

Courtyard Existence between the Past and the Present, Case Study: Central Region, Saudi Arabia

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Abstract The courtyard is one of the architectural features used in ancient times for many purposes, such as climate modifiers, as a place for family gatherings, and as a playground for children. Over time, the courtyard gradually disappeared, and it no longer has a special presence in residential buildings. The study deals with exploring courtyards in the old and modern buildings in the central region of the Kingdom of Saudi Arabia, which was characterized by its strong presence in ancient times. Therefore, the paper holds seven case studies to compare the most important features in commons, middle, and contemporary houses. The research reaches the truth of the extinction of the courtyard and its replacement by other elements that negatively affected the social, ecological, and economic aspects of Saudi residents, and assures the dependence on mechanical treatments that harmfully distressed the building energy likewise affected the social aspects at the level of family and society alike. Courtyards with environmental design basics provided high energy efficiency to building through daylight and ventilation which helps in decreasing electricity and HVAC loads. This paper invites researchers and builders to reuse the courtyard or the Patio concept again as a design tool in contemporary buildings to save future resources and maintain sustainability principles.

Keywords Courtyards, Saudi Arabia, Typology, Clusters, Sustainability, Energy Efficiency

1. Introduction

Studying and inspecting courtyards as an architectural feature in residential buildings, starting with the old vernacular Arabian architecture and ending up with the contemporary constructions of today, allows the essential nature of culture to be re-justified and properly analyzed in the context of the current era. Going through the history of courtyards in the vernacular architecture in Saudi Arabia since the 1950s, it was conventionally and commonly integrated because of its beneficial application and significance of natural design basics in Islamic and traditional architecture.

Courtyard housing is known as the oldest form of residence. It had shown for the first time in ancient civilization excavated at Kahun in The Middle East in Egypt, which back to 5000 years old to the City of Ur before 2000 B.C. [1-3]. In the beginning, the courtyard or Patio concept was mainly to provide a saved private family outdoor area from outside forces from humans and wild animals. Over time, the design of the Courtyard developed into a solid, logical configuration that maximizes the built-up area in the urban context and allows privacy, controlled sunlight, more ventilation, and plant growth [4]. Saudi Arabia had very hot weather in summer which needs well-studied ventilation to decrease HVAC loads and provide well-air distribution within the interior spaces.

Today, designers and notaries bear a heavy burden in documenting this rich heritage. Traditions are vulnerable in

the face of the sound waves of modernization and globalization. In response, research on vernacular architecture has focused on studying, documenting, and preserving historical and traditional buildings before they disappear [5].

It is well known that traditional societies in the Gulf Region and Saudi Arabia exhibited extremely harmonious relationships within their units. During the second half of the 20th century, these societies experienced rapid economic and social change, and this no longer applies. The built environment entails new characteristics that threaten values and experiences passed through generations. Designers have broken the previous relationship between people and their physical settings [6].

It might also be the new design approaches, the climate change, or even the sudden transformation of the perception and mentality of residents towards their built atmosphere, endless reasons would carry the answer hidden in between. Since there has been a transitional stage between the old vernacular architecture and the current contemporary one that exists at the present [7,8].

1.1. Research Objective

The research aims at studying and investigating the design motivations of courtyards, which utilizes the efficiency of the architectural concept itself and the influences on vernacular architecture throughout history. It also analyses the types of Najd courtyards and compares the main categories of Najd houses from different perspectives during different times and discovers more about the effective solutions that the courtyard offers as one of the significant sustainable applications in architecture.

1.2. Research Questions

At this point, critical research questions are raised.

- 1.2.1. Is it possible to adapt the concept of the courtyard to modern needs and seek its revival?
- 1.2.2. In terms of sustainability, what are the most likely benefits?

2. Materials and Methods

The research used qualitative methodology [9,10], based on the assessment of the architectural characteristics and properties of courtyards. This paper examined the effectiveness of courtyards as a design tool for vernacular buildings by examining buildings that reflect and preserve historical and cultural aspects. To examine all angles that affect the building's components, area, and functionality, the researchers selected various case studies from old and new houses.

The kingdom of Saudi Arabia has four provinces with totally different climatic conditions. Hence, the paper will study only the central region "Najd". The other provinces will be studied further in the upcoming series.

The paper explains the central region climate conditions as well as the houses elements and components considering several points, such as the average number of family members, the common average courtyards size, the average ratio of the built-up area, the average number of floors, and the number of openings. All the applied factors should be connected to the nature, surroundings, and cultural aspects as well. This paper aims to examine the effectiveness of courtyards as a sustainable technique taking into consideration various factors including economic, social, and ecological factors.

There will be seven case studies, three cases will show the application of courtyard and a detailed analysis of houses components in the vernacular architecture. The other four cases will represent new houses which are built recently with all related details. After analyzing all case study elements, the discussion will be shown.

3. Literature Review

3.1. History of the Courtyard

As a climate and privacy modifier, the courtyard serves an important role. Based on the region and the level of wealth of the builders, the importance of the courtyard and the relationship between its area and height differ [11]. It remains a square or rectangular plan despite these variations. Well-heeled townhouses might have gardens in their courtyards. Paved walkways raised above ground level divide these areas, which are usually richly paved with stone or tile as shown in figure 1. The owners construct a fountain or pool around the figure when they have water figures available. Even poor houses may have some trees, a plantation, or a small tank, demonstrating how the landscape was used as a visual feature within courtyards [12,13].





Figure 1. (a) Courtyard of an Egyptian House, (b) & (c) Fountains inside courtyards in Syrian houses. (Polished, Private, and Passive: Traditional Courtyard Houses and their Timeless Architectural Features | ArchDaily)

The courtyard provides a safe playground for the children, under the direct supervision of the mother or parents in general and provides a convenient space for living activities for adults in the open air, so it holds family gatherings during the daytime while enjoying coffee as an

example of cultural habits. The courtyards are usually surrounded by paths for circulation and one row of rooms. All the rooms have direct access to the courtyard, except for the male quarters [7,8,14,15]. Throughout the day, the courtyard's extensive surface area stores a large amount of thermal mass to provide warmth during cooler nights. In addition to limiting severe temperature stress, the courtyard reradiates the interior heat into the night air because of its high surface-to-volume ratio. As proven by Muhaissen and Gadi that the heating and cooling requirements of courtyard buildings are significantly influenced by their proportions [16-18].

The exposure of courtyards in contemporary Arab architecture reflects an evolutional modification of the concept of the Arabian traditional house. Before tracing the reasons for this emergence, it is important to spot some light on the traditional courtyard house in the vernacular architecture within the region which is considered as a doant paradigm in the context of sustainability for hot and dry climates [8].

Baruch Givoni emphasized this concept as he indicates that residential buildings with internal courtyards are considered the most appropriate and suitable in many hot regions, especially deserts [8,19]. Although housing typologies are a result of multiple determinants, climate and culture are the two most important determinants [20]. In this sense, Majdi Hariri identified the specific functions of the traditional courtyard in the region [21]:

- A family gathering area that can double as a living room and dining area.
- A place to sleep comfortably and calmly during the summer nights.
- Play area under the observation of the mother where children can safely have fun.
- For the nearby rooms, a source of natural light and ventilation.
- A pleasant microclimate within the building.
- A house-wide circulation hub that allows movement from one space to another.

Saudi Arabia is considered as one of the largest countries in the gulf, therefore, very-well established vernacular traditions will be found in different regions. Most researchers divide Saudi Arabia into four regions that each one has a completely different architectural style, construction techniques, and materials [5]. These regions are:

1. The Western (Hijaz) region, a hot humid coastal plain along the Red Sea.
2. The Central and northern (Najd) region, mainly a vast hot dry plateau in the center of the country or tile as shown in figure 2.
3. The Eastern region, a hot humid region along the Arabian Gulf.
4. The Southern (Asir) region is a high mountainous province to the southwest side.

