

Article

Investigating Sustainability of the Traditional Courtyard Houses Using Deep Beauty Framework

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Abstract: In Pakistan, power outages have become frequent over the past two decades, due to a continuing energy crisis. Reliance on machines for thermal comfort of buildings has led to high energy demands of the increasing population. The negative impacts of artificial environments have, also, diminished the sense of place, biophilia and cultural values. Moreover, globalization has standardized the built environments, causing a lack of regional identity and an absence of climate sensitivity in design. Keeping all these issues in focus, this article re-examines the fundamental aspects of traditional architecture and aims to stimulate architects and designers to create sustainable and life-enriching designs, which are appropriate for contemporary times. In this research, the first two levels of Deep Beauty (functional and typological) are used, as a conceptual framework for sustainable design, to analyse a representative of a traditional courtyard house. In conjunction with the theoretical underpinnings of the Deep Beauty framework, the analysis utilizes photographs, drawings, and diagrams to support the arguments. The research shows that the traditional courtyard house possesses numerous attributes of sustainable design, which can be incorporated into contemporary house design.

Keywords: energy crisis; sustainable architecture; traditional architecture; courtyard; sense of place; biophilic design; deep beauty framework; climate sensitivity



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1. Introduction

The two crucial issues that are linked with sustainable development in Pakistan are energy crises and degradation of the environment [1]. The country has been facing a severe energy crisis, for the past two decades. Energy infrastructure is not fully developed, adequate, or managed [2]. The data from the Economic Survey of Pakistan (2020–2021) show that, during the last ten years, the gross energy demand has exceeded the population growth rate; energy use has increased at 4.95% per year, while the population has grown by less than 2.26%. Of the total electricity produced, 49.1% is consumed by the residential sector [3].

Present-day housing design has become more and more dependent on artificial means, to create a comfortable interior environment. According to the Consumers Rights Commission of Pakistan (CRCP) survey, the two major electrical end-using categories are lighting and space cooling, in the domestic sector of Pakistan [4]. Since generating more energy is difficult for Pakistan because of limited resources, another possible approach is to decrease the energy demand. When spaces and places are shaped more intelligently, to minimize reliance on machines for heating and cooling, large amounts of energy can be saved. Energy use can be cut significantly, if buildings channel heat and air naturally, without using electricity [5].

The energy crisis, along with the heavy use of machines, has limited our connection with the outdoor environment. A general preference for spending time in air-conditioned indoor spaces has, nearly, brought an end to our cultural norms and social habits. Climate plays a small role in how we design our contemporary houses, communities, and neighborhoods, as any space can be altered, artificially, to achieve indoor comfort. A consistent indoor environment cuts us off from the outside world and brings in no social, cultural, or aesthetic richness to a place [5]. Generally, indoor environments are isolated, reducing our connection with nature. On the other hand, buildings that are partially or completely naturally ventilated give their users the ability to tolerate a wider range of temperature. Users, also, value their control over the environment, through actions such as opening a window and dressing according to the weather [6].

Globalization and advancement in science and technology as well as adoption of western models have moved us away from our traditional architectural practices. The strive for standardization of built environment has resulted in a lack of cultural and regional identity. The use of the same building methods, materials, and styles all over the world challenges our ability to achieve sustainable living [7]. This is quite evident, by observing the evolution of the modern-day residential architecture of Pakistan. We are putting away the richness of our culture and traditions, instead adopting a more energy-intensive western model of architecture. The houses, as being built today, are missing their relevance to their regional context.

Analysis in this research is an attempt to learn from the past, understand the present, and design for a better future. R. Lewcock (1988) emphasizes this approach when he says:

“At any given time, the man-made world is inevitably the measure we use to determine the direction of change. Whatever we may think of it, the world around us provides the basis for decisions about the future. We are keenly aware of its deficiencies, but not always so aware of its strengths. From time to time, it is wise to pause and consider whether what we might be losing when we change something. The corollary to this is to look back to see whether what we lost yesterday might, with little effort, be regained.”

(pp. v–vi) [8]

The paper proposes to reflect on the framework of Deep Beauty, as a potential to create a sustainable built environment, while staying rooted in our culture and traditions. It aims to promote awareness on an alternate approach of designing buildings, not just, carelessly, following the western models, based on the use of machines. With a viewpoint to build sustainability for the future, we must look back at examples that have passed the test of time [9].

2. Deep Beauty in Architecture

Deep Beauty is rooted in ecological ethos and a spiritual worldview that lies beyond mere aesthetics. The conceptual framework of Deep Beauty works on three interconnected levels: functional, typological, and archetypal. Through exploration of these three levels, architects and designers can create buildings and landscapes that possess meaningful layers of architectural experience in this modern-day beauty-less age [10]. The archetypal level has, already, been discussed and analyzed using courtyard houses [11].

2.1. Functional Level of Deep Beauty Framework

The functional level deals with the pragmatic needs and response to the climate, region and local context. Gary J. Coates (2014) defines functional level as:

“The Functional Level includes design for all the pragmatic needs of the building’s users. Truly functional buildings are also artfully integrated with their sites and respond simply and appropriately to available sun, wind and light. Such buildings, which are always no bigger than they need to be, are necessarily energy efficient, and make maximum use of healthy and locally available building materials. Biomimicry, as a functionalist approach to biophilic design, is included in this level. Everything associated with the technological

and functional aspects of ecologically and humanly sustainable design is included in this first, and necessary level of sustainable design."

The house is not only a structure; it is an institution that is built for multidimensional functions. Building a house is a cultural phenomenon, thus, the form and organization of a house depend on its cultural setting. In contemporary times, the purpose of the house is much more than a utilitarian idea and serves a greater objective, rather than only providing shelter. Shelter is considered as an ancillary purpose of the house, while its definite role is to create an environment that best suits its occupants' lifestyles. The house acts as a social unit of space [12].

Biomimicry, as a functionalist approach to biophilic design, entails learning strategies and designs from nature that have proven to be successful. In the past, architects have taken inspiration from various acts performed in nature and implemented them into works of architecture. Such architects, who follow biomimicry, believe that when designs are guided by nature, architecture becomes more life-like [13]. Nature can be mimicked for two purposes: it is possible to imitate forms found in nature to design a building's appearance, such as a Corinthian column with curling leaves, or to simulate nature to solve a practical challenge, such as flexibility, insulation, energy production, etc. Biomimicry is a design process that is focused on functionality and seeks solutions from the organisms and ecosystems that are the best performers of that function. Examples of biomimicry can be seen in the design of building structures, forms, daylighting systems, natural ventilation strategies, sounds, colors, and landscapes as well as urban design [13].

