

DOI: 10.38027/2020ICCAUA316235

Courtyard Housing around the World: A Cross-Cultural Analysis and Contemporary Relevance

Dr Donia Zhang

Chinese Culture Publishing, Neoland School of Chinese Culture, Ontario, Canada

Email : doniazhang@neolandschool.com

<https://orcid.org/0000-0001-9559-366X>

Abstract

The courtyard house is one of the oldest dwelling types, spanning at least 5,000 years and occurring in distinctive forms in many parts of the world across climates and cultures. This article takes a panoramic view and makes a cross-cultural analysis of the courtyard houses in six cultures: Chinese, Indian, Islamic, Greco-Roman, Spanish, and Hispanic-American, by addressing four areas of concern: cosmic axis and architectural symbolism, favorable orientation of buildings, socio-spatial organization, and cultural activities in the courtyard houses. It then looks at contemporary new courtyard housing around the world, which is often provided with common courtyards and shared facilities to meet human desire for social connectedness and the quest for sustainable architecture and urbanism. The paper concludes that the courtyard form is a common heritage of humanity that has a past as well as a future, because it satisfies human physical and psychological needs of a habitat. Moreover, the courtyard form has been built all over the world, and the shared meaning of the courtyard house is an earthly paradise, from which one may construe that the meaning of the world is a courtyard garden. The paper finally proposes a new courtyard-garden housing system that may have universal application.

Keywords: Courtyard House; Courtyard Housing; Cultural Landscape; Heritage; Social Connectedness; Sustainability.

1. Introduction: Why Courtyard House?

Set within the universe, humans need a shelter for peaceful existence, a space where one can observe the interchanges of the sun and moon, day and night, wind and rain, and the seasons. This space is the courtyard. A courtyard is a special place that opens to the sky and often to the earth, surrounded by rooms, trees, plants, and flowers; it provides residents with daily contact with nature, and is usually the liveliest place in a house.

Traditionally, a courtyard house denotes a private open space enclosed by buildings on three or four sides, or a part of the house is confined by walls. The courtyard is typically in square or rectangular shape. The buildings all face the courtyard and are normally 1-3-storey, occupied by an extended family. In contemporary world, family structure has changed to nuclear families. Hence, courtyard housing may refer to a semi-private open space enclosed on three or four sides by low-rise buildings, which can be walk-up apartments, attached, semi-detached, or detached houses in which the courtyard has become a common outdoor space shared by multifamily within the compound.

The courtyard house is one of the oldest types of human habitat, spanning at least 5,000 years, and occurring in distinctive forms in many parts of the world across climates and cultures. The author's literature research shows that nearly 40 countries in the world have identified with having traditional courtyard houses. These are found in the rural as well as urban areas of Asia (China, Japan, Korea, India, Pakistan, Sri Lanka, Russia, etc.), Middle East/Mediterranean countries (Iran, Iraq, Afghanistan, Kuwait, Turkey, Syria, Lebanon, Cyprus, etc.), Africa (Egypt, Saudi Arabia, United Arab Emirates, Oman, Libya, Algeria, Nigeria, Morocco, Tunisia, Kenya, etc.), Europe (Greece, Italy, Spain, France, Germany, Austria, Denmark, UK, etc.), Oceania (Australia, etc.), and South and North America (Chile, Cuba, Peru, Mexico, USA, Canada, etc.).

The courtyard house is environmentally friendly and energy efficient. Its form permits light, air, and views, as well as defense, security, family privacy, and control of noise and dust. In the online course "Interpreting Vernacular Architecture in Asia" (2019) offered by the University of Hong Kong with edX, Professor David P.Y. Lung made the following observation:

The courtyard can be said to intensify climatic aspects such as daylight by creating a designated area within the compound for daylight to penetrate. The courtyard is also able to dilute other aspects, such as the wind, by encircling an area to be less exposed to fast-moving, turbulent wind patterns. Enlarging or reducing the size of a central courtyard can have different effects on the conditions of the adjacent rooms.

Previous research findings suggest that if a courtyard is provided with a pool, fountain, trees, plants, and flowers, it can raise the relative air humidity and act as a temperature moderator, reducing heat in summer and warming up air in winter (Gamage *et al.*, 2017; Guedouh and Zemouri, 2017; Martinelli and Matzarakis, 2017). Moreover, square-shaped courtyards have

better thermal performance as a passive cooling strategy than rectangular-shaped courtyards (Soflaeia *et al.*, 2017a, 2017b; Taleb and Abumoeilak, 2020). Furthermore, a courtyard can regulate indoor light with high levels of exterior illuminances relatively reduced in summer and increased in winter through reflection on the vertical surfaces (Guedouh and Zemmouri, 2017).

The courtyard house also promotes cultural vitality. Its design and plantations were often based on the concept of heaven (or paradise) in world histories and philosophies (Land, 2006). In his book, *House Form and Culture*, Amos Rapoport (1969) eloquently argued that “house form is not simply the result of physical forces or any single casual factor; it is the consequence of a whole range of socio-cultural factors seen in their broadest terms” (p. 47). Factors such as climate, site, materials, construction and technology, may exert influences on house forms, however, physical setting only provides possibilities, not imperatives, and it is *human* that decides. In many societies, their organizations, moral systems, worldviews, ways of life, religion (symbols, rituals, cosmological aspects), and so on, have all contributed in determining house forms. Even when the two aspects correspond, as with *Feng Shui* (wind and water) theory of China, which is sometimes related to thermal comfort, but comfort will have to be compromised if it is contrary to the cosmological traits (Rapoport, 1969).

The aims of the study are threefold. First, to explore traditional courtyard houses in six cultures: Chinese, Indian, Islamic, Greco-Roman, Spanish, and Hispanic-American, with regards to their cosmic axis and architectural symbolism, favorable orientation of buildings, socio-spatial organization, and cultural activities. Secondly, to trace contemporary new courtyard housing around the world. Finally, to suggest a new courtyard-garden housing system that may be applied globally.

2. Traditional Courtyard Houses in Six Cultures

People of different cultures believed that the universe was born from a central core, from which there is a break in the plane. Communication among the three cosmic zones (underworld, earth, and heaven) is made possible through the “cosmic pillar,” which has been referred to as *axis mundi*. The image of the cosmic pillar is the Milky Way that was thought to support the heaven, and open to the world of gods. Such a cosmic pillar can only be located at the center of the universe as the world rotates around it, and the cosmic axis is the “Centre of the World” (Eliade, 1959, pp. 34–38). The cosmic pillar concept has impacted traditional courtyard house designs worldwide, whose universal characteristics are the progression along three imbedded axes: front to back, left to right, and top to base (Jones, 1996).

The vast and infinite universe has no orientation. But for the sacred, nothing can start without an orientation, and any orientation involves obtaining a center point. So, the sacred have always sought to discover the center as it is crucial for them to locate their dwellings at the center of the world (Eliade, 1959). Orientation of buildings in a courtyard house is of great importance, not only because of exposure to the sun, but also the layouts create links with the cosmos (Blaser, 1985). The east is generally considered auspicious because of the rising sun, and the west is often associated with decline, albeit this is not a universal pattern (Jones, 1996).

The walls surrounding the courtyard house marked the boundaries of a “patriarchal domain” (Bray, 1997, p. 93), demarcating the inside “sacred” and the outside “profane” (Eliade, 1959). Social hierarchy and gender segregation were commonly observed in traditional courtyard houses of China, India, and the Islamic world.¹ The rooms for senior family members were either at the back, on the top floor (if any), or on the right of the complex (Jones, 1996). The rooms for the guests and servants were further separated from that of the household members.

All over the world, the courtyard has functioned as a place for cultural activities and festivities when weather permitted. In a courtyard, one not only can perform household duties, but also observe the passage of time and be in tune with the rhythm of nature. The sunlight projected onto the walls and windows in the courtyard is a shift in the patterns of light and dark: east to west by day, and south to north by year (Knowles, 1996).

¹ It has also been noted that in the colleges of Oxford and Cambridge in England, the medieval pattern involving hierarchical position along the dining table was preserved; and it was practiced in peasant houses in Switzerland and elsewhere (Rapoport, 1969). Thus, it may be said that social hierarchies expressed in architecture existed in many societies around the world.

2.1 Chinese courtyard houses

2.1.1 Cosmic axis and architectural symbolism of Chinese courtyard houses

Archaeological excavations unearthed the earliest courtyard house in China during the Middle Neolithic period, represented by the Yangshao culture (5000–3000 BCE) (Liu, 2002). The Liangzhu Museum outside Hangzhou displays a drawing of a group of houses clustered around a central courtyard in Neolithic China (3400–2250 BCE) (Figure 1). Throughout history, Chinese builders have favored a number of conventional architectural plans and structural principles, among which are axuality, bilateral symmetry, hierarchy, and enclosure, as emphasized in *Feng Shui* cosmology (Knapp, 2005; Ma, 1999; Zhang, 2013/2016).



Figure 1. A group of houses clustered around a central courtyard in Neolithic China (3400–2250 BCE). Liangzhu Museum, outside Hangzhou, Zhejiang Province, China. Source: Photo by the author, 2018

Courtyards and lightwells were important features in the layout of a fully built Chinese house. Philosophically, the courtyards acted as links between heaven and earth, because during the Han dynasty (c.206 BCE–220 CE), Chinese people regarded heaven and earth as a macrocosm, and the human body as a microcosm to reflect the universe. They took three steps towards matching the cosmic order with the social order in a house. First, find a center of earth that was connected to the center of heaven by a cosmic axis. Second, locate east and west and correctly position the worship platforms for the Sun and Moon gods, and find the north-south axis from the position of the North Star. Third, orient the house according to the four cardinal directions (Chang, 1986).

2.1.2 Favorable orientation of buildings around Chinese courtyards

China situates in the northern hemisphere of the globe, in the east of the Eurasian continent, where most of its parts are in the north of the Tropic of Cancer (northern latitude 23°26'). Sunlight comes from the south all year round. Therefore, *Feng Shui* theory advocates that houses should “sit north and face south,” not only for receiving more sunlight, but also for avoiding chilly winds (Kou, 2005; Luò, 2006; Ma, 1999). The correct building orientation was essential for Chinese people also because they worshipped the Sun and Moon gods. Offering sacrifices to heaven and earth in the courtyards was considered crucial to bringing good fortune (Flath, 2005), since the central courtyard provided an opening to the sky, allowing the drift of smoke to heavenly gods, and a pit in the ground for worshipping earthly gods. This cosmological thinking dominated the arrangement of most Chinese houses until the end of the traditional period (–1911) (Chang, 1986).

