



The Use of Traditional Courtyard Design in Libyan Housing as a Way for A Sustainable Design

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ABSTRACT

The courtyard in traditional houses played a major role in giving local architecture its character and uniqueness as an architectural unit a social climate that left its mark over time. It was noticed recently and started with a wave of modernity and the social changes that man experienced in Libya, which produce the absence of this element from the local architecture, and the emergence of contemporary housing that is unsustainable and ineffective in meeting the cultural and environmental needs for its occupants. This article seeks a solution for contemporary housing through the adoption of the many features that a traditional courtyard design offers. In addition to its advantages for thermal comfort and utilization of natural lighting, the courtyard reinforces many values of social connectivity and privacy for the family. Through an architectural analysis, the research tests the different characteristics of courtyard design and provides guidelines for further implementation in contemporary housing. The results of the study show that the courtyard design has a good potential in supporting sustainability within the contemporary context, while still supporting the functionality needed by modern dwellers.

Keywords: traditional housing, contemporary design, courtyard

1. INTRODUCTION

The concept of the courtyard has been used in building designs for centuries throughout different urban civilizations, including European, South American, North African, and Asian traditional houses. One of the most important characteristics of the courtyard is its multipurpose utilization, as it serves as a social space for the house inhabitants and their guests. The courtyard can provide privacy and security, as well as ventilation and natural lighting at the same time. After hot days, the house residents leverage the courtyard for socialization in a relatively cooler temperature. The ability to provide ventilation, lighting, and reduction of heat without fuel usage allowed the courtyard to become a sustainable solution offering a low-energy design. The extended definition of sustainability to the social dimension is satisfied by the courtyard design as it unifies the house architecture. Moreover, the existence of courtyards across all houses allowed for the creation of sustainable cities (Almansuri et al., 2009). Housing is defined as one of the most basic human needs also an essential component of our daily lives (Schoenauer, 2000; Elwerfalli, 2016). Furthermore, houses are where inhabitants spend most of their day (Donovan et al., 2014).

Due to the design and execution of Libyan housing projects by international companies, the houses offered in the country were constructed to meet contemporary technological capabilities with modern designs (Amer, 2007). Moreover, several findings in the literature show the compromise of sustainability and its different dimensions, i.e. environmental, social, and cultural, with the implementation of contemporary designs in housing projects. The studies show that this type of design causes distortions in the traditional architecture, which leads to losing the cultural and architectural identity in the region (Shawesh, 1996, Almansuri, 2009).

The determinants and classifications of the construction and design of contemporary houses in Libya in most of them lack the advantages that were achieved in the traditional courtyard houses, including integration and integration with the environment and the comfort of the human being inside the building, i.e. securing comfort in it and also affecting energy saving. Lately, many new materials and construction patterns have appeared for houses that do not fit with the surrounding climatic conditions, and architectural elements have appeared that are not in line with the region, although the traditional architecture has many intellectual features that are in line with this environment and that have been neglected in the construction of contemporary buildings.

Subsequently, contemporary houses with traditional inspiration arose as a need and a solution. This design idea facilitated conformity with the population's cultural and social needs, in addition to the achievement of environmental goals. The design allows for the incorporation of the contemporary lifestyle while preserving the inhabitants' traditional identity

This study is an investigation into the rediscovery of traditional courtyard houses as a sustainable building approach to contemporary residential developments in Libya, by combining the concepts of traditional courtyard houses and contemporary villa designs, to generate a sustainable design with characteristics that affect the efficiency of the building and provide comfort to users through harmony with the surroundings. Architecturally, environmentally, historically, and socially, and its compatibility with human traditions and customs. Furthermore, the vernacular courtyard house is common in all Arab countries (Elwerfalli, 2016). It is a responsive design that evolved over several centuries to respond to the local environment as well as cultural conditions (Elwerfalli, 2016). Moreover, this housing sort provided a setting for performing daily activities in a balanced as well as a protected environment (Rabbat, 2010). Additionally, this was the case in Libya until the middle of the twentieth century (Amer, 2007). With the emergence of the oil economy, the modernization of Libya led to the replacement of the courtyard house with high-rise apartments, which is associated with individual villa developments (Elwerfalli, 2016). These new sorts are inspired by Western values as well as tend to ignore issues of privacy and local climate. In addition, rules which are associated with regulations of housing also planning law in Arab countries are modeled on Western practices (Edwards et al., 2006); (Elwerfalli, 2016). In addition, contemporary housing in hot climatic regions do not perform well which is associated with require extensive use of mechanical systems to create habitable, comfortable conditions (Al-Zubaidi, 2007); (Elwerfalli, 2016).

2. LITERATURE REVIEW

Sustainable Development

The importance of sustainable design is increasing continuously and occupies great importance in building design. Sustainable design must consist of all types of processes and activities, which increase the individuals' capacity or environment to satisfy the needs of humans and enhance the quality of individuals' life. Sustainable architecture principles have been studied and mentioned in many types of research. Therefore, at this step, we will summarize the studies conducted by Park (1998), Reynolds (2000), and John et al., (2005) as follows:

Park (1998) mentioned that sustainable design motivates to use the of renewable and natural materials, new technologies to control the use of energy, products, and materials, which are characterized by durability and recyclability, which can be effectively renewed and sustained. According to Park (1998), the sustainable building design can be summarized into four main principles as follows:

- Provide good ventilation to the workplace to add a healthy atmosphere.
- The selection of green materials and technologies including the use of local materials.
- The consumption of less energy by using the new systems if compared with market standards.
- Including a recycling plan for water and wastes.