To achieve sustainability, our communities must be able to support themselves in the same way that wild spaces are self-sufficient. If our society worked in an instinctive way, producing for itself, maintaining itself, and remaining in equilibrium with its surroundings, it would be a true imitation of nature [13]. Following in the footsteps of living creatures, it is possible to develop houses and communities that function as capable ecosystems. Biomimicry has the potential to lead the way towards sustainability.

2.2. Typological Level of Deep Beauty Framework

The typological level includes the adaptation of building traditions in contemporary designs, to create a sense of history, community, nature, and place, so that culturally centered meanings may, continuously, evolve. Gary J. Coates (2014) states:

"The Typological Level involves the adaptation of bioregional building traditions and historically situated building types in the design of contemporary buildings that are capable of evoking a sense of connection with history, community, nature and place. Rather than merely replicating historical forms, buildings functioning at this level enter critically into a conversation with the past in order to create something that is both familiar and yet somehow always fresh and new. At this level of design, culturally based meanings are continuously created and deeply rooted building traditions are continually given new life. Buildings at this level also embody the principles of biophilic design, connecting building users to elemental nature and to the patterns, rhythms and forms of the natural world, thereby fulfilling our intrinsic need to be connected to the regenerative processes of life."

Categorizing observations, according to similar characteristics and recurring principles, is an important component of the cognitive process. Humans perceive and communicate, by creating standards and systemizing patterns. In this perspective, architectural typologies consider the varying requirement of profiles of building types and spatial systems. Typologies deal on different levels: at the urban level, typologies deal with blocks, row or detached houses; and, at the building level, they can include residential houses, theaters, industrial plants, etc. Similarly, floor-plan typologies are defined by the circulation system that connects individual rooms. Even though the room itself behaves as a single functional space, different floor plans create different building types, such as patio houses, apartment houses [14], courtyard houses, and so on.

The typological examination begins with the reduction in shapes to basic geometries, but it is much more comprehensive than just that. Typological order ranges from construction details to socio-political interrelations, thus characterizing various appearances of the built environment. Examining typology involves a dialogue with history, to discuss the creation of ‘new’ from the ‘old’. Types are transformed over time, due to changes in user requirements, scale, context, or other mechanisms [14]. The remarkable thing about typology is that it is generative. Two forms can be of the same type but can appear and be constructed, entirely, in a different way. Therefore, studying a typology does not result in a repetition but a transformation [15].

It is a universal fact that the greatest architectural examples in history are awe inspiring. These models have more to offer than just beauty—these provide lessons about design principles. Architectural types, such as courtyard houses, which have passed the test of time, are important examples that have set high levels of excellence [16]. Douglas S. Kelbaugh (2002) explains the human attitude towards change that is too radical or too familiar. He writes:

“Humphrey postulates that what is both stimulating and legible is imagery that ‘rhymes’ with other familiar images, whether across space or over time. To ‘rhyme,’ images must be neither too similar nor too dissimilar. In the former case, the human tends to lose interest too easily and in the latter case to become confused and discouraged too easily.”

Architecture must be fresh, but it should, also, relate to the past. The wide range of materials, techniques, and design approaches present today have provided designers with numerous choices. This lack of limits and boundaries has minimized regional differences and resulted in apparent chaos. In comparison to other products, such as cars, clothing, and machines, architecture has a greater potential to represent a region. Since architecture is not generally mass-produced, it is difficult to turn it into a commodity. It is specific and unique to its site and can compete against standardization. Architecture can develop from the local characteristics and realities of the region, such as climate, building materials, construction methods, culture, and architectural typologies. Designers and clients have to change their selfish attitudes, if visual harmony, contextualism, and historical connection are to be seen in urban spaces [16].

Valuable lessons of beauty, sustainability, and vitality can be learnt from nature. The biological and ecological systems can serve as inspiration for the design. Green buildings operating only at the functional level of Deep Beauty can cater well for concepts, such as daylighting, use of local materials, reducing energy costs, and lower environmental impact. Subsequently, the next step is to design life-enriching, healing architecture that is nurturing and stimulates well-being. In other words, our way forward is a biophilic response [17]. An approach to creating a biophilic environment is integrating plants, animals, and water into the built environment. Throughout the history of the world, biophilic elements, such as domestic gardens, ponds, fountains, and garden courtyards, are apparent. In present-day buildings, elements such as green terraces, landscaped atria, and aquariums contribute to bringing nature into the built environment. Photographs and paintings of natural landscape are other ways of incorporating biophilia. Research has shown greater productivity in office workers and less recovery time for patients [17], as well as better performance of students in schools, when they were exposed to biophilic elements. Biophilic design has proven to be a way of enhancing the energy-centric model of sustainability. Research has confirmed the positive impacts of biophilia on our physical and psychological health as well as brain development [18]. Communities, houses, schools, hospitals, offices, and other indoor and outdoor spaces can be sustained using biophilic design strategies.

The typological analysis is an approach to compare the traditional and modern-day typologies. A building program is the implicit or explicit statement of spatial requirements, to be fulfilled within the constraints of available sites, budgets, and technologies; it can be simple or detailed, but it will usually define the building type (such as a detached one-family house or a thirty-unit apartment house) and the intended activities, such as eating, sleeping, or parking the car. A program will, also, usually specify what kinds of

spaces are to be provided for these activities, such as a kitchen, dining room, bedroom, or garage, and how large these spaces must be [19]. In this analysis, the building layout is studied in detail, along with an exploration of a sense of history, place, or community, together with biophilia.

3. Methods

3.1. Rubric for Analysis

Considering the previous studies, the rubric for analyzing on these two levels comprises of the following parameters [20].

Functional level: (1) orientation of building, (2) building materials and construction methods, (3) family structure, (4) social setup, and (5) comfort.

Typological level: (1) sense of history, (2) community and place, (3) building type, (4) layout and (5) biophilic design.

The following case study of a traditional courtyard house has been conducted using this rubric through observation, photographs, drawings, diagrams, and interviews of the resident/owner of the house. As previously mentioned, the archetypal level has already been investigated for the following traditional courtyard [11].

