



## Conference Proceeding

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# A Comparative Study of Mediterranean Courtyard Houses and the Bioclimate Impact on Their Design from Four Axes: Historical, Environmental, Social and Geometry

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**Abstract:** As a result of the many efforts made in recent decades to implement bioclimatic criteria and passive house models in Mediterranean areas, traditional architectural typologies can play a role in the contemporary environmental architectural framework. The interactive and adaptive relationship between climate, site, and building is a fundamental rule in the climate-responsive approach to reducing environmental impacts. Lately, this idea has been extended to include protecting the cultural identities of places. Many cases in the Mediterranean Basin show that conventional courtyard houses can provide high adaptability, sustainability, and functionality. Mediterranean courtyard houses are founded on a set of adaptable and sustainable standards derived from a combination of active and passive design approaches. This paper presents a comparative study of courtyard houses in five Mediterranean countries: Spain, Türkiye, Greece, Libya, and Palestine, addressing four areas of interest: history, environment, society and geometry. Considering the bioclimatic approach as a critical component in reorienting the construction process, the study's goal is to compare and evaluate the inner courtyards of these Mediterranean countries, analysing the most important constant factors and modification paths. The study concludes that the courtyard morphology is a shared human legacy with a past and future as it meets its inhabitants' physical and sociocultural requirements. Furthermore, despite the differences in some aspects, courtyard houses were constructed throughout the Mediterranean with a common meaning of heaven on earth; this could imply that the courtyard garden is the world's meaning.

**Keywords:** traditional Mediterranean architecture, courtyard houses, climate-responsive architecture, Mediterranean climate, comparative analysis, sustainable houses

## 1. Introduction

The Mediterranean Sea connects the three continents of the ancient world that surround it. Different people, religions, crafts, arts, traditions, and cultures from all over the world have passed through it, forming a common cultural identity and differences that can be seen in the multicultural and multiethnic cities on the Mediterranean coast [1].

Traditional Mediterranean architecture has developed over time to cope with issues related to housing. The climate was a catalyst for ancestors to discover ways to deal with extreme weather events through trials and mistakes [2]. Hundreds of years of experimental experience enabled the original dwellings to adapt to the local climate and terrain to

meet the inhabitants' daily needs [3].

Therefore, the need to investigate the characteristics of interior courtyards in various Mediterranean countries, particularly residential ones, has become critical because they differ according to era and place [4].

The traditional architecture of the Mediterranean countries is based on openings that face inward to maintain the privacy of inhabitants and places while also accommodating climatic conditions. This can be accomplished by utilising an indoor space that open to the sky. These areas are known as “the inner courtyards” because they have unique characteristics that correspond to the weather and social environment. At first glance, some may think these inner courtyards are identical; however, a closer examination reveals that they differ in terms of function, components, shapes, designs, materials used, environment, and social and cultural conditions [4]. These characteristics set each country apart from the rest of the Mediterranean countries. Whereas the interconnectedness of social, cultural and ecological features has formed the identity of the so-called ‘Mediterranean Basin City’.

The Mediterranean climate refers to the climate that prevails over cities located on the Mediterranean Basin’s coast as well as other parts of the world (Figure 1). It is characterised by a warm to hot, dry summer and mild, humid winter with an average annual air temperature of 16.3 °C, approximately 726 millimetres of precipitation annually, and 63.2% relative humidity. However, the existence of two geographical gradients can be used to explain the significant differences that are concealed by this overall picture: north or south, with the south being hotter and drier, and west or east, which is more impacted by the Atlantic or Asian cycle. The driest month is July, with an annual average rainfall of less than 500 millimetres [5].

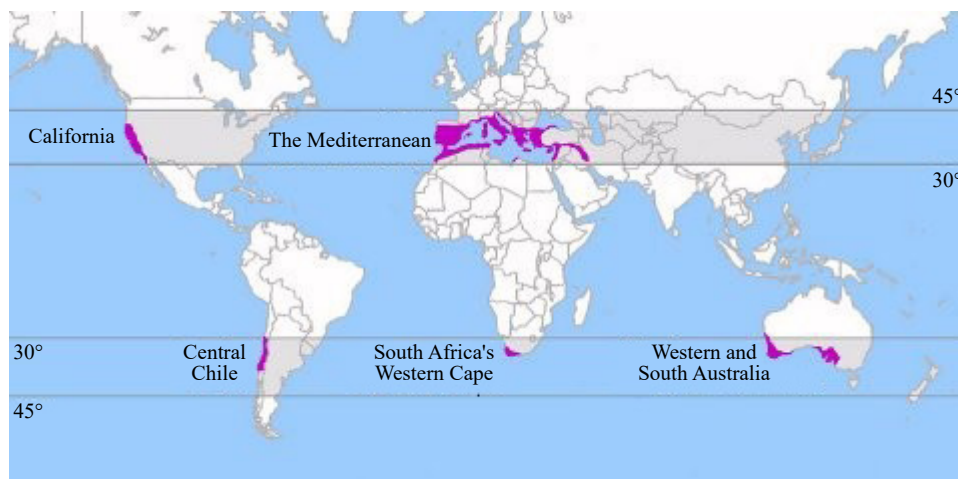


Figure 1. The Mediterranean climate zone [6]

