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Enhancing Well-Being in High-Rise Residential Buildings by Biophilic Design in Erbil, Iraq

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Abstract

Understanding how nature impacts mental health highlights the importance of biophilic design for high-rise residential buildings. Architectural solutions that connect residents with nature or incorporate nature-inspired elements are essential to elevate life quality and improve mental health. This connection is particularly important in rapidly growing cities like Erbil. This paper investigates the potential of biophilic design for improving well-being and promoting environmentally sustainable practices in designing high-rise residential buildings. A mixed-method approach was employed, combining a quantitative survey of 100 residents with qualitative analyses of five selected biophilic patterns for two case studies in Erbil city: Park View and Ganjan Life. The quantitative survey gathered residents' feedback, while the qualitative analysis involved on-site assessment of specific biophilic patterns (Visual Connection with Nature, Presence of Water, Biomorphic Forms & Patterns, Material Connection with Nature, and Prospect). The results indicate a statistically significant positive correlation between applying biophilic design features and the residents' enhanced mental health and well-being. The research revealed growing interest in biophilic design in urban housing as a valuable strategy for creating healthier and more sustainable environments. It delivers evidence of biophilic impacts in Kurdistan's high-rise housing, advancing salutogenic design scholarship and offering replicable metrics for similar fast-growing cities.

Keywords*:* Biophilic Design; Residential High-Rise Buildings; Mental Health; Well-being; Sustainable Architecture.

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1. Introduction

Humans generally feel more comfortable in spaces surrounded by nature, which plays a vital role in the built spaces (Totaforti, 2018). This suggests that people need daily contact with nature, and cities should not isolate them from the natural environment; by functioning as "unified entities" that organically integrate with nature, instead of acting as "barriers" (Newman & Matan, 2012). A home (resident), in addition to being a physical living environment, is also an "organic space" and—when well-balanced—even in high-density settings, can enhance housing quality, environmental satisfaction, and overall residential well-being (Gong et al., 2023). In these spaces, a natural living environment is preferred over an urban or built environment (Herzog & Bryce, 2007). Thinking about nature, therefore, has evolved into the concept of biophilic design as a viable solution to the current tensions between people and the urban environment, adding value and viability to residential design.

″The love for life″ is the original meaning of the word biophilia in the ancient Greek language (Berto & Barbiero, 2022). It literally shows the love of nature and the human desire to be that close to it, which formulated the biophilia hypothesis. In their study, Barbiero and Berto argued that humans have an innate tendency to affiliate with nature (Berto et al., 2022). Biophilic design incorporates patterns and natural components and features into the constructed environment, promoting comfort, cohesion, and efficiency. It enhances the physical and emotional well-being of human existence through encouraging harmonious relationships between people and the environment in the built environment (Ardiani, Prawata, & Sholihin, 2020). According to the Biophilia hypothesis, the positive effects of exposure to nature originates a biological bond between humans and the natural world (Kellert et al., 2011). Since everybody has the right to live in a good-quality residence that ensures health, safety, and happiness, as highlighted by the study by (Atmodiwirjo & Yatmo, 2011), biophilic design is widely adopted as a modern method in architecture for the solid foundation it lays for the development of healthy dwelling through employing artificial environmental design methods that harness the beneficial effects of nature, creating a healthier and more natural living environment (Gong et al., 2023). It also introduces a sustainable design strategy that reconnects people with the natural environment. Each one of the biophilic design definitions emphasizes the human-nature connection and the creation of a good place for people to live, which states its main definition (Zare et al., 2022).

This study examines the effective application of biophilic design in high-rise residential buildings in Erbil to enhance residents' psychological and physical well-being. Given Erbil's rapid urban growth and its shift from traditional courtyard housing to modern single-family houses and low-rise apartment buildings, and subsequently to contemporary widespread vertical apartment blocks with limited natural elements, the research aims to identify which biophilic elements are most relevant and how they influence users' satisfaction. This inquiry addresses a critical gap in the localized application of biophilic design within the specific urban-morphological context of Erbil.

1.1 Biophilic Design: Theoretical Background

Biophilic design has gained popularity in architectural discussions lately, but it has been around for a long time. Erich Fromm, a German-American humanistic philosopher, first used the word "biophilia" in the 1960s to mean "the passionate love of life and of all that is alive" (Akinyemi et al., 2024). The American biologist Edward O. Wilson later expanded on the idea, especially in his 1984 book Biophilia, where he proposed the biophilia hypothesis, which he defined as "the innate tendency to focus on life and life-like processes," which he used to define the word biophilia (Wilson, 1984).

Wilson based his hypothesis on evolutionary biology, comparisons between cultures, and psychological research that looked at how people feel about nature, including simple feelings like pleasure and safety and more complex ones like awe and fascination mixed with dislike (Viliūnas & Grazulevičiūtė-Vileniskė, 2022; Wilson, 1994). This theory posits that humans are genetically programmed to live in harmony with nature in a way that is good for their mental and physical health (Gong et al., 2023; Son & Lee, 2023).

Wilson collaborated with Yale environmental psychologist and social ecology professor Stephen Kellert in 1993 to publish "The Biophilia Hypothesis," which describes several beneficial ways that people respond to nature (Kellert & Wilson, 1993). Kellert developed the term "biophilic design," based on his work with Wilson, which indicates the incorporation of natural elements in buildings to enhance the human-nature connection (Söderlund & Newman, 2022). Kellert noted that there are many ways to strengthen this connection, such as bringing plants indoors, seeing pictures of natural scenes, or even using colors like green (Mousapour, 2024).

As biophilic design grew, it got more attention in the field of architecture. Researchers and practitioners saw its potential to make city life better by bringing back the connection between people and nature that has been lost in cities (Zhong et al., 2022). In this situation, it is still very hard to carefully think about, combine, and express "nature" in architectural spaces. Mousapour's study also shows that biophilic design can be used in many places, from buildings to cities and even whole regions (Mousapour, 2024).