2.1.3 Socio-spatial organization in Chinese courtyard houses

A traditional Chinese courtyard house would normally host an extended family of three or four generations. Social hierarchy is clearly expressed in the spatial arrangement of some extensive courtyard houses. After entering a typical Beijing *siheyuan* (Figure 2), one would immediately encounter the inverted “South Hall” that is “sitting south and facing north,” which was normally used by male servants and gatekeepers.

The Central Hall(s) serving as the living quarters for the oldest generation and guests is placed along the north-south central axis facing south, and is the highest and most exquisitely decorated. When there was no guest, the Central Hall(s) was used as a study, or place(s) for ancestral worship, conducting daily activities, holding life-cycle rituals, having seasonal festivities, and so on. The Central Hall(s) symbolize family unity, continuity, and the power of family clan (Knapp, 2005; Zhang, 2013/2016, 2015a).

The East and West Wing Halls are linked to the cardinal directions and social hierarchy; they were the quarters for the lower family members such as concubines and children, and were less decorated. Spaces for wives and unmarried female family members were placed deeper in the Northern Hall(s), far from the rooms for non-family visitors and the front rooms for male servants (Knapp, 2005; Zhang, 2013/2016, 2015a).

Thus, the best buildings in a Beijing *siheyuan* are the Central Hall(s) facing south, each with two Ear Rooms flanking on either side. The second best is the West Wing Hall facing east, and the least ideal are the South Hall facing north and the East Wing Hall facing west. Apart from cultural implications, the room rankings also relate to thermal comfort in the climate of northern China (Bai, 2007; Liang, 1998; Ma, 1999).

2.1.4 Cultural activities in Chinese courtyard houses

Family life was peacefully played out in a finely tuned Chinese courtyard house. Traditionally, the courtyard was a space for domestic activities. Cooking was normally conducted in courtyards in summer for reducing heat indoors. Tables and stools were placed in courtyards for study or recreation. Children would play in courtyards without adults having safety concerns. Pets, plants, and flowers were also nurtured in courtyards (Wang, 1999; Junmin Zhang, personal communication, 2010). A proverb vividly depicts the pleasurable lifestyle in a Beijing *siheyuan*: “canopy, fish bowl, and pomegranates; master, fat dog, and chubby maid” (Bai, 2007; my translation).

In southern China, such as Suzhou, where the climate is generally warm, scholars and artists would regularly meet in courtyard-gardens of private homes where they could actively socialize, quietly contemplate, philosophize, study, compose and read poetry, paint, play chess and games, drink tea or wine, pick herbs for medicine, make elixirs in pursuit of immortality, and the like. Many of these fashionable pastimes were practiced well into the Song (960–1279), Ming (1368–1644), and Qing (1644–1911) dynasties (Wang, 2005). Chinese courtyard-gardens thus functioned as spiritual and material refuges and facilitated a cultured way of life.

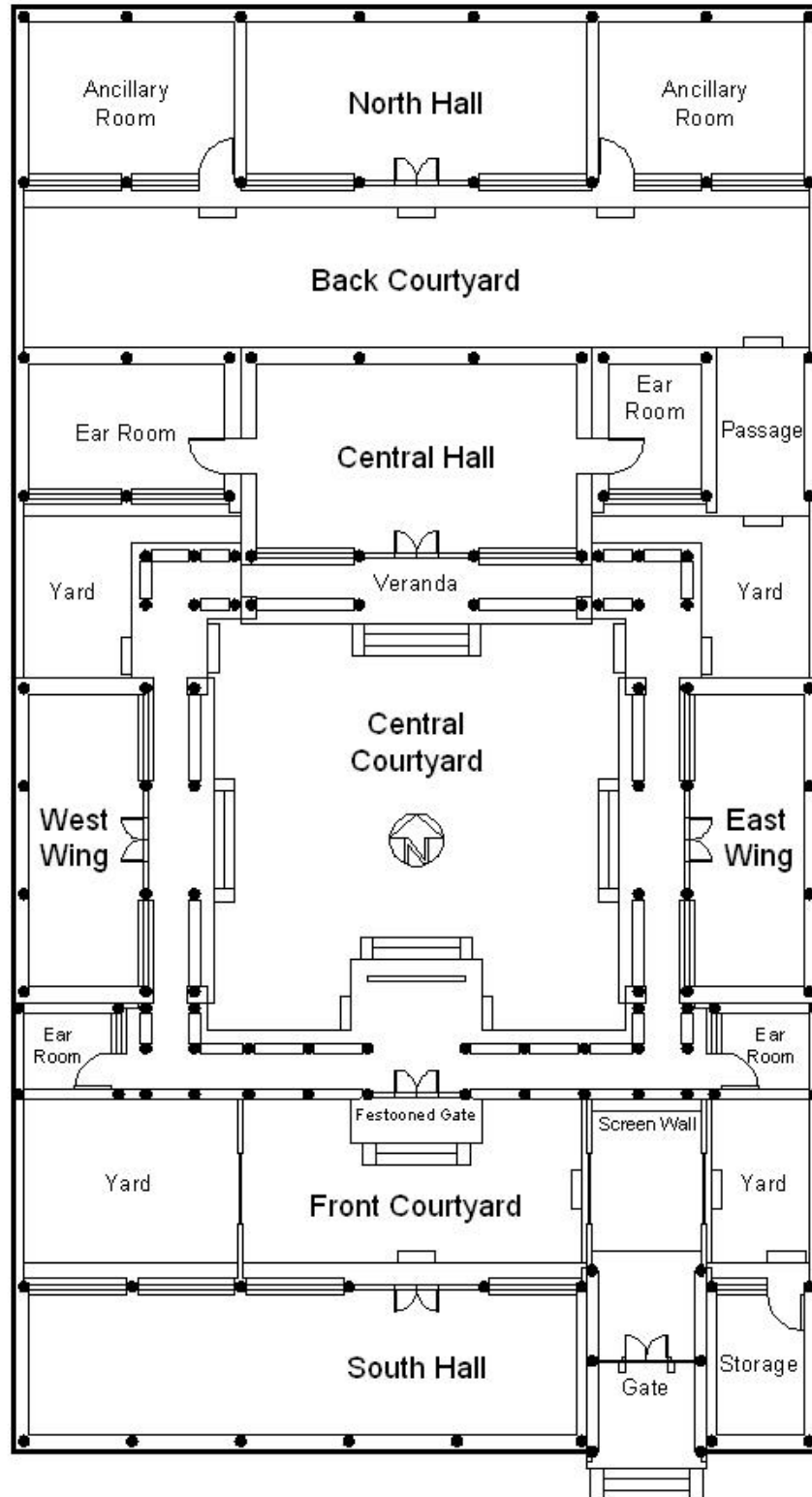


Figure 2. Plan of a typical Beijing *siheyuan* for a single-extended family.
Source: Drawing by the author after Ma, 1999, p. 17

2.2 Indian courtyard houses

2.2.1 Cosmic axis and architectural symbolism of Indian courtyard houses

Courtyard house is an indigenous architectural type in India as well, whose design was guided by a square mandala as a representation of the cosmos. The diagram is divided into a square grid with a network of lines running from north-south and east-west, each quarter designating the place of a god, with the central square left empty, symbolizing concentrated energy and the metaphor of the cave in the heart, in which soul/atman resides (Sinha, 1994). The human body, dwelling, and settlement must be correctly oriented within this cosmic square for health and wellbeing.

There are several regional variations in the design and construction of Indian courtyard houses, which led to different names: *haveli*,² *wada*, *nalukettu*,³ *rajbari*, and *deori*. The courtyard varies from being a narrow opening near the gate or rear part, to a large peristyle in the center of the house. There are also differences between the Hindu and Muslim courtyard house designs. The *haveli* (Figure 3) along the Ganges River were more for contemplation and religious purposes (Randhawa, 1999). The house windows often open into the scoop shaft for ventilation, although at different heights for retaining privacy. The *nalukettu* in Kerala is a southern Indian type that has smaller courtyards than a typical *haveli*. The courtyards are just enough to admit a moderate amount of sunlight, but often have a rainwater cistern in the center (Noble, 2003; Randhawa, 1999), comparable to Suzhou lightwells (Zhang, 2019, 2020).

2.2.2 Favorable orientation of buildings around Indian courtyards

The sun and seasonal wind directions, as well as cultural traditions determined Indian house orientation. The favorable orientations for most Indian houses are east, north, or west. South is considered an inauspicious direction because it faces the heat of the sun, and where lives the god of death Yama (Noble, 2003). Most Indian courtyard houses face east towards the Ganges River as it is the sunrise direction. North is also considered a favorable orientation because of the Himalayan Mountains that is the home of the gods (Mukerji, 1962).

In India, the hot summer winds come from the west, the cool winds come mainly from the north and the east, and the sunlight in the morning is stronger than that in the afternoon. Therefore, a house is best oriented towards the east or the north, which also helps with cooling (Mukerji, 1962). For Hindu tribal caste such as the Mahras, a house gate is preferably in the east due to its association with the rising sun, and the sun god Veneration of Surya is on the eastern horizon. East is also a vulnerable point through which benevolent forces can enter, thus dirty water and garbage are disposed from the western door (Beck, 1976; Noble, 2003; Sinha, 1994).

However, house orientation is not always consistent throughout India, it varies according to different religious groups, castes, or tribes, even within the same area. For example, a south-facing house is favored in Tamilnadu because it benefits from the southern breezes in summer and blocks the cold northern winds in winter. A southern orientation is also preferred on the Himalayan slopes, where the houses take advantage of stronger insulation, especially in winter (Noble, 2003; Randhawa, 1999; Sinha, 1994).

For the Indian Muslims, orientation is not as rigid as among the Hindus, the back of their houses is preferably facing the west – the direction of Mecca, for their daily prayers. Moreover, their master bedrooms must face east so that they can see the first rays of the morning sun. The courtyards are generally narrow enough to offer a shaded area in summer and wide enough to receive the winter sun with circulation space along the veranda (Noble, 2003; Randhawa, 1999; Sinha, 1994).