The majority of historic cities in the Mediterranean Basin are located in a Mediterranean climate zone, such as Tunis, Algiers, Athens, Beirut, Monaco, Naples, Rome, Barcelona, Jerusalem, Marseille, Izmir, Valletta, Valencia, etc. (Figure 2).



**Figure 2.** The location of the mentioned cities in the Mediterranean [7]

Traditional Mediterranean buildings provide a link between heritage and sustainability by supporting the basic components of sustainability [8]. Its architecture is identified as effective, practical, and environmentally sustainable [9]. Without a doubt, the Mediterranean countries share some characteristics in terms of traditional architecture, such as building technologies, materials, and climate [10].

Traditional Mediterranean homes are examples of community-designed local vernacular architecture. For example, natural clay and stones provided the Mediterranean community with a wealth of natural resources. Another feature of the traditional Mediterranean house is its simple appearance, which is distinguished by its functionality and comfort because it is an element of geometrical configurations arranged in such a way that they form an order [11].

Therefore, many cities overlooking the Mediterranean reflect the extent of the influence of climate on housing design by developing their traditional architecture in line with the nature of the prevailing climate, which imposes practical solutions to mitigate its effects. One of the solutions is to include the inner courtyard in the design. It is a unique way to bring the outside in while maintaining privacy and reducing the adverse climate effect. Courtyards have long been used as a tool to control the weather as well as to create a space for household social dynamics [12].

According to the climate-friendly approach, interactive and adaptive relationships between buildings, places, and climate are the primary rules for reducing environmental impacts and enhancing the energy performance of buildings. In recent years, this idea has expanded to include maintaining places' cultural identities. High levels of adaptability, sustainability, and functionality can be obtained from conventional housing. There is a possibility that the traditional house is founded on a set of adaptability and sustainability-oriented principles that result from a combination of an active and interactive design approach [13].

As many efforts have been made in the past decades to adopt passive house models and bioclimatic standards within the Mediterranean region, traditional architectural typologies can play a significant role in the context of contemporary environmental architecture [13].

Five Mediterranean countries' courtyard houses are compared in this study: Greece, Libya, Palestine, Spain, and Türkiye, with a focus on four aspects: environment, social, historical, and architectural contexts. It is believed that reorienting the building process requires a bioclimatic approach. The study aims to compare and evaluate the internal courtyards of the Mediterranean countries, as well as their most important fixed factors and modification paths, in order to identify similarities and differences.

## 2. Courtyard house

The Oxford English Dictionary defines a courtyard as “an area of ground without a roof that has walls or buildings around it, for example, in a castle or between houses or flats” [14].

The courtyard house design is based on an enclosed, uncovered space (open to the sky) surrounded by rooms from all directions. The courtyard varies to a certain extent from country to country, but the overall design concept, including the low height and building materials, remains the same. It features an inside orientation and several heights of exterior openings to adapt to climatic conditions and respect socio-cultural traditions [15].

The inner courtyard is a conventional architectural shape that contributes to the psychological and physical environment of the home [4].

A courtyard’s concept is one of the earliest and most recognisable elements of domestic architecture and has been a part of many civilizations for thousands of years. This concept has gone through a lot of complicated changes over time and is typically associated with countries in the Mediterranean, where the design of courtyard housing is greatly influenced by culture and climate [16].

Although most researchers referred to the Islamic religion as a fundamental factor in the built form and formation of the inner courtyard, Islamic societies were the driving force behind the formation of the built environment at the time for social and cultural reasons, particularly privacy, thus the process occurred concurrently with achieving a logical link with the environmental components. Linking the appearance and spread of the courtyard with Islamic architecture indicates inaccuracy. Courtyard houses and domain separation in general are used in crowded and hierarchical cultures, according to Rapoport [17]. He also noted that this strategy has been used in other parts of the world. It was also commonly used in the Middle East before the arrival of Islam, as in the case of Mesopotamian architecture [18].

Additionally, in Islam, a home serves as more than just a place to live and sleep; it also serves as a centre for teaching, learning, practising, and disseminating Islam’s principles among family members. By studying Islamic teachings and architectural knowledge, a home can be built to significantly enhance the Islamic way of life among its occupants. Given this, the courtyard ought to be incorporated into the house design as one of the essential functional spaces. The courtyard is a vital structure that was built to deal with difficult Islamic teachings, like efficiency and privacy, as well as to mitigate difficult climatic conditions [16].