There are many biophilic strategies that have been investigated, like using natural light, indoor plants, green walls, views of nature from windows, and using furnishings constructed from organic materials such as stone and wood (Samimi & Shahhosseini, 2020; Watchman et al., 2022; Yildirim et al., 2024). These strategies not only enhance the user experience, but they have also been shown to aid people in recovering mentally.

Numerous studies indicate that people prefer natural settings over artificial ones (Kellert et al., 2011). In a 2004 study, people asked to describe their ideal city often mentioned greenery and other non-urban features (Félonneau, 2004). Kaplan (2001) demonstrated that having access to natural views significantly increases the perceived value of a place, as reflected in the importance of reconnecting people with nature (Kaplan, 2001). In generalizing the concept of biophilic design based on these theories, biophilic design encourages the incorporation of natural elements and processes into the built environment as a source of inspiration for design (Kellert et al., 2011).

Browning and colleagues (2014) defined biophilic design as "the codification of human intuition for what makes a space a good place for humans", and in their publication "14 Patterns of Biophilic Design", they presented the relationships between nature, human biology, and the design of the built environment, shedding light on the significance of the human connection with nature in built environment (Browning, Ryan, & Clancy, 2014). These 14 patterns offer, in effect, a series of tools for understanding design opportunities and avenues for design applications that may enhance individual and societal health and well-being (Downton et al., 2017).
In this paper, five of these patterns are selected to study and investigate their impact on residents' health and well-being for the case studies that will be discussed. Table 1 shows and explains these chosen patterns, which are based on the work of Browning et al. (2014).

Table 1: Biophilic Design Patterns Used in This Paper.

Category	Pattern Name	Description
Nature in the Space	Visual Connection with Nature	Direct view of natural elements like plants, water, or landscapes.
	Presence of Water	Visual or auditory connection to water, such as fountains.
Natural Analogues	Biomorphic Forms & Patterns	Use of nature-inspired shapes, forms, and patterns.
	Material Connection with Nature	Use of natural materials like wood, stone, or clay.
Nature of the Space	Prospect	Open views and sightlines that create a sense of security.

As illustrated in Figure 1, the conceptual framework outlines the hypothesized relationships between biophilic design features (independent variables) and residents' well-being (dependent variables).

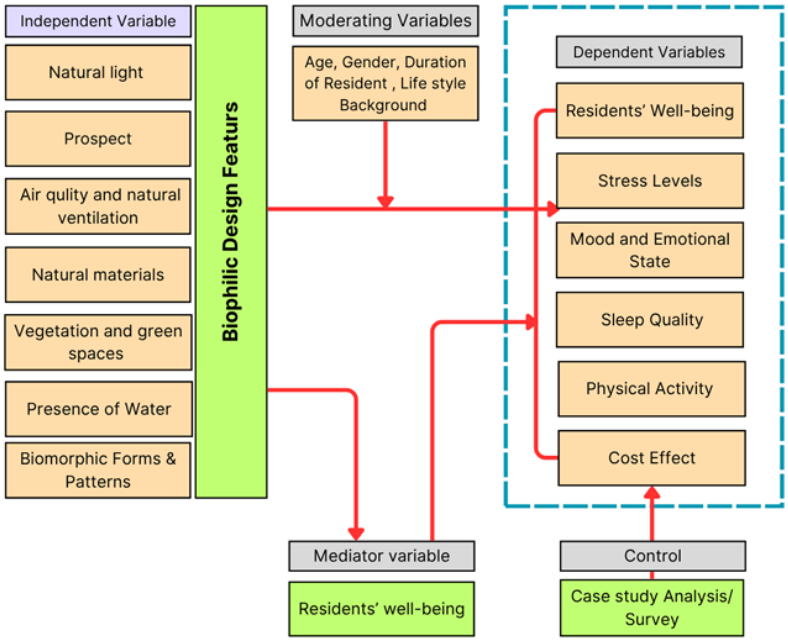

Figure 1. Conceptual Framework, Authors.

1.2 High-Rise Residential Buildings in Erbil: Research Problem

Due to its role in enhancing the well-being of residents, biophilic design has increasingly attracted attention in high-density urban environments (Yue et al., 2024). This role is relevant in Erbil, a city that has undergone rapid transformation—shifting from traditional courtyard homes then single-family houses and low-rise apartments to high-rise residential buildings (mainly towers), especially in newly developed areas beyond the 100 m ring road.

This dominant feature of Erbil's urban expansion, especially during the last two decades, was a response to the growing population and the increase in land values. However, these developments often lack the necessary natural features that were once inherent in the design of previous residential building types. Instead, these buildings are typically confined within gated communities having limited access to greenery, natural light, organic forms, and social street life, and according to Kellert, are facing a lack of human interaction with nature (Kellert, 2012). Exposure to sunlight and access to natural ventilation are also reduced compared to other building types as a result of the increased density of higher buildings, further influencing the life quality in such urban settings. According to Gong et al (2023), residents of poorly designed high-rise buildings often report feeling confined and detached from their surroundings (Gong et al., 2023)

Based on recent studies, it is prominent that environmental concerns are currently regarded as secondary issues in Erbil's residential master plans. "Mass housing" lacks ecological continuity, the sense of place, and walkability, with insufficiency of vegetation and sensory interaction with the natural world (Salih et al., 2025). As a result, urban residents become increasingly disconnected from nature - a factor directly related to higher stress, lower satisfaction towards life, and a decline in physical and mental health (Khoshnaw, 2023).

