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Original Research Article

Biophilic Reading of the Livable Landscape through the Courtyards in the Old Houses of Qazvin*

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Abstract | The courtyard holds a special and important position in the spatial structure of housing as the center of shared activities, influencing a large part of the house's functions. In the Iranian house, the courtyard, as a place of life and a livable landscape, appears as a microcosm within the larger world. The layout of the house begins from the courtyard, and the status and rank of the surrounding enclosed spaces are determined by their relationship with the courtyard. This paper interprets the livable landscape of the Iranian house courtyard from a biophilic perspective and evaluates the livability of courtyards in historic houses in the old fabric of Qazvin city. The research adopted logical and deductive reasoning, supported by the simulation of selected house samples using Depthmap software. The evaluation and analysis were carried out using a comparative reading of the samples based on combined indicators of livable and biophilic landscapes across three dimensions: environmental, physical, and functional. The results indicate that courtyard geometry, followed by spatial location (due to its impact on the extent of interior views), is the most important factor in this interpretation, according to software output values. The number of open spaces has a greater influence on the spatial cohesion index, while area is identified as the least significant factor in this assessment, as its effect depends on other factors (geometry, location, and number).

Keywords | *Livable landscape, Biophilic, Courtyard, House, Qazvin.*

Introduction| Neglect and lack of attention to the peaceful coexistence of humans, housing, and nature have led to the degradation of the quality of human-made environments and a failure to meet the spiritual and psychological needs of today's urban residents. The rapidly increasing demand for housing due to urban population growth in recent decades has resulted in extensive construction and changes in housing patterns. On the other hand, the verticalization of living spaces has further distanced humans from the earth and nature, which has led to a decline in social relationships and vitality, disrupting housing livability. In this context, biophilic design, which can reduce stress, improve quality of life, and conserve energy, has gained increasing importance with urbanization. Its goal is to empower every user to access desirable and high-quality housing that meets human needs. While the reduction of landscape quality and the shrinking of landscape areas in contemporary housing is taking place, often under the assumption that they are unnecessary, landscape-like spaces in historic houses and the integration of landscape and housing have provided a livable refuge that embodies the components of biophilic landscape and architecture as an organic form. "The historic house, by guaranteeing a sense of security, enclosure, and being surrounded, is considered a living entity with a symbolic maternal function that, as a place of human residence, is more than just a physical body" (Varmaghani, 2022, 176). The Iranian courtyard, with its introverted design, use of natural elements such as water and plants, natural light and ventilation, has always played a central role in family life, social interactions, creating multi-sensory and therapeutic spaces, and providing quality of life and mental health for its residents. The courtyard, which creates a semi-open space at the heart of the house, has a direct connection to nature and, due to the special type of emotional and social experiences at this point of connection and interaction, has become part of the residents' identity and collective memory, providing a refuge from the outside noise, and a place for contemplation and tranquility. In this research, the term "landscape" refers to the courtyard and semi-open spaces connected to it, such as the veranda, as well as rooms and halls that have views toward it. The courtyard and the views toward it are examined from open, semi-open, and covered spaces. This study seeks to clarify and prioritize the common indicators of livability and biophilic theory at the courtyard spatial scale, relying on a comparative reading of

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the spatial and physical elements of historic houses. It draws on the knowledge that the theory of livability, especially from the environmental dimension, shares many common aspects with biophilic theory (nature-friendly). The research question is: How is the courtyard, as a livable landscape in the historic texture of Qazvin, interpreted and evaluated from the perspective of biophilic indicators? And what are the factors influencing this interpretation? The research approach includes both quantitative and qualitative aspects, using a combination of descriptive-analytical methods and logical and deductive reasoning, conducted in three main steps: theoretical studies on housing, alignment of livability literature with biophilic theory components, and analysis of theoretical and syntactic indicators based on space syntax theory in a comparative reading of selected samples from historic houses in Qazvin's old urban fabric.

Research Background

Previous studies on the biophilic approach, especially regarding livability, have mostly focused on urban topics, with limited attention given to landscapes and open spaces within the built architectural environment. Among related research examining landscapes in architectural spaces, Dami & Esmaeeldokht (2023a) studied biophilic landscaping in the open area of the Autism Charity Center in Fars Province. They aimed to provide biophilic landscape patterns suitable for children with autism and demonstrated that, due to the differing sensory stimuli effects on autistic children, typical biophilic landscape models suitable for the general population cannot be directly applied as therapeutic landscapes for autistic children. Yazdanirostam et al. (2023) modeled the theoretical relationship between biophilic components and the efficiency of intermediate spaces in residential complexes, arguing that these spaces add optimal features to residential environments. Bitaraf et al. (2018) examined the biophilic approach as a means to improve the quality of life in residential complexes, showing that connecting humans with nature creates higher-quality spaces that respond adequately and diversely to the physiological and psychological needs of users. Dami & Esmaeeldokht (2023a) also explored biophilic therapeutic landscapes for educational spaces for autistic children through quantitative and qualitative exploratory methods and tested proposed strategies. Tondrosaleh et al. (2023) prioritized biophilic architectural factors influencing stress reduction in housewives in Shiraz residential complexes, finding that refuge, presence of water, and non-rhythmic sensory stimuli were the most effective factors, while non-visual connections to nature were the least effective. Although urban livability and its components have been extensively studied, architectural-scale research remains limited. Radaei et al. (2022) investigated ecological and livability approaches in native houses of Yazd's historic texture, suggesting that revitalizing ecological rationality principles at multiple scales can enhance the livability of contemporary urban textures. Padashi Amlashi et al. (2021) analyzed indigenous architecture to propose livability indicators in Amlash city, concluding through statistical analysis that the environmental dimension holds the highest priority for promoting housing livability based on Amlash's native architectural patterns. This study, by referring to both livability and biophilic theories and focusing on their shared aspects, targets landscape spaces at the housing scale. It specifically analyzes the courtyard as a livable landscape in the old texture houses of Qazvin, relying on space syntax methods for evaluation.