Moreover, Reynolds (2000) created principles for a new design, which are imperative for sustainable development through applying "Hannover Principles" that are implemented in the development of EXPO 2000 as the following:

- The right of nature and humanity to exist within a sustainable.
- Identify the relationship between human beings and the natural and healthy circumstances and a sustainable world.
- Develop the connection between material and spiritual awareness.
- The aftermath of decisions taken during design on humanity and ecosystems.
- Generate objects with safety and long-term value and remove the waste concepts.
- Dependence of the natural flows of energy.
- Understanding the design boundaries.
- Encouraging the direct connection between local individuals and architects.

Wetherill et al. (2007) mentioned that to help the construction industry in an attempt to enhance sustainability, he proposed many guidelines which can be adopted by the industry as follows:

- Minimize resources consumption.
- Maximize resource reuse.
- The use of recyclable and reusable resources.
- Natural environment protection.
- Encourage the creation of a non-toxic and healthy environment.
- Seek to create an environment with good quality.

John et al. (2005) provide an article about sustainable building solutions. He added many points which have been quoted from the OECD and mentioned in his article. The author mentioned that sustainable buildings have five goals as follows:

- Effectivity of resources.
- Effectivity of energy such as reducing greenhouse gas emissions.
- Prevent pollution such as reduction of noise and internal air quality.
- Harmonization with the environment.
- Systemic and integrated methods.

In addition to what has been mentioned above about sustainable development, many other authors studied this concept including Sherlock (1991) McDonough (2000), Cofaigh et al. (1996), and John et al. (2005), where all of them summarized the following principles for sustainability in architecture:

- Respect the socio-cultural values of users: Rapaport (1969) mentioned that various architectural forms are seen due to the host of technological, cultural, physical, economic, and social variables.
- Adapting the climatic conditions: the sustainable building must be capable to get benefit from the local climatic circumstances to seasonal and daily changed climate.
- Energy conservation: the energy consumed by a building is not only for heating, cooling, and lighting by the energy may be lost in the construction. Building construction needs a high amount of energy where this energy ranges from moving earth to the welding process. In addition, materials that are used in the architecture should be produced, processed, and transported to the building location smoothly.
- The use of local materials: the use of local materials will highly contribute to respect and improving the environmental problems.
- Respect the location (site conditions): it is necessary to know that the design of building and construction do not mainly influence the location typography and the surrounding architectural style.
- Water Efficiency: since the consumption of water is a critical environmental concern, it is necessary to regulate its use and reuse outside and inside the building.
- The use of natural light and ventilation: the design of windows and buildings which use natural light and ventilation will lead to preserving the electrical lighting energy, reducing the peak electrical loads, and decreasing the cooling and heating consumption of energy.
- The studied use of colors: colors have a psychological influence on the human body in addition to their aesthetic values where lighting plays an important role to decrease and reflect the solar rays on external walls.
- Treatments for ecological problems including noise pollution: noise looks like lighting in its impact on the psychological status of humans and the building must be protected from noise sources.

Sustainable Housing

The main advantages and utilizations of residential development were criticized by Colvin (2006), who summarized them into providing safe sheltering for families and their daily activities. Additionally, the author stated that inadequate quality provided by a residential development hinders providing a higher level of life amenities, including education, work, and healthcare. Sustainable residential development and its essence were discussed by Pett (2004) as the methods and practices that facilitate easing life for present and future generations in their dwellings. The assessment of energy generation and consumption is argued to be the most significant principle in residential development by Miller and Buys (2013). The authors extended the concept to the cultural and climatic contexts of the development, similar to the understanding established by Birkeland (2008). The development of an adequate dwelling is a crucial need for human self-dependence, social cohesion, and wellbeing (Edwards and Turrent, 2013). Based on the research of Chiu (2012), sustainability in residential development is defined as "Housing development that meets the housing needs and improves the housing conditions of this generation without compromising the ability of future generations to do the same" (p. 91).

The vagueness in concept definition imposes a vital challenge to sustainable residential development as major studies were not able to formulate a unified and coherent comprehension to address all its meanings and principles (Pett, 2014). Despite its emergence in the 1950s, the term "sustainability" is a source of confusion by itself (Salama, 2002). Several terms were associated with sustainability since then, which increases the complexity of its understanding. The relevant concepts include "good design", "energy-conscious" and "energy-efficient" design that was firstly used in the 60s and 70s, which finally led to the current term used worldwide. According to the author, the term "sustainability" is perceived with the negative impacts of human activities more than the actual solutions implemented to achieve its goals.