Therefore, the courtyard initially protects residents and goes on to address religious, climatic, and social issues. After that, the courtyard changes in both its purposes and forms to accommodate more complicated issues like religious privacy. As a result, the courtyard can improve Islamic teaching and practice in addition to serving as a climate mitigator and protector. This evidence of the wisdom of conventional architecture is pervasive throughout Islamic regions [2].

Myneni [19] mentioned that by keeping the elements that make the house comfortable, the internal courtyards meet the requirements of the traditional family system. Lighting, ventilation, and heat protection are examples of these. The internal courtyards also serve as a social gathering space for families to interact and socialise. Based on the spaces and walls that surround them, the internal courtyards are classified as open, semi-closed, or closed according to the walls that surround them (Figure 3) [4]. It not only provides security and privacy to its residents but also offers light to the surrounding rooms. Typically, it entails constructing a shallow pool in the centre of the courtyard and planting trees [20].

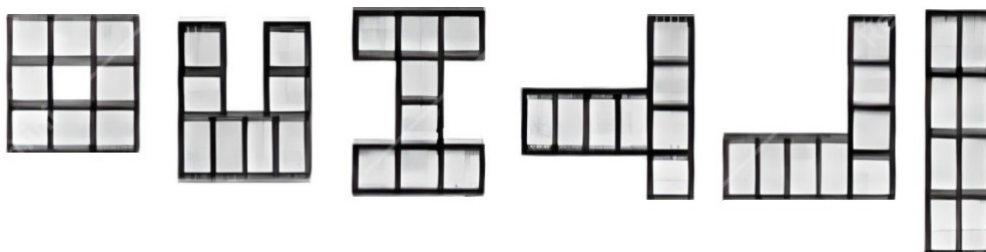


Figure 3. Internal courtyard forms [4]

Some studies have been done on how traditional courtyard houses perform in changing climates. Swan [21] stated, for instance, that the house's central courtyard is the most effective air conditioner because it stores the cold desert night air and gradually releases it to adjacent rooms during the day through an integrated cluster. The courtyards, according to Edwards et al. [22], provide a climate-controlled space away from several unwelcome forces of nature, like wind and storms. Fortea [23] says that the courtyard has two important functions. It has a significant impact not only on the family's social life but also on the climate of the living areas by providing rooms with air and light [15].

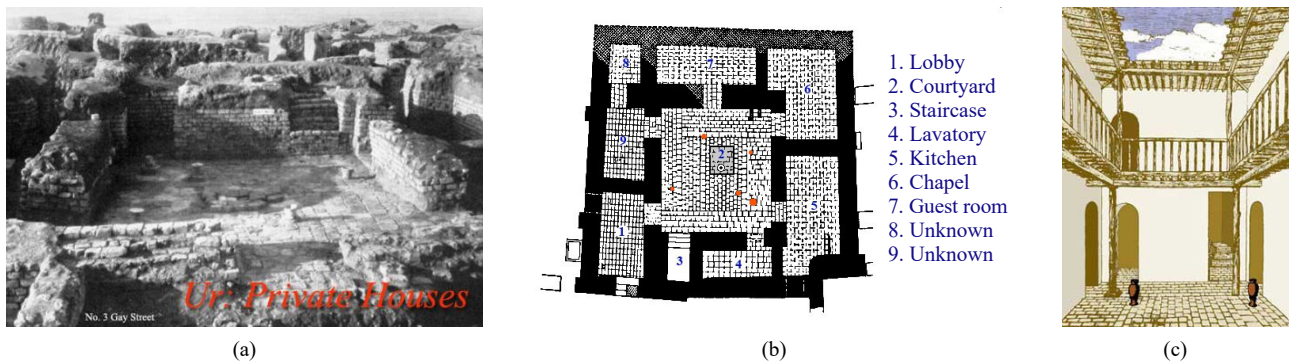
These previous studies are summarised in Table 1.

**Table 1.** The findings of some researchers about the courtyard

Researchers	Year	Findings
Swan	2011	The central courtyard is the most effective air conditioner in the house.
Edwards et al.	2005	The courtyard provides a climate-controlled space away from unwelcome natural forces.
Fortea	1989	The courtyard serves two important functions. It influences the family's social life as well as the climate of the living areas.

## 2.1 Historical overview of the courtyard housing

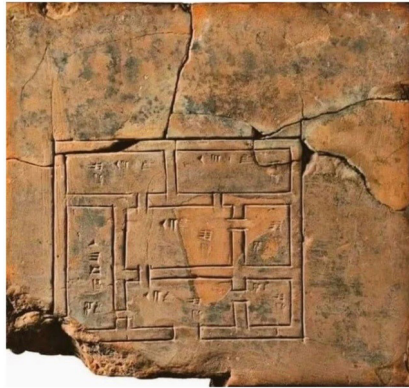
Courtyard housing is the oldest type of housing. It is thought to be 5,000 years old, dating back to the Chaldean City of Ur before 2,000 before Christ (B.C.) (Figure 4). The characteristics of courtyard houses are determined by the culture and environment of a specific region's group; for instance, courtyards can serve as the house's focal point or as an internal garden.