Vernacular architecture in the four regions is stately different. The four vernacular styles were developed and improved over time to create a comfortable living setting in response to many multiple factors such as harsh climate, culture, economy, and availability of local building materials within the same context of the ecosystem [22,23].

The main vernacular architectural styles and their basic building techniques in the four regions are summarized by Mahjoub and Hwais. They stated the general features of the vernacular architecture [25,26]. The paper focuses on the Central region (Najd) for houses' case studies to represent the essence of the research, which builds its argument based on the literature review where this region is the most

one that has courtyards connected with its climate as shown in figure 3.

3.2. Courtyard Types & Existence Importance

Majdi Hariri classified courtyard types in traditional Saudi houses into three categories including, family courtyard, guests' courtyard, and animals' courtyard [21] as shown in figure 4. Courtyards have been generally referred to as a microclimate changer, due to their ability to mitigate high temperatures, channel breezes and adjust the degree of humidity [28].

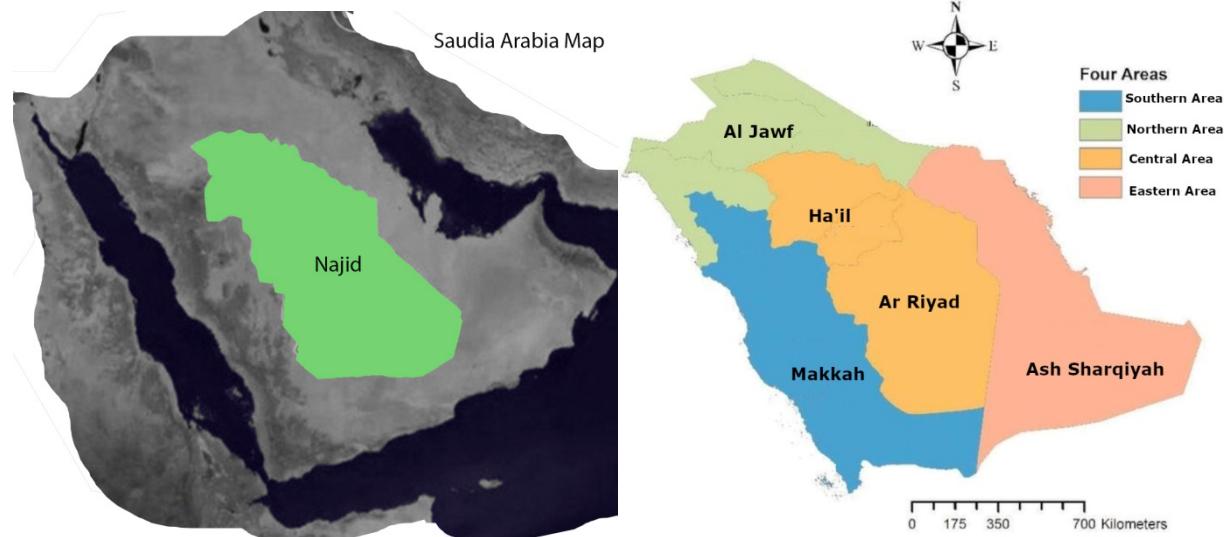


Figure 2. Saudi Arabia Four Regions (Adapted from [24])



Figure 3. House's courtyard with different design [27]

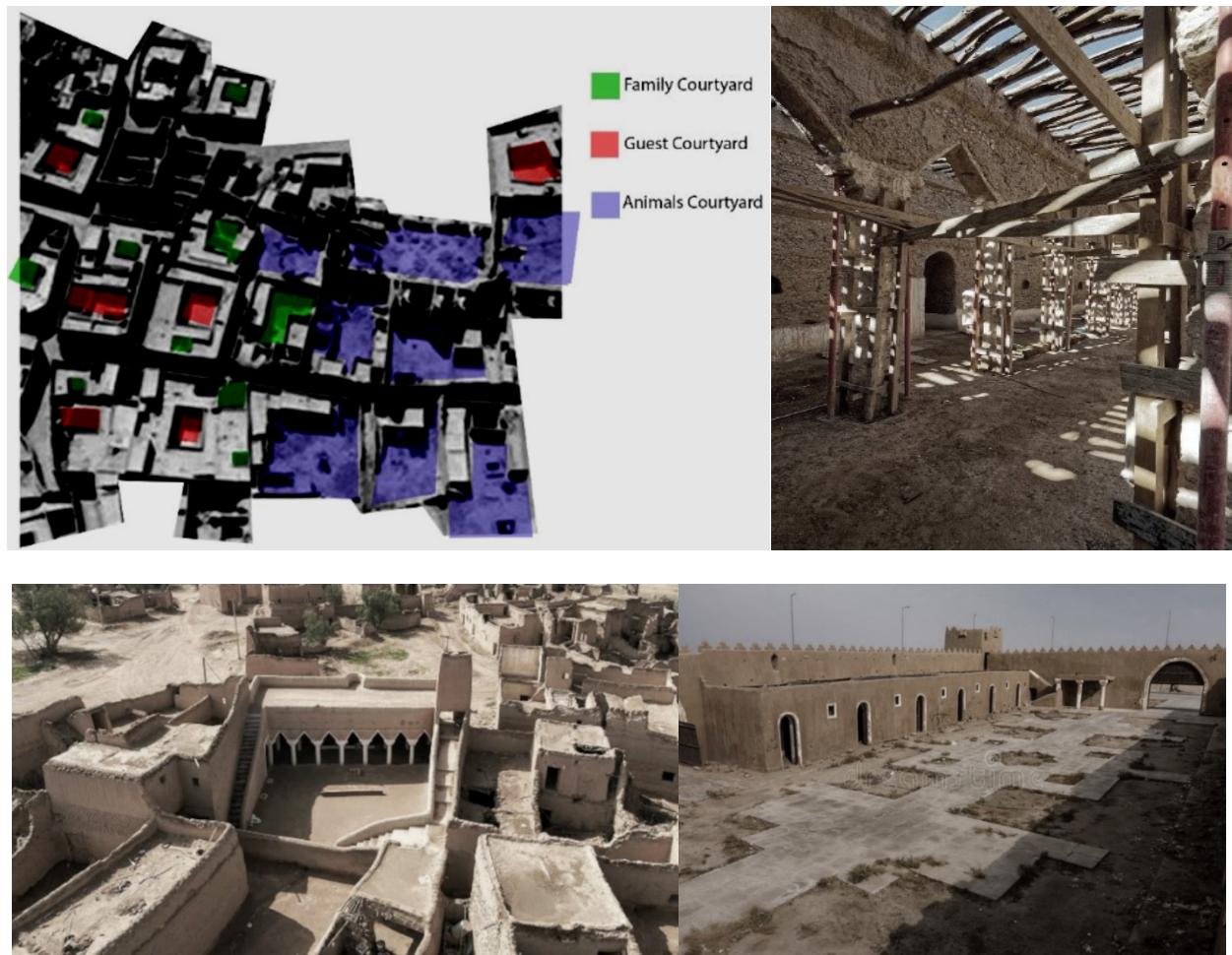


Figure 4. Traditional Saudi houses' courtyard type into three categories & Family shaded courtyard, The guest courtyard which opened to the roof, Animal courtyard connected with house. [11]