3.2. Case Study: Barood Khana Haveli

Barood Khana Haveli is a traditional courtyard house/mansion (*haveli*), located in the Old Walled City of Lahore and built in the 18th century under Sikh rule [11]. Constructed as the residence of the commanding general of the Sikh army, it, also, contained ammunition and, hence, the name “barood khana”, which means “ammunition depot”, was given to this place. The features of this haveli represent the indigenous courtyard residences and their suitability for the local climate, as machines were not available at that time, to provide thermal comfort. As the urban area was densely populated, the courtyard typology was prevalent to address the needs of ventilation and light, along with other social requirements. The haveli was built of indigenous materials and construction methods of that time, such as brick, lime mortar, and wood. Other traditional architectural elements of the region, such as *jharokas* (balconies), *beramdahs* (verandas), and *jalis* (screens), make an integral part of the house, facilitating the social setup of gender segregation and creating a comfortable thermal environment. This haveli has, elegantly, stood the test of time for over 200 years and, still, continues to thrive, mostly in its original form. It has been used as a residence throughout the years in contrast to other remaining havelis of the Walled City, which have been converted to schools, colleges, or left unused and taken care of. In the later years, this haveli, also, served as a base camp for the educational movement of Muslims in the region and a home to many notable personalities of that time [21]. Currently, it is owned and resided in by Mian Yousaf Salahuddin. As the haveli has hosted several personalities throughout the years, it has sustained all of its beauty and glory, such that it is now considered a cultural symbol of the city.

The haveli is surrounded by streets on the north and the south side (Figure 1). On the west side are residences, shops, and a hospital. The haveli faces a cinema and more shops on the north. The shops in this area are on the ground floor, with residences on the first floor. Across from the cinema, a private entrance for residents is situated. Further down this street, another entrance is located for guests, which leads into a car-parking area. This car-parking area was used for communal interactions with the neighbors and public, in the old days. From this car-parking area, one enters into the main courtyard of the haveli.



Figure 1. Site context.

Upon entering the main courtyard (Figure 2), water ponds, fountains, trees, and plants can be seen. Two inner courtyards are separated with screens. The inner courtyard towards the west has a fountain in the center, bedrooms on the south side, a sheesh mahal on the west, and a veranda on the north. The sheesh mahal was built as a religious place for the Sikh. The religious book of the Sikhs, called the Guru Granth Sahib, would be set here. Currently, the owner of the house is a Muslim, who uses the house as a relic room. On the north side of the sheesh mahal is the basement, which is accessed through a small and steep staircase. This basement is used as a low-level seating area. The second inner courtyard is smaller in size, with a veranda on the north side that leads to the dining hall and the kitchen. On the north side, the private entrance for the residents, arrives at a car porch. A corridor links the car porch to a sitting room, the office of the resident, and the second inner courtyard.



Figure 2. Ground floor plan.

Three independent staircases climb up to three different terraces (Figure 3). From the main courtyard, a staircase leads into a terrace that is split into three levels on the south side. The two lower levels look outside into the street, and the higher level is more private, which looks into the inner courtyard. Underneath the lower-level terrace is a bank that opens to the street. The other two terraces are private. They are accessed from the inner courtyards and look down into the courtyards of the haveli. On the first floor, three more bedrooms, a dining room, and a TV lounge are located on the north side of the haveli. The roof is easily accessible, directly from the courtyards as well as the first floor. The monumental Badshahi Mosque is visible from the roof, along with neighboring streets and residences.



Figure 3. First floor plan.

The haveli retains its original form, except that some purposes of the areas have changed. The communal space adjacent to the haveli has been converted to car parking, the *baithak* has been changed to a bedroom, and the sheesh mahal has been converted to a relic room. The kitchen has been renovated with modern equipment, and air conditioners and a heater have been installed in the house, for extreme weather. The haveli has been well adjusted to the changes in family setup and technology advancement.

4. Results and Discussion

4.1. Functional Level

At this level, it is explored how well the building fits with the site in terms of climate, orientation, and use of local materials and indigenous construction methods. It is assessed, by if the pragmatic needs of the users have been met, and the architecture responds to the social needs of the family and provides them thermal comfort.

4.1.1. Orientation of Building

The terraces and the courtyards are situated on the southern side, with maximum sunlight (Figure 4). Christopher Alexander and their colleagues highlight the importance of the south-facing outdoors, in their book *A Pattern Language* (1977):

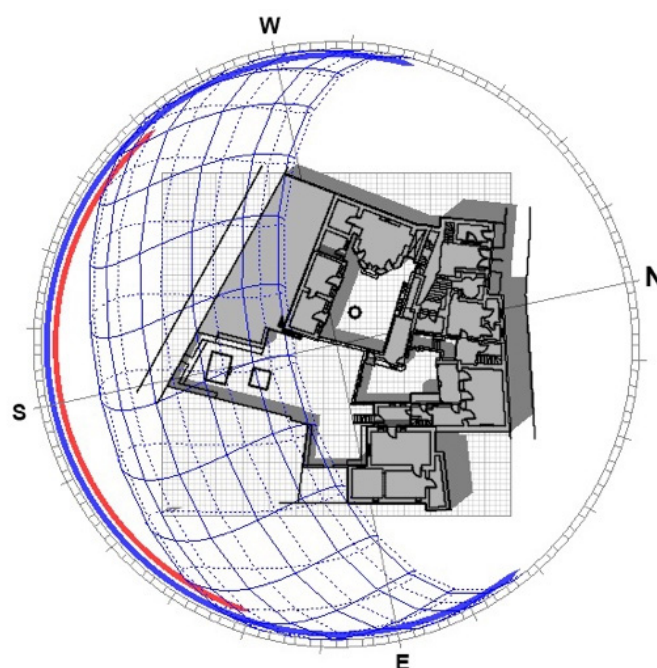


Figure 4. Orientation of outdoor and indoor spaces.

“People, use open space if it is sunny, and do not use it if it isn’t, in all but desert climates.”

(p. 514)

Regardless of how beautiful the outdoor space might be, if it is not placed correctly, it will never become a happy place. The survey conducted by Alexander (1977) proved that people with north-facing backyards did not use them at all, as south-facing front yards were preferred. They, also, noted that south-facing outdoor spaces must have sunny areas and will not work if they are covered with a band of shade [22]. In this haveli, a two-story structure is constructed on the north side, and the rooms on the south-west side are only single story, which allows maximum light to enter the courtyard and provide minimum shade.

About the placement of rooms, Alexander (1977) explains that most important rooms should be placed on the south side, to make the house happy and cheerful, and the building should be spread out along the east-west axis. The enclosed form of the haveli spreads out in the east-west direction, and most windows have diffused sunlight entering into the rooms. The early-morning sun lights up the entrance area and the first-floor bedroom used by the owner himself. From here, the sun moves toward the kitchen and dining areas on the south, lighting up the breakfast and cooking spaces, hence, showing good positioning of these spaces. The windows for office spaces face toward the north, experiencing low sunlight, which could be placed toward the east or south orientation, to enliven the work environments. Diffused sunlight enters through the windows of the remaining bedrooms, sheesh mahal, and lounging areas, all making them ideal places to relax in the summer.