2.2.3 Socio-spatial organization in Indian courtyard houses

The northern urban Indian courtyard house basically has three parts. The front is a roofed veranda, which is a few steps up from the street. Then there is a room used by males for gathering, entertaining friends, and sleeping in the monsoon season. The last section of the house often has an open veranda, a dining room, storage, and sleeping rooms. Social rank and gender segregation were observed in Indian courtyard houses. Both the front and back of a house have an upper floor designated for the females in the household, with the windows either facing the courtyard, or the upper level of the street. The balconies on the upper floor allow the inhabitants to look down into the courtyard without being seen, aided by screens and reed curtains. The balconies can also be used for watching the street activities while giving the house an elegant appearance. Latrines are provided outside the house in communal facilities (Noble, 2003; Randhawa, 1999).

² The word *haveli* is derived from the old Arabic word *haola*, meaning “partition.” In modern Arabic, the word *havaleh* means “encircling,” confirming the connection (Randhawa, 1999).

³ A *nalukettu* denotes one courtyard with four corners, whereas *ettukettu* signify two courtyards with eight corners (Randhawa, 1999).

Throughout western and northern India, the term *haveli* is widely used to refer to 2-5-storey residential compounds built around a number of courtyards. The *haveli* normally has a narrow, elongated, rectangular plan. Some grand houses have 5-6 courtyards. The main gate has big wooden doors with a smaller window for use when the gate is locked to ensure privacy and security. The gate is often offset in façade and opens into a foyer where a secondary gate leads into the courtyard and the house. If there is a second gate to the street, it is usually very small and is located in the back wall, used primarily by the females of the household (Noble, 2003; Randhawa, 1999).

2.2.4 Cultural activities in Indian courtyard houses

The courtyard is the most important part of an Indian house, where many household activities would take place and spread out to the street. The courtyard also has chief symbolic functions. Since it is an open-to-sky space, wedding ceremonies were often performed in the courtyard, to be witnessed by heavenly bodies as required by Hindu customs. Special rituals and ceremonies were occasionally held at the threshold. In addition, other religious rites associated with births, deaths, and festivals were also carried out in the courtyard (Noble, 2003; Randhawa, 1999; Sinha, 1994).

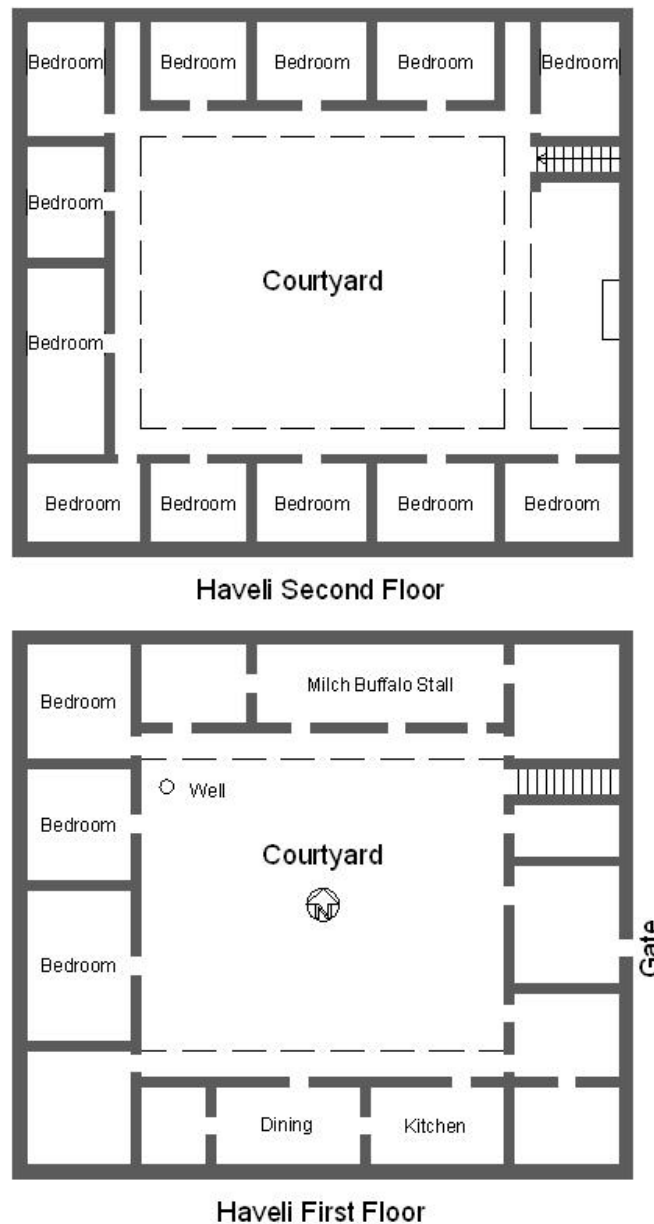


Figure 3. Plans of an Indian *haveli*. Source: Drawing by the author after Mukerji, 1962, p. 164

2.3 Islamic courtyard houses

2.3.1 Cosmic axis and architectural symbolism of Islamic courtyard houses

An Islamic courtyard evokes the “Garden of Eden” or the Paradise. In cosmological terms, the courtyard is not open to the sky, but roofed by the sky, and stars at night. The Arabs have applied architectural metaphors in their cosmology so that the sky was regarded as a dome supported by four pillars, giving a symbolic value to their courtyard house, which was considered as a representation of the universe. The four sides of the courtyard house represent the four pillars that carry the dome of the sky. The sky itself roofs the courtyard, and is reflected in the habitual fountain in the center of the courtyard because water is the most vital life-giving element in nature, symbolizing the universal sum of essence, and the reservoir of all the potential existence (Eliade, 1959; Fathy, 1969/1973).

The basin for the fountain in the middle of an Islamic courtyard usually has four corners chamfered to form an octagon, which is a symbol of a dome of the sky. The eight sides represent the eight angels who support the throne of God. For the Arabs, the sky was once the home of the holy and the most peaceful aspect of nature, and was thus ideal for bringing into their houses. Their ways of doing this is through the courtyard, a hollow square, with all the rooms looking into it, from which one can only see the sky. This enclosed private domain allows the inhabitants to have an intimate contact with the sky so that the house is continually refilled with energy from the universe, which is unattainable by any other architectural feature (Eliade, 1959; Fathy, 1969/1973). Rooms are grouped on three levels, producing alleyways that are shadowed by the projections of windows and roofs that reduce heat in summer and protect against rain in winter (Al-Azzawi, 1969).

2.3.2 Favorable orientation of buildings around Islamic courtyards

The orientation of Iranian courtyard houses (Figure 4) is largely determined by the prevailing wind and the sun path directions, although climatic conditions, landscape, and street and neighborhood patterns also govern the shape, proportion, and orientation of houses in different parts of Iran (Reynolds, 2002). An Iranian courtyard house gate is usually towards the west, the direction of Mecca. In Iran, it was prohibited to have squat toilets towards the west (Mecca), and the lavatory has to be located far from the living spaces, especially the kitchen (A. Foruzanmehr, personal communication, 2010). The Iraqi peasants normally built their living rooms to face south, backing it with a north-facing loggia (Figure 5) (Fathy, 1969/1973).

The orientation of Egyptian courtyard houses was determined partly by the sun path and partly by wind directions. Their living rooms usually face north, to benefit from cool northerly breeze, and to ensure there is no reflected radiation. There is no specific orientation requirement for an Arab courtyard house gate, although ideally it faces west – the direction of Mecca (Memarian and Brown, 2006).

The orientation for Middle Eastern courtyard houses is more the result of prevailing wind direction or street alignment than the sun path (Al-Azzawi, 1969), because the midday sun is mainly overhead. The problem is often solved by having fabric awnings or lattice screens. The morning and afternoon sunlight are generally filtered by providing timber shutters and fruit trees (Edwards *et al.*, 2006).

2.3.3 Socio-spatial organization in Islamic courtyard houses

The Arab courtyard house was a private world created especially for women, to be away from the harsh reality of commerce, warfare, and so on. Comparable to the Chinese word 安宁 (*an'ning*, meaning “peace and tranquility”) denoting a harmonious family with a female (女) and a male (丁) under the roof (宀), the Arabic name *sakan* to signify the house is related to the word *sakina*, meaning “peaceful and holy;” whereas the word *harim*, meaning “woman,” is linked to *haram*, “sacred,” which suggests the Arab courtyard house as a holy place (Fathy, 1969/1973).

The gate to an Iranian courtyard house is different from that to the courtyard as a privacy measure, and it had to look modest, not showing the financial/social superiority of the owner (A. Foruzanmehr, personal communication, 2010). House gates on opposite side of the street may not face each other for privacy concern (Rapoport, 1969; Reynolds, 2002).

Inside the gate, there is often a small entrance hall/vestibule/lobby acting as a buffer zone to separate the public from the private domain, and to change the direction and block the view to the house. A reception room is reserved for male guests. The entrance hall is connected to the courtyard with a corridor that opens up to the courtyard near one of the corners (Al-Azzawi, 1969).

There is a clear privacy requirement in the house as women and men from the same family need to be separated from each other after reaching the adult age, which leads to the divided men and women quarters. In some Islamic cultures, private courtyards provided the only outdoor space for women to relax without being seen by passersby in the street or neighbors, as one cannot have a window overlooking the neighbor’s courtyard, which is often their living space (Abdelkader and Park, 2018; Abdulkareem, 2016).

Generally, the courtyard houses in Iran and Iraq have no functionally designated rooms for cooking or sleeping. Inhabitants move horizontally and vertically in a day and throughout a year to gain natural cooling in summer and warmth in winter. The flat rooftops were often used for sleeping in hot weather (Al-Azzawi, 1996; Foruzanmehr, 2016; Khajehzadeh *et al.*, 2016; Soflaeia *et al.*, 2017a, 2017b).

The windows and roofs are designed to prevent anyone from intruding into the house. Windows on exterior walls are small and few to reduce heat gain in summer and are cast in steel bars to provide security against thieves. The vertical sliding perforated timber screens allow natural daylight and ventilation while ensuring privacy, reducing direct solar radiation, and providing an evenly shaded interior environment (Al-Azzawi, 1969; Rapoport, 1969).