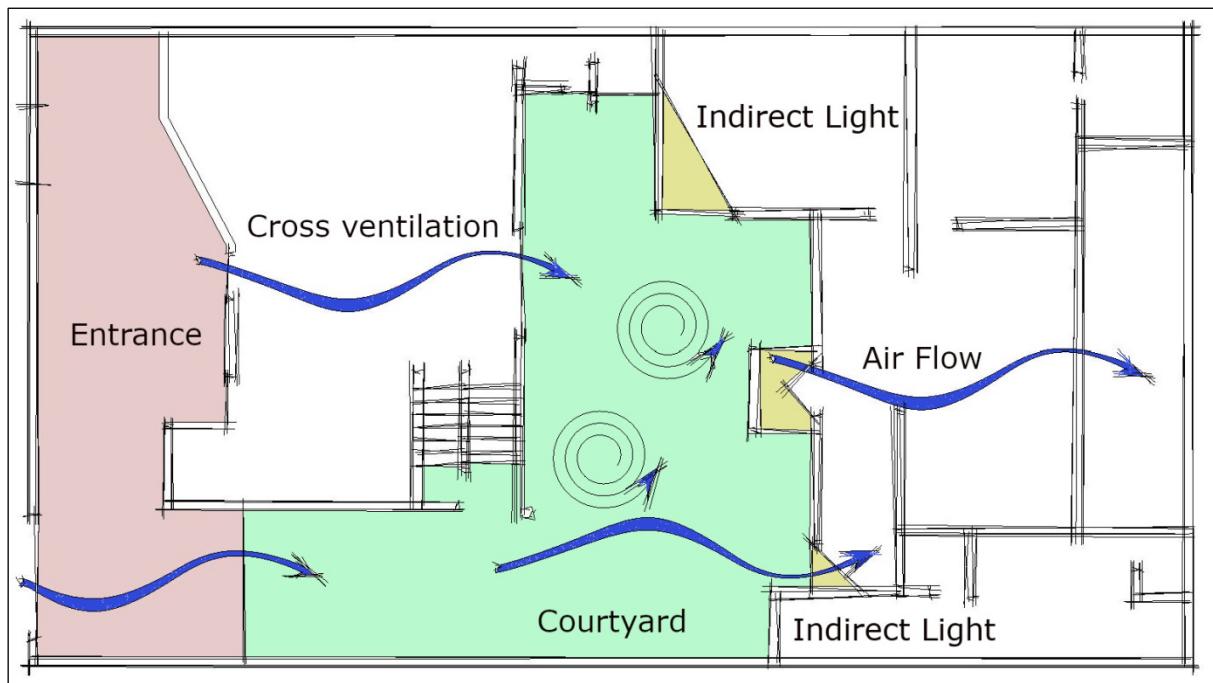


Figure 5. House plan example shows the ventilation of airflow through the courtyard

Courtyards also were acting as a source of airflow thermal comfort to the residence. With the right position to the house and suitable material, it can also help to reduce the heat gained this will act efficiently with the properties of self-shading and thermal lag. Additionally, courtyard acts like a cool air reservoir, especially in hot-arid climates [2,29,30] as shown in figure 5. Not only is the courtyard used as an air controller, but also it is a method of adapting the strategies of vernacular design as a major trend in the bioclimatic architecture [31-33].

4. Results

Many papers in the literature proved that the complete dependence on the active systems ignoring the importance of climbing gradually the three tiers of sustainability as shown in figure 6 [34,35] and applying the fundamental sustainable basics at the first phases of design, “such as the interior planning, site design, landscaping, building orientation, exterior shading, openings, construction materials, and building form”, will create a huge instability in the building performance. This unbalance might cause many health problems for the users like sick building syndrome (SBS), which is a condition when people in a building suffer from symptoms of illness or become

infected with chronic disease from the building in which they work or reside [36,37].

It will even affect the conservation of the building energy and raise the amount of consumption on the other side. The advantages of courtyards are clear in all perspectives. It provides efficient ventilation flows for different plan configurations, small, middle, large, indoor, and outdoor [38]. It helps to decrease the ratio of energy consumption and reinforces the general performance of the building and supports its efficiency by allowing the building to embrace more natural light and make use of it.

4.1. Courtyards in the Central Region (Najd)

One of the very interesting fields to be investigated is the emergence of courtyards in the central region of Saudi Arabia. Going back to the vernacular structures during the old past, Najd was densely packed with cellular courtyard houses of all sizes and shapes, linked and connected by a maze of winding lanes, alleys, and cul-de-sacs. Housing is organized into quarters or neighbourhoods based on occupation, religious sect, or ethnic group. The below figures 7 and 8 depict the distinction between past and present house clusters [25,39].



Figure 6. The three-tier approach to designing efficient and effective heating, cooling, and lighting systems in buildings

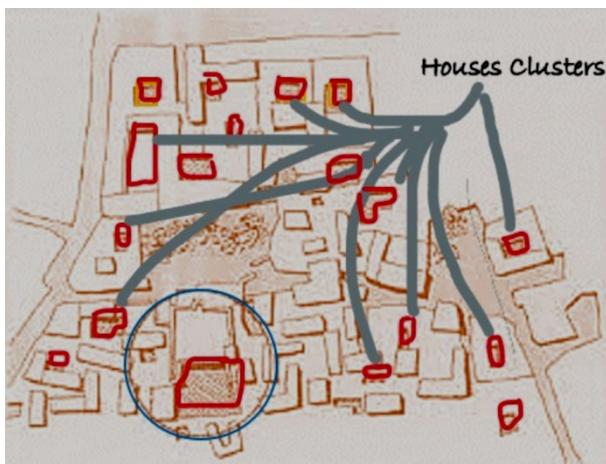


Figure 7. Plan of vernacular homes clusters in the Najd region



Figure 8. Contemporary houses

Clusters of houses in the vernacular architecture at Najd were more associated to each other, which affected the psychological manners and cultural habits of residents. This type of configurations reinforced with the use of

courtyards support socializing, openness, collaboration, and generosity. The concept of neighborhoods is that they are one spirit, what one house needs the second one will immediately offer [40].

4.2. Climate Analysis, Central Region (Najd)

For the specific region, there will be many factors that affect the construction techniques, sustainable applications, and finishing materials. Micro-climate is considered one of the most significant factors that plays a major role in the architectural atmosphere. Therefore, the demands of a hot climate led to several design characteristics. A courtyard is a well-recognized one that has been used for many buildings in houses, schools, mosques and government buildings, but for this research, the residential category is the highlighted one.

In the central region, mostly summers considered long as shown in figure 9, sweltering, and arid; the winters are cool and dry, and it is mostly clear year-round. Throughout the year, the temperature usually varies from 49°F (9.4°C) to 110°F (43.3°C) and is seldom below 41°F (5°C) or above 114°F (45.6°C).

The hot season stays for 4 months, from May 13 to September 23, with an average daily high temperature above 102°F (38.9°C) as shown in figure 10. The hottest day of the year is July 25. The cool season stays for 3 months, from November 26 to February 26, with an average daily high temperature below 76°F (24.4°C). The coldest day of the year is January 11.

