AND AL-QATIF: CHALLENGES AND TYPOLOGIES COMPARED

Djerbian architecture emphasizes the marriage of form and function, with clear communication through the design. Each component serves a distinct purpose, and the integration of chimneys signifies the presence of a hearth. Human craftsmanship, minimalism, and simplicity are the guiding principles. In contrast to the vernacular architecture of al Qatif, which heavily incorporates gender segregation and specific cultural values into the architectural design, Djerba's housing typologies highlights a more functional, utilitarian, and environmentally responsive approach. The Menzels here are white monuments integrated with the surrounding landscape, serving as a central element for family life and resource connection. In summary, while both case studies focus on traditional architecture, the architecture of Djerba places more emphasis on functional and environmental aspects, with minimalistic and human-centric design principles, in contrast to the gender-segregated and culturally driven architecture of al Qatif. The notion of privacy, central in Islamic architecture, seems to be present across both case studies and reflects how socio-cultural life in North Africa and the Gulf are interlinked reflecting a strong influence of religion on people's habitat.

The architecture of Menzel in Djerba and the case study from Qatif exhibit distinct architectural and socio-cultural characteristics. In the Qatif region, the architecture is tailored to maintain familial privacy and is designed to accommodate extended families spanning multiple generations. The ground floor typically lacks exterior openings or features small ones positioned above eye level to ensure privacy. Houses are considered flexible and adaptable, with the potential for future expansion to accommodate a growing number of family members. The construction takes into account possible expansion, with the inclusion of extended wooden beams and thicker ground floor walls to support additional floors. The final size of the house is determined by the family's size and evolving needs.

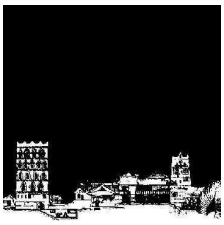
In contrast, the Menzel in Djerba focuses on simplicity, functionality, and harmonious integration with the environment. It does not emphasize gender segregation or the specific requirements of extended families. Instead, it prioritizes the core couple's needs and the utilization of space for practical purposes, like resting and ablutions. The architecture is minimalistic and driven by human-scale proportions.

While both architectural styles reflect regional cultural values and practices, they differ in their core objectives. The Qatif case study highlights adaptability to accommodate extended families, while the Menzel in Djerba emphasizes a more functional and minimalist approach to space and design.

NOTES AND REFERENCES

[1] The United Nations Educational, Scientific and Cultural Organization (UNESCO), 2023
[2] Ibid.
[3] Djerbi, Ali. *L'Architecture Vernaculaire de Djerba: Pour une Approche Semio-antropologique* [Translated: The Vernacular Architecture of Djerba: For a Semioanthropological Approach]. R.M.R Editions (2011), p. 143-44.
[4] Hakim, Besim. *Arabic Islamic Cities: Building and Planning Principles*. Routledge, 2013.
[5] Djerbi, Ali. *L'Architecture Vernaculaire de Djerba: Pour une Approche Semio-antropologique* [Translated: The Vernacular Architecture of Djerba: For a Semioanthropological Approach]. R.M.R Editions, 2011.
[6] Ibid.
[7] Bernard, Élise. "Djerba, International Tourism, and New Migratory Developments." *Revue europeenne des migrations internationales* 18, no. 1 (2002), p. 5-5.
[8] Boubakri, Hassan. "Modes de gestion et réinvestissements chez les commerçants tunisiens à Paris." [Translated : Management methods and reinvestments among Tunisian merchants in Paris.] *Revue européenne des migrations internationales* 1, no. 1 (1985), p. 49-65.
[9] Bernard, Élise. (2002)
[10] Djerbi, Ali. 2011
[11] Boussoffara, Faouzi and Abdelhamid Ghribi. "Djerba : Testimony to a settlement pattern in an island territory. " UNESCO Dossier (2022).
[12] Faleh, Majdi. "Law and Vision: A Reading of Islamic Culture and the Socio-Spatial Structure of Traditional Settlements." Australian Journal of Islamic Studies 6, no. 1 (2021), p. 47-64.
[13] Hazbun, Waleed. *Beaches, ruins, resorts: The politics of tourism in the Arab world*. U of Minnesota Press, 2008.
[14] Carboni, Michele, Carlo Perelli, and Giovanni Sistu. "Is Islamic tourism a viable option for Tunisian tourism? Insights from Djerba." *Tourism Management Perspectives* 11 (2014), p. 1-9.
[15] Widz, Monika, and Teresa Brzezińska-Wójcik. "Assessment of the overtourism phenomenon risk in Tunisia in relation to the tourism area life cycle concept." *Sustainability* 12, no. 5 (2020): 2004.
[16] Mzabi, Hassouna. "La Tunisie du Sud-Est: géographie d'une région fragile, marginale et dépendante." *(No Title)* (1993).
[17] Article 2 of the code states : «responsible for ensuring, for cultural, tourist and commercial purposes, the implementation and management of the program for the development and exploitation of archaeological, historical and museographic heritage as well as natural sites of a historical nature; to promote and develop cultural tourism and to encourage the creation and development of cultural industries in relation to heritage and cultural goods» Law no. 88-11 of February 25th 1988 establishing the National Agency for the Valorisation and Use of Archaeological and Historic Heritage, Journal Officiel République Tunisienne of March 4th, 1988, pp. 338-339.
[18] Boussoffara, Faouzi and Abdelhamid Ghribi. (2022)
[19] Djerbi, Ali. 2011
[20] Emara, E. *Main Cities: Qatif City (In Arabic)*, Eastern Emara. Available from: http://www.easternemara.gov.sa/qattef.asp Accessed December 20, 2014
[21] Almoslem, M. *Waha Ala Difaf Alkhalige: Al-Qatif (In Arabic)*, Third Edition edn, Alrida, Dammam, 2002
[22] Ibid.
[23] King, G. *The Traditional Architecture of Saudi Arabia*, I.B Tauris & Co Ltd, 1998
[24] Ibid
[25] Almoslem, M., 2002
[26] Emara, E.
[27] Information, CDOSA. *Census Eastern Province 2004*, Central Department of Statistic and Information. Available from: https://www.stats.gov.sa/en/13 Accessed June, 15, 2023
[28] Information, CDOSA. *Population Estimate 2010-2025*, Central Department of Statistic and Information. Available from: https://www.stats.gov.sa/en/13 Accessed June 15, 2023
[29] Ibid
[30] Khan, M & Kumar, A., *'Impact of "Urban Development" on Mangrove Forests Along the West Coast of the Arabian*