In the case of Libya, sustainability should not be perceived or addressed differently. It is evident that any residential development in the country is required to satisfy the current needs without jeopardizing the needs of future generations. It is also important that the application of sustainability in Libya is extended towards the social and cultural needs of the population as they are as unique as other worldwide communities. Due to the challenge in concept comprehension, it is necessary to simplify it and increase its appeal to the public. All misconceptions can be clarified through a supported comparison between existing residential projects that did not consider sustainability requirements and those proposed ones with the implementation of the concept.

The understanding of the influence of sustainability on residential development is significant due to its close relationship with the environmental aspects (Singh & Pandey, 2012). As one of the major development sectors, the implementation of sustainability in residential development can reduce the overall environmental impact. The benefits of sustainability in housing extend towards economic aspects through cost savings in energy, resources, and materials. A good energy design can reduce the footprint of the residential unit while satisfying its basic needs for lighting, heating and cooling, and ventilation. The availability of several technologies in each discipline, in addition to the development of international and domestic sustainability frameworks and regulations, was behind the increased interest in this type of development. Several techniques are currently used for sustainable housing development:

- Energy saving and resource preservation.
- Pollution reduction, waste, and environmental degradation
- Implement comfortable and healthy living environments (Al Rimmawi & Bhardwaj, 2007).
- There is a high number of innovations available for the efficient operating of buildings such as using recycled materials for construction, wastewater treatment and use, solar heating, passive solar heating, energy efficiency, and creating urban green spaces in nearness to the compact housing.
- High quality of architecture, compact urban development, social diversity, economic development, and ecology.
- It respects the heritage of the past and meets the needs of the present.

Design of Courtyard Houses

The courtyard houses design is based on a twofold strategy to achieve protection and privacy. The two goals affected the design, architectural details, and spatial relationships of the courtyard house (Bagnid, 1989). Most of the houses in the Islamic world include a courtyard where it represents a constant feature of the local architecture. Nevertheless, it has been developed in different methods, affected by the present domestic traditions, environmental elements, and construction materials (Edwards, 2006). In Islam, a courtyard house represents an optimal solution to male and female houses. Courtyard houses preserve privacy and protection for families particularly the women from the gaze of others and at the same time provide an open space for the family and its children to interact with each other. Furthermore, its design is flexible, able to accommodate and satisfy the growth and extension of families.

Many studies were performed on the performance of the courtyard houses to modify the climate impacts. climate design in traditional houses had a strong role to modify and moderate indoor temperature (El-Shorbagy, 2010). The central courtyard works as a protection element to the occupants from the unwanted impacts of air pollution, wind, sand, and storms (Edwards et al., 2006; Fortea, 1989). Therefore, the Arab courtyard creates a complex system of heat transfer which works as the domestic climate in a passive way (Scudo, 1988). So, it is considered a final product of the complicated historical procedure of the unconscious climatic design. Nevertheless, the effectiveness of this strategy is highly dependent on the design details of the building composition to provide a suitable airflow pattern to the courtyard. Fathy (1986) and Safarzadeh et al. (2005) mentioned that the high walls of rooms constructed around the courtyard offer wind shading influence for one another and therefore decrease the infiltration of dusty and hot winds. The courtyards with water pools, shrubs, trees, and flowers create a microenvironment and decrease the temperature to a few degrees and slightly higher in relative humidity whereas the tall trees of the courtyard work on shading the ground and walls from the direct high radiation of the sun during the summer season. These features together decrease the heat gain of the house (Fathy, 1986). However, recently published research on the importance of details reject the simple belief that the courtyard house is the optimal solution to achieve thermal comfort, especially in hot climates. So, the Centre for Desert Architecture and Urban Planning reviewed many studies which mention that the internal courtyard does not necessarily work as a thermal modifier in the building environments of hot climates. The studies concluded that the success of similar courtyards to create a good microclimate is highly dependent on the detailed design, which requires careful attention to various elements such as the use of vegetation, geometry, and finish materials (Elwerfalli, 2016).

Although climatic considerations are regarded as crucial factors contributing to the existence of this form of design, the design itself succeeds in meeting the socio-cultural demands (Makiya, 1986). Both physical and socio-cultural aspects have a major influence on a dwelling's form (Rapoport, 1969). The main feature of the courtyard house is the inwardness of its layout.

The effect of religion and social interaction on traditional architecture can be observed, Islamic religious teaching encourages privacy and modesty, and courtyard houses fulfilled this condition by providing an inward-looking house (Amer, 2007).

Courtyard helps to improve privacy with houses. In a courtyard house, there was a separation between the male reception area and other family private areas. Direct access is provided from outside for male visitors into the male reception area to limit visual contacts into family spaces. The courtyard provides privacy for family life and isolation from the public (Abarkan and Salama 2000).