Research Methodology

The research methodology consists of three main stages: literature review, field studies, and quantitative and qualitative data analysis. In the first stage, information was collected in the domain of research literature to explain and categorize the objective and subjective indicators of the biophilic approach in architectural design, as well as the definitions and concepts of habitability and related theories, through a literature review. In this stage, the reciprocal relationship between biophilic and habitability indicators, as well as the goals and emphasized aspects of these two approaches, was examined. In the second stage, field studies were conducted to identify patterns of open spaces in historic houses within the study area (the old texture of Qazvin city). In the third stage, quantitative and qualitative data analyses were performed through a comparative reading of landscape elements and open and semi-open spaces of the houses. This was done by analyzing the relationship between humans and nature, the relationship between open and enclosed spaces, and by examining social patterns in architectural and landscape plans using Depthmap simulation software, based on the research components. This analysis leads to an interpretation of the habitability landscape in the semi-open areas of historic houses, grounded in biophilic design principles. The sampling method was purposive so that the spatial organization and morphological diversity of open spaces in the selected historic houses could be more comprehensively explored and analyzed based on the indicators derived from the literature and the biophilic landscape model. Since Depthmap software analyzes the meanings and social organization of space based on the spatial organization and form of architectural and urban plans, diversity in the elements and geometric shapes of courtyards and semi-open spaces was considered. To examine the role of courtyards in spatial configuration, among the six selected houses, one (Amini House) has four courtyards, one (Beheshti House) has three courtyards, one (Behrouzi House) has two courtyards, and three houses (Nabavi, Yazdi, and Zaeim) each have one courtyard. This selection reflects the predominance of single-courtyard houses in the old texture. The courtyards in the latter three houses occupy different positions relative to each other within the plan organization. Additionally, the floral motifs and decorations in these houses are among their prominent features.

Theoretical Foundations

• Biophilic design

Based on the biophilic theory, human beings are naturally attracted to living organisms, plants, and animals, and humans have an inherent need and desire to connect with the natural world. In other words, there is an innate affinity and bond between humans and other living systems (Kellert, 2012, 35). Biophilia is realized and manifested in human-made environments to facilitate humans' connection with nature. This approach encompasses various aspects of nature, including morphology, essence, meaning, sensation, and environmental metaphors. Its goal in the built environment is to reestablish positive relationships between people and the natural environment, and specifically in architecture, to strengthen the connection between building users and nature (Kellert et al., 2011). Biophilic design involves two main approaches: direct and indirect use of nature (Ryan et al., 2014). In the first approach, the direct presence of natural elements in the built environment is utilized, such as plants, natural light, natural ventilation, replacing synthetic materials with natural materials in construction, and using images, symbols, and signs of natural landscapes in interior architecture, façades, and spaces (Bitaraf et al., 2018, 337). The second approach initially studies the geometric and complex patterns of natural elements and then applies them in architectural or structural design, with its perception being indirect and subjective (Tardast et al., 2020, 127). Therefore, biophilic architecture model's nature in two forms: direct (natural elements) and indirect (artificial elements) (Varmaghani, 2023b, 5). Kellert identifies six attributes in the practical application of biophilic design: environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships, and evolved human-nature relationships (Kellert, 2012: 7). Natural patterns and processes, as components of biophilic design, are shaped through order within complexity, creating mysterious and discoverable environments, attractiveness and beauty, and connection with geographical and historical contexts. Kellert's biophilic indicators demonstrate that natural features, forms, and processes—such as climate, sunlight, plants, landscapes, and green views—are the most prominent elements of biophilic design (Zhong et al., 122). For example, maximizing daylight in space design (environmental features), simulating and imitating natural forms in building façades and interiors (natural shapes and forms), evoking diversity and attraction in the experience of natural environments, spatial arrangement and lighting through the intertwining of light, space, and material (light and space), and designing connections between the building and the geographical, ecological, historical, and cultural characteristics of the site (place-based relationships) are among the strategies of nature-friendly and habitable design (Yazdanirostam et al., 2023).