Recent studies highlight that environmental considerations remain secondary in Erbil's residential master plans. "Mass housing" projects often overlook ecological continuity, offering limited opportunities in terms of walkability, vegetation, and sensory interaction with the natural world (Salih et al., 2025). As a result, urban residents face growing disconnection from nature (Figure 2)—an issue strongly linked to increased stress, lower satisfaction, and a decline in physical and mental health (Khoshnaw, 2023).

This physical and mental disconnection accentuates the urgency to introduce concepts of "biophilia" to the high-rise residential typology of Erbil. As vertical living becomes the norm, reconnecting people with nature through thoughtful design is no longer optional—it is essential.

Current high-rise developments in Erbil lack empirically tested biophilic strategies, leaving planners without evidence-based guidance to mitigate the well-being deficits of dense vertical living.

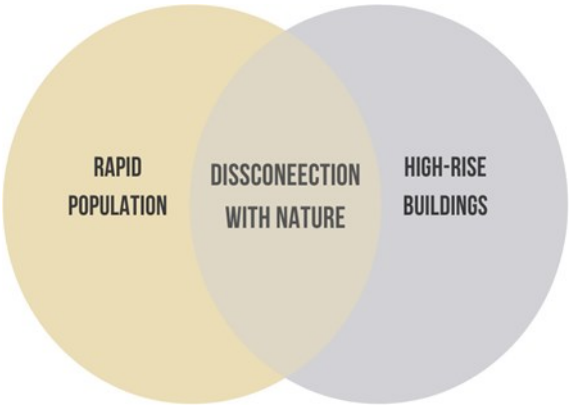

Figure 2. Research Problem, Authors.

1.3 Research Objective and Hypotheses

The research aims to explore the impact of incorporating biophilic design in high-rise buildings to nurture the sense of well-being. The benefits of biophilic architecture include enhancing mental and physical health, reducing stress, increasing productivity and creativity, and promoting a sense of overall well-being (Adityo, 2024; Al Khatib et al., 2024; Cobreros et al., 2023; Sayyed & Al Azhari, 2025). Biophilic architecture aims to create healthier, more enjoyable, and sustainable spaces that improve residents' life quality through connecting humans with nature in the built environment (Adityo, 2024). This human-nature connection increases people's life satisfaction (Rakita et al., 2020), and offers an effective way to improve living conditions (Bratman et al., 2015). Interacting with nature can encourage creativity, innovation, and problem-solving (Adityo, 2024). Recognizing our connectivity with nature fosters a responsibility to protect and preserve the natural environment, which encourages sustainability practices (Adityo, 2024), by its positive influence on climate change (Lee & Kim, 2021), affecting humans' behavior and responsibility towards the natural environment (Whitburn et al., 2020). In the context of architectural design, Gong et al. (2023) explained that incorporating natural elements, natural materials, and natural lighting can create a pleasant state of mind. Thus, meeting these elements through design can create balanced future living environments, improve housing and environmental quality, and enhance residents' satisfaction with housing in rapidly urbanized settings (Gong et al., 2023). By embracing our connectivity with nature, we can create healthier, resilient, and more sustainable buildings that value and protect the natural world. Figure (3) illustrates these objectives.

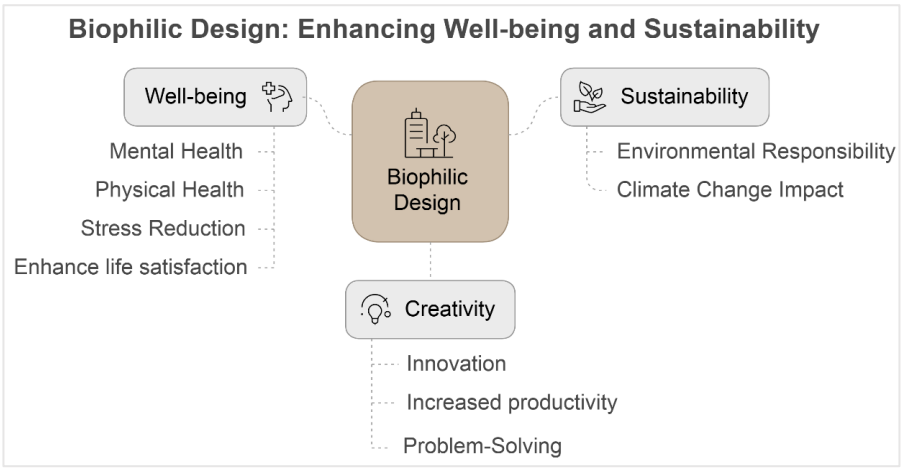

Figure 3. Research Objectives, Authors.

1.4 Significance and Structure of the Paper

The study explores awareness of the significance of biophilic design in high-rise buildings and its impact on enhancing human well-being and mental health by investigating the presence or absence of the five selected biophilic design patterns (Table 1) and how this presence or absence is perceived by residents. This study is organized into several sections as follows: an introduction to the concept of biophilic design, a background on relevant studies and theory development, followed by the research problem concerning the disconnect between people and nature in high-rise buildings, and finally, the advantages of using biophilic principles. The methodology employed in this research is a two-fold process: pattern analysis of selected case studies and a questionnaire survey conducted with their residents. Extracting results is followed by discussing the findings and, finally, sharing the conclusion. This approach ensures a comprehensive understanding of biophilic design's influence in high-rise buildings, offering a foundation for future advancements in sustainability and human well-being.
By merging resident-level survey data with on-site pattern scoring, we extend biophilic design theory into a Middle Eastern high-rise context and provide a transferable evaluation protocol for future studies.

2. Research Methodology

To achieve the purpose of this research and investigate the effects of the five selected patterns, a mixed-methods approach was implemented (Figure 4). A quantitative survey research method was used to collect feedback from residents regarding two projects of high-rise residential buildings (case studies) in Erbil city. The structured survey aimed to gather data related to these selected patterns. Additionally, a qualitative examination of the analyses of these biophilic patterns is deemed more applicable than others in the selected case studies.