Gulf', e-Journal Earth Science India, vol. 2, no. III.p.161, 2009
[31] Alhammad, Z., *Itigah Altawassol Alimrani le madinat Alqatif 1960-2010AD (In Arabic)*, AlMajlis Albalady Bemohafazat Alqatif. Available from King Fahad National Library: http://ecat.kfnl.gov.sa/ Accessed March 22, 2012
[32] Alghanm, B., *Altasahor Youhaddid Akbar Waha fe Sharq Aljazeera al Arabiyaah (In Arabic)*, Alhayat. Available from: <http://daharchives.alhayat.com/issue_archive/Hayat%20KSA/2007/1/8/>. Accessed October 25,2012
[33] Khan, M & Kumar, A., *'Impact of "Urban Development" on Mangrove Forests Along the West Coast of the Arabian Gulf', e-Journal Earth Science India*, vol. 2, no. III., 2009
[34] Alhammad, Z., 2012
[35] Olgyay, V., *Design with Climate*, Princeton University Press.1963
[36] Oliver, P. *Shelter and Society*, Praeger Publishers,Inc., New York, USA, 1969.
[37] Ragette, F., *Traditional Domestic Architecture of the Arab Region*, American University of Sharjah, 2003
[38] Almoslem, M., 2002
[39] Winterhalter, C., *Indigenous Housing Patterns and Design Principles in the Eastern Province of Saudi Arabia*, thesis, Swiss Federal Institute of Technology Zurich, 1981
[40] Oliver, P, .1969
[41] Heath, K., *Vernacular Architecture and Regional Design: Cultural Process and Environmental Responce*, Architectural Press, Oxford, 2009
[42] Rapoport, A., *House Form and Culture*, Prentice-Hall, Inc, 1969.
[43] Al-Naim, M., *Continuity and Change of Identity in the Home Environment: Development of the Private House in Hofuf,* Saudi Arabia, thesis, University of Newcastle Upon Tyne, United Kingdom, 1998.
[44] Al-Naim, M., *'Identity in Transitional Context: Open-Ended Local Architecture in Saudi Arabia', Archnet-IJAR*, vol. 2, no. 2, pp. 125-146, 2008
[45] Oliver, P., 1969
[46] Ragette, F., 2003
[47] Ibid
[48] Habraken, NJ., *The Structure of the Ordinary: Form and Control in the Built Environment*, MIT Press, USA, 2000.
[49] Bianca, S., *Urban Form in the Arab World: Past and Present*, Thames & Hudson Ltd., UK, 2000.
[50] Rapoport, A., p.64, 1969
[51]Edwards, B., Sibley, M, Hakmi, M. & Land, P., *Courtyard Housing: Past, Present & Future*, Taylor & Francis, USA, New York.p.79, 2006.
[52] Ibid
[53] Talib, K., *Shelter in Saudi Arabia*, Great Britain. p.54, 1984.
[54] Brown, GZ & Dekay, M, *Sun, Wind & Light Architectural Design Strategies*, Second Edition edn, John Wiley & Sons, Inc., 2001.



TRADITIONAL DWELLINGS AND SETTLEMENTS WORKING PAPER SERIES

Volume 333
Contributors

HOUSE FUNCTIONS

Nermine Aly Hany
Arab Academy for Science, Technology & Maritime
Egypt
nermine.aly.hany@gmail.com

Manar Bint Abdulaziz AlYabis, Mohammed Bin Saeed Al-Aisan Al-Ghamdi
King Saud University
Saudi Arabia
manar.alyabis@gmail.com

Sima Tawakoli
Canada College
USA
lilac1381@yahoo.com

Majdi Faleh [1], Shams Alshamasi [2]
[1] Nottingham Trent University, UK
[2] Prince Mohammad Bin Fahd University, Saudi Arabia
majdi.faleh@ntu.ac.uk