• Livability

Appleyard (1981, 65) was the first to use the term "livability" specifically in spatial domains and emphasized that the physical characteristics of spatial environments continuously improve the livability of places. He also asserted that livable places are safe, private, and free from pollution and congestion. This concept is defined in the Jacobs and Appleyard statement as the possibility of comfortable living in the city (Carmona, 2019, 53). Webster's dictionary also defines livability as the suitability of a place for human habitation (Merriam-Webster, 1993). According to Veenhoven (1988, 254), livability is the judgment people make regarding the degree or level of desirability of the quality of life; however, it is not entirely clear which society is more livable, but it is evident that people are happier and more satisfied in communities where their needs are better met. Kevin Lynch (1981) emphasizes five elements of livability: vitality, meaning, adaptability, accessibility, and surveillance. According to Jan Gehl (2006), a livable place is chosen for lingering, staying, and meeting, rather than for quick passing through. Ley (1996, 475), in urban geography discussions, shows that livability is a multidimensional issue; the conditions of livability for residents of medium-sized cities are entirely different from those required in small towns. Livability is a human-centered perspective, encompassing a set of objective and subjective characteristics that make places attractive and desirable, and it can be assessed at various scales using diverse indicators. According to Newman (1999, 222), the livability of human environments cannot be separated from their natural surroundings. Lennard & Lennard (1987) introduced livability indicators such as a sense of enclosure, presence of green space, complexity, and diversity. Charles Landry (2000) considers useful population density, diversity, accessibility, safety and security, identity and distinctiveness, creativity, communication, and interaction as criteria for livability. Livability is a concept focusing on the habitability of a place, meaning its ability and capacity to meet the residents' material and immaterial life needs to improve the quality of life. Therefore, it is interpreted as "living conditions" that explain the biological capabilities available in the environment. The American Institute of Architects identifies livability criteria, including human-scale design, providing choice, creating identity, preserving views, creating interactive spaces, and flexible spaces with functional diversity. The World Health Organization defines four fundamental conditions for livability: safety, health, comfort, and convenience (Liu et al., 2020).

The UK offers a more precise definition of livability, emphasizing cleanliness, safety, and the presence of plants in the local environment (Hahlweg, 1997). Livability focuses on quality of life at the local level, reflecting comfort, health, spatial quality, accessibility, environment, and aesthetic quality. Robert Cowan defines a livable place as a suitable place for living

(Cowan, 2005, 44), while Casellati considers it the individual's experience of their living environment (Casellati, 1997, 225). Thus, livability is related to residents' satisfaction with both the objective and subjective aspects of housing (Fig. 1).

• **Space syntax**

The application of space syntax theory lies in revealing and understanding the social logic embedded within architectural configuration (Hillier, 2007, 77). This theory considers pedestrian movement as the central and crucial intermediary concept in spatial configuration. Hillier defines a set of spaces, regardless of complexity, within a spatial hierarchy that forms based on movement, influenced by the permeability, attractiveness of spaces, and their functions (Farshidi et al., 2022, 113). In this theory, spatial configuration is regarded as the primary factor predicting pedestrian passage, focusing on how individuals move and the relationships between environmental elements and, more broadly, the spatial configuration (Behmanesh et al., 2023, 51). Essentially, this theory distinguishes between spaces and paths and ranks them from the most integrated to the most segregated; the more integrated a space or path is, the easier it is to access (Varmaghani, 2023a, 204). In the space syntax method, three indicators—connectivity, depth, and integration—are used to examine the physical and social characteristics of samples (Karbasi, 2023, 6). Depth refers to the separation of a space from the overall configuration and the segregation between public and private realms, which also increases the degree of spatial privacy (Griffiths & Vaughan, 2020, 492). Connectivity indicates the number of direct accesses leading to a space; it counts the number of lines connected to each space or, in other words, the number of immediate neighbors directly accessible from a given space. Integration of a point reflects the extent of its connection to the overall structure or its subsets. An integrated space achieves access to the greatest number of spaces with the least change of direction, whereas the greatest fragmentation or change in direction results in lower integration (Vaitkeviciūte, 2019, 13). Visibility graph analysis (Isovist) refers to the amount of visible area perceived by a person located in a spatial step within the environment. This indicator is measured stepwise; at each step, the exact visual field of a typical human is determined, allowing analysis of the spatial area visible to an observer at each step. Therefore, a higher Isovist value corresponds to greater visual openness and spatial integration (Hillier, 2007, 108). Observer circulation refers to movement patterns within space and the likelihood of passing through each spatial gate. A convex space is defined as a space without obstacles, from which the entirety of the space is visible from any point within it (Hillier & Hanson, 1984, 104). The relationship between biophilic and livable landscape variables and the application of space syntax theory in analyzing landscape livability is presented in Fig. 2.

Introduction of Studied Samples

The study population consists of houses in the old fabric of Qazvin, located in the southern part of the city. Six mansions from the Qajar era in Qazvin were selected, representing configurations with four, three, two, and one courtyard(s). The Amini House, also known as Hosseiniyeh Aminiha, is one of the mansions in Qazvin that currently features four main courtyards and a narrow private courtyard providing access to the bathhouse. The Mahmoud Beheshti House, with three courtyards (Andarouni, Biruni, and servants' courtyard), is located on Molavi Street. The two-courtyard Behrouzi House is situated in Zargar Alley on Imam Street; its Andaruni courtyard contains wide and open spring porches on the eastern and western sides. The Nabavi House (Saad al-Saltanah), with one courtyard and a recessed entrance relative to the main passage, has a clear and well-defined spatial domain. The Zaeem House is divided into northern and southern sections on either side of its single courtyard in the current plan. The Yazdi House also has one courtyard and is located on Salehieh Passage. Fig. 3 illustrates the location of these houses within the old urban fabric, and Fig. 4 presents their spatial structure. A noteworthy feature in the decoration of these houses is the extensive use of vegetal motifs, which, along with the real presence of water and plants in the courtyards, clearly emphasizes the importance of coexistence with nature and the direct and indirect utilization of it (Fig. 5).