2.3.4 Cultural activities in Islamic courtyard houses

The cultural significance of an Islamic courtyard is important. The courtyard is used primarily as an extension of the living quarters and as a multipurpose room where most family activities would take place, which strengthens the family and community life (Advameg Inc., 2007; ArchNet, n.d.; Boussaa, 1987; Edwards *et al.*, 2006; Fathy, 1969/1973; Petruccioli, 2006). In ancient Mesopotamia (now Iraq) and some neighboring countries, seasonal celebrations were important traditions which took place in the courtyards. The courtyards accommodated ceremonies and rituals that can still be observed in many Iranian, Iraqi, and Syrian towns (Ujam, 2006). The joy of celebrating under the sky, but within a house compound suggests a sense of eternal existence and continuity. Over centuries of natural and cultural transformations, the tree planted in the courtyard by the Sumerians has acquired cultural meaning, often referred to as “sacred tree” or “tree of life” (Giedion, 1981).

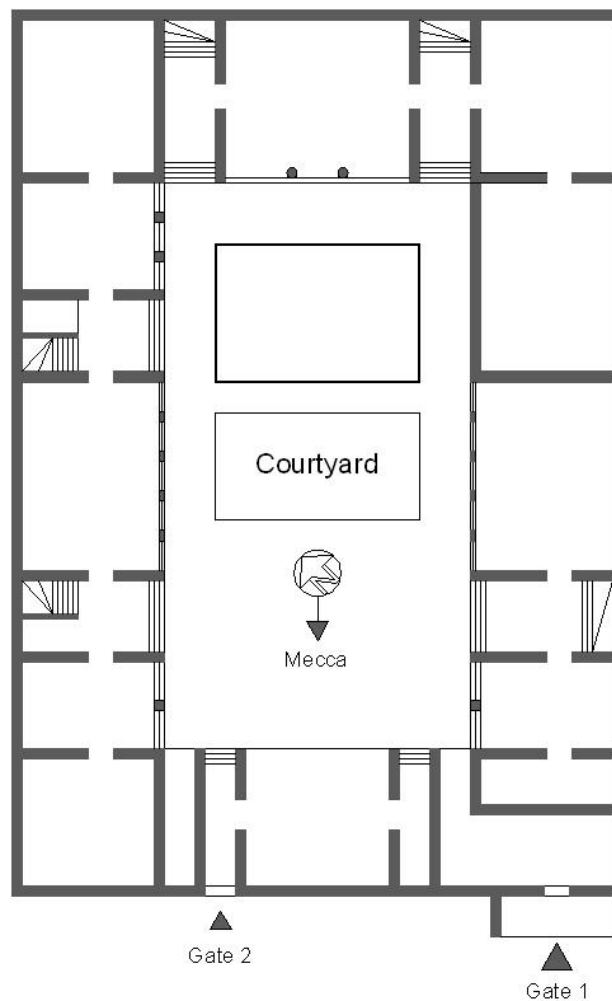


Figure 4. Plan of Iranian Shiraz Model House.

Source: Drawing by the author after Memarian and Brown, 2006, p. 27

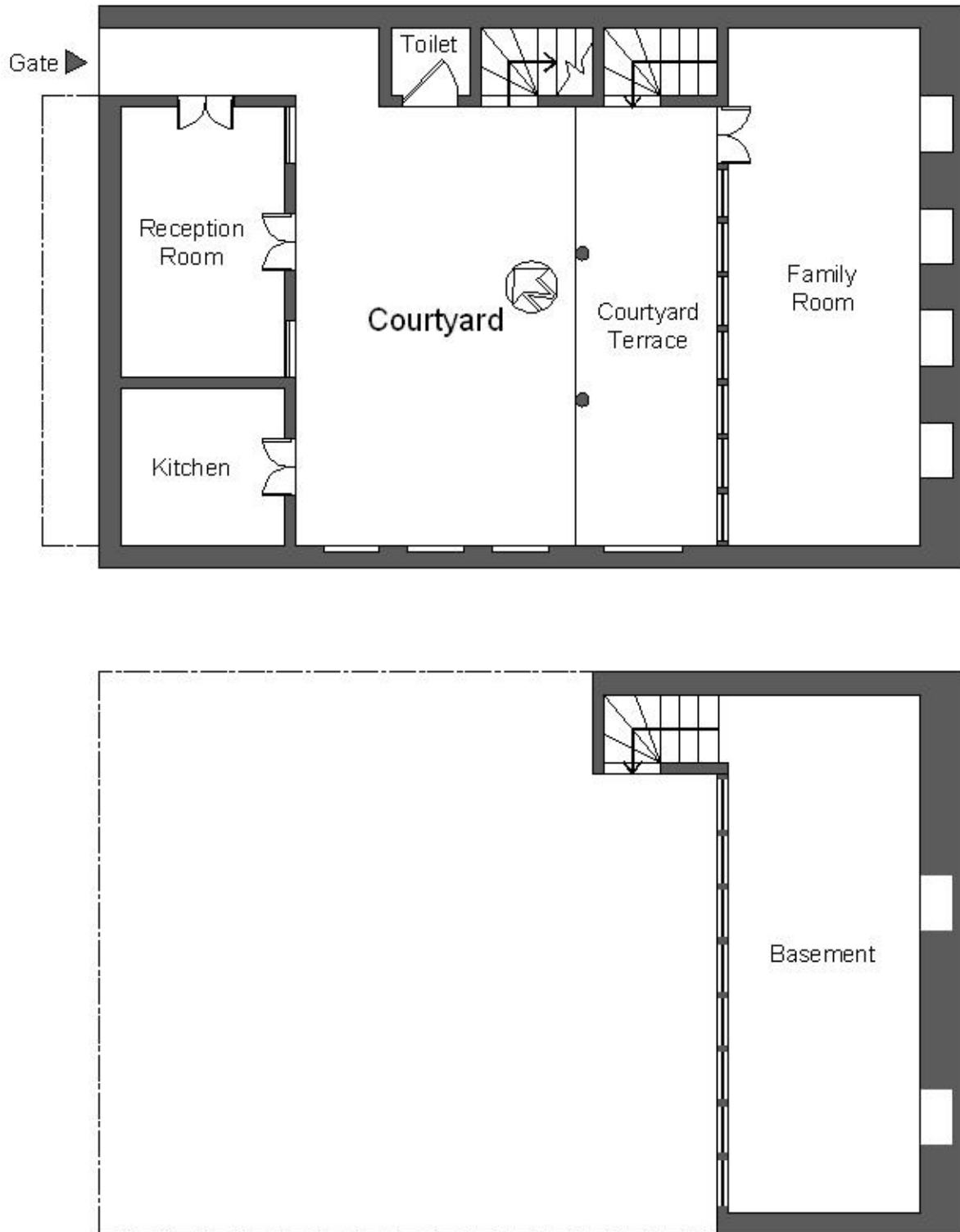


Figure 5. Plans of an Iraqi courtyard house.
Source: Drawing by the author after Al-Azzawi, 1969, p. 92

2.4 Greco-Roman courtyard houses

2.4.1 Cosmic axis and architectural symbolism of Greco-Roman courtyard houses

With the conquests of Alexander the Great (356–323 BCE), Greek culture in all its forms spread across the eastern Mediterranean and beyond, bringing with it the Greek idea of courtyard house (Figure 6). In Greek mythology, the symbolism of the courtyard is the “Isles of the Blessed” (Blaser, 1985, p. 9), or an Earthly Paradise.

The Roman courtyard houses are typically found in the ruined city of Pompeii, dating back to the late 4th or early 3rd century BCE. Its surviving structures represent a notable transition from Greek to Roman architectural style. The central uncovered area in a Roman house is called “atrium” (Figure 7). Nowadays, we often use the term to refer to a space covered by a glass roof.

The hundreds of recovered Pompeian houses show that courtyard was a significant factor in its urban layout, and was an integral part of a house. There was at least one courtyard in almost every house, while some houses had three or four courtyards. These houses were usually of two kinds: having a central courtyard in the colonnaded peristyle, or having a small central atrium. Large courtyard houses may also have a garden. The House of Polybius is one of the oldest and most interesting, which had a peristyle courtyard enclosed by a portico on the north, east, and south orientations. Under the portico on the east was a large atrium with an underground cistern, which stored rainwater drained from the roof, and which supplied water for the household to use (Becker, 2020; Imperium Romanum, 2004-2019; MacDougall and Jashemski, 1981; Masson, 1966).

2.4.2 Favorable orientation of buildings around Greco-Roman courtyards

Roman courtyard house plans did not seem to pay attention to the orientations, as they were built parallel to the street (Becker, 2020).

2.4.3 Socio-spatial organization in Greco-Roman courtyard houses

The author has not found any literature on the socio-spatial organization in Greco-Roman courtyard houses, but it is worth investigation.

2.4.4 Cultural activities in Greco-Roman courtyard houses

The peristyle courtyard and atrium were the center of every Pompeian house related to many aspects of Roman life. The courtyard houses built by the Samnites during the 2nd century BCE reflected the influence of the Hellenistic peristyle. Nonetheless, instead of the paved courtyard found in Hellenistic houses, it became a vibrant garden added to the house. A love for beauty and nature, and herbs and flowers, had been an integral part of the Roman character (Becker, 2020; MacDougall and Jashemski, 1981; Masson, 1966). From the excavated remains and restored drawings, one may reasonably assume that Pompeians used their courtyards/atriums for daily living, cooking, dining, planting, family gathering, and so on.