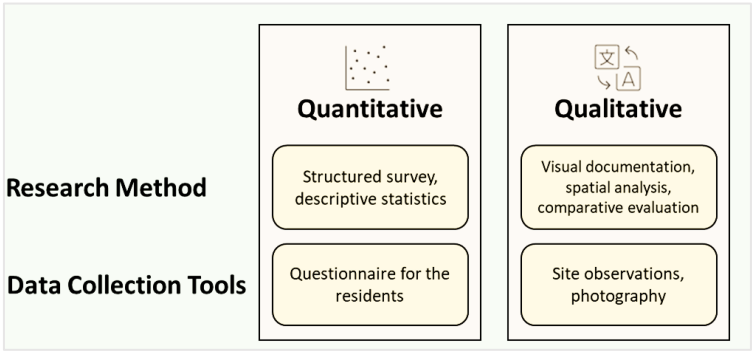

Figure 4. Research Methodology, Authors.

2.1 Study Design and Setting

A targeted online survey was conducted by the authors to collect users' feedback separately for each case study. The first case study (Park View) complex is located within a crowded zone outside Erbil city centre and is considered one of the most familiar building complexes in this district. This project consists of 12 towers (18 stories each) (Ali, 2022). The second case study (Ganjan Life) is located further off-center within one of the developing and vital areas in Erbil, outside the 100 m Road, which is witnessing rapid development and expansion in terms of transportation and construction of residential complexes. This project is part of a larger zone within the Ganjan City project, of which only the western part is completed and inhabited, which is the part that represents the case study. The questionnaire was shared online for 30 days. The survey consisted of five main sections. The first section was for participants' general information related to their living history in this building and the area and location they are accommodating. The second section, comprising four questions, aimed to evaluate the independent variables related to the biophilic design features and patterns. Section three was designed with six questions in total and was meant to observe the dependent variables (Well-Being and Satisfaction). Section four proposed a study of the environmental effect with three questions.

Finally, the last section was composed to collect some general feedback with three questions, with a total of twenty questions, of which eighteen were closed-ended and two were open-ended.

2.2 Participants

The total number of respondents selected for this survey based on these criteria was 100. The selection is based on the following criteria (target respondents):

1. Residents who moved from a single-family building (house).
2. Families of medium size members (4-6).
3. Residents who have lived in the building for over 2 years.

This aimed to gain a better understanding of how the residents' experiences – having transitioned from a different style of living and having lived in high-rise buildings for a considerable time – affected their perception of the questionnaire topic. These cases were selected from two different locations: Park View Complex (50 participants), which is situated in a crowded area, and Ganjan Life Project (50 participants), which is located far from the centre, as shown in Figure 5.

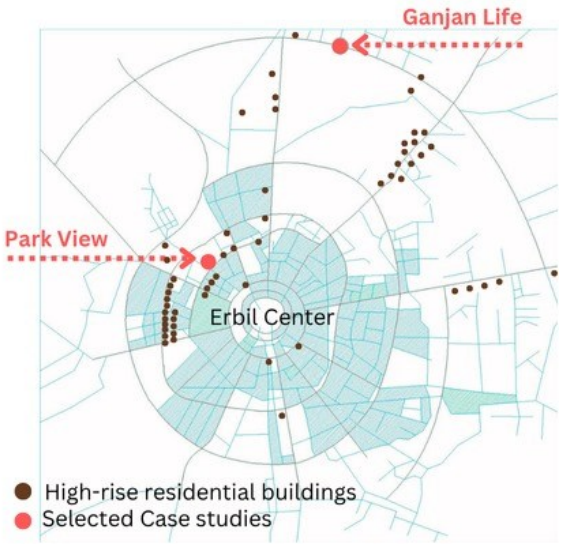

Figure 5. Case Study Locations in Erbil, Authors.

Park View and Ganjan Life represent >70 % of Erbil's occupied tower typologies (17–20 floors, gated compounds). Their demographic mix (owners and tenants, 4–6 family members) closely mirrors the city's official census, making the findings applicable to most new high-rise districts. The mixed-methods protocol is readily transferable to other Middle Eastern cities experiencing similar vertical expansion.

2.3 Materials and Equipment

The paper employed a structured questionnaire using Google Forms and shared it on a variety of social media platforms. Statistical analysis was conducted using SPSS software to examine the relationships between biophilic design features and residents ' well-being employing correlation tests to identify the strength and direction of associations, thereby providing quantitative evidence to support the research hypotheses.

2.4 Biophilic Design Pattern Analysis

A qualitative analysis of the five selected biophilic design patterns, as referenced in the book "14 Patterns of Biophilic Design" by Browning et al. (2014), is as follows (which were referred to earlier in Table 1):

1. **Visual Connection with Nature**: This pattern aims to reduce stress, enhance well-being, and foster a sense of connection to the natural world through creating visual access to natural elements, such as greenery, water, or landscapes.
2. **Presence of Water**: Incorporating water features into built environments to enhance sensory experiences and create a calming atmosphere. This pattern aims to reduce stress, improve focus, and foster a sense of connection to nature.
3. **Biomorphic Forms & Patterns**, which emphasizes the use of shapes, textures, and patterns that mimic natural forms. This approach aims to create a sense of connection to nature by incorporating organic and sequential patterns into the built environment, enhancing aesthetic appeal and well-being.
4. **Material Connection with Nature**: The aim is to create a tactile and visual connection to nature, enhance the sensory experience, and foster a sense of place by focusing on the employment of natural materials such as wood, stone, and others in the built environment.
5. **Prospect:** This pattern highlights the value of open, unobstructed views for enhancing the sense of safety and control. This design principle promotes mental clarity and comfort by providing expansive sightlines and a strong visual connection to the environment.