Religious, social, and cultural factors in Libya play a significant role to control and direct the behavior of people inside the internal and external spaces. Various authors including (Daza 1982, Shawesh 1996, Emhemed 2005, and Amer 2007) have mentioned the main Libyan social and cultural factors as follows: the privacy of the Libyan community is a prior consideration inside the spaces of the house. The separation of age, gender, and guests are determined the roles played inside the family. The elderly people occupy special and great status in the Libyan community. The way of life has many sides, which must be taken into consideration in terms of the external and internal spaces. The internal spaces are important in the Libyan houses due to the way of preparing foods in the kitchen, the need for storage spaces, and the way to serve food to family members and guests. Security and safety are important for Libyan society. Although all of these details and elements have been studied and addressed in Libyan architecture, most of them do not exist in the Libyan contemporary houses. Emhemed (2005) mentioned that the influence of social interaction and religion on Libyan architecture can be realized in two ways; the Islamic religious rules which encourage and modesty and privacy and the courtyard houses satisfy this issue by offering an inward-looking house.

As we mentioned before, the cultural sustainability of housing is associated with perseverations of housing heritage. In contrast, although contemporary houses are lack attention to the cultural and social demands and accepted standards of life, they comprise many benefits including more privacy, comfort, flexibility, and the ability to use new technologies. Amer (2007) summarized the benefits of both types of houses in Tripoli. Amer (2007) studied the opinions of the population and professionals about the design of houses in Tripoli in terms of future design. The author identified many recommendations for the new houses and some of them are as follows: The design of the house must be appropriate to the geographical location and reflect the domestic identity and social and cultural aspects. Also, the house must combine the benefits of conventional and contemporary design of houses.

3. METHODOLOGY

Aim of Research

The current research aims to provide a better understanding of how to revive the idea of traditional courtyard houses in contemporary Libyan housing for sustainable contemporary design. Explore contemporary courtyard housing in Libya by integrating the concepts and the environmental -socio and cultural features of the traditional courtyard houses with the contemporary villas ideas to create an entirely new form of sustainable housing. In addition, the research clearly describes concepts that can inform sustainable housing design by individuals as well as housing authorities on housing projects. As a trying to improve the internal and external environment of homes in Libya, and then enrich contemporary Libyan architecture with the vocabulary of traditional architecture, leading to a contemporary architectural design, with traditional values.

Case Study

There are more than eight major cities in Libya overlooking the Mediterranean Sea, cities of high density (Tripoli the capital in the west, Benghazi in the east), cities of medium density (Derna and Tobruk in the east, Sirte and Misurata in the middle, Al Khums, Zuwara and Sabratha in the west), which are cities of importance for the presence of ports in them, and cities of low density, which are modern urban centers that appeared with oil, all of these cities are characterized by the same geographical and climatic characteristics because the nature of the coast is one and the geographical nature is one.

The city of Benghazi was chosen because it is considered the second-largest city in Libya, and was chosen in 2012 as the economic capital by a decision of the Interim Government, It also constitutes a weight in Libya, being the city that includes the most tribes out of all the Libyan cities that make up the three regions (East - West - South).

The availability of employment opportunities caused by economic prosperity led to the increase of internal migration towards Benghazi. Consequently, the demands for residential development have increased exponentially as a response to the exponential population growth. Based on governmental forecasts, demands for residential developments in the city are expected to increase by 50% by 2025 from the available 24,000 units in 2000 (UPA, 2006; Mohamed, 2013). Due to the attempt of the developers to cope up with the demand, an increase in energy demand has occurred.

Two case studies are investigated in the current research, which is the traditional and contemporary housing types. The guidelines provided aim to merge both types in response to the local environment and social contexts of Libya. Models are adapted from the coastal region of the country and are used as generic examples of the usual house layouts that are offered in that area. Figure 1 shows the areas of Benghazi that are included in the study.



Figure 1. The case studies of the research,

Region (1) The old city (traditional houses with courtyard); Region (2) contemporary houses (villa – detached houses); Region (3) contemporary houses (apartments)

From region 1(The old city) in Figure 1, a sample is presented for the traditional house design as shown in Figure 2 with typical floor plans for the ground and first floors. Figure 3 shows a section through the structure and Figure 4 shows an internal