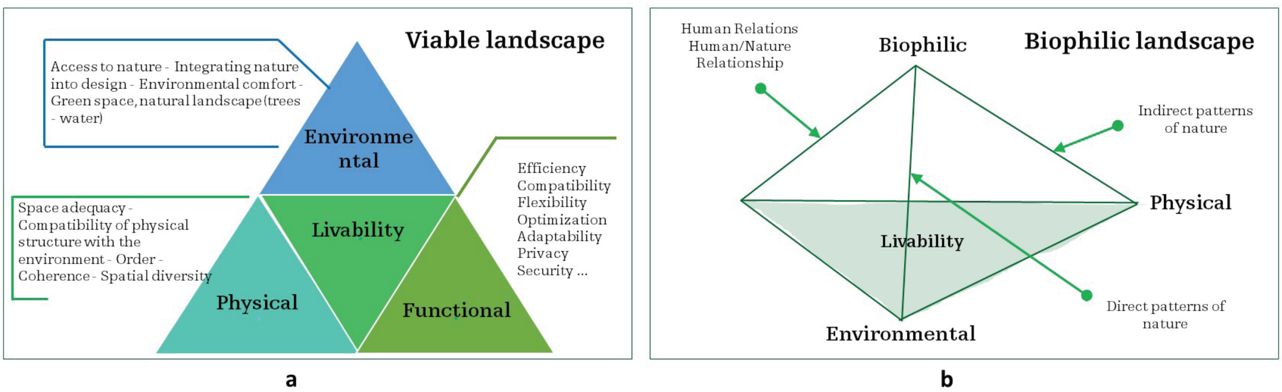


Fig. 1. a: Dimensions and indicators of the livable landscape; b: Combined livable/biophilic landscape. Source: Author.

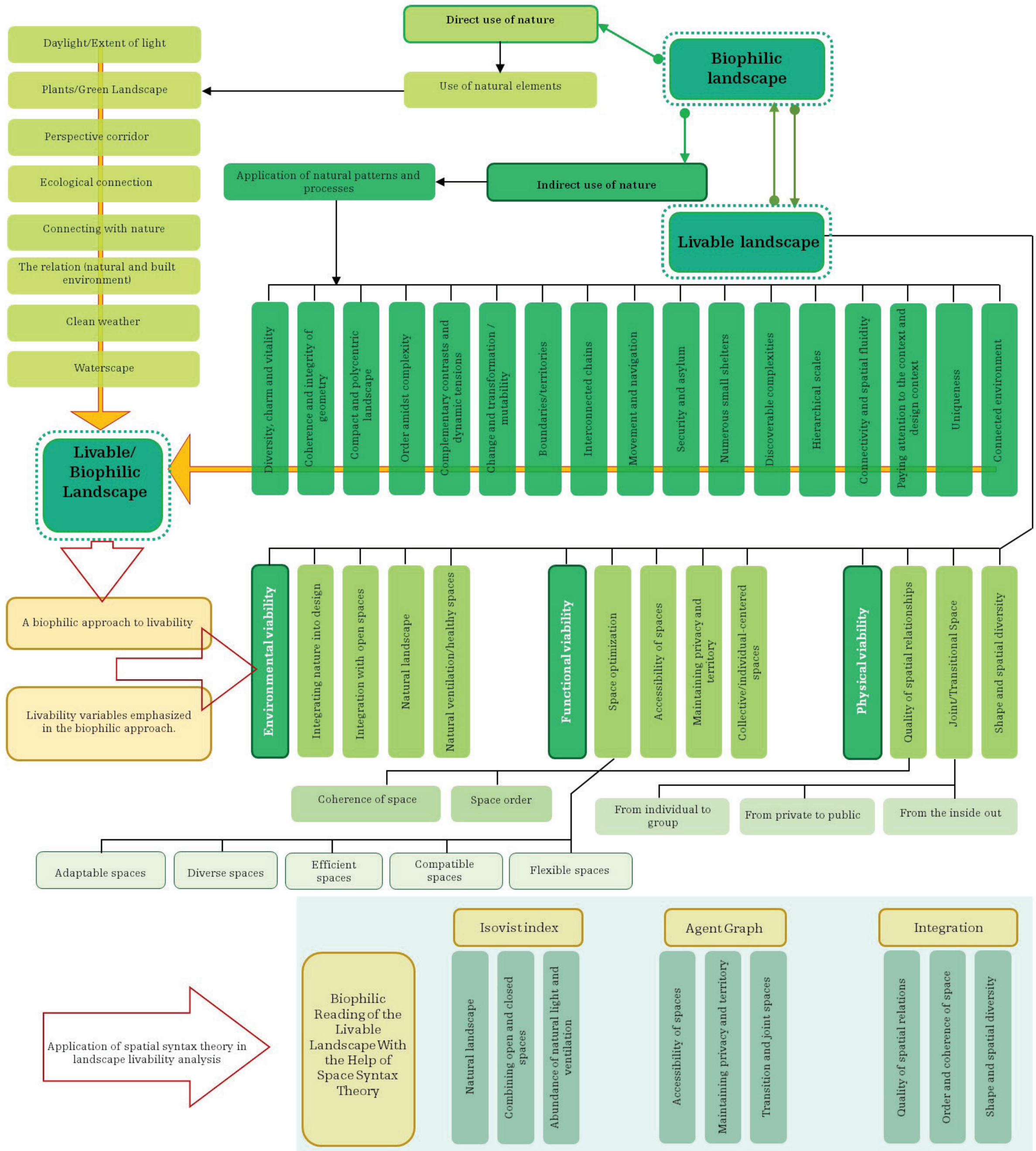


Fig. 2. Relationship among variables in the conceptual model of the study. Source: Author.