**Figure 4.** (a) Excavation of Ur's private house, (b) plan of No. 3 Gay Street and (c) reconstruction of the courtyard at the same street [24]

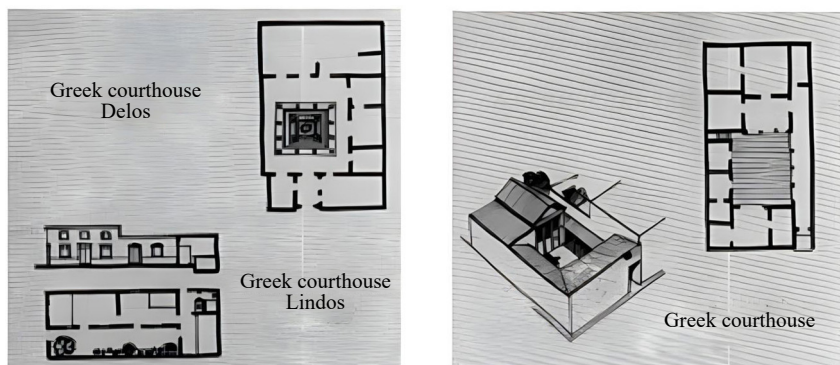
Other forms of courtyard planning and housing have been documented thousands of years ago, with Pharaonic Egypt and Sumer among the earliest cultures in the Middle East holding the oldest examples of courtyards (Figure 5) [25].





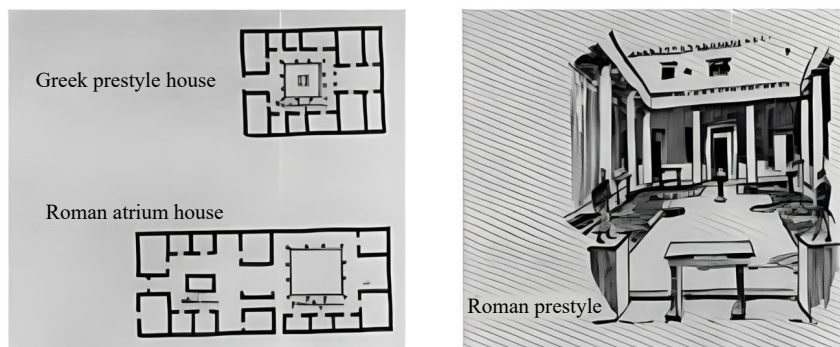
**Figure 5.** A house plan made by Sumerians 5,000 years ago (the ground plan of a residence in Umma with a central courtyard) [26]

Later, western cultures like Rome and Greece featured structures of this kind. In Italy around 700 B.C., a new type of courtyard, known as an atrium house, emerged from the old one to provide private outdoor space (Figure 6) [27].



**Figure 6.** Greek courtyard house [27]

The Greek pre-style, with its distinctive design of columns encircling a small courtyard, collided with the atrium house. Courtyards are a common architectural feature in hot and dry climates in the Middle East and can be found in other old cities, as well as attempts to create a private space for introversion (Figure 7) [27].



**Figure 7.** Roman atrium house [27]

### 3. Materials and method

Although numerous studies of courtyard houses have been conducted, little attention has been paid to the common characteristics and differences between Mediterranean countries in terms of climatic and spatial compositions.

So, it's important to show the climatic and spatial logics that make traditional homes and buildings what they are. The houses have similar common principles, despite slight stylistic differences. As a result, the purpose of this paper is to demonstrate the fundamental principles underlying the spatial composition of Mediterranean courtyard houses and to identify the distinctive characteristics that set them apart.

The primary architectural and planning features of the internal courtyards of traditional houses in Mediterranean countries were identified through observational and photographic records as well as retrospective and comparative analyses.

This paper compares and analyses the inner courtyards of traditional houses in five Mediterranean countries: Spain, Türkiye, Greece, Libya, and Palestine. These countries are spread across the three continents that overlook the Mediterranean Sea.

The selection criteria are based on similarities and differences: for similarities, these countries are located on the Mediterranean Sea, are subject to the same Mediterranean climate, and courtyard houses are considered one of their traditional architectures; for differences, they differ in cultural background, social standards, and religious beliefs; and each country has the architectural character that distinguishes it from the other countries.