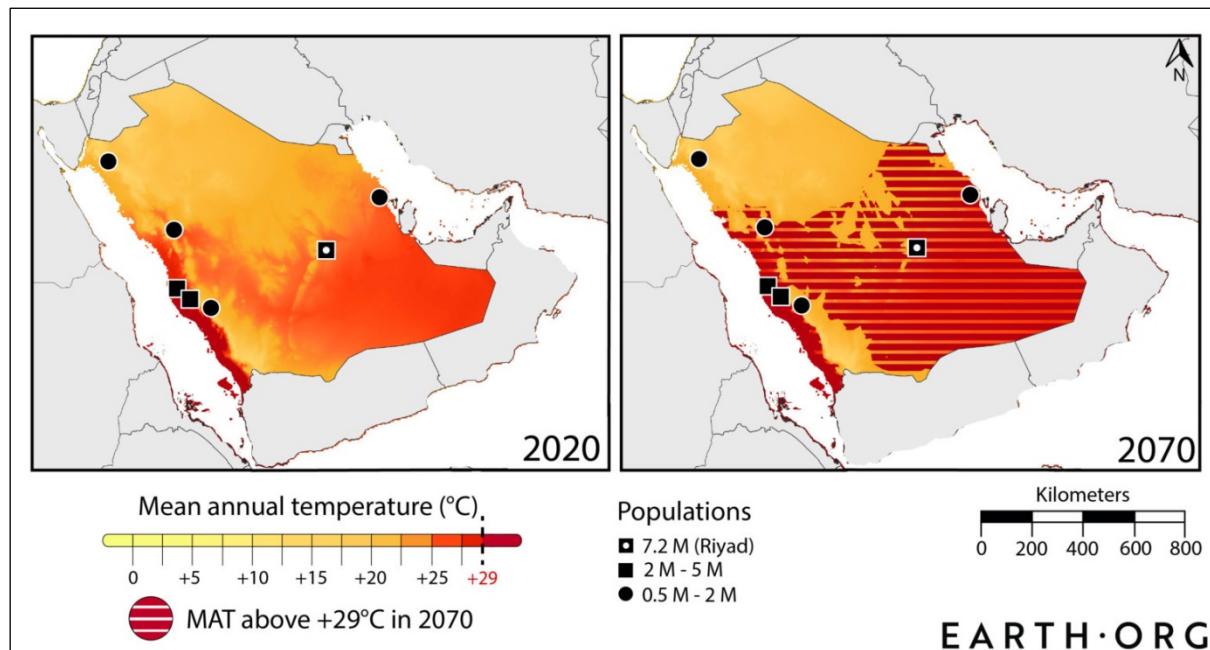
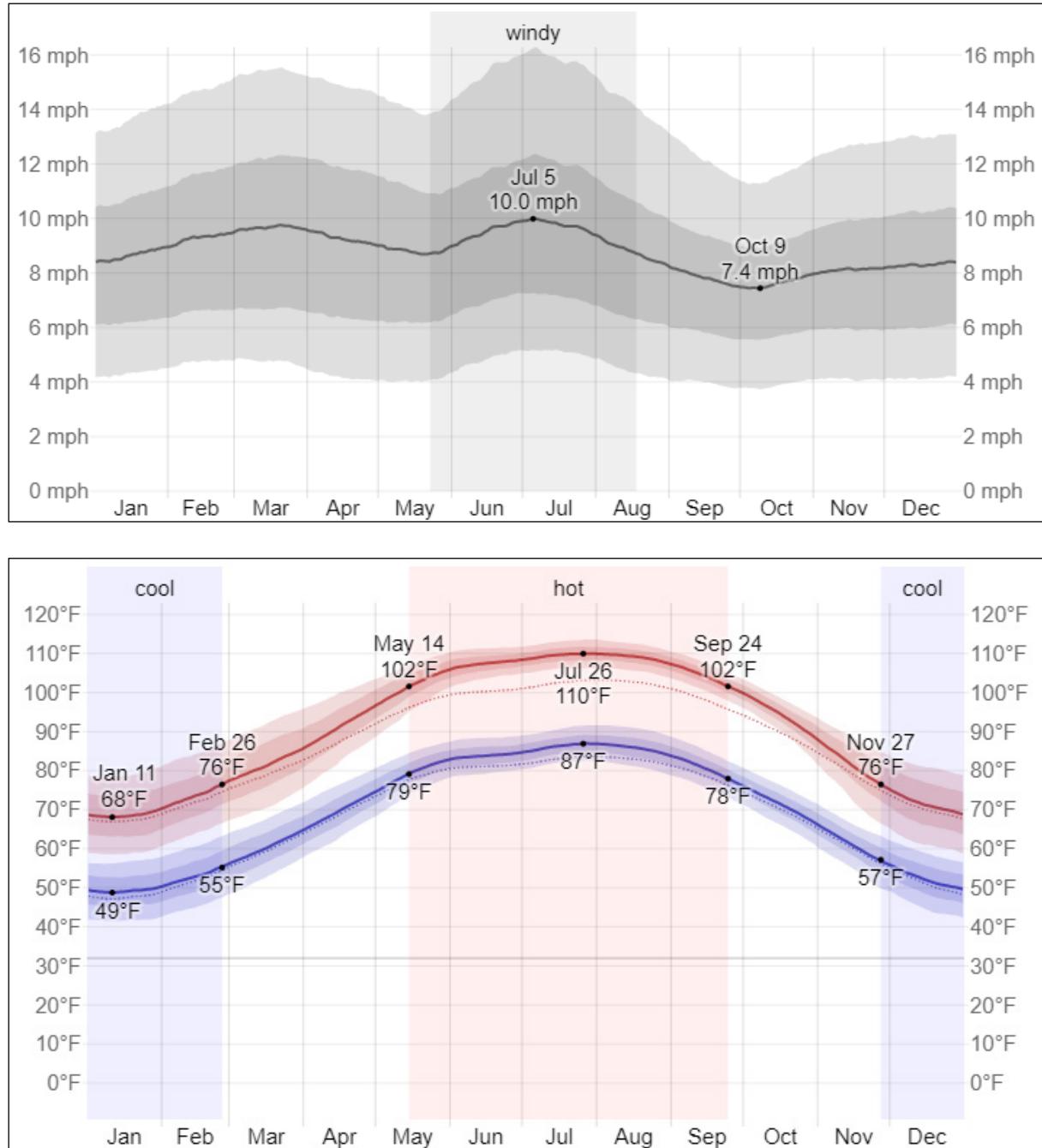


Figure 9. Climate change is set to level the playing field by making over half of Saudi Arabia as hot as today's Sahara by 2070. (Too Hot to Live: Climate Change in Saudi Arabia | Earth.Org)



Source: © WeatherSpark.com

Figure 10. Average Wind Speed in Riyadh & Average High and Low Temperature in Riyadh

4.3. Vernacular Case-study, Central Region (Najd)

To start the comparison between the courtyard existence in the past and the present, here is a case study that shows the main features as shown in figure 11, and general characteristics of the traditional house in the central region, as an example of the sustainable application of the vernacular architecture in Najd.

As an application of sustainability and how it's all connected to many other aspects, the geometrical shape,

the construction techniques in the vernacular architecture of the central region were successfully achieving sustainability regarding the three tiers approach of the sustainable design, taking into consideration the current location and the micro-climate as well. It emphasized the effective basic building design [41], and reinforced the building performance using the passive HVAC systems and minimizing the use of mechanical equipment, electrical machines, and active systems in general, refer to figure 12, [42].