These patterns were selected based on their frequency and direct awareness of their significance. In most cases, people can relate directly to them as factors that can impact their mental health and well-being. These patterns can be seen employed in varying degrees in many similar case studies.

3. Results

The results of this study reveal a strong and clear relationship between biophilic design patterns and the well-being and productivity of residents in high-rise residential buildings. This conclusion is based on an investigation of the impact of biophilic design through two case studies of residential complexes in Erbil, Iraq (Park View and Ganjan Life). A mixed-methods approach was employed, which included on-site analysis of the selected biophilic patterns and a structured questionnaire where the responses of 100 participants were selected.

- Below is a summary of the findings, which will be elaborated upon in detail in subsequent sections:
- Both case studies, Park View and Ganjan Life, were found to be beneficial to the well-being and mental health of the residents to varying degrees.
- The approval ratings for the visual connection with nature, orientation, and use of natural materials were highest in both case studies.
- • Biomorphic forms were the least present and least valued in Ganjan Life, reflecting their physical absence in the design.
- • Across both complexes, residents associate biophilic design with reduced stress, improved mood, and increased productivity, which validates its impact on enhancing the quality of urban life.

3.1 Case studies analysis

The initial quantitative analysis focused on the binary scoring data obtained from the assessment of the five selected patterns for each project using a binary presence/absence scale, marking each attribute as either present (1), (0.5) for partially present or (0) for absent, (Lei et al., 2022; Marte et al., 2020).

The researchers visited the selected residential complexes on-site to observe, document, and record the implementation of the specified biophilic design patterns, which are listed in Table 1. The design of both complexes exhibited an integration with natural elements. Table 2 and Figure 6 present the key observation results from the visit as follows:

Table 2. Selected Patterns in the Case Studies, Author.

Selected pattern	*1. Visual Connection with Nature*	*2. Presence of Water*	*3. Biomorphic Forms & Patterns*	*4. Material Connection with Nature*	*5. Prospect*	*Total Score*
Case Study 1: Park View Score	1	1	1	1	1	5
Case Study 2: Ganjan Life Score	1	0.5	0.5	1	1	4

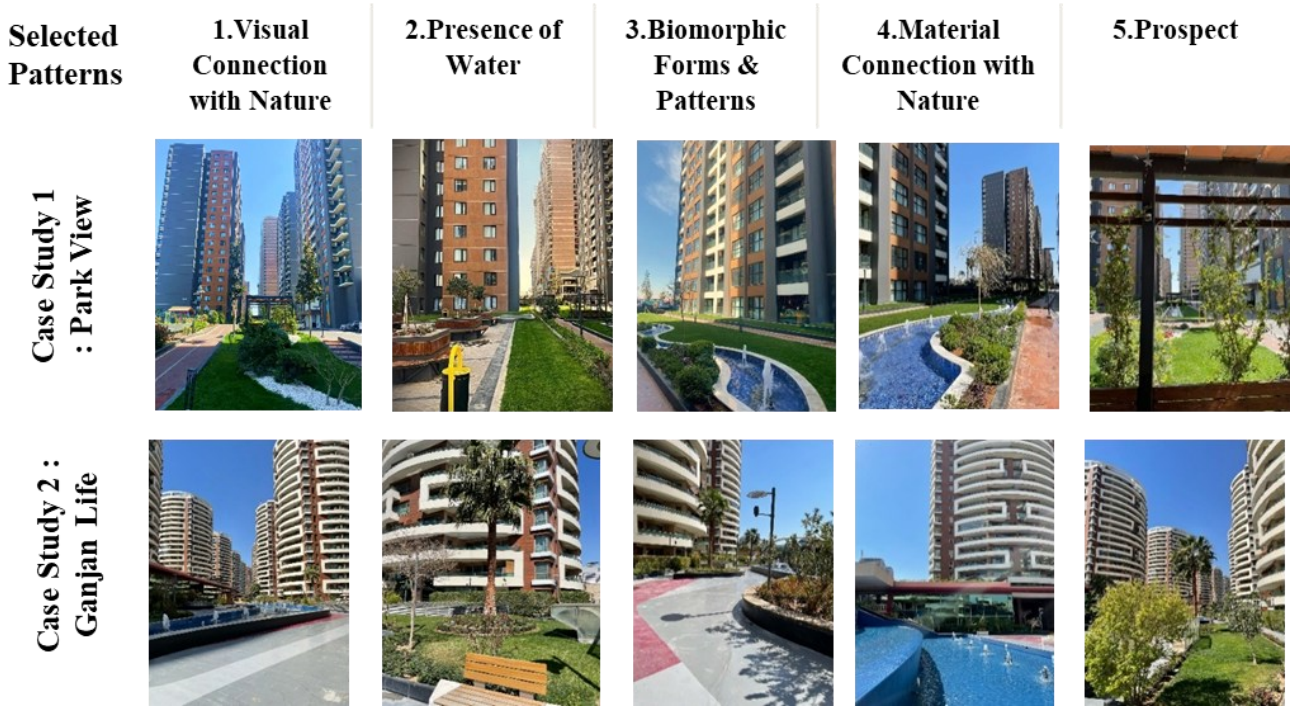

Figure 6. Selected Patterns in the Case Studies, Author. (Refer to table)

In reference to Table 2 and Figure 6, the following aspects were observed:

3.1.1 Park View Project

Park View is one of many other residential projects within a bustling residential/commercial zone in Erbil city. It is located on Gulan Road, the road leading to Erbil International Airport, which also meets the 100m Road (Figures 4 & 7). The project includes a group of residential apartment buildings with commercial and recreational functions in the lower floors. The buildings are gathered around a communal outdoor area that includes playgrounds, gardens, on-ground parking lots, and pathways.

Figure 7. Park View Project, Erbil, Iraq, Author 2025.