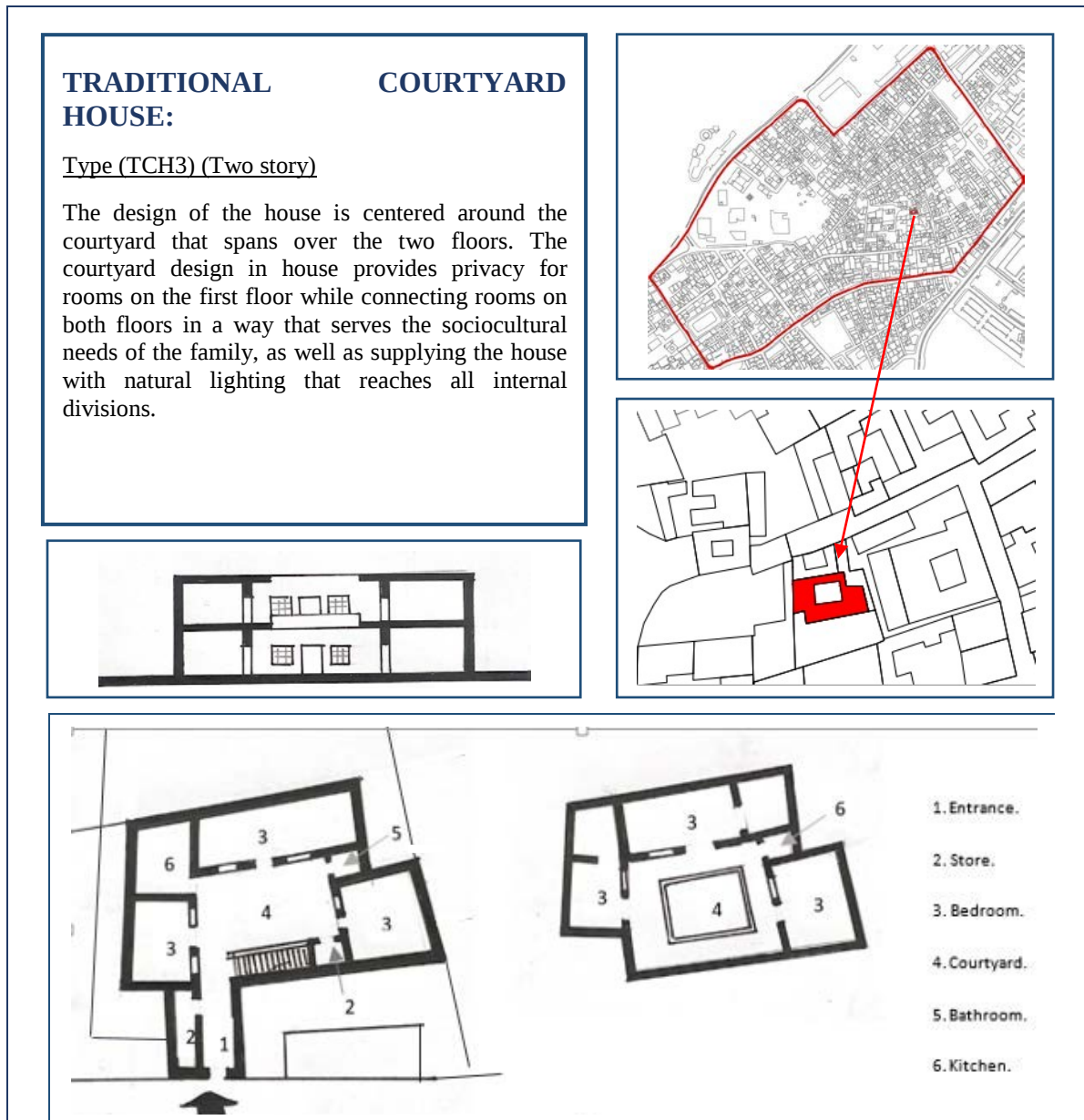


Figure 2. Sample of the traditional house design, type (TCH3)

The second house type of the case study in the region (2,3) in Figure 3, is the contemporary one, which comes in the forms of villas and apartments. Figure 3 shows the floor plan for the ground and first floors and a front picture of a contemporary villa sample.