Figure 11. Vernacular Architecture traditional house case-study; application of courtyard, Najd

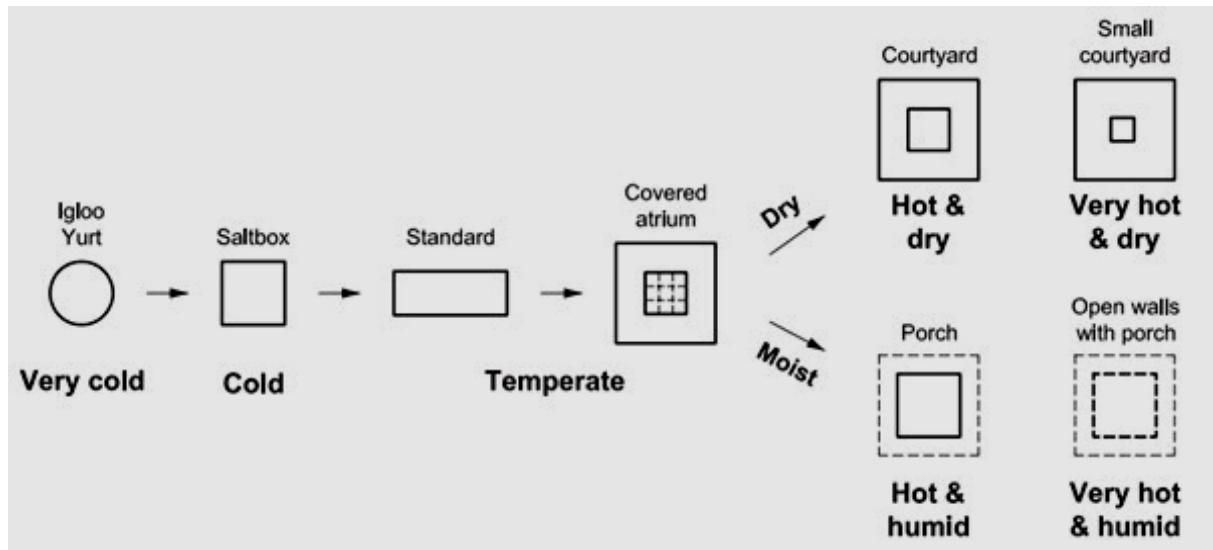


Figure 12. The ideal building form is greatly influenced by the local climate. The building form can minimize heat loss or gain, affect maximum [42]

For further information to have a better understanding of the following case studies, nature context considered one of the major ecological and human characteristics in the vernacular architecture of “Najd”, the central region. Najd is considered as a desert ecosystem, a large, extremely dry area of land with sparse vegetation. It is one of Earth’s major types of ecosystems, supporting a community of distinctive plants and animals specially adapted to the harsh nature [43].

4.4. Design of Najd Traditional Houses

Traditional houses in central region include identical spaces and features and their form has mainly two floors, two sections for Male & Female, with two separate entrances. The Courtyards consistently existed, but differences were there with relation to the house size, based on the economic aspects.

In Saudi Arabia, earth-based architecture has been used for thousands of years. It is believed that Al Dir’iyah, the first capital of Saudi Arabia, was built with earth a long time ago. Dir’iyah’s first recorded settlement dates back to 1446 AD. In the period between 1745 and 1818, Al Dir’iyah developed into a large city containing amazing earthen architecture as shown in figure 13 [43].

4.5. Examples of House Types in Najd (Case studies)

There are seven case studies: three types of traditional buildings and four of Contemporary houses in Najd.

Thus, after these classifications, the house elements will be presented easily in the following table 1 [43,44].



Figure 13. Saad ibn Saud Palace in Ar Riyad, Saudi Arabia

4.5.1. Commoners Houses Examples

The maximum built-up area is 60 -70 m² and was considered the most common type of house during that era. They have small openings in general. An example of an existing case-study for the commoners' type is shown in the below figure 14, named commoners regarding the dominance of this planning system to be the most common type among residents during that era. In the commoners' type example, the depth of rectangular courtyard has a major airflow inside spaces [45].

4.5.2. Middle-class Houses

Middle houses could reach 100 m² and have small openings in general as shown in figure 15. The second example of the traditional housing in the old capital of the first state of Saudi Arabia, Al Dir’iyah represents the Middle-class category. The house usually contains more than one courtyard, entrance, stairs, and several bedrooms [46].

Table 1. Elements of houses in Najd region.

Existing Elements	House Type		
	Commoners	Middle Class	Upper Class
Number of Stairs	1	2	2-3
Number of Courtyards	1	1-3	5 & above
Lobbies	1	1-3	5 & above
Number of Entrances	1	1-3	4-5 & could be more
Animals Area	Yes	Yes	Yes
Bedrooms	1-2	2 & above	5 & above
Separated entrance	None	Yes	Yes
Bathrooms	1	2 & above	5 & above
Storage	Small	Moderate	Large
Dining	None	Yes	Yes

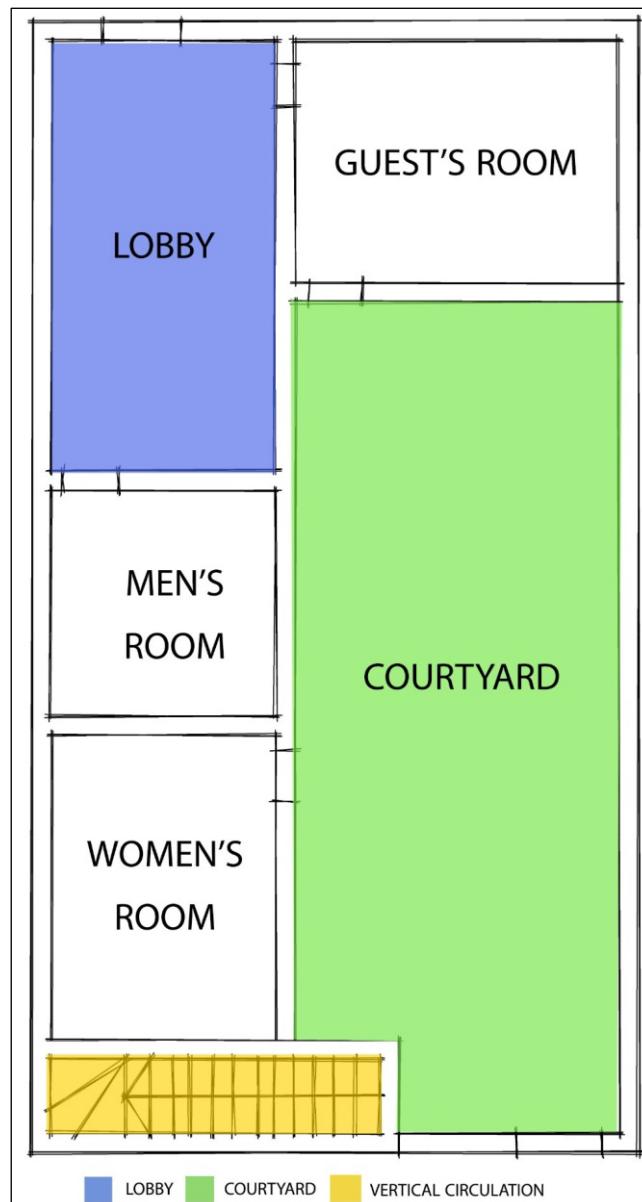
**Figure 14.** Commoners' houses example





Figure 15. Example of the middle-class type [45]

4.5.2. Upper Class Houses

As shown in figure 16, more than 600 m² usually belongs to the businessmen and their wealthy families who were known as traders during that time. The Third case study belongs to a famous businessman/trader "Tajer" during that period, named AL Bassam. The estimated built area for the house is over 3500 m².

The summary of the three selected case studies is represented in the table 2.

As shown in figure 17, the last phase of the comparison

will include different categories from the contemporary type during the current modern era, and the new design approaches, after the economic growth, the discovery of petroleum. Functions and needs of residents kept changing throughout history and the recent decades, so the comparison will show and list the differences between the old housing systems, and components with the contemporary ones.

The four selected case studies of Contemporary houses are represented in the figure 17 and summarized in table 3.