The study will compare and analyse the main factors influencing the design and use of courtyards in these five countries from four perspectives:

- a. Historical: It investigates the courtyard's origins, who influenced its design, and what architectural symbolism it represents.
- b. Environmental: It studies the architectural elements that affect the microclimate in the courtyard and the surrounding rooms, such as the openings, their location and size, the walls surrounding the courtyard, the materials used, colours, and shading strategies, in addition to the use of natural elements such as water and plants.
- c. Social: This study sheds light on the social background of the country and how it affected the function of the courtyard, the location of its entrance and the Iwan (a vaulted room that opens onto a courtyard on one side. It was popular in Persian and Sassanid cultures, as well as Islamic architecture later on), and the extent to which it provided privacy for the residents.
- d. Geometry: This study deals with the dimensions of the courtyard, its shape, the ratio to the total area, and its orientation.

Data analysis provides valuable insight into the unique characteristics, programming, and zoning of critical spaces associated with courtyard spaces. And the factors that influence its growth.

The research steps are as follows:

- a. Choose a framework for the study based on a review of the literature and the history of the courtyard's evolution.
- b. Data collection and summarisation for the chosen case studies.
- c. Data analysis: a comparison of different courtyard housing types based on history, environment, social, and geometric factors, with drawings and descriptions for each.
- d. The study findings are based on the differences and similarities between the courtyard houses.

The result of the study will contribute to the exploration of traditional courtyard houses in five Mediterranean cultures concerning their social and climatic backgrounds. Also, the result is useful to track the common features and differences and emphasise the climate as the main driver for such a style of traditional architecture.

### 4. Case study analysis

The table below summarises the main factors influencing the design and use of the courtyard in the five countries: Spain, Türkiye, Greece, Libya and Palestine (Figure 8) from four perspectives: historical, environmental, social, and geometric (Table 2)

**Table 2.** The historical, environmental, social and geometrical aspects of traditional courtyard houses in five countries around the Mediterranean

Case study	1	2	3	4	5	
County	Spain	Türkiye	Greece	Libya	Palestine	
Climate	Interior Mediterranean climate [29]	Coastal Mediterranean climate [30]	Interior Mediterranean climate [31]	Mediterranean climate influenced by subtropical dry arid (desert) climate [32]	Mediterranean influenced by subtropical dry semiarid steppe climate [33]	
Plan layout	[34]	[25]	[34]	[15]	[35]	
Historical	Influenced by Roman, then Arab Muslims from North Africa	Saljuk, then the Byzantine, Iranian, and Islamic Mamluk	Greek mythology and Greek culture	Arab traditional houses, then Islamic architecture	Arab traditional houses, then Islamic architecture	
Environmental	Architectural symbolism (inspired by) Earth-Sky the universe and the heaven	The Universe and Earth: Paradise “Garden of Eden”	Blessed Isles, Paradise of the Earth	“Garden of Eden”, the Universe, and Paradise	“Garden of Eden”, the Universe, and Paradise	
Opening-location and size	Introverted, inward-looking: limited and small openings in the external wall	Introverted, inward-looking: limited external opening in the ground floor	Introverted, inward-looking: limited openings towards the street at high levels	Introverted, inward-looking: small, high-level slit-openings in the external wall	Introverted, inward-looking: limited and small openings in the external wall	
Walls surrounding courtyards	Arched colonnades from three or four sides	Arched rewalks (spaces that connect indoor and outdoor areas, have a column-supported roof, and are open on at least one side) run along two or three sides	An arched portico runs along three or four sides	High walls and arcades run along one or more sides	High walls and arcades run along one or more sides	
Materials	Stone masonry and plaster	Yellow or white limestone and basalt	Mud brick and stone and then plastered	Stone and sun-dried brick	Mud or adobe, stone	
Colours	Light colour	White, black and yellow	Light-dyed colour	White or light colour	Light colour	
Fountain and well	Fountain	Fountain or wells	Fountain	Fountain or wells	Fountain	
Vegetation	Planted garden and potted plants hanging on the wall	Landscaping, grapevines and pomegranate trees	Vibrant garden herbs and flowers, potted plants	Palm trees and other local plants	Palm and citrus trees	
Shading strategy	Unknown	Pergola: grapes, leaves and trees	Unknown	Fabric awnings or trees	Trees, awnings, and wooden shutters	
Social	Entrance	The entrance points to the courtyard centre	Entered from one corner through a corridor	The entrance points to the courtyard centre	Entered from one corner through a corridor	Indirect entrance through a corridor to ensure privacy
Activities	Daily life, cooking and dining, nature contact, children, play with pets, social gatherings, folkloric events, etc.	Rituals and ceremonies, seasonal festivities, social activities, family gatherings, tree planting, etc.	Vibrant garden, daily life activities like cooking, dining, gardening, family gatherings, etc.	Household activities and family gatherings, social events weddings and funerals, play space for children	Household activities, family gatherings, social events, weddings and funerals, play space for children	
Iwan	Iwan	Seasonal Iwans	Iwan	Two gender Iwans	Two gender Iwans	
Privacy in the surrounding function	No privacy, blurring the lines between private and public realms	Family privacy: two courtyards, one for the public and one for the family	Family privacy: the courtyards are mainly used by women	Women’s privacy: protect them from the view of male visitors	Women’s privacy: influenced by religion and gender factors	
Geometrical	Dimensions of the courtyard	Spacious according to the social rank	Varies, one or two courtyards and social rank	Small, one or two courtyards and social rank	Varies in proportion to the height of the building	Varies according to the social rank
Shape	Regular shape, square or rectangle	Square, rectangle or skewed	Regular shape, square or rectangle	Square, rectangle or circle	Square, rectangle, circle or polygon	
Percentage of the total area	20 to 35%	20 to 30%	20 to 25%	20 to 30%	20 to 25%	
Orientation	Parallel to the street	Parallel to the street	Parallel to the street	Facing north, south, or west	Facing north, south, or west	