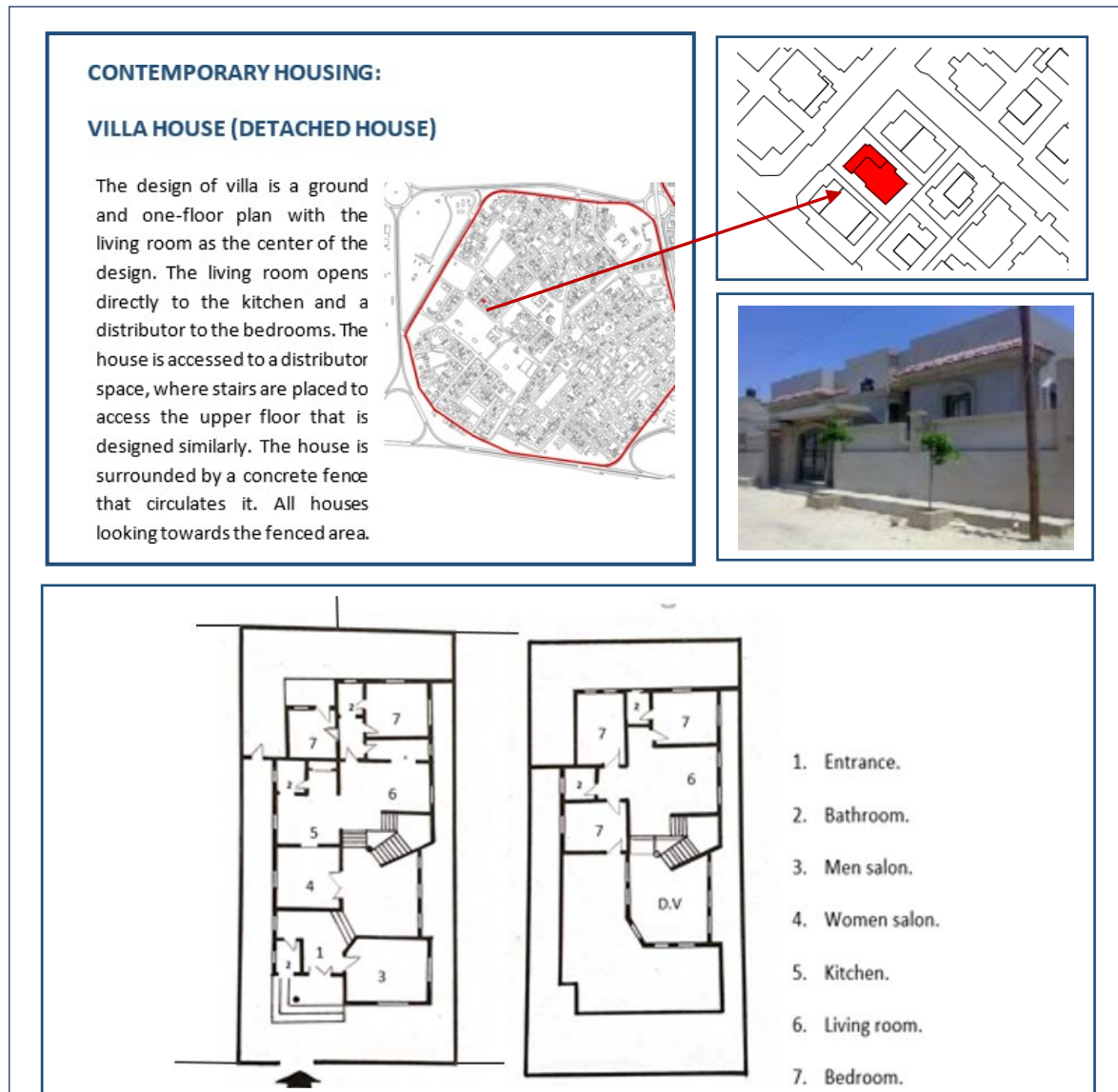


Figure 3. Sample of contemporary house design, (Villa)

Another contemporary housing example is the apartment type, as shown in Figure 4.

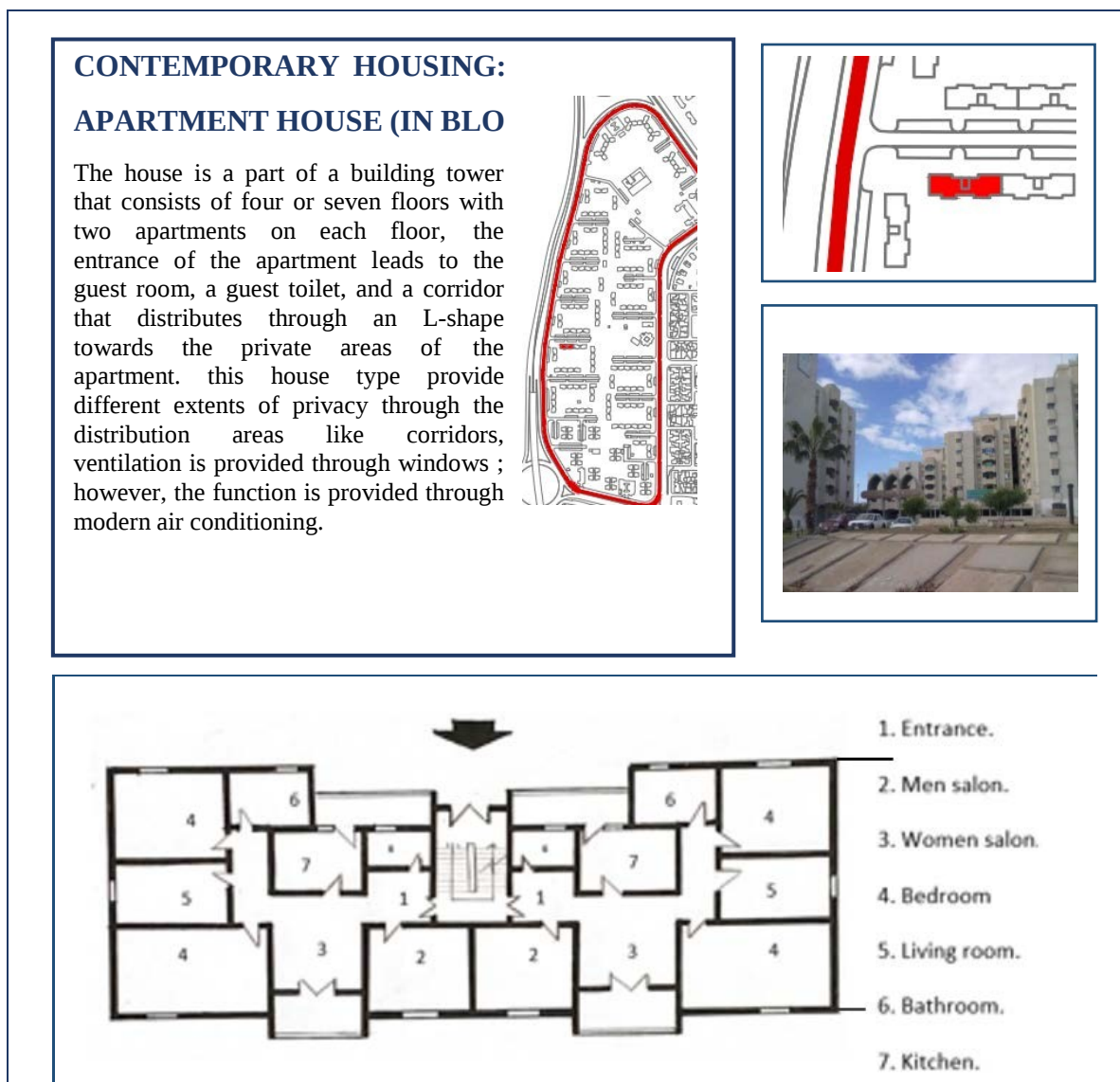


Figure 4. Sample of contemporary house design, (Apartment)