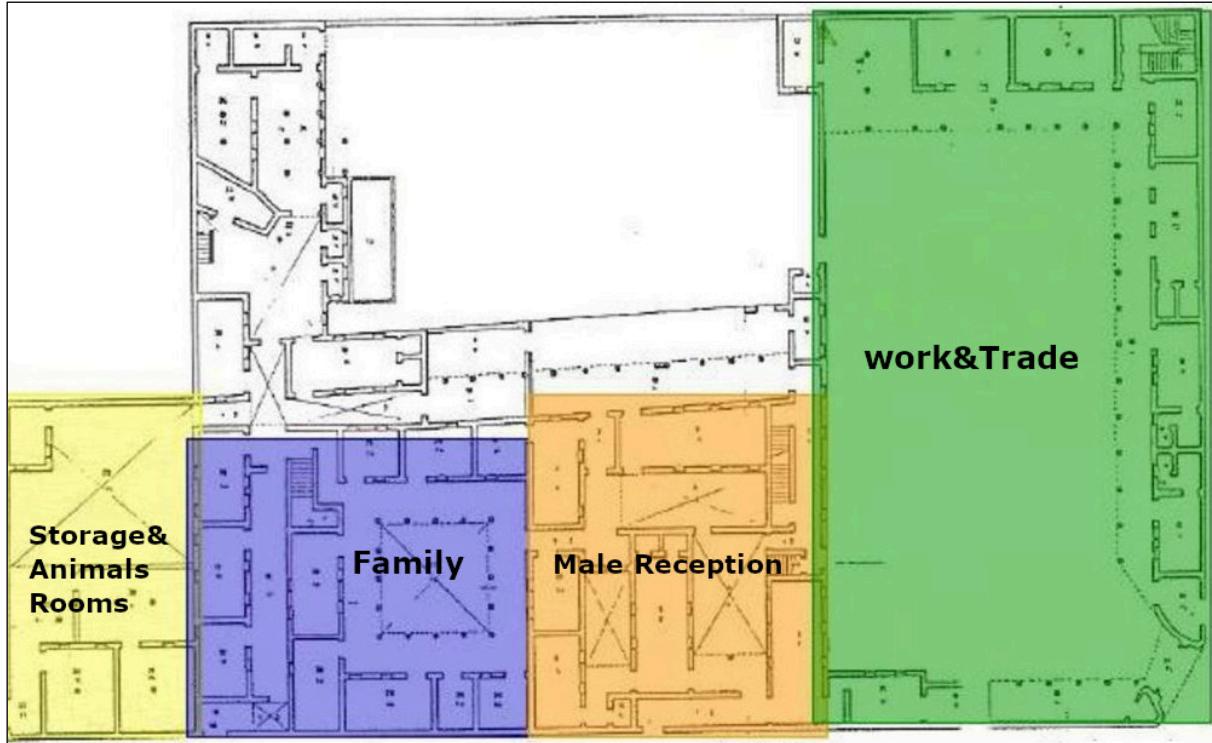


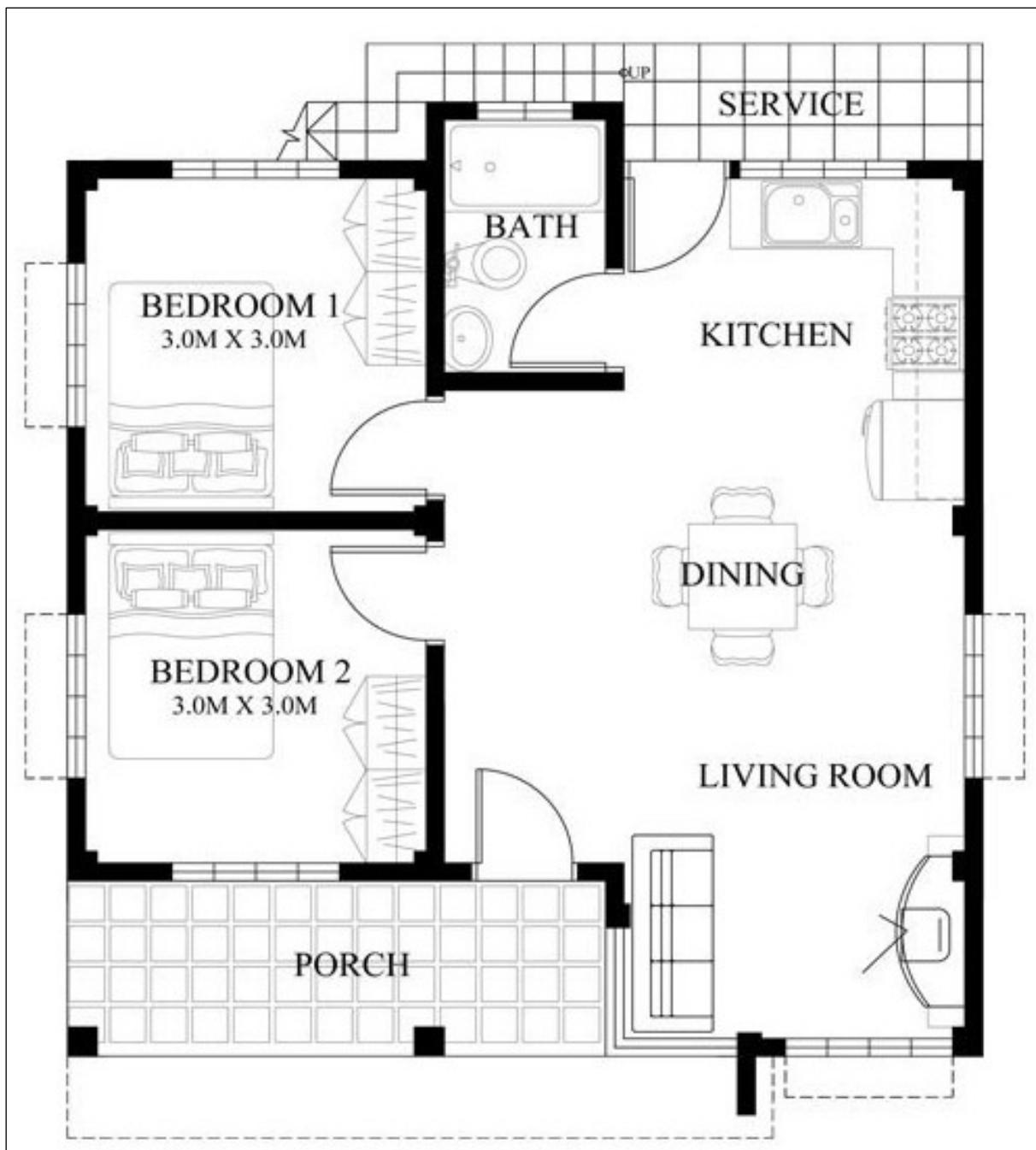
Figure 16. Upper Class House (Al Bassam Heritage House | Ministry of Culture (moc.gov.sa))

