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Biophilic Design in Architecture: Impacts on Well-being

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Abstract

In the last ten years, 'nature' and biophilic design have received widespread attention in architecture, especially in response to growing environmental challenges such as psychological and mental disorders. The biophilia hypothesis posits an innate biological and genetic connection between humans and nature, including an emotional dimension to this connection. The biophilic design builds on this hypothesis in an attempt to design human-nature connections into the built environment. However, open questions and controversies remain regarding conceptualizing and addressing 'nature' in practice and research The present research aims to investigate the components of biophilic architecture and examine their impact on well-being in successful case studies. In the end, solutions are proposed to enhance the sense of well-being through biophilic architecture. A mixed qualitative-quantitative approach has been employed to achieve the practical objectives of the research. In the research process, initially, the components related to biophilic design, including three categories nature in space, analog nature, and nature of space, were extracted through library and documentary studies. Then, based on the data obtained from the qualitative section, a researcher-made questionnaire was provided to experts in the fields of architecture, psychology, environment, and health. The results of the experts' questionnaire, analyzed using the SPSS software, revealed that the influence of nature on space components was greater than other components. In the third step, the indicators of nature in space, examined in the case studies, and solutions were proposed to promote a sense of well-being through biophilic architecture.

Key words: *Nature, Biophilic design ,Architecture, well-being,*

1-Introduction

According to a majority of researchers, the proximity of health and social prosperity is of great importance for the 21st-century human population, particularly in dense urban environments where the infiltration of nature is limited by technologically advanced lifestyles (Freudenberg, Galea, & Vlahov, 2006; World Health Organization, 2007; Wolch, Byrne & Newell, 2014). Extensive research in this field indicates that these urban environments contribute more to health concerns than they solve (Sclar, Garau & Carolini, 2005; Rydin et al., 2012; Hardoy, Mitlin & Satterthwaite, 1992; McMichael, 2000). A significant health concern in poorly designed buildings is the lack of adequate sunlight and ventilation, resulting in compromised indoor air quality. Insufficient physical comfort and poor acoustics contribute to the emergence of Sick Building Syndrome (SBS) (Boubekri, 2008; Burge, 2004).

The concept of biophilia, initially introduced by Erich Fromm, is a conclusion drawn from humanity's innate affinity for nature (Fromm, 1973). Biophilia emphasizes the pivotal role of nature in enhancing human physical and mental well-being. Numerous studies have demonstrated the beneficial effects of biophilia, particularly in healthcare environments, where nature contributes to restoration and healing (Frumkin, 2001; Reeve et al., 2017). Restorative environment design aims to create spaces that promote human health and well-being by incorporating specific environmental features (Kaplan, 1995; Scopelliti et al., 2019).

Soderlund and Newman (2015) explored the evidence supporting the intrinsic psychological and physiological connection between humans and nature, as well as the emerging research highlighting the social, environmental, and economic benefits of biophilia. Beatley (2016) emphasizes that nature is not an optional aspect of modern urban life but an essential quality. Newman et al. (2017) further argue that integrating biophilia into buildings and cities can help reduce reliance on fossil fuels and create more resilient urban areas. The significant benefits of biophilia necessitate the conservation and restoration of existing natural elements, as well as the exploration of new ways to incorporate nature in the twenty-first century (Newman et al., 2017; Beatley, 2016).

This research aims to explore the components of biophilic architecture and examine their impact on human well-being. Additionally, strategies are proposed to enhance a sense of well-being through biophilic architecture. To achieve these objectives, the following questions are addressed:

-What are the components of biophilic design?

-How do biophilic elements contribute to human well-being?

-What strategies of biophilic architecture are recommended for promoting a sense of well-being?