All five selected biophilic design patterns were incorporated. This makes it a strong example of integrating biophilic design in a high-rise setting:

1. Visual Connection with Natural Elements: large windows and balconies overlooking the internal green landscape area (water, trees, and meandering pathways).
2. The Presence of Water: Water is incorporated into the design of the shared outdoor area of the complex as fountains. These range from linear water channel fountains aligned with the walking pathways to a stepped fountain near the complex entrance.
3. Biomorphic Forms and Patterns: These are evident in the general architectural language used throughout the design of the complex, like the use of curved edges of the building, resulting from the cylindrical masses, and the organic spatial layouts and nature-inspired motifs used in the landscape and form of the pathways and fountains.
4. The Use of Materials to Connect with Nature: This pattern appears in the frequent use of natural or natural-like materials and textures. Claddings of the buildings incorporate warm wood-like finishes. Natural materials, colors, and textures are also used in the landscape, including stone and stone-like finishing materials in the shared outdoor area.
5. Prospect: This is achieved through the positioning of the apartments overlooking the complex' shared open area or towards surrounding city views. In addition, the spatial arrangement of the buildings and the transparency of the facades allow residents to experience the depth and layered sightlines.

Altogether, applying these elements indicates a deliberate design strategy aimed at enhancing the residents' connection with nature.

3.1.2 Ganjan Life

This case study is part of "Ganjan City", a residential complex that includes, in addition to high-rise buildings, a variety of different other housing types such as single-family houses and villas. This part includes a group of apartment buildings linked by open spaces of playground areas, gardens, pathways, and a running track. The project is situated further from the city center than the other case study (Park View) (figure 4).

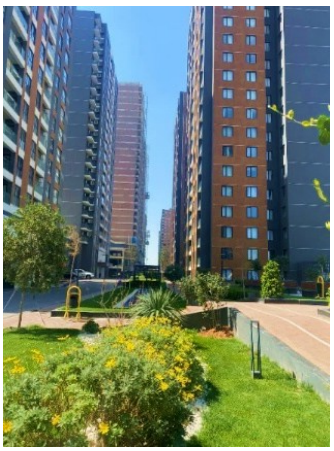

Figure 8. Ganjan Life, Author, 2025.

The integration of the selected biophilic patterns in this residential block varies in certain aspects here. The block, however, covers an area similar to Park View. Although part of the project is still under construction, buildings on the western part and the shared outdoor area of this part were finished and inhabited, Figure (8). Upon the site visit of this project, the following points of the selected biophilic design patterns were observed:

1. Visual Connection with nature is present in the designed landscape of the shared outdoor area between the buildings and the surrounding setting and views. The building's design employs large windows and uses balconies to support and enhance this connection.
2. Water Features: are evident but in smaller areas in the form of small fountains embedded within the grass-covered spaces.
3. Biomorphic Forms and Patterns are less evident here than in Park View. They can be seen in the curved shapes of the water fountains and green spaces.
4. The Use of Materials to Connect with Nature: The colors and textures used show precise imitations to integrate natural-looking exteriors. The materials and textures used in the landscape of the green shared area are designed to mimic natural settings in a variety of different textures and materials.
5. Prospect: The open layouts and strategic orientation of the buildings offer expansive and unobstructed views of the internal shared outdoor space, the shared outdoor area between the towers, or the surrounding cityscape.

The design shows less use of organic patterns and water surfaces. However, it can show an intentional connection with nature oriented around the idea of enhancing the residents' experience and fostering a quiet and peaceful lifestyle through these patterns.

3.2 Statistical Analysis: Questionnaire findings

The following findings are based on the responses gathered from residents through a shared questionnaire for the selected samples in two high-rise residential projects: Park View (50 apartments) and Ganjan Life (50 apartments).

3.2.1. Biophilic Design's Impact on Health: Benefits and Satisfaction

The participants' responses relating to their health benefits are shown in Table 3 and are as follows:

Table 3. Residents' Feedback on Health Benefits of Biophilic Qualities

	Health Benefits from Exposure to Natural Elements in Their Building	Park View	Ganjan Life
1	Reduced stress levels	68%	64%
2	Improved sleep quality	40%	36%
3	Enhanced mood and well-being	78%	60%
4	Increased physical activity (e.g., walking in garden areas)	62%	66%

- **Stress Reduction**: The psychological benefits of green spaces, natural views, and biophilic materials in residential design are further supported by the fact that more than 60% of the residents in both locations (68% in Park View and 64% in Ganjan Life) reported feeling less stressed.
- **•Improved Sleep Quality:** Natural materials, lighting, and ventilation all contribute to healthy sleep patterns, as evidenced by the 40% of Park View residents and 36% of Ganjan Life residents who reported better sleep quality and nighttime relaxation.
- **Mood Enhancement:** The positive emotional response to biophilic design elements is suggested by 78% of Park View and 60% of Ganjan Life residents, who reported improved mood and well-being.
- **Increase in Physical Activity:** 62% of Park View participants and 66% of Ganjan Life participants reported walking or using common outdoor areas more frequently due to the presence of greenery and outdoor spaces.

3.2.2. Biophilic Design's Impact on Well-Being and Productivity

The residents' responses regarding their well-being and productivity are presented in Table 4 and are as follows:

Table 4. Impact of Biophilic Design on Well-Being and Productivity, author.

Project	**Park View**			**Ganjan Life**		
Criteria / Response Type	Positive	Neutral	Negative	Positive	Neutral	Negative
Improved overall well-being since moving to the building	46%	34%	20%	48%	40%	12%
Perception of Natural Elements in your building on your well-being	82%	12%	6%	66%	34%	0%
Impact of using organic shapes in the building on well-being	60%	34%	6%	82%	18%	0%
Impact of Biophilic Design on Residents' Productivity Levels	50%	48%	2%	74%	24%	2%

- Residents in both complexes positively associate biophilic design with well-being and productivity, as reflected in the higher percentage of positive responses compared to neutral or negative ones.
- Park View residents valued natural elements more highly (82%).
- Ganjan Life scored higher on productivity (74%) and on the perceived impact of organic shapes (82%), despite not including biomorphic forms in its structural layout—suggesting the effect may come from other organic references, such as greenery or views.