Research Findings

The literature indicates that the concept of livability encompasses multiple indicators and complex aspects across three dimensions: environmental, functional, and physical. The most tangible commonalities between the livability and biophilic approaches lie in the environmental dimension (access to nature – natural views), the physical dimension (order, coherence, and spatial diversity), and the functional dimension (spatial security through enclosure and preservation of privacy and territory). The environmental dimension was examined by simulating the Isovist index in the selected samples of house courtyards (Table 1). The color variations on the maps are used to display the level of visual field in each courtyard, with their numerical values measured in square meters using software. To ensure accurate comparison between samples and control for differences in house area, the percentage of each courtyard's visual field relative to the total area of that house was measured and considered as the evaluation criterion. For comparing the internal views toward the courtyards (views from rooms to the courtyard), the courtyard area must be subtracted from the total Isovist value. The remaining value and its percentage relative to the total area were calculated for each sample and listed in Table 1, with their analysis provided below.

The Isovist graph of the Amini House reveals the overlap of visual landscape perspectives of the three courtyards, due to the presence of a central open hall. Furthermore, despite

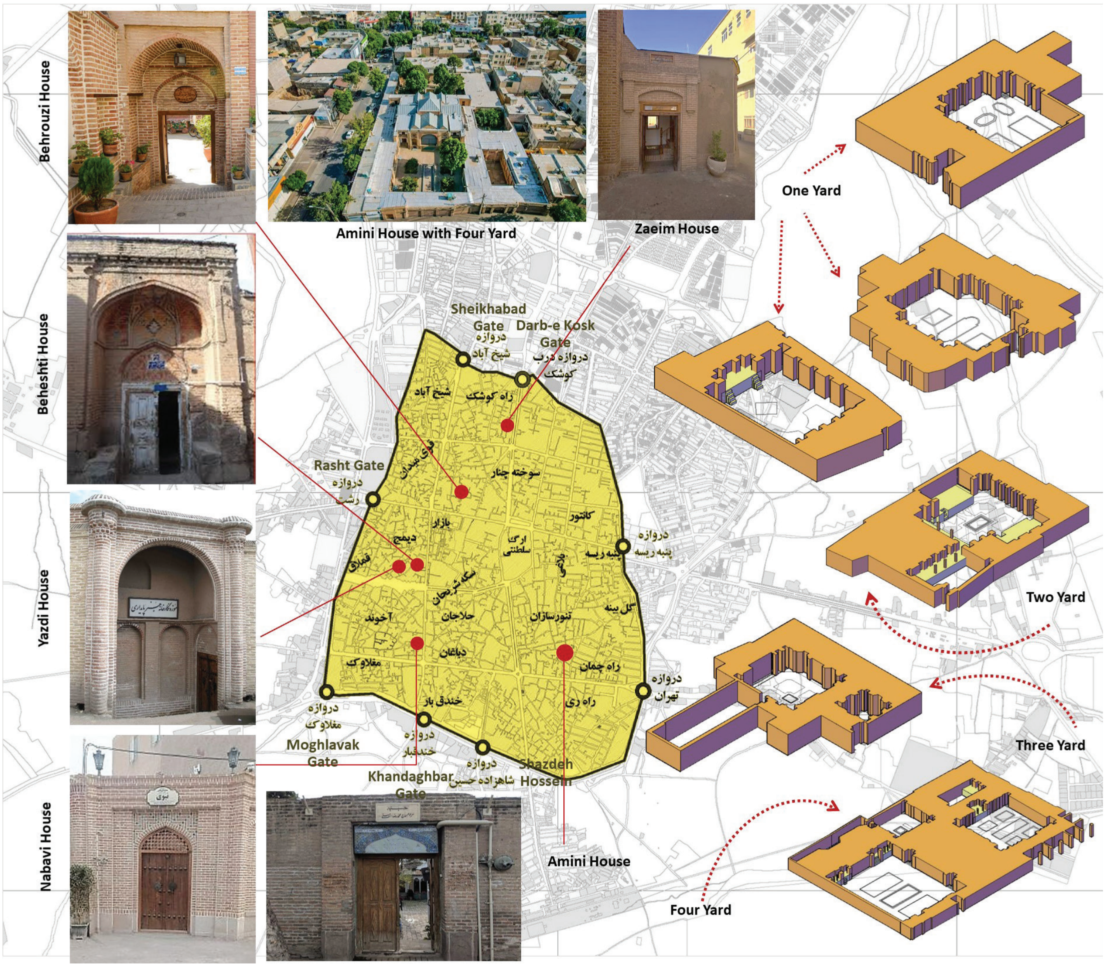


Fig. 3. Location of the studied houses within the old fabric of Qazvin city and the position of courtyards in 3D representations. Source: Author.