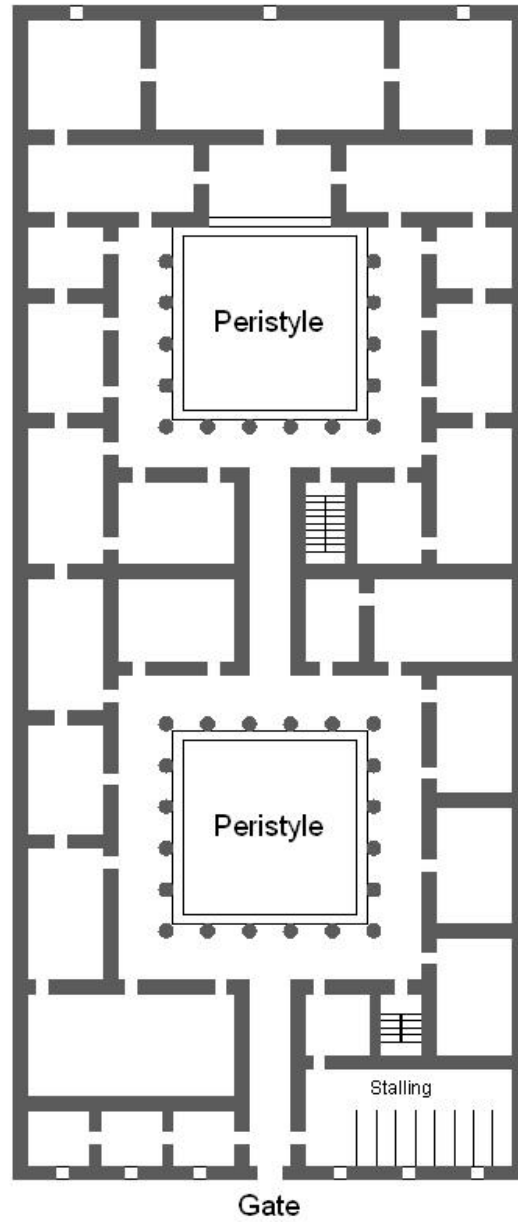


Figure 6. Plan of a Greek peristyle courtyard house.
Source: Drawing by the author after Vitruvius, 1960, p. 186

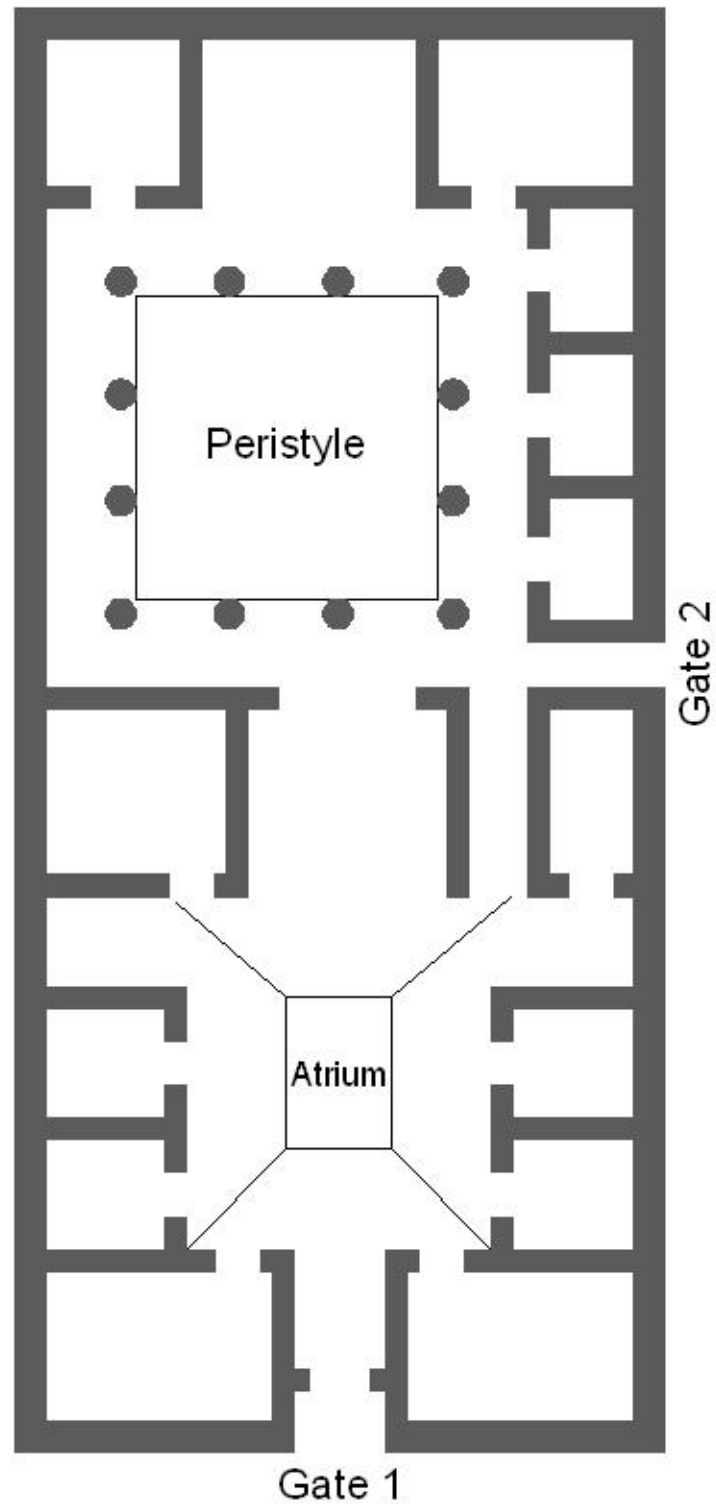


Figure 7. Plan of a Roman courtyard/atrium house.
Source: Drawing by the author after Vitruvius, 1960, p. 178

2.5 Spanish courtyard houses

2.5.1 Cosmic axis and architectural symbolism of Spanish courtyard houses

Spain was conquered by Arab Muslims from North Africa in about 750, and was occupied by the Arabs for over 500 years. Spaniards have integrated many Arab cultural patterns, one of which was courtyard house (Hall, 1976; Figure 8), whose architectural symbolism is the “Sky and Earth.” A typical Spanish courtyard house entrance is pointing to the courtyard center. Some courtyards place the gate in a way that leads directly to an arcade along the courtyard, rather than the center (Reynolds, 2002).

2.5.2 Favorable orientation of buildings around Spanish courtyards

In general, the orientation of Spanish courtyard houses depends on that of the street. At least one wall of the house will be nearly parallel to the street, which leads to many variations of the courtyard form. The house wall oriented to the elongated east-west have their longer sides face north and south, so that direct sun in summer can be prevented from entering the longer sides with shallow overhangs, leaving the openings available for wind. The shorter sides of the walls get strong direct sun across the length in the morning or evening. When plans are elongated north-south, the longer walls face east-west. There are difficulties with summer sun in the morning or afternoon, but one long wall partially shades the other at the earliest and latest hours. Meanwhile, the shorter side of the wall (facing the equator) gets direct sun across the length around noon. Winter sun is welcome, and near noon, some walls receive warmth (Reynolds, 2002).

2.5.3 Socio-spatial organization in Spanish courtyard houses

The author has not found any literature on the socio-spatial organization in Spanish courtyard houses, but it is worth investigation.

2.5.4 Cultural activities in Spanish courtyard houses

In Spain, the most common uses of courtyards are as extensions of living, dining, and cooking spaces, and everyday repetitious activities benefit from a change of the setting (Reynolds, 2002).

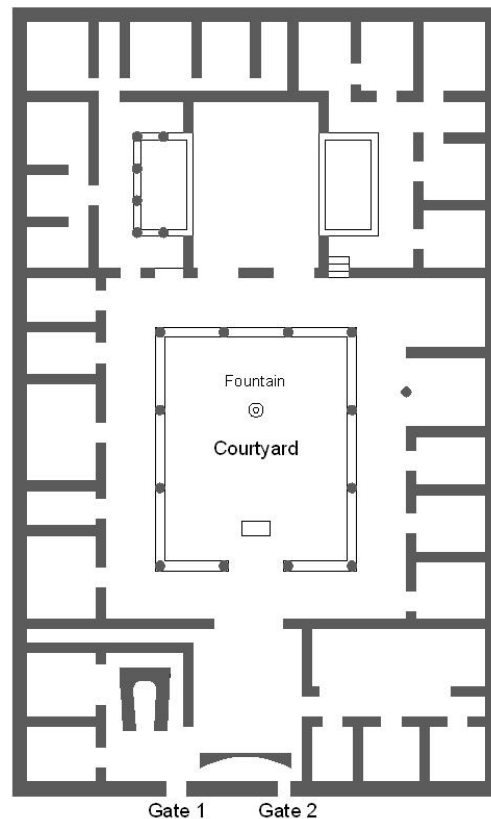


Figure 8. Plan of a Spanish courtyard house, Italica.
Source: Drawing by the author after Petruccioli, 2006, p. 4

2.6 Hispanic-American courtyard houses

2.6.1 Cosmic axis and architectural symbolism of Hispanic-American courtyard houses

Since the Spanish conquests of South America in 1492, entire new cities with courtyard houses were established in Latin/Hispanic America (Figure 9), following the settlement patterns of Iberian models influenced by Arab Muslim culture (Land, 2006). Its architectural symbolism is the “Sky and Earth.” However, semi-courtyard houses existed prior to the Columbian civilizations, such as the pre-Inca city of Chan-Chan in north Peru, which confirms the universality of the courtyard form till the 20th century (Reynolds, 2002).

Immediately after the Great New Orleans Fire of 1794, a new housing type was introduced to the State of Louisiana, USA: two-storey patio townhouse with rear courtyards that may be small and intimate, or large and designed for lavish living in the center of the city. They may accommodate private families, or be utilized as semipublic space, for example, as garden dining areas for starving passersby (Edwards, 1993).

In the view of Edwards (1993), Spanish culture offered New Orleans courtyard house style and features, while French culture, the model and forms. Since courtyard house is also indigenous to France,⁴ it is appropriate to French colonial settlements in the New World without reference to Spanish culture.

2.6.2 Favorable orientation of buildings around Hispanic-American courtyards

In older Mexican cities with no grid pattern of streets, there is a huge variety of courtyard house orientations. In newer gridded cities, the streets and courtyard houses are either oriented to the cardinal directions of north-south and east-west, or set at about 45° degree of the cardinal directions, which is typical of many Spanish colonial towns. The result of 45°-degree orientation is an even distribution of sunlight on the building facades throughout the year. On the summer solstice, morning sun fills the northeast-facing walls, while evening sun infuses the northwest-facing walls. On the winter solstice, morning sun infiltrates the southeast-facing walls, while evening sun imbues the southwest-facing walls (Reynolds, 2002).

2.6.3 Socio-spatial organization in Hispanic-American courtyard houses

The author has not found any literature on the socio-spatial organization in Hispanic-American courtyard houses, but it is worth investigation.