Figure 8. The location of selected case studies around the Mediterranean [28]

## 5. Discussion

### 5.1 Historical

It was possible to detect commonalities in the general strategies utilised in courtyard houses in the studied Mediterranean countries, despite the vast distance between them. This is primarily due to the prevailing climate but also to the combination of Arab and Roman cultural influences.

As shown in Table 2, the strategies used for the internal courtyard in the countries studied and their objectives are very similar. These strategies focus more on passive cooling due to the hot and dry summers. Although each society has its own identity due to different needs and requirements, as well as many human and natural factors and their interactions, this is in addition to the customs, traditions and cultural background that are reflected in the design of the buildings. Therefore, it is noted that the architectural symbolism of the inner courtyard varies; although the main motive for its existence is the nature of the climate, it acquired, along with other factors, its symbolism from social or spiritual beliefs.

As a result of invasions, conquests, and the mixing of cultures and traditions, numerous civilizations and architectural styles had an impact on the design of the courtyard.

The Spanish courtyard has developed since the Roman era, and when the Arab Muslims in North Africa conquered Spain, they brought many Arab cultural patterns with them, including the courtyard house, whose architectural symbol is “Heaven and Earth”. Meanwhile, the Turkish courtyard houses are developed in Saljuk and influenced by the Byzantine, Iranian, and Islamic Mamluks. Therefore, the architectural symbolism is influenced by the “Garden of Eden” [34].

The Greek concept of courtyard houses is drawn from ancient Greek mythology and the Greek culture that spread across the Eastern Mediterranean and beyond, whose architectural symbolism of the courtyard represents the Paradise of the Earth and the Isles of the Blessed depicted in their mythology [34].

Arabic Islamic culture had a significant impact on both Libya and Palestine, and the “Garden of Eden” or Heaven served as inspiration for their courtyards. The Arabs applied architectural metaphors to their cosmology, such as considering the courtyard covered with sky and stars during the night rather than being celestially open. Therefore, the sky appeared in the form of a dome supported by four columns representing the four sides of their courtyard house, lending the courtyard houses a symbolic value that was regarded as an illustration of the universe [36].

Culture, society, the environment, and human needs are important factors that influence home design and human attitudes. All of them are used to create a more comfortable and private life inside the homes while keeping the climate in mind as the primary goal.

## 5.2 Environmental

The design of the courtyard in the studied countries varies depending on the details of the shape and size of the surrounding walls, the location and size of the openings, materials, colours, shading devices, fountains and plants. All these aspects are used as additional options to improve the environment. According to Meir [37], despite the varying influences of social, economic, cultural, and environmental conditions, the design of courtyards often appears to be the same.

In all the countries included in the study, all the surrounding rooms overlook the open courtyard and depend on it for almost all lighting and ventilation, as the majority of windows are introverted, looking inward, and are distributed throughout the inner courtyard, which protects it from direct climatic influences. In the Turkish courtyard, there are two levels of windows, upper and lower, that open towards the courtyard.

Although the location of the windows affects the courtyard's environmental behaviour, it is largely subject to social norms, which have led to the avoidance of external openings and reliance on inward-looking windows for visual privacy, which has affected the natural ventilation process in the courtyard and, as a result, the overall thermal performance of the house [34].

To address this, alternative solutions were used, such as creating a limited number of small openings in the external walls. On the ground floor, these openings overlook the alleys at a high level, as is the case in Türkiye and Greece, while in Libya, these openings have the shape of a narrow, high-level slit. On the first floor, these openings are generally large, oriented towards the prevailing winds, avoiding the view of the neighbours' houses (in Palestine, these openings are oriented to the west and north), covered with wooden gratings, or 'Mashrabiya', and were used to improve cross ventilation and air movement, especially at night.