3.2.3. Assessment of Biophilic Design Patterns

Table 5 shows the input from respondents on biophilic design patterns as follows:

- Visual connection and Connection to the natural environment were highly valued in both complexes, mostly in Ganjan Life, while Satisfaction with Greenery Coverage was much higher in Ganjan Life, possibly due to its location and the availability of more open land in the project area.

- Water features scored low in sufficiency in both complexes, suggesting a design area for improvement, which is supported by over 50% of the responses thinking it is a desirable factor for their built environment.
- Biomorphic forms received weaker ratings in Ganjan Life, aligning with the site analysis that they are almost absent.
- Natural materials were more appreciated in Ganjan Life, though perceived as more sufficient in Park View.
- Prospect Pattern was highly notable in both projects, with Ganjan Life showing stronger results due to its location within a more open residential zone further from the city center, allowing broader views of surrounding natural landscapes.

Table 5. Residents' Feedback on the Selected Biophilic Design Patterns, Author.

Pattern	**Factor**	**Park View**	**Ganjan Life**
Visual Connection with Nature	Satisfaction with Greenery Coverage in Shared Spaces	66%	70%
	Connection to the natural environment	80%	84%
Presence of Water	Resident Interaction with Building's Water Features	50%	42%
	Sufficiency of Water Features in Design	44%	30%
Biomorphic Forms & Patterns	Use of Nature-Inspired Patterns and Organic Shapes	64%	34%
	Sufficiency of Organic Forms in Design	72%	44%
Material Connection with Nature	The Importance of Natural Materials and Colors	66%	88%
	Sufficiency of natural materials in the building	76%	42%
Prospect	Positive impact of orientation on connection to natural elements	84%	86%
	Significance of overlooking a view of natural landscapes	62%	80%

3.3 Statistical Correlation

To further explore this relationship, a Pearson correlation analysis was conducted between biophilic design features (independent variables) and self-reported well-being (dependent variables). The results shown in Table 6 are as follows:

Table 6. Pearson Correlation Between Biophilic Design Features and Residents' Well-Being, Authors.

		Well-Being
Biophilic Design Features	Pearson Correlation	.242*
	Sig. (2-tailed)	.015
	N	100

This positive correlation ($r = 0.242$) is statistically significant at the $p < 0.05$ level, indicating a moderate and meaningful relationship between the presence of biophilic design features and improvements in residents' well-being. In other words, as the perceived quality or presence of biophilic elements increases, so does the reported level of well-being among residents.

A scatterplot analysis was conducted in Figure 9 to visualize the relationship between biophilic design features and self-reported well-being. The results show a clear positive linear trend, indicating that

residents who report higher satisfaction with biophilic elements tend to experience greater levels of well-being. The regression line reinforces the strength and direction of this association.

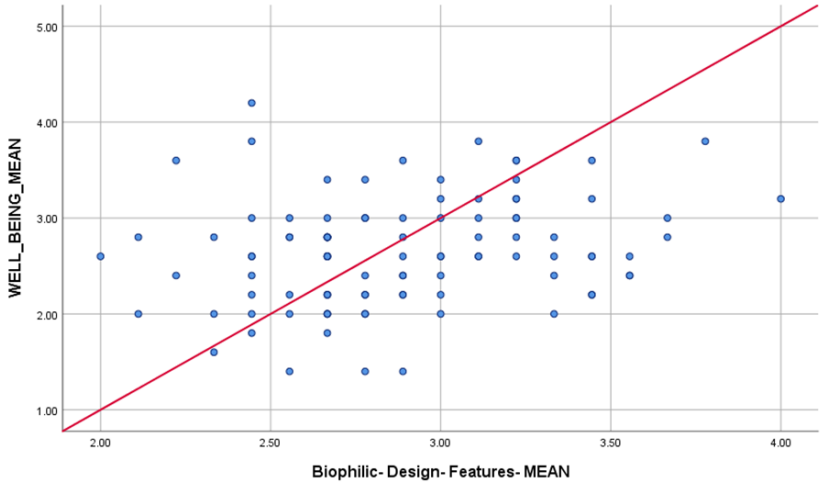

Figure 9. Scatterplot analysis between Well-being and Biophilic design features, Authors.

For more evaluation the relationship between biophilic design features and self-reported well-being, a Spearman's rank-order correlation test in table (7) was conducted, results as below:

Table 7, Spearman's Correlation Between Biophilic Design Features and Self-Reported Well-Being, Authors.

Correlations

		Biophilic Design Features	Well-being Mean
Spearman's rho	Correlation Coefficient	1.000	.251*
	Sig. (2-tailed)	.	.012
	N	100	100

*. Correlation is significant at the 0.05 level (2-tailed).

A Spearman's rank-order correlation revealed a significant weak positive association between biophilic design features and psychological well-being at the 95% confidence level., $\rho(100) = 0.251$, $p = .012$, this mean biophilic features increase, well-being tends to increase slightly.