4. ANALYSIS

The three types of design in the case study are preliminary analysed based on the fifteen sustainability criteria that were targeted from the LEED and BREEAM assessment systems. The analysis aims to investigate the potential aspects of each sustainability criteria within these designs to understand the possible outcomes of the research method and compare the results with the analysis at the end of the research. Table 1 shows the sustainability analysis of the three designs of the case study. Based on the analysis, traditional house design with a courtyard has an opportunity for a sustainable design on all criteria, whereas contemporary design faces challenges on several aspects: seven for villa design and ten for apartment design.

Table 1. Sustainability analysis of the case study designs

Criteria	Traditional House with Courtyard	Contemporary Villa	Contemporary Apartment
Rainwater management/ harvesting	Rainwater harvesting opportunities at the roof of the house, at the top of the courtyard, and at the bottom of the courtyard that can be transferred through gutters to a reservoir	Rainwater harvesting can be carried out at the roof and the backyard of the villa then transferred to a reservoir	No direct opportunity for rainwater harvesting. A collective rainwater management system would have to be implemented for all building units, which has reduced capabilities based on collection area and number of building residents
Interior lighting/ Light pollution reduction	Due to daylight supply at the top of the courtyard, light pollution can be reduced during daytime	Possibility of increased light pollution due to the need for lighting at the backyard and fence area	Average lighting demand with no increased lighting usage. Daylight is limited to windows
Indoor water-use reduction	Water use is compensated by reservoir through rainwater harvesting	Water use is compensated by reservoir through rainwater harvesting	Average water consumption with no additional sources other than network water
Refrigerant management	Courtyard contributes to regulating temperatures during different seasons, which limits the usage of refrigerant	Increased refrigerant usage during the hot season due to separations between house segments	No strategy for usage reduction
Energy performance	Energy is saved through reductions in lighting and refrigeration consumptions	Increased energy consumption due to increased lighting and refrigeration needs	Increased energy consumption due to increased lighting and refrigeration needs compared to courtyard design
Renewable energy production	Solar energy can be produced through units on the roof and courtyard skylight	Solar energy can be produced through cells on the roof	No opportunity for substantial renewable energy production
Local source of material/ Resource efficiency	Most construction and finishing material can be found locally	Most construction and finishing material can be found locally	Most construction and finishing material can be found locally
Indoor air quality performance	Constant air circulation and ventilation is performed through the courtyard design	House segments are separated, which makes air circulation challenging	No clear opportunity for enhanced air quality
Material with low emission/ low impact	Use of low emission material is possible	Use of low emission material is possible	Use of low emission material is possible
Thermal comfort/ microclimate	Microclimate can be produced through the shades within the house and temperature differences caused by the courtyard leading to thermal comfort	Therma comfort would have to depend on air conditioning systems. No chances for microclimate creation	Therma comfort would have to depend on air conditioning systems. No chances for microclimate creation
Daylighting	Increased daylight supply through the courtyard that can reach to most house segments	Daylight supplied from windows depending on house orientations	Daylight supplied from windows depending on house orientations
Quality views/ Landscape	Possibility for quality views and indoor landscape area at the bottom of the courtyard	Possibility for quality view and landscape areas	Possibility for quality views but no landscape areas
Acoustic	House design with	High possibility of noise	Average possibility of

Criteria	Traditional House with Courtyard	Contemporary Villa	Contemporary Apartment
performance/ Noise pollution	courtyard is compact which reduces impacts of noise pollution. Acoustic performance can be enhanced through the material.	pollution due to proximity to the outside environment. Acoustic performance can be enhanced through the material.	noise pollution. Neighbouring apartments can affect and be affected by acoustic issues. Acoustic performance can be enhanced through the material.
Demographic needs and priorities	Highly compatible with residents' social needs due to internal openness while maintaining privacy between guest areas on the ground floor and family areas on the first floor.	Highly compatible with residents' social needs due to closeness of house rooms while maintaining privacy with a separated guest suite.	Average compatibility with residents' social needs as living room space on the ground floor opens towards the kitchen and a room distributor.

A preliminary analysis is performed for the three designs based on the social, economic, and environmental factors of sustainability, as shown in Table 2. The final analysis of these factors is further assessed after the completion of the case study.