2.6.4 Cultural activities in Hispanic-American courtyard houses

In Mexico, the most common uses of courtyards and arcades are as extensions of living, dining, and cooking spaces. The courtyard is also children’s playground of a great variety, as the typical courtyard floor offers both hard and soft surfaces: one serves toys with wheels, the other for digging, forming earth or sand, channeling water, and so on. In the courtyard, children learn to care for pets, feed the fish in the pond, and observe birds building nests in the vines. The courtyard offers children enough contact with nature (Reynolds, 2002).

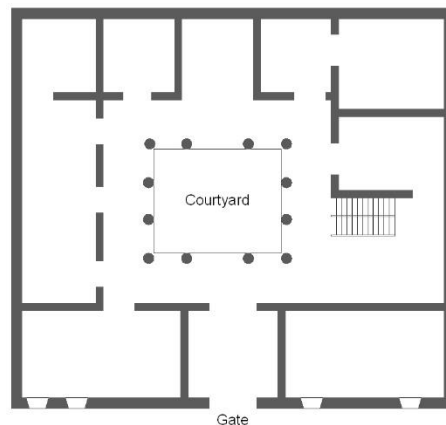


Figure 9. Plan of a Hispanic courtyard house.
Source: Drawing by the author after Reynolds, 2002, p. 4

⁴ The popularity of Parisian courtyard houses is revealed in the large-scale 1739 *Plan de Paris*. This document depicts every permanent structure in the city and discloses much of the history of the urban courtyard townhouse of the Ile de France. The plan is stored in the Southeastern Architectural Archive, Tulane University Library, New Orleans (Edwards, 1993, p. 28).

3. Contemporary New Courtyard Housing around the World

3.1 Contemporary new courtyard housing in Asia

China renovated traditional courtyard houses incrementally (Zhang, 2015b), and Chinese-style new courtyard housing has been built since the 1990s, such as the Juer Hutong (Wu, 1999; Zhang, 2006, 2013/2016, 2016a) and Nanchizi projects (Zhang, *forthcoming*) in Beijing, and the Tongfangyuan, Shilinyuan (Zhang, 2020), and Jiaanbieyuan (Zhang, 2019) estates in Suzhou. Since the 2000s, there also emerged Chinese-style courtyard-garden villas in many parts of China (Zhang, 2017).

3.2 Contemporary new courtyard housing in Europe

Denmark began cohousing experiment in the 1960s. A successful example is the Tinggård (b. 1971–1978) in Herfølge, consisting of 90 rental housing units subdivided into six groups, each with about 15 units centered on a common courtyard and a community house. There is also a large community center located on the main street that is shared by all the groups. The chief function of the communal spaces is to provide residents with the opportunities for social interaction and daily activities, from which more communal life can develop (Gehl, 1971/2001; Vandkunsten Architects, n.d.).

3.3 Contemporary new courtyard housing in America

A few outstanding new courtyard housing projects are found at Popayan and Tunja, Colombia; Lima, Peru; Quito, Ecuador; and La Paz, Bolivia. Another is the United Nations Experimental Housing project, PREVI, in Lima, Peru, in 1974. This new estate with 450 mostly courtyard houses was sponsored by the Government of Peru and the United Nations. It was to demonstrate, among other things that, the low-rise concept with courtyards and compact gardens can achieve high densities and produce a human-scale built environment better for family life than high-rise apartment buildings (Land, 2006).

California adapted courtyard housing from Spanish precedents by American architects, notably the husband-and-wife team Nina and Arthur Zwebell, who designed and built it in the 1920s–1930s (Hawthorne, 2005; Leigh, 2004). Beginning in the 1960s, new courtyard housing was constructed in American cities, such as the atrium houses in Madison Park (b. 1961) and Hyde Park (b. 1967) in Chicago (Blaser, 1995), Sunnyside Gardens in New York, and Rivermont House Carrfour Supportive Housing in Miami, Florida (Enterprise Foundation, 2002).

In 1990s USA, courtyard housing revived in the form of bungalow courts as part of the New Urbanism movement. The examples include Fair Oaks Court and Vista del Arroyo Bungalows (restored 2007–2008), Gartz Court, Granada Court, the award-winning Harper Court (b. 2002), Laurel Court (b. 2004), Meridian Court (b. 2004), Mission Meridian Village (b. 2002), Silver Spur Court (b. 2008), among others. Most of these projects are in Mediterranean style, designed or restored by California-based American architects Stefanos Polyzoides and his wife and partner Elizabeth Moule, who attempted to reconnect with Los Angeles history and improve the urbanism of the city (Broffman, 2008; Jarmusch, 2004; Leigh, 2004; Newman, 2002). Courtyards are often found to be at the top of an American homebuyer's wish list (Keister, 2005).

The State of Oregon also has a heritage of courtyard housing, often built in English cottage style in Portland's streetcar-served neighborhoods during 1900–1950. To honor this tradition, the City of Portland (2008) organized a courtyard housing design competition in 2007 with 257 entries, and published a subsequent report entitled *Courtyard Housing: A Catalogue of Designs and Design Principles*, showcasing their four winning schemes. This event signaled a strong support of the continuity of courtyard housing in America today.

Influenced by the "Garden City" movement in 1898 in the UK, courtyard housing started in Canada as early as 1910. The examples are the Three Streets Housing Co-operative (b. 1910), Bain Apartments Co-operative (former "Riverdale Courts," b. 1913–1920s), and Spruce Court Housing Co-operative (b. 1913–1926) in Toronto, Ontario. The latter two projects were designed in English Tudor style by Toronto architect Eden Smith (1858–1949). This unique set of buildings was the first social housing in Canada constructed by the Toronto Housing Authority. The Bain Apartments Co-operative was incorporated in 1977 as one of the first housing co-operatives in Ontario (Austin, 2013).

Since the 1980s, courtyard housing revived in Canada, typically in the name of "co-operative housing" built by the Co-operative Housing Federation of Canada. The author's 2013 survey shows that 16 of 53 (30%) co-operative housing in Toronto have identified with one or more courtyards. The Toronto co-operative housing with common courtyards include Arcadia Housing Co-operative, Church-Isabella Residence Co-operative (b. 1917), Courtyard Housing Co-operative (b. 1993), Hugh Garner Housing Co-operative (b. 1982), Jenny Green Co-operative Homes, New Hibret Co-operative Homes (b. 1996), Oak Street Housing Co-operative (b. 1987), Peggy and Andrew Brewin Housing Co-operative (b. 1995), Windward Co-operative Homes (b. 1986), among others. Bristol Court (b. 2003) and Kingsmere (b. 1998) are non-cooperative housing with courtyards. The award-winning Toronto Courtyard House (b. 2006) designed by ethnic Chinese architects Christine Ho Ping Kong and Peter Tan is their home and studio.

The Canadian Cohousing Network (formed in 1992) is part of a global cohousing initiative. The design of these communities promotes social interaction through central courtyards and community gardens, as well as a common house with shared facilities. These self-managed communities create social ties that help achieve a high quality of life, and cars are generally kept at the peripheries of the community properties (Mosaic Village Cohousing, n.d.).

Cohousing is gaining popularity in North America. In early 2020, Canadian Cohousing Network website listed 14 completed cohousing projects across Canada, with four under construction, eight in development, and 12 in formation. The completed projects include Prairie Sky in Calgary, AB; Belterra Cohousing in Bowen Island, BC; Cranberry Commons in Burnaby, BC; Creekside Commons in Courtenay, BC; Harbourside in Sooke, BC; Pacific Gardens in Nanaimo, BC; Quayside Village in North Vancouver, BC; Roberts Creek in Roberts Creek, BC; Vancouver in Vancouver, BC; WindSong in Langley, BC; Terra Firma in Ottawa, ON; Prairie Spruce Commons Cohousing in Regina, SK; Radiance Cohousing in Saskatoon, SK; and Wolf Willow in Saskatoon, SK.

Also, in early 2020, the Cohousing Association of America website listed 302 cohousing communities, compared with 289 by the end of 2015, it increased 13 in 5 years. These figures indicate a trend of North American housing development is to incorporate common areas indoors and outdoors to achieve better social interaction and cultural vitality.

4. Conclusion and Recommendations

This paper discussed six distinctive styles of traditional courtyard houses and contemporary new courtyard housing around the world, whose concept derived from the cosmic axis, and each culture has assigned their architectural symbolism to the courtyard, set their favorable orientation of buildings, defined their socio-spatial organization in the houses, and conducted cultural activities in the courtyards (Table 1).

Table 1. A Cross-Cultural Analysis of Traditional Courtyard Houses around the World

No	Courtyard House	Cosmic Axis + Architectural Symbolism	Favorable Orientation of Buildings	Socio-Spatial Organization	Cultural Activities
1	Chinese	North-South, Heaven-Earth	Facing South	By social rank and gender	Ceremonies and rituals, seasonal celebrations, domestic activities, cooking, study, recreation, children's play, nurturing pets, plants, flowers, etc.
2	Indian	North-South, East-West, Heavenly Energy, Cave in the Heart	Facing East, North, or West	By gender and social rank	Ceremonies and rituals, household activities, weddings, births, deaths, etc.
3	Islamic	Garden of Eden, Paradise, Universe	Facing North, West, or South	By gender and social rank	Ceremonies and rituals, seasonal celebrations, family activities, planting trees, etc.
4	Greco-Roman	Isles of the Blessed, Earthly Paradise	Parallel to the Street	Unknown	Daily living, cooking, dining, planting, family gathering, etc.
5	Spanish	Sky-Earth	Parallel to the Street	Unknown	Daily living, cooking, dining, children's play with pets, fish, birds, contact with nature, etc.
6	Hispanic-American	Sky-Earth	Facing North, South, East, West, or 45° of Cardinal directions	Unknown	Daily living, cooking, dining, children's play with pets, fish, birds, contact with nature, etc.

Source: Author's summary; there are also regional variations to the norms listed in the table.

The study finds that the courtyard house is a common heritage of humanity that has been built all over the world; it has a past as well as a future. In a courtyard, nature and culture are intertwined, and the shared meaning of the courtyard house is an earthly paradise, from which one may construe that the meaning of the world is a courtyard garden.

The research also finds that across the six cultures, there is *no* fixed favorable orientation of buildings around the courtyard. The differences in preference lie in the geographical location of the country/region, the desired amount of sunlight and wind, which relate to thermal comfort, and the different religious faiths and practices. It clearly indicates that local climate and cultural beliefs are the two major forces in orienting courtyard buildings.