4.1.2. Building Materials and Construction

The walls of the haveli are made of indigenous and locally available materials: the traditional *Lakhuri* bricks, held together with lime mortar. Both these materials have a low carbon footprint and low embedded manufacturing and processing energy. Brick is a porous material, and lime has hygroscopic properties and high absorbent values, constantly creating a cooling effect in the surrounding spaces and a breathable form of construction. The thick walls provide insulation and low thermal conductivity, keeping the internal temperatures stable. Decorative patterns are formed by arranging bricks, in a way to break the monotony of the straight wall. Currently, parts of the haveli have been plastered and

painted white, while some of the brickwork is left exposed. The courtyards and terrace floors are paved with brick that is decorated with tile work. Wooden ceilings, doors, blinds for windows, and screens are painted dark brown, to retain the harmonious appearance. Wood, moreover, has low thermal conductivity, reducing heat transfer through the ceilings and, also, through the windows. Replacement of wooden shades, instead of contemporary glass windows, eliminates the greenhouse effect in interior rooms. Patterns of colored glass cover the ventilators, through which light infiltrates into the interior.

4.1.3. Family Structure

Currently, the residents of the haveli include the owner, Yousaf Salauddin, his nephew, and over ten servants [23].

4.1.4. Social Setup

Outdoor furniture such as benches, swings (Figure 5), and traditional beds (*charpai*) are placed in the courtyard and the terrace, for the residents to socialize and relax. During the winter season, a portable fireplace is set in the center of the courtyard, around which comfortable seating arrangements are made (Figure 6). The basement functions as a music room. Due to its cool temperature, it is frequently used in the summer to relax and enjoy music. The rooftop and terraces are used to acquire sunlight.

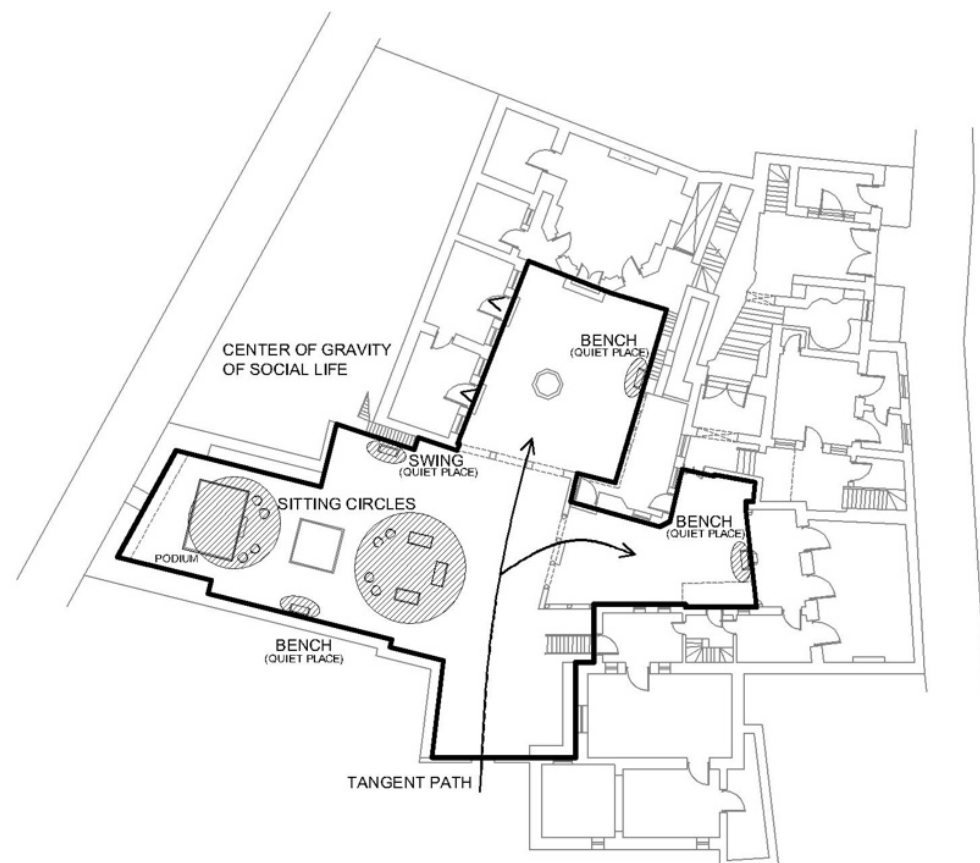


Figure 5. Center of gravity of social life, tangent paths, sitting circles, and quiet places.

Christopher Alexander and their colleagues, in their book *A Pattern Language*, discuss the pattern of “common areas at the heart”. They say, “No social group . . . can survive without constant informal contact among its members” (p. 618). To create a space that, effectively, promotes such contact, it must have three characteristics: it should be located at the center of gravity of the building, the paths in the building should lie tangent to it, and it should have an outdoor area and a space for communal activities. ‘Sitting circles’ is another pattern, which follows the same characteristics, to form an effective sitting arrangement for people

to interact. In the pattern ‘alcoves’, the book says: *“To give a group a chance to be together, as a group, a room must also give them the chance to be alone, in one’s and two’s in the same space”* (p. 829). Family members want to be together, but, at the time, they all wish for some level of privacy as well. A common area should provide them with a quiet place, where one or two people can interact, privately, without having to leave the entire group [22].



Figure 6. Main courtyard with fireplace during the winter season [23].

The Barood Khana Haveli has all these three patterns, effectively (Figure 5). The courtyards lie at the center of gravity of social life in the haveli. Sitting circles formed inside the main courtyards are such that paths touch them at a tangent, so that people passing by interact with the circles but do not cut through the sitting arrangement. In the same courtyards, benches and a swing are placed close to the wall, separate from the sitting circle that provides a quiet place for anybody who needs privacy from the group.

The courtyard and the terraces are used for many social events, such as wedding ceremonies, musical evenings, dinner parties, and shooting of music videos (Figure 7). People, other than the residents of the house, use the house to hold their social gatherings, upon permission from the owner. This haveli has, also, become a heritage site because of how well it depicts the traditional architecture of the city. The owner of the house allows guests to visit the place, for the purpose of learning.



Figure 7. Courtyards decoration during social events [23].