Table 2. Comparison and analysis of the designs based on social, economic, and environmental factors of sustainability

Criteria	Traditional House with Courtyard	Contemporary Villa	Contemporary Apartment
Family structure and size	Design is intended for big extended families. The household can include grandparents and grandchildren.	Dependent on the house size, it can accommodate big families.	Mostly for small to moderate size families with no room for extended family.
Accommodation of family growth	Can accommodate additional growth of the family to few generations	Can accommodate family growth of one additional generation	Limited family growth opportunities
Suitability for family functions	High accommodation of family social functions at the courtyard	Dependent on the size of external facilities. Contemporary villas with limited external areas may not offer this option.	High limitation on social functions.
Size of extended family	Large accommodation of extended family	Limited availability of space for extended family	No space for extended family
Satisfaction of family taste	Traditional houses rarely accommodate for individual tastes, rather than focus on the collective benefit of the household	High attendance to individual taste with families tending to assign private or semi-private rooms for individuals with various internal and external spaces	Limited possibility for individual taste with limited space; however, it is also dependent on family and apartment sizes.
Preservation of national identity	High reflection of national identity due to the implementation of the courtyard element that is consistent amongst housing from the traditional era	Moderate preservation of national identity depending on the internal, external, and functional design of the villa.	Limited preservation of national identity. The apartment purpose is to provide housing for a single family rather than attending to this issue.
Safety and security	High level with internal windows, lack of external	Low security due to external windows and	Moderate to high security depending on floor level.

Criteria	Traditional House with Courtyard	Contemporary Villa	Contemporary Apartment
	windows, and a single house entrance.	vulnerable external fences.	
Privacy and family values	High privacy for house residents with private areas assigned on higher levels	Dependent on internal layout, with privacy increased with external guest facilities.	Low privacy as rooms are connected mostly with a single corridor
Support of spirituality and religious values	The availability of the courtyard allows residents to keep higher spiritual practices and extend them using the courtyard	Availability of external facilities allows residents to hold different religious functions	Moderate level with less possibility of social religious practices
Social cohesion and sense of community	High sense of community with houses often very close to each other, or even sharing walls, and connected with narrow alleys.	Moderate social cohesion due to low density housing in an area	High density modern housing is related to the diminishing of social cohesion, but it dependent on the social context and the relationships between the residents of the building
Adaptability to modern work-family life	Low level with high number of residents within a single household, if this design is used in modern times. However, the design served well these needs during ancient time due to low woman workforce ratio and the tendency of a family to work in a single trade.	Several opportunities to create balance between work and family with spacious spaces	Mainly focused on providing a family space with less suitability for self-employed individuals
Cost of air conditioning	No costs due to availability of courtyard	High cost depending on villa size	Moderate to high cost dependent on size
Benefits of living space	Design is focused on functionality through providing shelter and basic amenities	Higher possibility for free spaces that can be utilized for different and additional functions	Basic living space with more spacious basic amenities
Reduction of consumption	Minimalist design for low consumption	No dedication for consumption reduction	No specific dedication for consumption reduction but it is tied to the limited family size
Property value	Moderate property value due to historic nature	High property value due to space and availability of private recreational spaces. Value for location cannot be determined in the current analysis.	Low to moderate property value depending on proximity from urban centres
Suitability to income level	Suitable for big and extended families with moderate to low income level	Inhabited by moderate to high income level residents	Low to moderate income levels
Suitability for summer climate	Designed for summer climate with the advantages of the courtyard	Highly dependent on cooling system	Highly dependent on cooling system
Suitability for winter climate	The courtyard and the design of the external walls allow the preservation of heat within	Highly dependent on heating system	Highly dependent on heating system

Criteria	Traditional House with Courtyard	Contemporary Villa	Contemporary Apartment
	the house		
Natural ventilation	Highly available through courtyard	Highly available through external windows	Highly available through external windows
Sunlight	Moderate and limited to courtyard	High due to exposure of all walls to external environment	Highly dependent on house orientation
Thermal comfort	High thermal comfort with suitable temperatures throughout the year	Dependent on heating and cooling systems. No specifics to architectural design.	Dependent on heating and cooling systems. No specifics to architectural design.
Benefits of wind direction	High utilization through courtyard function	Available with four external walls	Highly dependent on house orientation
Green and recreational spaces	Low to non-available, unless courtyard had planters	High availability of with external spaces	Lacked from apartment designs and highly dependent on neighbouring facilities
Availability of quality views	No external views. The view is limited to courtyard	Views to external facilities. Low floor number may limit this factor.	Dependent on location. High floors can provide high quality views to natural and urban sights.

5. CONCLUSION

The analysis performed in the study shows that contemporary designs for villas and apartments are essential for the modern life functionality and satisfy the needs of the family. However, there are additional advantages that can be provided with the incorporation of the courtyard elements from traditional housing designs to add value to contemporary designs. It is evident that considering a courtyard in contemporary housing increases thermal efficiency, enhance ventilation, and increase natural lighting utilization. These features are primary to increasing the sustainability of the design and reduce dependency on energy consumption. Additionally, social benefits have a great potential to increase the liveability of the space through increasing interactions, while reinforcing privacy needed in the Libyan society. There are also potential economic advantages to courtyard incorporation in contemporary housing that are emerging from the reduced energy consumption, as well as the increase of property value. Future research on the subject continues to investigate the potential of courtyard designs through user feedback, which is a task taken on by the researcher.

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