This is because, during the night, when the fresh air descends into the courtyard and then, using windows, to the surroundings, openings are needed in the walls facing the street to let the warm air escape and provide natural ventilation [20].

The surrounding walls vary according to the local architectural styles. Arched colonnades surround the Spanish courtyard from three to four sides, whereas in Türkiye, there are arched *rewaks* on two to three sides in front of the structure masses. In Greece, the peristyle courtyard is enclosed by a portico on three of four sides, while in Arab Islamic countries, *loggias* (arcades) were built along one or more sides of the courtyard and surrounded by high walls to provide additional shade to the surrounding rooms, as in both Libya and Palestine [15].

Traditional house designs were based on local natural resources for building materials. All are available locally and are used to build high-temperature-resistant walls. Another way to beat the heat is to paint the exterior walls and roof white, which reflects the sun's rays. Therefore, materials vary according to local availability. It is noted that all countries in the study used stone and light colours, mostly white, as building materials for the walls with some differences in other materials, such as in Spain and Greece where they used light-coloured plaster, while in Türkiye, they used black basalt in addition to yellow and white limestone. As for Greece, Libya and Palestine, in addition to the stones, they used sun-dried bricks or mud bricks for the walls and painted them in light colours.

Natural elements are used in the courtyard to improve thermal comfort and can reproduce environmental benefits, such as trees, shrubs, and flowering plants, by providing a shaded area. Therefore, fountains, water sprays, and awnings were used to keep the inner courtyard and its surroundings cool, particularly during the summertime [2].

Previous research has shown the considerable impacts of the elements of a courtyard on the environment that surrounds it by lowering air temperature through landscape shading and decreasing solar radiation, which will offer users thermal comfort. Moreover, designers can manipulate these elements during the design stage to provide a more positive impact on the courtyard.

Therefore, in all the countries studied, there is a fountain or a pool in the courtyard in addition to the plants, but they differ in the shape and symbolism of the fountain and the types of local plants.

In Islamic architecture, water and plants play important roles. As mentioned earlier, the courtyard is surmounted by the sky itself, and the regular pool in the courtyard's centre serves as a representation of it. This is because water is both the reservoir of all potential life and the universal sum of its essence, making it the most vital element in nature.

The four corners of the pool in the centre of an Islamic courtyard are typically chamfered to form an octagon, which represents the sky's dome. The octagon angels that support God's throne are represented by the eight sides [2].

So, when the Muslims arrived in Spain, the courtyards gained importance and began to incorporate these new

features (gardens and fountains) to recreate the Islamic concept of heaven. In Türkiye, there are flower beds all around the fountain, and occasionally a well is in the corner. While in Greece, the fountain and garden were drawn from Greek mythology.

All the studied countries gave importance to the plants in their courtyards, and therefore, all of them have a planted courtyard, but they differ in the types of trees and plants.

In Spain, contact with nature was especially important, which is why they turned their courtyard into a cultivated garden where potted plants hung on the wall. In Türkiye, the courtyard has become a small landscape planted with grapevines and pomegranates, while in Greece, the courtyard is a vibrant garden with herbs, colourful flowers and potted plants around the pool. In Libya, the courtyard is planted with palm trees and other local plants, while in Palestine the courtyard is planted with fruit trees, especially citrus and palm trees, which are planted next to doors and windows outside and inside houses [34].

As for the shading method, there is no shading device known to both Spain and Greece. However, it is noted that they mostly depend on trees, while in other countries such as Libya and Palestine, fabric awnings are used as shading tools, and in Türkiye, pergolas and equipment for growing grape leaves have been installed.

### 5.3 Social

Climate and privacy are two important factors that influence the design of the courtyard, and they have been considered to show the physical results of these factors that reflect social and cultural ties and attempt to create a private world for family life [38].

The entrance of a typical Spanish and Greek courtyard house points to the centre of the courtyard. According to Reynolds [39], the gates in some courtyards are placed in a manner that leads directly to the arcades that surround them instead of the middle. While the Turkish, Libyan, and Palestine courtyards are usually accessed from a corner through a gallery to provide family privacy, the upper floor incorporates a similar gallery that surrounds the courtyard to give access to the first-floor rooms [40].

Courtyards are commonly used as expansions of living, eating, and cooking spaces, where daily repetitive affairs take advantage of the change in place [39]. They also provide space for family gatherings, especially in the evening. Some special activities are also held according to the country's social and cultural background.

In Spain, the courtyard provides a good place for children to play with pets, birds, and fish, contact nature, gather with family and neighbours, attend folklore events, etc. So that these spaces play a role like public spaces, as they encourage social interactions between citizens [41]. These courtyard gardens provide a space for social interaction and cultural expression, accommodating a unique lifestyle in this urban environment where the lines between private and public realms are blurred.