the differences in size between the inner (Andarouni) and outer (Biruni) courtyards, the interior visual fields (excluding the courtyard areas) in both spaces are nearly equal. This is attributed to the central placement of the inner courtyard, despite its smaller size, and the lateral placement of the outer courtyard, despite its larger size. In other words, spatial positioning plays a more significant role than size in shaping visual landscape perspectives. The central hall's exact location at the heart of the house, and its role in integrating natural views across the courtyards, further demonstrate the importance of the placement of landscape-defining elements within the spatial organization of the house. In the Beheshti House, the function of each courtyard is directly related to the extent to which the surrounding enclosed spaces benefit from natural views. The Isovist value of the inner courtyard (the private domain of the house), excluding the courtyard area, is considerably higher than that of the outer courtyard, owing to its multiple visual openings into indoor spaces. Additionally, the Se-dari room, located between the inner and outer courtyards, acts as a spatial buffer to create privacy, boundaries, and territorial definition, rather than facilitating visual continuity between landscaped domains. The geometric form of the inner courtyard in the Behroozi House is another factor, along with its location, that increases the area of interior spaces benefiting from natural views. The cruciform geometry of the courtyard—with its wide eastern and western open verandas (Bahar-khab) and a deep southern Iwan—allows for greater visual penetration into enclosed areas and enhances indoor-outdoor spatial integration. In contrast, the outer courtyard, due to its function and lateral positioning, has limited visual access, primarily toward the semi-open western façade (Iwan and corridor). The importance of geometry and spatial positioning is also evident in the Isovist analysis of the Yazdi House courtyard. Its cruciform shape allows the maximum level of visual penetration and natural landscape visibility (13.8% of the total house area), the highest among all the cases studied. A comparison of the Isovist data reveals that the interior spaces of single-courtyard houses have greater access to natural views than those with multiple courtyards. However, the total amount of natural landscape views in multi-courtyard houses may still offer more overall visual benefit. This comparison once again emphasizes the decisive role of spatial positioning. The convex space simulation maps and observer circulation graphs (Table 2) and the numerical values of the simulation (Table 3) were drawn and analyzed to interpret indicators such as spatial order and coherence, spatial diversity,

Fig. 4. Introduction of plans, courtyard locations, and images of selected samples. Source: Author.

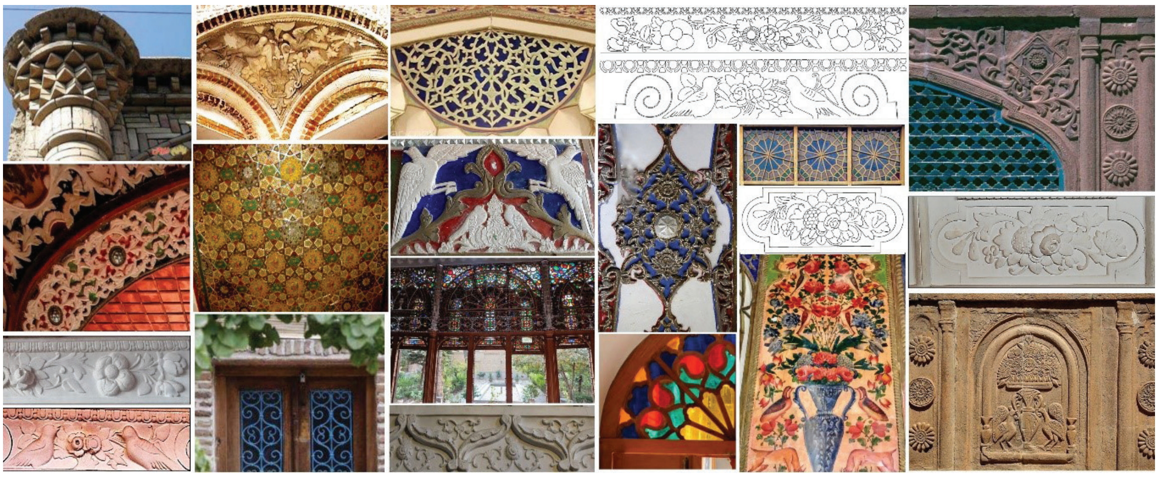
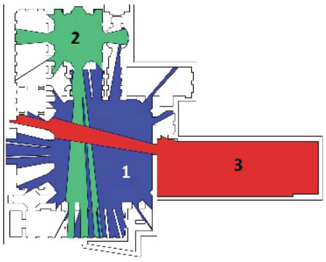
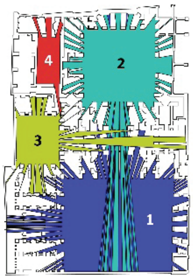
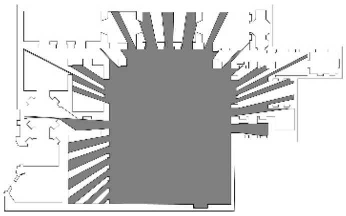
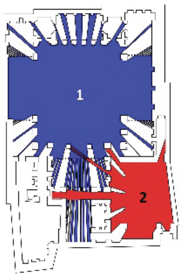
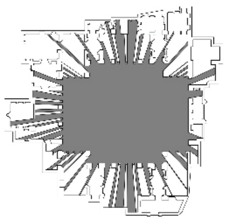
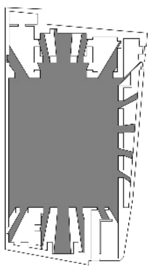


Fig. 5. Some decorative patterns of vegetal motifs in the studied houses. Source: Author.

and enclosure. Variations in map color on the convex maps represent differences in space integration values—warmer colors indicate higher integration, while cooler colors indicate lower integration. Similarly, in the observer circulation graphs, warmer and cooler colors reflect higher and lower probabilities of movement through each spatial gate, respectively.