4.1.5. Comfort

Migration is a strategy, in which the residents move from one zone to another, to achieve thermal comfort [24]. During the summer season, the basement and the courtyards of the haveli are cool in the daytime, and at night the terrace and rooftops allow the cool breeze to help remove heat from the building. In the winter season, the roof and the courtyards have maximum exposure to the sun during the day, and at night the first floor is occupied because of the warmth it had from being occupied from the sun (Figures 8 and 9).

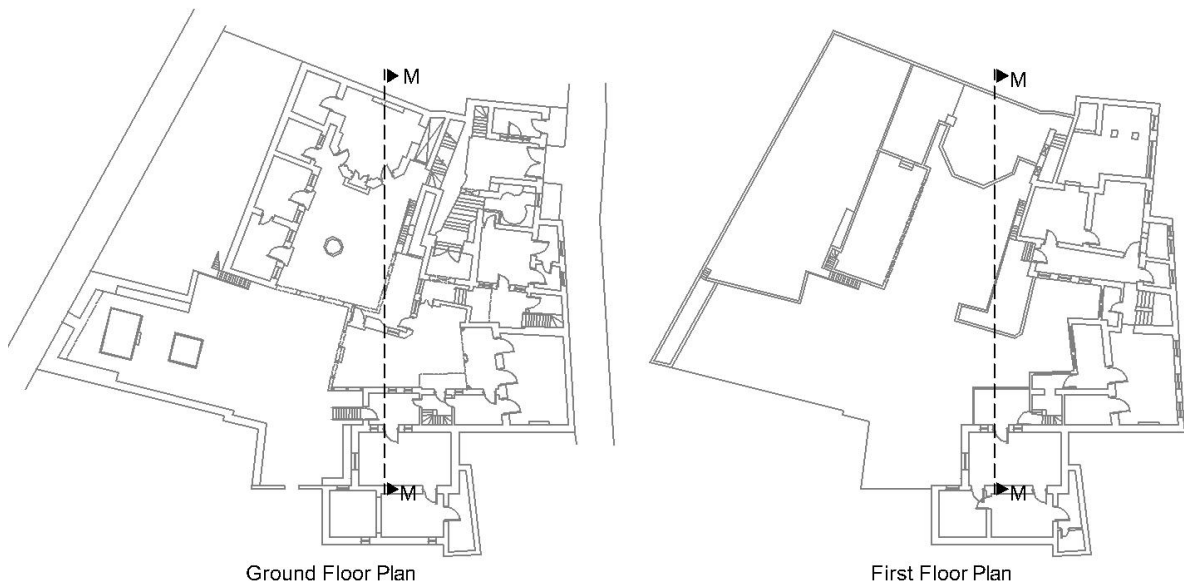


Figure 8. Plans showing section line MM for migration strategy.

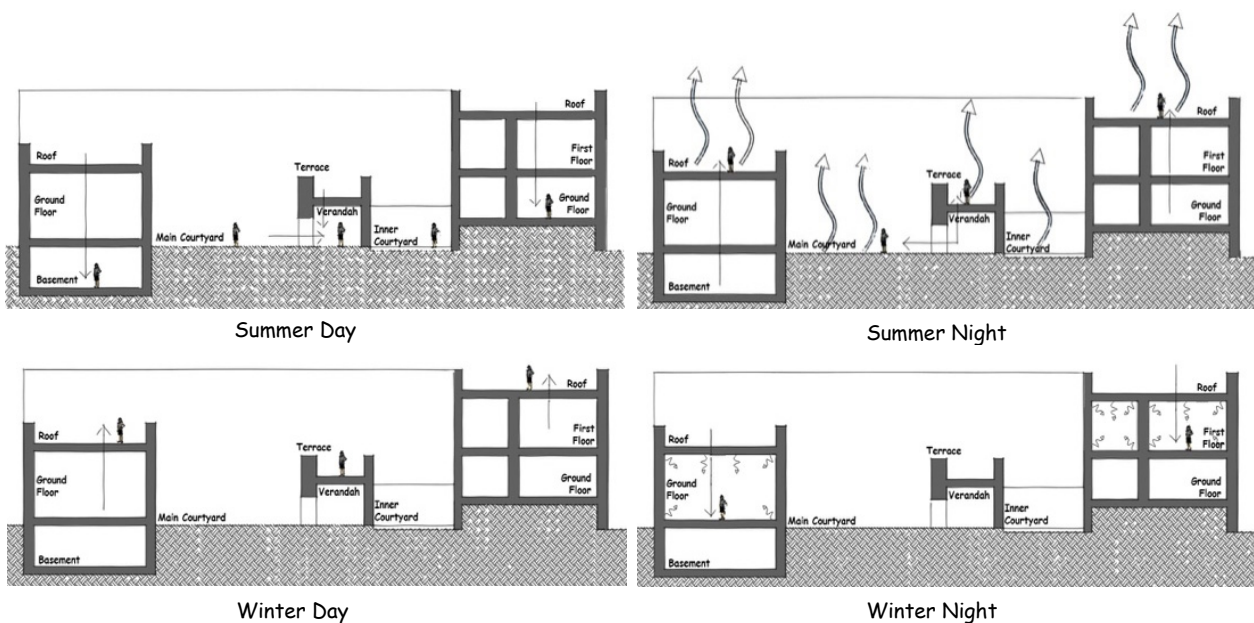


Figure 9. Migration strategy in Summer and Winter (section MM).

Currently, migration is not practiced in the courtyards, terraces, and interior rooms. Air conditioners and heaters have been installed inside, which make migration unnecessary. Other passive techniques maintain thermal comfort in the house, which is why the need to run these machines is minimal.

Jharokas (balconies) are semi-covered spaces, covered with *jalis* (screens), from where the residents are able to enjoy the breeze, without having to face the scorching summer sun [25]. The *jalis* themselves cannot produce cooling, but their intelligent use prevents glare and allows daylight and air to enter. The prevention of direct solar radiation keeps the interior spaces cool. *Beramdahs* (verandahs) provide shaded spaces that connect a person to the outside, with protection from extreme weather conditions. Besides these permanent features, the *haveli*, also, has movable shading devices. Screens made from cane serve the purpose of curtains. In winters, to avoid heat loss through the openings, windows are closed with solid wooden planks. Vines covering the *jharokas* respond to the climate, providing full coverage during the summer, with their foliage, and allowing the winter sun, by shedding their leaves.

The fountains and pools in the courtyards cause evaporative cooling. The swing in the main courtyard allows the user to experience a light breeze, with its gentle movements during the warm and humid times of the year (Figure 10).



Figure 10. Swing in the main courtyard [23].