The study further shows that Eastern (Chinese, Indian, and Islamic) cultures seem to have a stronger social hierarchy and gender separation in the room allocations in the courtyard houses than that of Western (Greco-Roman, Spanish, and Hispanic) cultures, but more studies should be conducted to warrant this claim.

Moreover, the study indicates that the courtyard has been an essential space for performing ceremonies and rituals, seasonal celebrations, daily activities to be in touch with nature, with the family, with the community, and with themselves.

The study suggests a future research on courtyard housing under different climatic conditions, with regards to their optimum proportion of building height to distance, and so on, for best environmental performance and socio-cultural activities.

Prominent Chinese architect and scholar, Liang Sicheng (1998) asserted that each nation has its architectural language guided by its architectural “vocabulary” and “grammar,” with which their newer generations must familiarize; otherwise it would be impossible to create architecture with national, regional, or local identity (pp. 227–228).

Amos Rapoport (2000) likewise maintained that the courtyard form is the results of the aims and desires of unified groups for an ideal environment, and as such they have symbolic values. The safeguard of historic and cultural heritage is to maintain cultural diversity and hence preserve “cultural gene pool.” Cultural landscapes are desirable because they make the world richer and more diverse. Since human biological nature is much more strongly in favor of constancy than change, the courtyard house of the past may still be valid to meet our present physical and psychological needs and behavioral patterns. Understanding this significance will have a major impact on the development direction of the built environments.

The author’s previous research findings indicate that the courtyard form is still a preferred housing design strategy (Zhang, 2013/2016, 2015/2017), not only because it gains better daylight and natural ventilation, and consumes less energy, but also the courtyard space facilitates better social health and happiness. Therefore, the courtyard form should be promoted in our current search for sustainable architecture and urbanism. The author proposes a new courtyard-garden housing system that may be applied anywhere in the world (Figures 10-12).



Figure 10. Proposed new courtyard-garden housing compound based on a system of 78 m × 78 m standard block size, the common courtyard is 26 m × 26 m shared by eight nuclear families, with each household enjoying a private garden of 12 m × 6 m at the front and the back. Each housing unit measures 10 m × 12 m (total 240 sqm) with a semi-basement and 2 ½ storeys. Source: Zhang, 2015/2017, 2016a, 2016b, 2017



Figure 11. Proposed new courtyard-garden housing compound accommodating eight nuclear families. Source: Handmade music boxes as thatch-roofed English Cotswold cottages by Pauline Ralph; the courtyard configuration following the same planning principle suggested by Zhang 2015/2017, 2018



Figure 12. Proposed new courtyard-garden housing compound accommodating eight nuclear families. Source: Individual commercial wood houses made in China; the courtyard configuration following the same planning principle suggested by Zhang 2015/2017, 2018

The 26 m × 26 m courtyard size complies with the minimum 25-meter social distance for privacy concern mentioned in Gehl's book *Life Between Buildings* (1971/2001). It also meets the optimum ratio of building height to distance 1:3 in my previous research. These measures result in the optimum number of eight households surrounding a common courtyard.

The three models demonstrate that regardless of the architectural style in façade design, or the size of each housing unit, the courtyard system can be applied universally. The goal of the proposal is for the betterment of human habitat pattern to promote environmental, social, and cultural sustainability through architecture.

Acknowledgment

The research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

- Abdelkader, R., and Park, J.-H. (2018). Spatial principles of traditional Cairene courtyard houses in Cairo. *Journal of Asian Architecture and Building Engineering*, 17(2), 245-252. <https://doi.org/10.3130/jaabe.17.245>
- Abdulkareem, H.A. (2016). Thermal comfort through the microclimates of the courtyard. A critical review of the middle-eastern courtyard house as a climatic response. *Procedia - Social and Behavioral Sciences*, 216, 662–674. Urban Planning and Architecture Design for Sustainable Development (UPADSD), 14-16 October, 2015. <https://doi.org/10.1016/j.sbspro.2015.12.054>
- Advameg Inc. (2007). *Culture of Libya*. Retrieved January 13, 2020 from: <http://www.everyculture.com/Ja-Ma/Libya.html>
- Al-Azzawi, S. (1969). Oriental houses in Iraq. In P. Oliver (Ed.), *Shelter and society* (pp. 91-102). New York, NY: Frederick A. Praeger. ISBN: 9780214667961
- Al-Azzawi, S. (1996). Daily impact of climate on the pattern of urban family life: Indigenous courtyard houses of Baghdad regions of the hot-dry climates Part I: Daily shifts or daily movements in summer. *Renewable Energy*, 8(1), 289-294. [https://doi.org/10.1016/S0960-1481\(96\)90145-7](https://doi.org/10.1016/S0960-1481(96)90145-7)
- ArchNet (n.d.). *Dictionary of Islamic architecture: T-Z*. ISBN: 9780415213325. Retrieved January 13, 2020 from: <https://archnet.org/publications/8807>
- Austin, A. (2013). *100 Bain Avenue, Toronto, Canada's Garden City 1913-2013*. Toronto, ON: Alwyn Austin. ISBN: 9780981301310
- Bai, H. (2007). *Living in the old Beijing* (《老北京的居住》, Chinese edition). Beijing: Yanshan Publishing House. ISBN: 9787540212186
- Beck, B. (1976). The symbolic merger of body, space, and cosmos in Hindu Tamil Nadu. *Contributions to Indian Sociology*, 10(2). <https://doi.org/10.1177/006996677601000202>
- Becker, J. (2020). *Roman domestic architecture (domus)*. Retrieved February 7, 2020 from: <https://www.khanacademy.org/humanities/ancient-art-civilizations/roman/beginners-guide-rome/a/roman-domestic-architecture-domus>
- Blaser, W. (1985). *Atrium: five thousand years of open courtyards*. New York: Wepf and Co. AG, Basel. ISBN: 9783859770805
- Blaser, W. (1995). *Courtyard house in China: tradition and present* (2nd enlarged ed.). Basel/Boston/Berlin: Birkhäuser Verlag. ISBN: 9783764310912
- Boussaa, D. (1987). *Housing design: towards a responsive approach: Dellys as the setting of research*. MPhil thesis, University of York, UK.
- Bray, F. (1997). *Technology and gender: fabrics of power in late imperial China*. Berkeley: University of California Press. ISBN: 9780520208612
- Bray, F. (2005). The inner quarters: oppression or freedom? In R.G. Knapp and K.-Y. Lo (Eds.), *House home family: living and being Chinese* (pp. 259-279). Honolulu: University of Hawai'i Press. ISBN: 9780824829537
- Broffman, W. (2008). *Romancing the courtyard*. Retrieved January 29, 2020 from: <https://www.mparchitects.com/site/press/romancing-courtyard>
- Canadian Cohousing Network (2020). *Building community with cohousing*. Retrieved January 15, 2020 from: <https://cohousing.ca>
- Chang, S.S.-H. (1986). *Spatial organisation and socio-cultural basis of traditional courtyard houses*. PhD thesis, University of Edinburgh, UK. <https://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.375592>. ISNI:0000 0001 3528 2691
- City of Portland (2008). *Courtyard housing: a catalogue of designs and design principles*. Portland, OR: Strategy Custom Publishing.
- Edwards, B., Sibley, M., Hakmi, M., and Land, P. (Eds.) (2006). *Courtyard housing: past, present, and future*. New York: Taylor and Francis. ISBN: 9780415262729
- Edwards, J.D. (1993). Cultural identifications in architecture: the case of the New Orleans townhouse. *Traditional Dwellings and Settlements Review*, 5(1), 17-32. <https://www.jstor.org/stable/41757703>
- Eliade, M. (1959). *The sacred and the profane: the nature of religion* (translated from the French by Willard R. Trask). Toronto: Harcourt Harvest Book. ISBN: 978-0156792011
- Enterprise Foundation (2002). Rivermont House Carrfour Supportive Housing, Miami, Florida. Retrieved January 15, 2020 from: <http://carrfour.org/rivermont-house>