Spatial openness of the main hall in the Amini House and direct access to the large northern and southern courtyards (the inner courtyard and Hosseiniyeh courtyard) result in maximum observer movement. Despite the multiple open spaces present in the Amini House, the location and geometry of some of these spaces, such as the kitchen courtyard and the bathhouse courtyard, reduce the role of open spaces in the accessibility of natural views and landscapes. Overall, in all six houses, physical enclosure of the natural landscape is observed to be more dominant than landscape accessibility, which causes even spaces immediately adjacent to the courtyards to be positioned in the deeper layers of the movement hierarchy within spatial movement graphs. Although the courtyards of the Amini House have relatively high spatial movement values, their

Table 1. Isovist shape simulation of courtyards and numerical values of this index with and without considering courtyard areas. Source: Author.

House	Figure	Yard	with considering courtyard areas	without considering courtyard areas
Beheshti		1	266.74 (38%)	129.04 (18.4%)
		2	96.17 (13.7%)	62.85 (8.9%)
		3	152.66 (21.8%)	27.57 (3.9%)
Amini		1	1117.66 (32.6%)	379.77 (11.1%)
		2	718.69 (21.1%)	340.6 (10%)
		3	306.28 (8.9%)	155.35 (4.5%)
		4	101.6 (2.98%)	23.82 (0.6%)
Nabavi		-	333.29 (45%)	103.72 (14%)
Behrouzi		1	514.82 (38.8%)	137.23 (10.3%)
		2	155.23 (11.7%)	55.11 (4.1%)
Yazdi		-	450.59 (47%)	132.68 (13.8%)
Zaeim		-	363.09 (61.5%)	81.29 (13.8%)

lateral positions reduce their visibility and optimal function. This condition is even more evident in the Beheshti House; for example, the very high observer movement in the lateral courtyard—which is completely detached from the overall geometry of the house—does not contribute to the visibility of this space and thus does not provide a livable landscape

Table 2. Convex space simulation map, agent graph, and numerical values of connectivity and integration of courtyards on the convex map ((C): Number of Yards' connection, (i): Yards' integration). Source: Author.

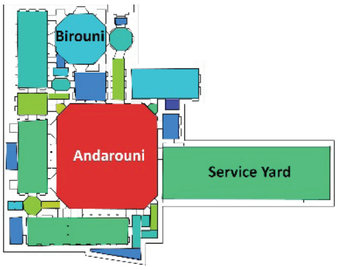
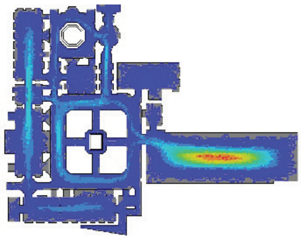
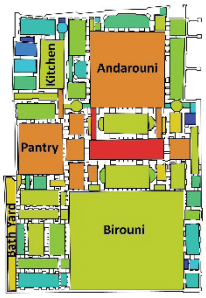
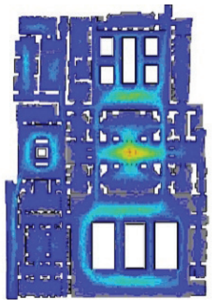
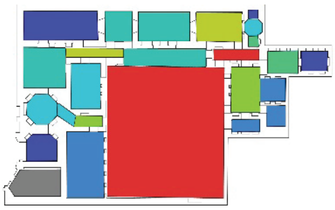
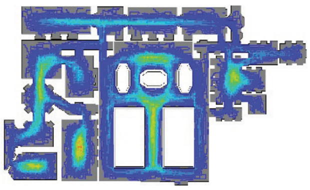
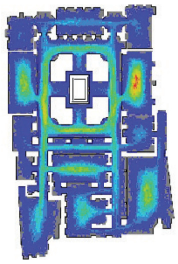
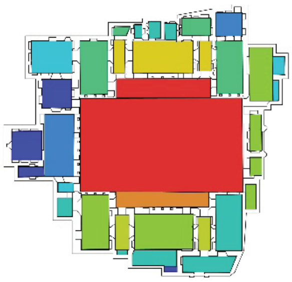
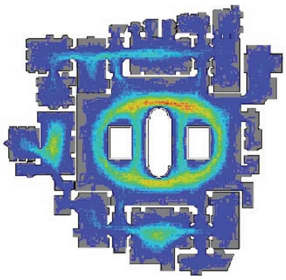
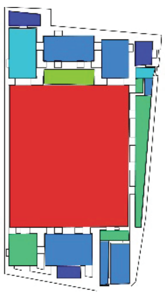
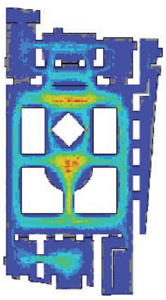
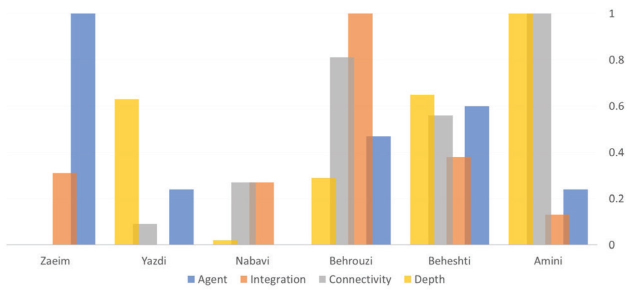
House	Convex space simulation map	Agent graph	Numerical values of connectivity and integration
Beheshti			C1=6, C2=2, C3=2 / i1=1.66, i2=0.81, i3=1.04
Amini			C1=4, C2=4, C3=3, C4=3 i1=1.09, i2=1.37, i3=1.34, i4=1.1
Nabavi			C=4/ i=1.67
Behrouzi			C1=6, C2=3/ i1=1.78, i2=0.84
Yazdi			C=5/ i=2.09
Zaeim			C=5/ i=2.09

Table 3. Numerical values of agent graph, integration, connectivity, and depth indices in the overall spatial configuration of the houses. Source: Author.