Cross-ventilation is a significant cooling strategy in warm climates because, other than removing heat from the environment, it creates a feeling of cooling, by increasing the rate of evaporation of people [24]. The *haveli* follows both cross-ventilation and stack-effect principles. In a situation where two openings are placed in the same wall, the interior air velocity is 22% higher than the outside air velocity. This results in a better rate of cross-ventilation and cooling [24].

The majority of the rooms in the house have two or more openings in the same wall (Figures 11 and 12).

Ventilators with high ceilings in the *sheesh mahal*, kitchen, verandah and bedrooms create stack ventilation (Figure 13). The warm air rises and escapes through the ventilators and the cool air enters the room through the windows.

The walls of the *haveli* are three-feet thick, which provide insulation. The exterior walls are, mostly, painted white in color, while some are beige. The light colors of the walls reflect maximum radiation from the sun.

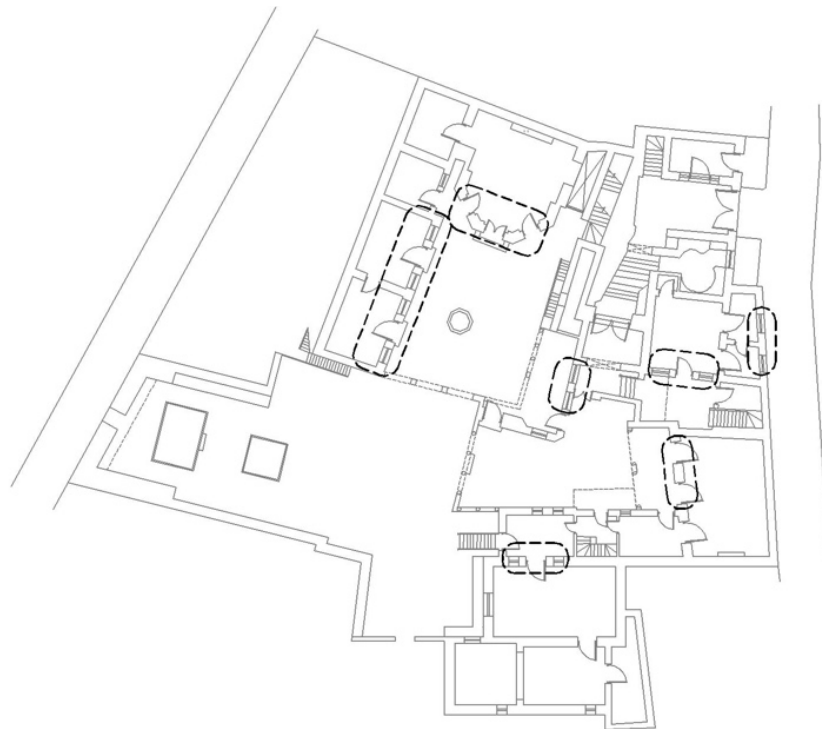


Figure 11. Ground floor plan, showing two or more openings in the same wall.



Figure 12. First-floor plan, showing two or more openings in the same wall.

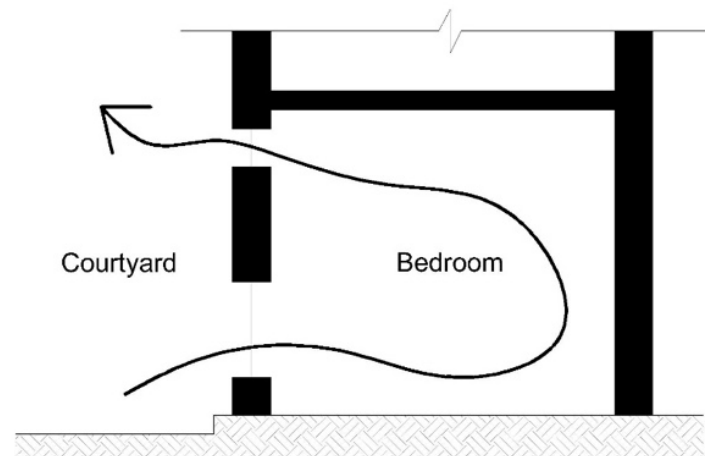


Figure 13. Stack effect in Barood Khana Haveli.

4.2. Typological Level

The typological level is a way to compare the traditional and modern-day typologies and analyze the adaptation of historically situated building types, which can evoke a sense of history, community, and place. It is not about, merely, replicating the historical form but rather creating something relatable and new. Through biophilic design, buildings connect users to the forms of the natural world, fulfilling our primitive need to connect with nature.

4.2.1. Sense of History, Community, and Place

The house is an example of local authenticity. It depicts the uniqueness of the sub-continent, through its use of building materials, passive design techniques, accommodation of social structure, and building type. Rejecting the standardization trend and refusing to follow the westernized single-family-house type, the house is able to well represent the time in which it was created, while, also, being able to fit in with the present. The design of the house respects history, by following the time-tested architectural type of a courtyard house. This haveli does not have any changes made to its design that might appear as unfamiliar and has been able to, efficiently, accommodate developing advancements in lifestyles, such as the use of the car, need of office space, and addition of split-air-conditioning units.

4.2.2. Building Type

The Barood Khana Haveli is based on the traditional courtyard-housing type of the region. The typical layout plan of a haveli has been transformed, to meet the needs of this particular family. Over time, the house has been able to adjust well with the changes that have occurred in the family setup, advancement in technology, and personal taste of the users.

4.2.3. Layout

Christopher Alexander and their colleagues discuss the pattern ‘courtyards which live’ in their book *A Pattern Language*. Courtyards in modern buildings become dead spaces because of no distinction between the inside and the outside, an insufficient number of doors opening into the courtyard, and courtyards that are cordoned off [22]. To overcome these problems, they suggest a way to create courtyards that are alive.

“Place every courtyard in such a way that there is a view out of it to some larger open spaces; place it so that at least two or three doors open from the building into it and so that the natural paths which connect these doors pass across the courtyard. And, at one edge, beside a door, make a roofed veranda or a porch, which is continuous with both the inside and the courtyard.”

(p. 564)

The layout of the courtyards in the Barood Khana Haveli follows the above-mentioned pattern, as shown in Figure 14 below.