- Fathy, H. (1969/1973). *Architecture for the poor: an experiment in rural Egypt*. Chicago and London: University of Chicago Press. ISBN: 9780226239163
- Flath, J.A. (2005). Reading the text of the home: domestic ritual configuration through print. In R.G. Knapp and K.-Y. Lo (Eds.), *House home family: living and being Chinese* (pp. 325-347). Honolulu: University of Hawai'i Press. ISBN: 9780824829537
- Foruzanmehr, A. (2016). Thermal comfort and practicality: separate winter and summer rooms in Iranian traditional houses. *Architectural Science Review*, 59(1), 1-11. <https://doi.org/10.1080/00038628.2014.939132>
- Gamage, W., Lau, S., Qin, H., and Gou, Z. (2017). Effectiveness of air-well type courtyards on moderating thermal environments in tropical Chinese shophouse. *Architectural Science Review*, 60(6), 493-506. <https://doi.org/10.1080/00038628.2017.1383230>
- Gehl, J. (1971/2001). *Life between buildings: using public space* (translated by J. Koch). Copenhagen, Denmark: Arkitektens Forlag (The Danish Architectural Press). ISBN: 9781597268271
- Giedion, S. (1981). *The beginnings of architecture*. Bollingen Series XXX. 6.11, New Jersey: Princeton University Press. ISBN: 9780691018355
- Guedouh, M.S., and Zemmouri, N. (2017). Courtyard building's morphology impact on thermal and luminous environments in hot and arid region. *Energy Procedia*, 119, 153-162. International Conference on Technologies and Materials for Renewable Energy, Environment and Sustainability (TMREES17), April 21-24, 2017, Beirut, Lebanon. <https://doi.org/10.1016/j.egypro.2017.07.063>
- Hawthorne, C. (2005). Courts with a new spark: L.A.'s architectural heritage. *Los Angeles Times (Home)*, September 15, 2005. Retrieved January 29, 2020 from: <https://www.latimes.com/archives/la-xpm-2005-sep-15-hm-courtyard15-story.html>
- Imperium Romanum (2004-2019). *Pompeii*. Retrieved January 13, 2020 from: <https://www.imperiumromanum.edu.pl/en/roman-geography/roman-cities/pompeii>
- Jarmusch, A. (2004). Lofts at Laurel Court: West Hollywood, California. *Architectural Record*, 192(11), 204-207. Retrieved April 13, 2020 from: <http://www.theloftcompanyla.com/the-lofts-at-laurel-court>
- Jones, P.B. (1996). An anthropological view of architecture. In C. Melhuish (Ed.), *Architecture and anthropology* (Architectural Design, pp. 22-25). Seattle, WA: Academy Press. ISBN: 9781854902597
- Keister, D. (2005) *Courtyards: intimate outdoor spaces*. Layton, Utah: Gibbs Smith Publisher. ISBN: 9781586855406
- Khajehzadeh, I., Vale, B., and Yavari, F. (2016). A comparison of the traditional use of court houses in two cities. *International Journal of Sustainable Built Environment*, 5, 470-483. <https://doi.org/10.1016/j.ijbsbe.2016.05.010>
- Knapp, R.G. (2005). *Chinese houses: the architectural heritage of a nation*. North Clarendon, VT: Tuttle Publishing. ISBN: 9780804835374
- Knowles, R. (1996). Rhythm and ritual: a motive for design. Paper Session 3A. In J. Noe and G. Tyau (eds.), *Proceedings: ACSA Western Regional Meeting*. Honolulu: University of Hawaii at Manoa.
- Kou, X. (2005). *A treasure dictionary for prosperous residences: a guide to residential Feng Shui* (《旺宅宝典: 住宅风水指南》 Chinese edition). Beijing: Culture and Art Press. ISBN: 9787503926648
- Land, P. (2006). Courtyard housing: an 'afterthought.' In B. Edwards et al. (Eds.). *Courtyard housing: past, present, and future*. New York: Taylor and Francis. ISBN: 9780415262729
- Leigh, C. (2004). California dreaming: architects aim to reconcile growth with LA's past. *Features*, September 15, 2004. Retrieved January 29, 2020 from: http://www.princeton.edu/~paw/archive_new/PAW04-05/01-0915/features2.html
- Liang, S.C. (1998). *Frozen music* (《凝固的音乐》, Chinese edition). Tianjin: Hundred Flowers Literature and Art Publishing House. ISBN: 9787530625958
- Liu, X. (2002). The origins of Chinese architecture. In X. Fu et al., *Chinese architecture* (pp. 11-31). New Haven: Yale University Press. ISBN: 9780300095593
- Luò, Z.Z. (2006). *Feng shui and modern residences* (《风水学与现代家居》 Chinese edition). Beijing: China City Press. ISBN: 9787507417647
- Ma, B. (1999). *The architecture of the quadrangle in Beijing* (《北京四合院建筑》, Chinese edition). China: Tianjin University Press. ISBN: 9787561811979
- MacDougall, E. and Jashemski, W. F. (Eds.) (1981). *Ancient Roman gardens*. Washington DC: Dumbarton Oaks, Trustees for Harvard University. ISBN: 9780884021001

- Martinelli, L. and Matzarakis, A. (2017). Influence of height/width proportions on the thermal comfort of courtyard typology for Italian climate zones. *Sustainable Cities and Society*, 29, 97-106. <https://doi.org/10.1016/j.scs.2016.12.004>
- Masson, G. (1966). *Italian gardens*. London: Thames and Hudson. ISBN: 9780500015810
- Memarian, G. and Brown, F. (2006). The shared characteristics of Iranian and Arab courtyard houses. In B. Edwards *et al.* (Eds.), *Courtyard housing: past, present, and future* (pp. 21-30). NY: Taylor and Francis. ISBN: 9780415262729
- Mosaic Village Cohousing (n.d.). *We are working to build our community in Calgary, AB*. Retrieved January 15, 2020 from: <https://www.mosaicvillage.org>
- Mukerji, A.B. (1962). Field pattern in a Telangana village. *Indian Geographical Journal*, 37(4), 153-164.
- Newman, M. (2002). Courtyard housing revival. *Architecture Week*, July 24, D1.1-2. Retrieved January 29, 2020 from: <https://www.mparchitects.com/site/press/courtyard-housing-revival>
- Noble, A.G. (2003). Patterns and relationships of Indian houses. In R.G. Knapp (Ed.), *Asia's old dwellings: tradition, resilience, change* (pp. 39-69). New York: Oxford University Press. ISBN: 9780195928587
- Petrucchioli, A. (2006). The courtyard house: typological variations over space and time. In B. Edwards *et al.* (Eds.), *Courtyard housing: past, present, and future* (pp. 3-20). New York: Taylor and Francis. ISBN: 9780415262729
- Polyzoides, S., Sherwood, R., and Tice, J. (1982/1992). *Courtyard housing in Los Angeles: a typological analysis* (2nd ed.). New York: Princeton Architectural Press. ISBN: 9780910413534
- Randhawa, T.S. (1999). *Indian courtyard house*. New Delhi: Prakash Books. ISBN: ISBN: 9788172340230
- Rapoport, A. (1969). *House form and culture*. Englewood Cliffs, NJ: Prentice-Hall. ISBN: 9780133956733
- Rapoport, A. (2000). Culture and built form: a reconsideration. In K. D. Moore (Ed.), *Culture-meaning-architecture: critical reflections on the work of Amos Rapoport* (pp. 175-216). Aldershot: Ashgate. ISBN: 9781138712331
- Reynolds, J.S. (2002). *Courtyards: aesthetic, social, and thermal delight*. New York: John Wiley and Sons. ISBN: 9780471398844
- Sinha, A. (1994). The centre as void: courtyard dwellings in India. *Open House International*, 19(4), 28-35.
- Soflaeia, F., Shokouhian, M., Abraveshdarc, H., and Alipour, A. (2017a). The impact of courtyard design variants on shading performance in hot-arid climates of Iran. *Energy and Buildings*, 143, 71-83. <https://doi.org/10.1016/j.enbuild.2017.03.027>
- Soflaei, F., Shokouhian, M., and Soflaei, A. (2017b). Traditional courtyard houses as a model for sustainable design: a case study on BWHS mesoclimate of Iran. *Frontiers of Architectural Research*, 6(3), 329-345. <https://doi.org/10.1016/j.foar.2017.04.004>
- Taleb, H. and Abumoeilak, L. (2020). An assessment of different courtyard configurations in urban communities in the United Arab Emirates (UAE). *Smart and Sustainable Built Environment*, 1 April, <https://doi.org/10.1108/SASBE-08-2019-0116>
- Ujam, F. (2006). The cosmological genesis of the courtyard house. In B. Edwards *et al.* (Eds.), *Courtyard housing: past, present, and future*. New York: Taylor and Francis. ISBN: 9780415262729
- Vandkunsten Architects (n.d.). *Tinggården Herfølge 1971-1978: the successful experiment*. Retrieved February 14, 2020 from: <https://vandkunsten.com/en/projects/tinggaarden>
- Vitruvius (1960). *The ten books on architecture* (trans. Morris H. Morgan). New York: Dover Publications. ISBN: 9780486206455
- Wang, J.C. (2005). House and garden: sanctuary for the body and the mind. In R.G. Knapp and K.-Y. Lo (Eds.), *House home family: living and being Chinese* (pp. 73-97). Honolulu: University of Hawai'i Press. ISBN: 9780824829537
- Wang, Q. (1999). *Beijing siheyuan* (《北京四合院》, Chinese edition). Beijing: China Bookstore. ISBN: 9787805689333
- Wu, L. (1999). *Rehabilitating the old city of Beijing: a project in the Ju'er Hutong neighbourhood*. Vancouver, BC: University of British Columbia Press. ISBN: 9780774807272
- Zhang, D. (2006). New courtyard houses of Beijing: direction of future housing development. *Urban Design International*, 11(3), 133-150. <https://doi.org/10.1057/palgrave.udi.9000173>
- Zhang, D. (2009/2010/2011). *Courtyard houses of Beijing: past, present, and future*. Saarbrücken, Germany: VDM Verlag. ISBN: 9783639996302
- Zhang, D. (2013/2016). *Courtyard housing and cultural sustainability: theory, practice, and product*. Oxfordshire, UK: Ashgate/Routledge. ISBN: 9781409405030
- Zhang, D. (2015/2017). *Courtyard housing for health and happiness: architectural multiculturalism in North America*. Oxfordshire, UK: Ashgate/Routledge. ISBN: 9781472449115

- Zhang, D. (2015a). Classical courtyard houses of Beijing: architecture as cultural artifact. *Journal of Space and Communication*, 1(1), 47-68. <https://doi.org/10.15340/2148172511881>
- Zhang, D. (2015b). Courtyard houses of Beijing: lessons from the renewal. *Traditional Dwellings and Settlements Review*, 27(1), 69-82. http://iaste.org/swp/wp-content/uploads/2012/09/2016/05/Zhang_27.1_TDSR.pdf
- Zhang, D. (2016a). Juer Hutong new courtyard housing in Beijing: a review from the residents' perspective. *International Journal of Architectural Research*, 10(2), 166-191. <https://archnet.org/publications/10699>
- Zhang, D. (2016b). Courtyard housing in North America: Chinese design for health and happiness. *Urban Design International*, 21(4), 281-297. <https://doi.org/10.1057/udi.2016.6>
- Zhang, D. (2017). Courtyard housing in China: Chinese quest for harmony. *Journal of Contemporary Urban Affairs*, 1(2), 38-56. <https://doi.org/10.25034/ijcua.2017.3647>
- Zhang, D. (2018). Cooperative housing and cohousing in Canada: the pursuit of happiness in the common courtyards. *Journal of Architectural Research and Development*, 2(1), 12-22. <https://doi.org/10.26689/jard.v2i1.279>
- Zhang, D. (2019). Jiaanbieyuan new courtyard-garden housing in Suzhou: residents' experiences of the redevelopment. *Journal of Chinese Architecture and Urbanism*, 1(1), 526. <https://doi.org/10.36922/jcau.v1i1.526>
- Zhang, D. (2020). Shilinyuan new courtyard-garden housing in Suzhou: residents' experiences of the redevelopment. *Journal of Chinese Architecture and Urbanism*, 2(1), 530. <https://doi.org/10.36922/jcau.v2i1.530>
- Zhang, D. (forthcoming). Nanchizi new courtyard housing in Beijing: lessons from the redevelopment. *Journal of Architectural and Planning Research*.