Table 2. Summary of vernacular case studies

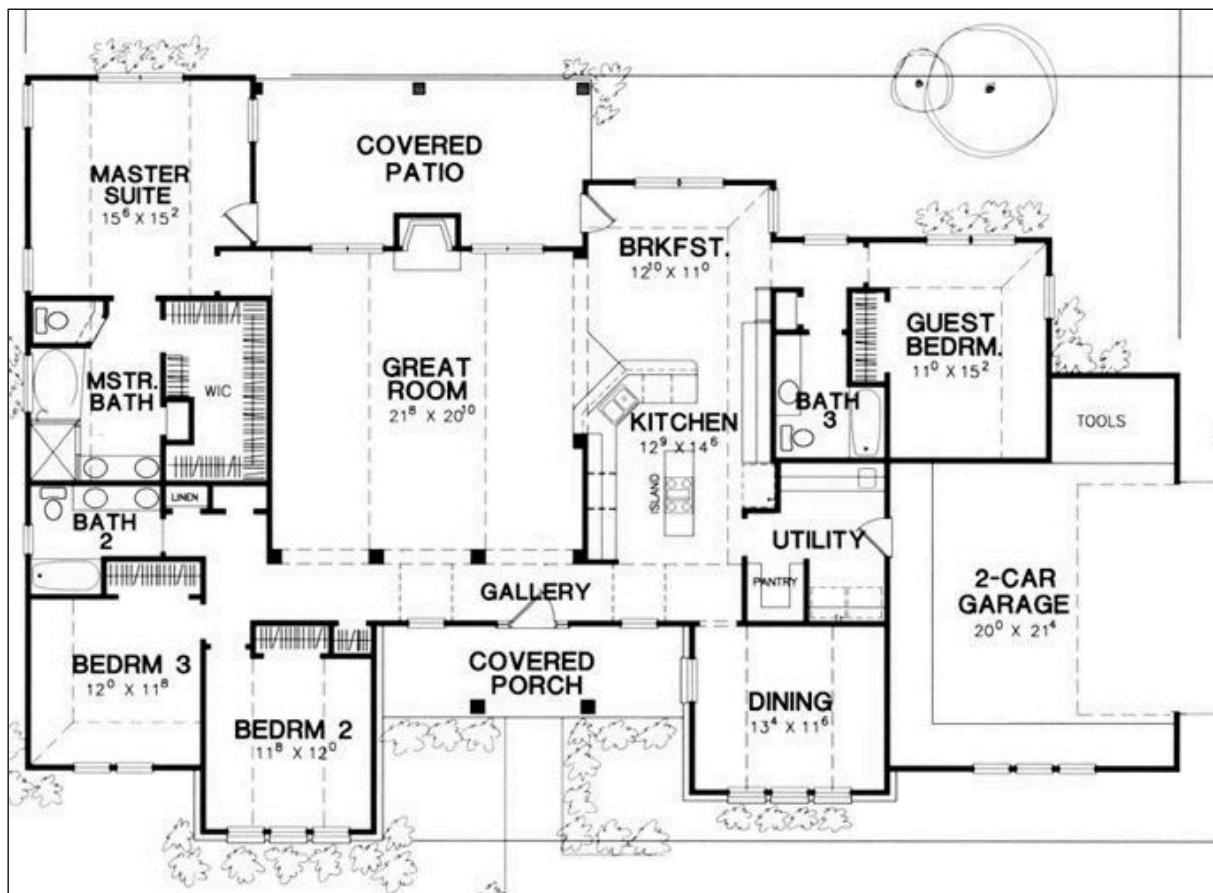
Existing Elements	House Type		
	Commoners	Middle class	Upper class
Number of Stairs	Only 1	3	5
Number of Courtyards	Only 1	2	Above 10
Lobbies	Only 1	Yes	Above 10
Animals Area	Not separated, located inside the courtyard mostly	Yes, 1	A whole separated section in the house. The estimated numbers of rooms are above 5
Bedrooms	Only 1	5	The family section has over 6 rooms
Female/Male reception	Yes, separated	Yes, separated	Yes, male guests have a separate section in the house
Bathrooms	Only 1	2	Above 5
Living room	Not separated, other existing rooms are multipurpose	Yes, 1	The family section has over 6 rooms
Dining room	Not separated, other existing rooms are multipurpose	Yes, 1	The family section has over 6 rooms
Storage	Not separated, usually inside the kitchen or courtyard	Yes, 2 and separated	A whole separated section in the house within the animals' area

Table 3. Summary of contemporary case studies

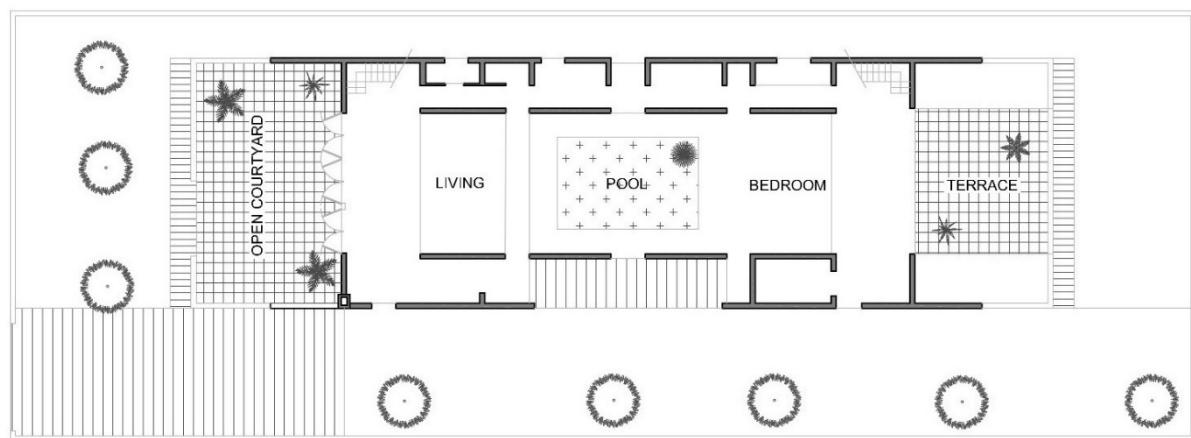
Existing Elements	House 1	House 2	House 3	House 4
	(Small apartment)	(One floor +extended floor)	(Big apartment)	(Villa)
Floors	Only 1	Only 1	Only 1	2
Stairs	1 for entry	2	1 for entry	2
Courtyard	None	None	None	None
Lobbies	Yes	Yes	Yes	Yes
Kitchen	Yes	Yes	Yes	Yes
Animals Area	None	None	None	None
Bedroom	2	4	2	4
Female/Male reception	Only 1	Only 1	Only 1	Only 1
Bathrooms	None	Only 1	Only 1	3
Toilets	Only 1	2	2	Only 1
Living room	As reception	Only 1	Combined with the Dining area	Only 1
Dining	Only 1	None	Combined with the Living one area	Only 1
Storage	None.	Only 1	Only 1	None
Terrace	Only 1	None	2	3
Exterior yard	None	Yes	Yes	Yes
Multipurpose room	Only 1	Only 1	Only 1	None