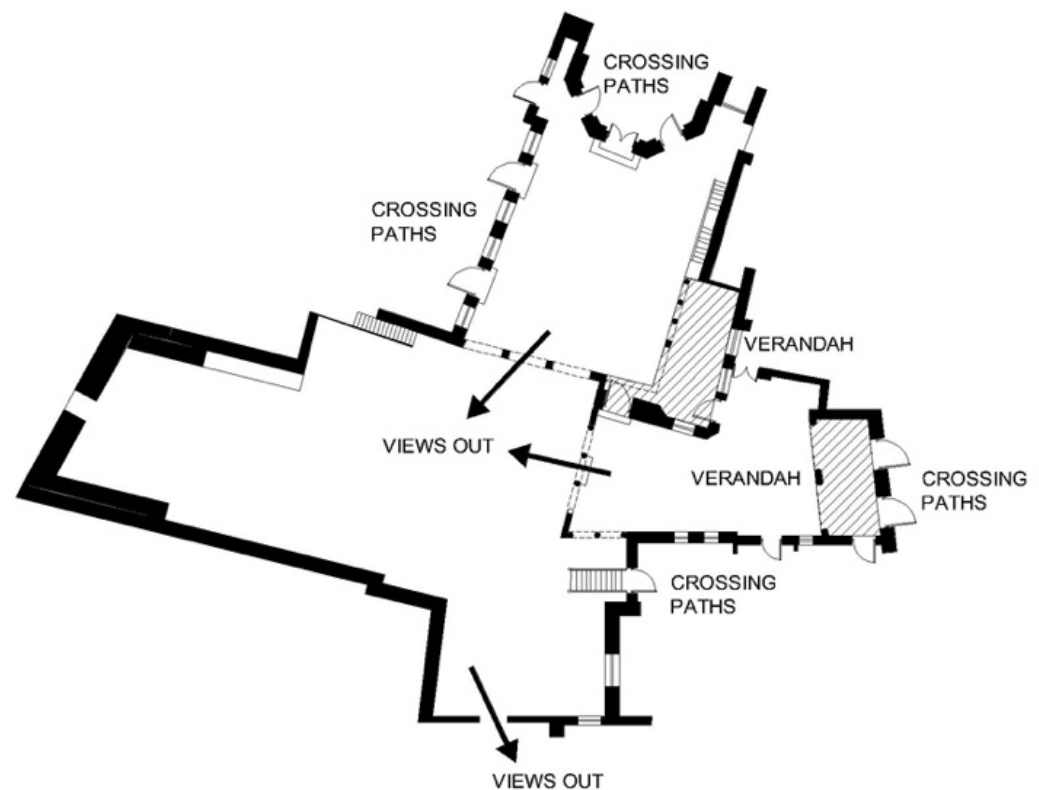


Figure 14. Courtyards which live.

Christopher Alexander and their colleagues, in the book *A Pattern Language*, also, discuss the pattern of intimacy gradient. They say,

“Unless the spaces in a building are arranged in a sequence which corresponds to their degrees of privateness, the visits made by strangers, friends, guests, clients, family, will always be a little awkward”

(p. 610)

In this haveli, a definite gradient from formal spaces to informal spaces can be observed (Figure 15). The entrances lead to the main courtyard and the office space, which are more formal areas. Further into the house are the more intimate inner courtyards and, then, the enclosed rooms. Moving to the first floor, the level of privacy increases. Slowly over time, the intimacy gradient has diminished.

4.2.4. Biophilic Design

Within the privacy of the haveli, the courtyards and the terraces create a calm and beautiful zone that provides relief from the busy urban streets of the Walled City. Plants, water, and animals are all part of the haveli design, bringing residents closer to nature. Trees, potted plants, hanging plants, climbers, floating lilies, and various other flowers make the outdoors part of the house. The shade from the trees and the transpiring leaves cool the courtyards, while the climbers serve the purpose of a green wall (Figure 16b). The wind blows through the leaves, so that the ear can hear them rustle, the eyes can visualize the coolness, and the skin can feel the breeze. Though the courtyards and the terraces are completely paved, and very minimal earth and grass are visible, the plants soften the overall look of the outdoor spaces. As the courtyards serve the role of circulation spaces as well, it is easier to keep the place clean, if it is paved. During rain, the wet floor reflects the building around it, the sky, and the sunlight (Figure 17). Few rooted plants are found in the

haveli, compared to the many potted and hanging plants (Figure 16a) that sprout colorful flowers during the spring. Reynolds (2002) says,

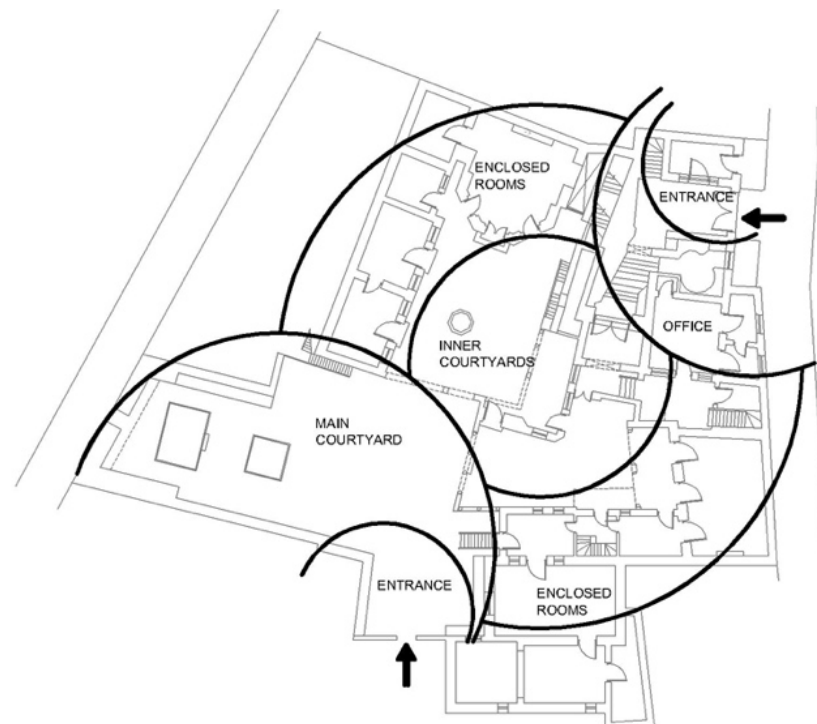
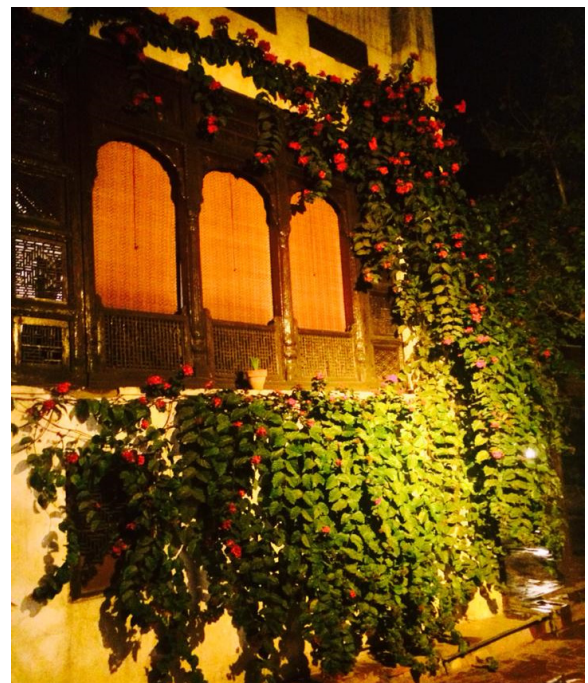


Figure 15. Intimacy gradient.