2-Methodology

Given the research objective, this study employs a combination of qualitative and quantitative methods, which are practical. The data collection process involved reviewing texts and library documents. Initially, the components of biophilic architecture were extracted by examining the theoretical foundations and prior research in the field. Literature searches were conducted in psychology, health, environment, and architecture databases including SCOPUS, Web of Science, ProQuest, and Google Scholar. The search terms and their synonyms included: 1) Biophilia, 2) environmental psychology, 3) Built environment, 4) Well-being, and 5) Restorative environment. Subsequently, a researcher-developed questionnaire was randomly distributed to 30 specialized professors in the research field, including architecture (7 individuals), psychology (8 individuals), health (7 individuals), and the environment (8 individuals). The purpose of this questionnaire was to prioritize the components and measure their effectiveness on well-being. The collected data from the questionnaire were analyzed using SPSS 26 software, and a one-sample t-test was employed as a parametric method to test the population mean. In the following step, each of the direct components of biophilic design was analyzed using successful samples, and the results regarding their impact on well-being were examined. Finally, design solutions were proposed to enhance well-being through each of the direct components of biophilic design. The research process diagram is presented in Diagram 1.

Biophilia and its manifestation in design, known as biophilic design, have been the subject of scholarly discourse. The term "Biophilia" was initially introduced by German psychologist Fromm (1973), who described it as "the passionate love of life and of all that is alive." Its roots can be traced back to ancient Greek, where "bios" means life and "philia" means love. American biologist Wilson (1984) later popularized the term and defined biophilia

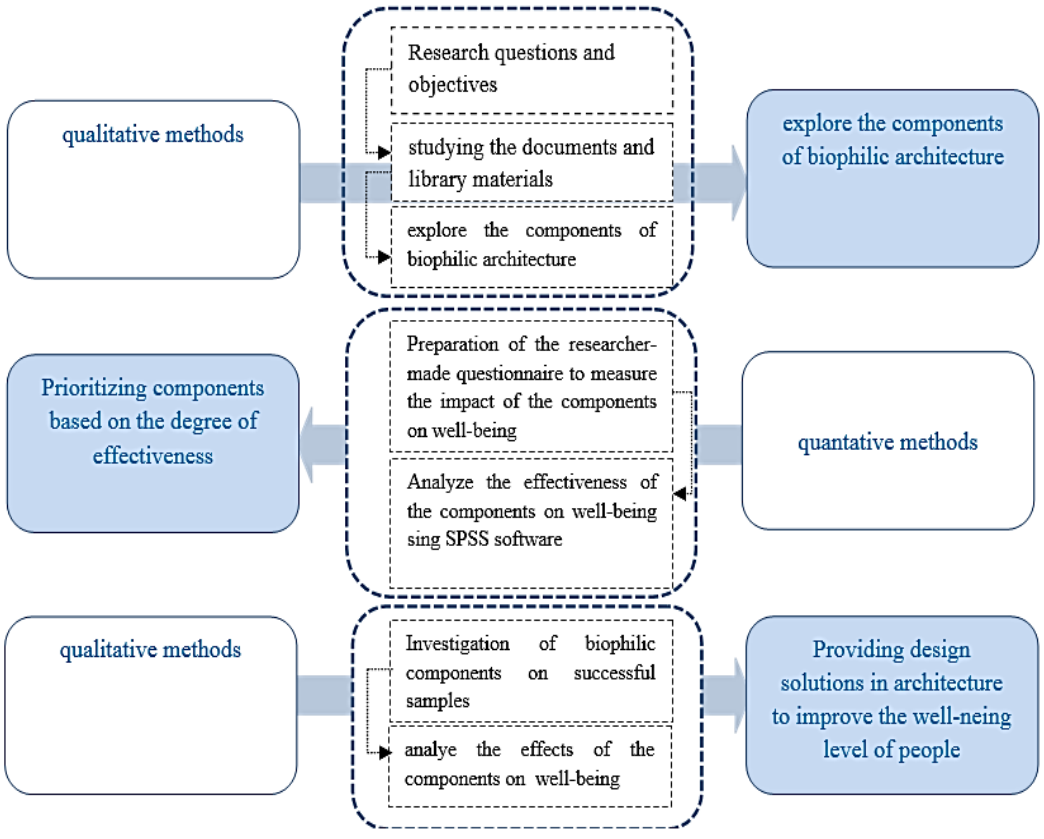


Diagram1- research method

as "the urge to affiliate with other forms of life" (Kellert and Wilson, 1993). Throughout human evolution, it has