In Türkiye, the courtyard is used for special activities such as rituals, ceremonies, seasonal festivities, social activities, family gatherings, tree planting, etc., while in Greece, the courtyard is considered a vibrant garden that has been added to the house and used for daily life such as cooking, dining, family gatherings, gardening, etc.

In Libya and Palestine, the courtyard is considered the house's heart and the most active area. Besides being used for household activities and family gatherings, it is also an activity space for social events such as weddings and funerals. It provides a safe play area for infants and children where their mothers can easily monitor them [40].

In Türkiye, the courtyard is used for special activities such as rituals, ceremonies, seasonal festivities, activities, family gatherings, tree planting, etc.

All courtyard houses have an Iwan; it is the most used place during the hot season, especially in the early morning and late evening hours, where users spend most of their time. In Islamic countries, as in Libya and Palestine, there are two Iwans, one for men and one for women, while in Türkiye, there are more than two Iwans used according to the seasons [18].

In Spanish courtyard houses, privacy is fading and the lines between private and public realms blur, while in Türkiye and Greece, the interior design of houses is primarily intended to protect the family's privacy. Hence, sometimes in Türkiye, there are houses with two courtyards, one for the public and one for the family. Meanwhile, the courtyard in Islamic countries is influenced by religion and gender factors. The house's layout aims to provide women with privacy, or, in other words, to protect female family members from male visitors' views [15].

Religion and social interactions have two distinct influences on domestic architecture. Islamic religious tutoring

promotes humility and privacy, and courtyard houses meet these requirements by providing an inside-looking home along with the climatic features of the courtyard.

## 5.4 Geometric

The location and shape of the courtyard are determined by the style of the house's architecture and the historical epoch in which it was built.

In general, in all the countries included in the study, the dimensions of the courtyards differ according to social rank, while they are affected by the height of the building as it was designed to give sufficient shade on summer days, as is the case in Libya, or by the number of courtyards, as in the case of Greece and Türkiye, where some houses had more than one courtyard [15].

In general, courtyards do not have a specific shape, but the most common courtyard shapes across the countries studied are rectangular or square. In Spain and Greece, these regular shapes are widely used, while circular, trapezoidal or polygonal shapes are found in other countries such as Türkiye, Libya and Palestine, depending on the plot area and shape, topography, and building orientation [18].

The area of the courtyard varies according to social rank and the size of the house. But not less than 20% of the total area of the house. In both Greece and Palestine, it ranges between 20 and 25%, while this percentage increases to 30% in Türkiye and Libya. Spain is distinguished by its spacious courtyard, which may occupy an area of up to 35% of the total area of the house.

The courtyard houses are generally oriented according to the street direction (minimum one of the house walls may be almost bordering the street) or the sun path and the prevailing wind direction. In Arab Islamic countries (Libya and Palestine), the favourite direction of the courtyard is usually north, south, or west [15]. Therefore, the microclimate inside the courtyards is also controlled for various functions at various hours of the day and throughout the year.

## 6. Conclusion

In this paper, five distinct types of traditional Mediterranean courtyard houses are discussed in light of their historical, environmental, social and geometric aspects and the factors affecting them.

Even though these styles seem similar at first glance and the prevailing climate is the primary source of inspiration, their characteristics, concepts and applications differ according to the cultural, social and religious context. The paper concludes that the annihilation of the courtyard houses is a shared human legacy built around the globe, and it has a past and a future. In the courtyards, where culture and nature intertwine, their concept was derived from the cosmic pivot, as each culture allocated to the courtyard its architectural symbolism, but it can be concluded that the shared meaning is heaven on earth, through which the courtyard garden is the meaning of the world.

The study indicates that the courtyard was a focal space for daily life, family gatherings, social and cultural activities such as weddings, funerals, rituals, ceremonies, and seasonal celebrations, and a place where children could play and communicate with nature while maintaining family privacy. The study further shows that Islamic cultures seem to have stronger gender segregation and social hierarchies than those of Western (Greek and Spanish) cultures.

Environmentally, all windows look inward and are largely subject to climatic and social norms, while natural, local and sustainable materials have been used. Meanwhile, the most important elements are water and plants, through which the concept of earthly paradise is realised.

The study also finds that across the five countries, there is no specific shape to the courtyard and it is dependent on the plot area and shape, topography, and building orientation, while the dimensions are subject to social rank. Therefore, cultural convictions and the local climate are the two principal triggers for orienting courtyard buildings.

As a result, the concept of these styles was drawn from the cosmic pivot, and each country has its architectural language that is guided by its architectural symbols, determines its preferred orientation, and is aware of its local social structure and religious beliefs and practices that were reflected in the designs of the courtyards, their location, and area, in addition to the types of social and cultural activities that took place in these courtyards, which give the traditional architecture its unique regional, national, or local identity.

## Conflict of interest

The authors declare that there is no conflict of interest.

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