(a)



(b)

Figure 16. (a) Potted and hanging plants and (b) climbers [23].



Figure 17. Courtyards after rainfall [23] (left: main courtyard; right: inner courtyard).

“Sometimes vines are seen as harbors for mosquitoes or other undesirable insects, unwanted birds, or even for rats. This may explain why so many courtyards contain many potted plants but few rooted ones.”

(p. 74) [26]

One tree in each courtyard and three shrubs in the main courtyard provide partial coverage (Figure 18a). The heavy foliage during the summer cools the benches, swings, and other outdoor furniture, located below. During the winter, the foliage thins out, allowing sunlight to filter through the leaves, creating various shadows on the paved floors.



(a)

(b)

Figure 18. (a) Trees in the main courtyard and (b) bird nests [23].

The haveli is home to many animals, including birds, fish, and dogs. Bird nests are decorated on the walls, from where their chirping can be heard (Figure 18b). The rectangular and octagonal pools, with circular fountains in the center, are geometric forms within which the lilies and fish create an organic order (Figure 19a). These lilies and fish respond to the sun, the temperature, the time of day, and the year. Dogs are kept safe from the traffic on the streets (Figure 19b).



Figure 19. (a) Fish in pool, main courtyard, and (b) dogs resting in courtyard [23].

Two fountains are evident as water features, located in the main courtyard and the inner courtyard (Figure 20). The fountains in their mirror-like pools evoke all the senses. The running fountain and the ripples bring life into the courtyard, refreshing the mind and cooling the body. At night, the building around the courtyards obstructs the lights from the street and the neighboring houses, offering a darkened courtyard that allows a view of the moon and the stars (Figure 21). Fruit, such as oranges, grapes, jamun, and mulberry, are grown inside the haveli, bringing delight to our sense of taste. The presence of nature is central to the house, thus making it possible for everyone to benefit from it, from almost anywhere in the house.



Figure 20. Fountains and pools [23] (left: main courtyard; right: inner courtyard).



Figure 21. Night sky from courtyard [23].

5. Conclusions

Originated in the Indus valley civilization, the time-tested traditional courtyard house is one of the most successful models of climate-responsive architecture and is relevant to the socio-cultural context of Pakistan. The research concludes that Barood Khana Haveli, a representative of the traditional courtyard house of Lahore, fulfils the criteria of Deep Beauty, on functional and typological levels. The design of the haveli can be used to stimulate architects and designers to learn lessons from it, to create sustainable and life-enriching designs, appropriate for contemporary times.

Lying at the center of gravity, the south-facing courtyards of the haveli are well-lighted, fulfilling both psychological and physiological needs [27], by promoting the health and well-being of its occupants. The position and design of these courtyards, along with outdoor furniture, plants, and fountains, portray a vibrant cultural and social life. Most of the openings of the rooms are oriented towards the northern and southern sides, though solar heat gains are minimized, by using verandahs as buffer zones on the south. The basic construction materials used are locally available brick and lime, commonly found in traditional vernacular buildings of this region. These materials are well-suited to the regional climatic conditions due to their porous nature that creates a cooling effect in summer. Three feet thick walls provide insulation to minimize heat transfer. The design of the haveli provides flexibility, in terms of the configuration of spaces, to adopt a migration strategy for thermal comfort during day and night, in both summer and winter seasons. The extensive use of plantation and water bodies throughout the haveli causes evaporative cooling. Other design strategies for thermal comfort include cross-ventilation and stack ventilation, by providing openings on different levels in the same walls. Shading devices such as *jharokas* (balconies), covered with *jalis* (screens) and *beramdahs* (verandahs), protect the users from extremities of weather, while keeping them connected with outside.

Courtyard houses evolved as a typology in response to the climatic and cultural conditions of the context. Alexander et al. (1977, p. 514) suggested courtyards should be placed in such a way that there is a view out of them, to some larger open spaces, with at least two or three doors opening into them [22]. In the haveli, several rooms open into the courtyards on multiple sides, allowing residents to continuously pass through them and enliven them throughout the day. The verandas not only act as a buffer zone for thermal comfort but also provide a transition, through which people can naturally flow between the outside and the inside. The layout of the haveli has a sequence according to the degree of privateness, thus, positive social interaction is made possible. Furthermore, the presence of biophilia in the haveli is evident through the abundant trees, potted and hanging plants, climbers, floating lilies, and various other flowers and fruits. These elements enrich the outdoor experience and soften the image of the paved courtyards and terraces.

Henceforth, the traditional courtyard typology is a fundamental component of sustainable design that satisfies the functional and typological levels of Deep Beauty. For centuries, the courtyard has laid down its crucial role of distinction in society and the field of architecture. Even with the conclusion that the traditional courtyard house is more sustainable, it cannot be reproduced as such in contemporary times, due to several factors. The most significant limitations for middle-class houses include inadequate plot sizes, budget constraints, and strict by-laws of housing authorities [25].

Considering the energy crisis of the country and reliance on machines for achieving thermal comfort, the need of the hour is to revive the courtyard typology, in accordance with contemporary needs. This typology needs architectural reinterpretation, without unsettling the traditional and regional concerns. The contemporary approach to courtyards challenges a multiplicity of functions, creation of adaptable socio-cultural and recreational spaces, as well as flexibility to interchange and alter spaces. The Barood Khana Haveli stands as an effective and sustainable model for architects and designers, so, the design strategies and lessons learned from this research can be used to create life-enhancing architecture in contemporary times. The significance of courtyards needs to be redeveloped, applying it

effectively not just for its symbolic meaning or aesthetic appeal, but implementing it to its full potential for sustainable, life-enriching designs.

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