House 1



House 2



House 3

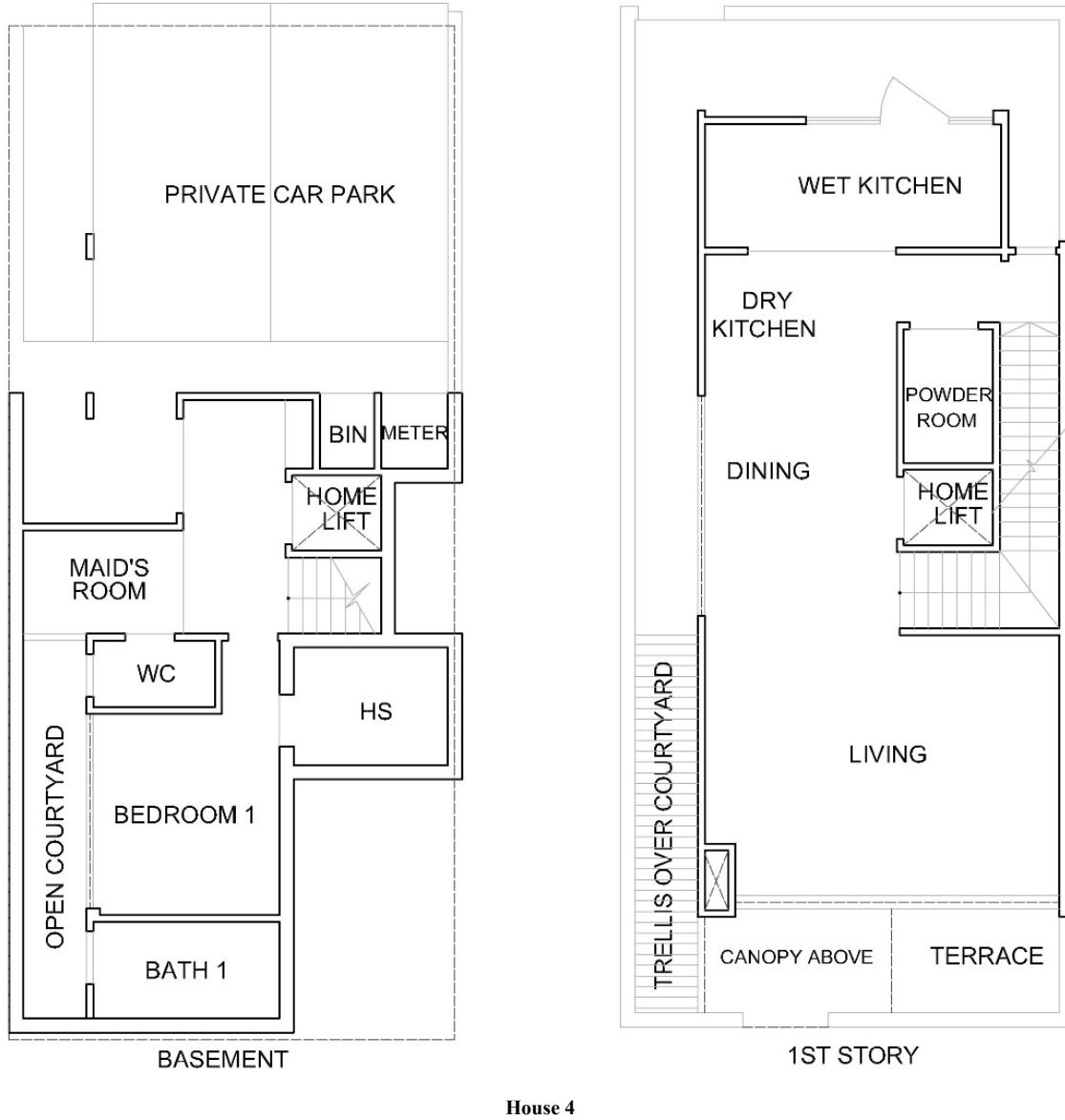


Figure 17. Example of existing contemporary houses, current era [45]

5. Discussion

After the observation of different case studies of the vernacular buildings including the three main categories, commoners, middle-class, and the upper class, the dominant sustainable application was the courtyard, and it exists in all three types as a mutual feature. One of the advantages of the courtyard during that time is the availability of this factor for all the social classifications,

poor, middle, and wealthy people.

The efficient application of courtyards as a sustainable technique served the climate of the region wisely and provided healthy ventilation, and a sufficient amount of energy to raise the level of the building performance of light and HVAC as shown in the below figure 18. It provided a strong fundamental reinforcement during the complete lack of active systems such as mechanical equipment and electrical systems.

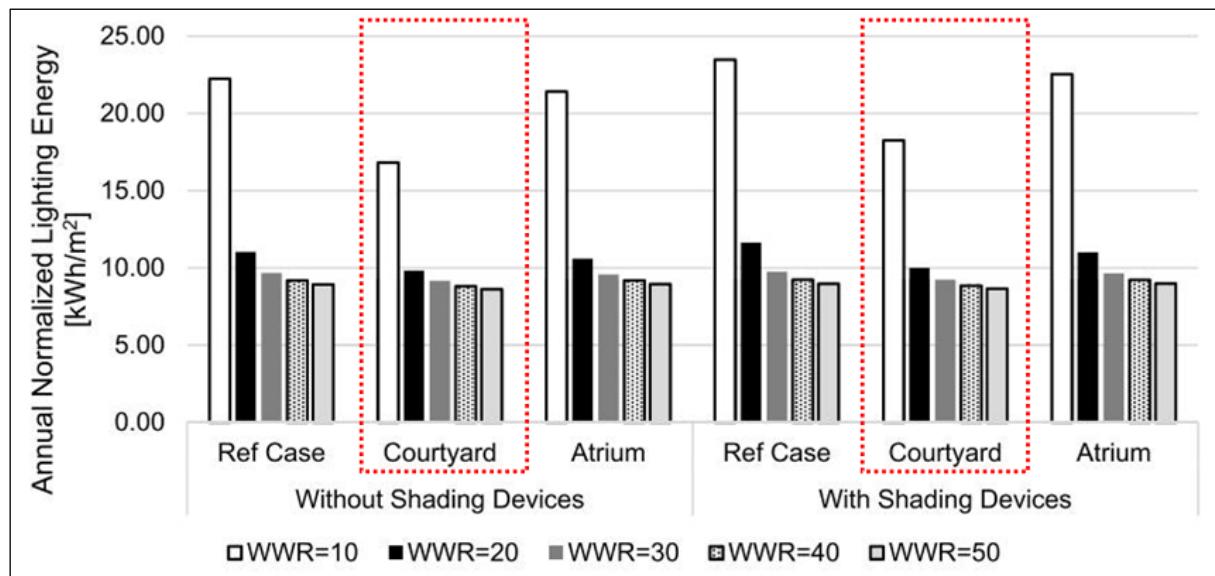


Figure 18. Energy efficiency in Annual light loads with courtyard design [47]

For the second part of the comparison where the contemporary designs of houses show up, there are four common types, small apartments, big apartments, floor villa with an extension, and two floors villa. Many changes can be noticed, but the first common feature in this part is the absence of courtyards in all four houses.

Also, there are new elements that showed up, such as terraces, exterior yards, and even dirty kitchens which could be one of the new items as well. In addition, some new modifications for the plan configuration like the multipurpose rooms, exterior storage in the yard, and exterior reception room "Diywaniya". Additionally, Animal rooms were eliminated of the new approach of residents in owning or constructing farms in different areas, could be inside or outside the city[11].

After the absence of courtyards, the new elements that showed up instead, of them might be good alternatives at first sight, and some are not. The concept of a courtyard was reconfigured to be an external space that is distributed all around the built area of a house, which is later called a yard. This new feature led people to build higher fencing systems to create a private enclosure for users and to have a ventilation flow around the house openings.

Active systems were integrated into buildings as well, and it became more dependent on the use of electrical systems and mechanical ventilation, unlike the vernacular era which used to be mainly dependent on natural-passive systems.

6. Conclusions

After the general analysis of the case studies both the vernacular and the contemporary, it would be simple to understand the consequences behind the abandonment of

courtyards in the current house designs. The amount of dependence on the electrical systems and mechanical equipment raises both the construction and the operation cost currently, while buildings of the vernacular architecture have lesser costs at both levels.

Taking into consideration the changing needs throughout the decades of users, some invented features did not serve the building performance in some aspects and weren't scoring their highest levels of efficiency along with the climate-wise of the region. The courtyard was an effective application during a time air conditioning was not integrated yet within the building's structure.

Courtyard encourages users to approach more sustainable habits, such as having indoor planting, water features and skylights [48]. Patios will still have the ability to match the needs of users, the current climate change, and the new design approaches. Through the comparison and analysis of the selected vernacular and contemporary case studies in the central region, it is found that the combination of the vernacular architecture features in the building, and the wise use of technology, mechanical equipment, and electrical systems will lead to a modern eco-responsive construction which will guide the societies to a green future and sustainable vision.

Recommendations

This research called for a return to sustainable design, which depends on architectural treatments from the design stage and adherence to important elements such as the presence of courtyard, which supports not only the conservational aspect but the economic and social aspect and searches for interconnection between family and society members as a whole.

Clusters of houses in the vernacular architecture at Najd were more associated to each other, which affected the psychological manners and cultural habits of residents. This type of configurations reinforced with the use of courtyards support socializing, openness, collaboration, and generosity. The concept of neighborhoods is that they are one spirit, what one house needs the second one will immediately offer [40].

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