4. Discussion

4.1 Results in relation to the research question

This study discusses the importance of applying biophilic design patterns in high-rise residential buildings to enhance human well-being. The results have shown a positive impact on the residents' well-being and mental health, which directly addresses the research question. The survey data in *Tables 3 and 4* consistently show that residents in both Park View and Ganjan Life reported reduced stress levels, enhanced mood, and overall well-being. Feedback based on particular biophilic design patterns (Table 5) showed that in both case studies, the visual connection with nature, the connection to the natural environment, and the positive effect of building orientation towards natural elements were very valued. This suggests that these elements of biophilic design have the strongest potential impact on well-being. While Table 4 provides good percentages, particularly highlighted in Ganjan Life, on how biophilic environments can increase productivity levels. The lower scores for biomorphic forms in Ganjan Life, where they were less clear, indicate a correlation between the presence of a biophilic

element and the residents' perception and appreciation of it. while statistical results provide clear evidence of a significant relationship between biophilic elements and enhanced psychological comfort. Pearson correlation confirmed that satisfaction with these features correlates with higher well-being scores. Scatterplot illustration and Spearman's correlation further explained this association, emphasizing the importance of these features. Overall, the findings support the research hypothesis that biophilic design contributes positively to residential well-being. The results also highlight the need for context-sensitive application of biophilic patterns specifically within the scope of high-rise residential buildings in Erbil.

4.2 Comparison with Previous Studies

This research aligns with the existing literature supporting the positive impacts of biophilic design on well-being and mental health and the importance of specific natural elements in the built environment. The findings match the principles of biophilic design explained in prior researches by (Gong et al., 2023; Kellert, 2012) , (Totaforti, 2018) that consistently demonstrates the positive effects of nature and natural elements on mental health, stress reduction, and overall well-being, which align with residents' feedback shown in Table (3) and Table (4). While Table (5) emphasized the role of visual connection with nature, natural materials, and prospect, highlighting the significance of these specific elements in fostering a connection with nature and enhancing well-being in built environments that harmonized with the studies of (Mousapour, 2024; Mousavi Samimi & Shahhosseini, 2020; Watchman et al., 2022). A connection with nature has been shown to enhance creativity and productivity, as evidenced by the study by (Adityo, 2024), and is further supported by the results of Table 4. Furthermore, the perceived increase in physical activity due to accessible outdoor green spaces (Park View: 50%, Ganjan Life: 74%) supports the broader understanding of nature's role in promoting active lifestyles and well-being.

Satisfaction with the greenery coverage in Park View (central, denser)/Ganjan Life (off-center; potentially more surrounding green space) is a leading example of the way the surrounding urban context shapes perceptions and influences certain aspects of biophilic elements. This aligns with the study by (Kabisch & Haase, 2013), discussing the challenges of integrating nature into high-density urban environments.

4.3 Strengths and Limitations

The study has faced some limitations represented by limited sample size as it served a total of 100 residents who have moved to live from houses to apartments within last two years with a medium family size (4-6) persons, this small sample size may limit the generalizability of the findings to the broader population of high-rise residents in Erbil or other cities. Moreover, this study discussed two specific case studies that might be similar in design and resident demographics, and the related findings may not be applicable to other high-rise residential buildings in Erbil. Furthermore, the study concentrates on five selected biophilic design patterns out of 14, which might not capture the full impact of biophilic design on residents' well-being. However, the study employs a mixed-methods approach with regional focus which combines user perception surveys with qualitative analysis of biophilic features in particular high-rise residential case studies, is one of its main strengths. By using observed architectural patterns to validate subjective experiences, this dual strategy enhances the findings. Moreover, an urgent urban issue is addressed by the emphasis on mental health in Erbil's vertical housing context. The study also identifies practical methods for incorporating biophilic design to improve the quality of urban housing.

5. Conclusion

Summary of Key Findings

This study intended to explore the role of biophilic design in enhancing human well-being in high-rise residential buildings. This study confirms a statistically significant link between biophilic patterns and

well-being in Erbil's high-rise housing. Visual Connection with Nature and Material Connection with Nature produced the strongest resident benefits (Pearson $r = 0.242$, $p < 0.015$), while Presence of Water showed moderate but still positive effects. These results support our hypothesis that targeted biophilic interventions can mitigate the psychological and environmental deficits of dense vertical living.

Implications of the Findings

Academically, the work extends salutogenic and biophilic theory into a rapidly urbanizing Middle-Eastern context, demonstrating a replicable mixed-methods protocol that unites pattern scoring with resident-level metrics. Practically, the findings offer planners a priority list of patterns to integrate into Erbil's forthcoming tower projects and retrofits.

The results demonstrated visual connections with nature from residents, beyond the use of natural materials in their buildings. The majority of residents reported stress reduction and mood improvement due to the presence of natural elements in their residential complexes.

By incorporating biophilic design in these buildings, we can improve residents' satisfaction and mental health in high-density residential environments through connecting humans to nature, thereby increasing the sense of well-being. This approach has the potential to produce buildings that are ecologically sustainable, fostering the innate human connection to nature. This research contributes to validating Biophilic principles in high-density living. It demonstrates the benefits of biophilic design principles by showing how built environments address a key challenge in rapidly urbanizing cities. Moreover, it raises awareness among developers in the region about the importance of integrating nature into the built environment.

This study demonstrates that biophilic design has considerable potential to enhance the overall well-being of residents in Erbil's rapidly growing high-rise residential sector. It calls for urban planners and developers to use biophilic design more widely, creating healthier and more sustainable urban environments. Future research should focus on translating these results into design guidelines and policies that can be used in the region.

Recommendations for Future Research

To improve this research, the authors suggest some future directions, such as combining Erbil's socio-climatic detailed study with cultural context, which would enrich the analysis and address how biophilic design principles must adapt to regional needs. Future research could investigate the long-term economic benefits (property value, reduced healthcare costs) and broader sustainability impacts (energy savings, biodiversity enhancement) of biophilic design in high-rise buildings in the region. Additionally, a comparative study in other rapidly urbanizing cities with different cultural and climatic contexts is needed to understand the generalizability of the findings.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding author/s.

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Nareen Al-Hity: Validation, Writing - Review & Editing, Project Management, Formal Analysis.
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