House	Agent	Integration	Connectivity	Depth
Beheshti	21.716	0.981	2.333	3.41
Amini	16.103	1.025	2.592	3.584
Nabavi	8.648	0.953	2.16	3.093
Behrouzi	18.887	1.127	2.482	3.226
Yazdi	14.076	0.888	2.055	3.399
Zaeim	30.372	0.964	2	3.078

Fig. 5. Comparison of syntactic index values in the studied houses. Source: Author.



for the residents. In contrast, the courtyards of the Behrouzi House, in addition to having favorable spatial movement values, provide appropriate accessibility for their surrounding spaces—especially the veranda of the outer courtyard and the eastern and western porches of the inner courtyard. The spatial movement graph reveals the high connectivity of courtyards to inner spaces due to the presence of direct corridors between enclosed and open spaces. Among the single-courtyard houses, the cruciform geometry of the Yazdi House courtyard and the dynamic layering of soft spaces (garden beds and fountains) in the courtyard of the Zaeim House have significantly increased spatial movement and enhanced functionality by creating multiple pause areas in this type of spatial organization. Analysis of the observer movement graph shows that biophilic indicators in shaping a livable landscape—such as accessibility from interior spaces, connectivity, and the degree of courtyard enclosure—depend on their location, the number of connected spatial chains, and the arrangement of landscape elements in the courtyards. Among these, the arrangement and placement of elements within the spatial configuration play a more influential role. Convex maps clearly show the impact of the number and positioning of courtyards on increasing spatial order and coherence, i.e., integration. The homogeneous distribution of open spaces in the Amini House among enclosed spaces increases connectivity and results in high integration (warm colors) in nearly all subspaces of this house. However, the presence of a central hall with maximum connectivity (8) in multiple directions and highest integration (red color: 1.57) plays a more effective role in the overall cohesion of the configuration through connecting the courtyards. In the Behrouzi House, the maximum overall integration (1.27) is mainly due to the inner courtyard's central location, while the outer courtyard, with low integration (dark blue color: 0.84), does not contribute to the overall cohesion of the house's spatial configuration. The convex map of the single-courtyard Yazdi House reveals another aspect of the livability component in landscape: connectivity and order/integration do not necessarily result from placing a large courtyard at the center surrounded by peripheral spaces. In Yazdi House, this leads to minimum connectivity (2.05), minimum integration (0.888), and increased depth (3.399). Even the Nabavi House courtyard, with its two-layered outer facade, provides higher integration and connectivity and much lower depth. Thus, two important indices in shaping the livable and biophilic landscape (enclosure and spatial order/cohesion) show an inverse relationship in the analysis of the houses: increasing integration (spatial coherence) accompanies decreasing depth (privacy and hierarchy). Fig. 6 compares the research indices across the studied samples.

Conclusion

A review of the literature and a comparison of the variables in the two approaches—livability and biophilic design—indicated that, to address the first research question, the three dimensions of environmental, physical (form), and functional aspects should be used as the basis for interpreting and evaluating the courtyard as a livable landscape from the perspective of biophilic indicators. In this study, the environmental dimension includes visual access to nature and natural views, which were assessed using the Isovist tool within space syntax. This tool measures the visual value and degree of openness and benefit of a space from environmental views by reading the area of the field of view from each point in the space. The physical dimension, encompassing spatial order, coherence, and diversity, was evaluated using convex maps. This map represents a partitioning and arrangement of convex spaces in the plan and, with the help of the integration (connectivity) index, assesses the cohesion and unity of the plan. It also identifies the distribution and spatial elements that organize the configuration. This index was employed to measure the role of courtyards in spatial distribution and plan coherence. In the functional dimension, components such as enclosure, privacy, and territoriality were examined using the observer movement index in space syntax. This index counts the probable passageways through each space and measures physical accessibility; it is directly related to the depth index and inversely related to the connectivity index in space syntax. In other words, reduced physical access is caused by deep spaces in the plan with few connections. This index in the present study evaluates the role of the courtyard in increasing or decreasing enclosure and physical accessibility. The answer to the second research question was clarified through the evaluation of samples. The Isovist index demonstrated that the geometry of the courtyard is an influential factor in the inside/outside connectivity and utilization of natural views. The cruciform (cross-shaped) courtyard pattern in traditional houses has a significant ability to enhance the indicators of a livable landscape. Adjacency and location are other effective factors in interpreting this kind of landscape; the central or lateral position of the courtyard notably alters the research approach's indices. The type, geometry, position, and transparency of the surrounding spaces (adjacency factors) clearly affect the courtyard's potential to create a livable environment. The results show that, contrary to the assumption that a larger courtyard provides a more desirable livable environment, correct positioning is more effective even with smaller areas. Comparison of the desirability of the number of courtyards in the houses revealed that the pivotal role of the open space in single-courtyard houses in providing natural light and ventilation, along with careful adjacency of surrounding spaces, increases the potential of a single courtyard to create a livable landscape and especially to maintain privacy, territoriality, and enhanced enclosure. However, the independent role of each open space in multi-courtyard houses in coherence, integration, and spatial diversity is considerably greater, contributing to the creation of a livable landscape from another aspect.

Declaration of No Conflict of Interest

The authors declare that they have no conflict of interest in conducting this research.

Endnotes

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