Picture1- Presence of Water www.archdaily.com

Picture2- Workplace by Greenery and an Abundance of Nature. www.archdaily.com

Picture3- The use of timber in Construction. www.archdaily.com

been observed that 99% of living species have developed adaptive responses to the natural environment and its various influences (Kellert and Calabrese, 2015). These responses have fostered a long-standing reliance on nature and its resources. Biophilic design, on the other hand, represents the interdisciplinary integration of biophilia into the design principles of the built environment (Kellert et al., 2011).

3-1- Origins of biophilic design

Biophilic design goes beyond the concept of biophilia and incorporates various theories from environmental psychology that highlight humans' inherent connection to nature. These theories shed light on how interactions with natural elements contribute to both physical and mental well-being (Peters and D'Penna, 2020; Söderlund and Newman, 2015).

This paper investigates biophilic design from the perspectives of environmental psychology and architectural design, identifying six theories that provide a contextual understanding for the literature review and form the theoretical basis for the development of biophilic design.

3-1-1- Restorative Environmental Design (RED)

Restorative Environmental Design (RED) seeks to replenish individuals' emotional reserves and offer assistance in mentally challenging situations or distracting surroundings. RED proposes that natural environments are more effective in restoring Directed Attention resources, which are crucial for focus, alertness, sustained cognitive tasks, problem-solving, and adaptive decision-making. (Kaplan, 1995)

3-1-2- Place Attachment Theory

Place Attachment Theory examines the relationship between individuals and specific locations, encompassing a sense of comfort and adaptation to the surroundings (Altman,1992). It surpasses sensory or visual elements and incorporates emotional connections and memories that shape an individual's bond with a place (Stedman, 2003).

3-1-3- Attention Restoration Theory (ART)

ART is relevant to biophilic design as it addresses attention fatigue and cognitive depletion (Kaplan, 1995). ART recognizes attention as a resource necessary for adaptability to the environment and task completion (Kaplan, 1989). Nature has been found to have restorative benefits, calming and stimulating the mind, enhancing well-being and productivity, and providing relief from fatigue and reduced performance resulting from prolonged use of Directed Attention (Kaplan, 1995, Berto, 2005)

3-1-4- Stress Reduction Theory (SRT)

Stress Reduction Theory (SRT) centers on the rejuvenating advantages of natural outdoor environments following excessive psychological or physiological arousal, as well as excessively low arousal.SRT examines the impact of emotional stressors on fatigue and emphasizes the positive transformations in physiological systems, behavior, emotional states, and cognitive functioning that occur as a result of exposure to nature.This theory established the groundwork for subsequent research investigating the stress-reducing effects of various forms of nature, including images, scents, and vistas, in diverse settings. (Ulrich, 1983).

3-1-5- Prospect-Refuge Theory

The Prospect-Refuge Theory, stemming from the field of landscape aesthetics, explores individuals' spatial experience preferences and posits that specific spatial arrangements, termed "Prospect" and "Refuge," are inherent evolutionary inclinations shared by all people. Prospect pertains to the inclination for open areas that provide visibility and the ability to observe potential dangers, while Refuge represents the tendency to seek out protected spaces away from activity where one can find retreat. (Appleton, 1975)

3-2- Defining biophilic design

Biophilic design, an integration of nature into architectural practices, has emerged from concepts in environmental psychology. Since 2001, this concept has been interpreted in various ways by scholars and professionals. Heerwagen and Hase (2001) were pioneers in defining characteristics of biophilic architecture, identifying eight features related to habitability, natural elements, design processes, geometry, joyfulness, and enticement. Kellert et al. (2008) presented a more systematic interpretation, proposing two dimensions, six elements, and over seventy attributes. Other researchers, including Heerwagen and Gregory (2008), Hildebrand (2008), and Cramer and Browning (2008), suggested perceptible attributes of natural spaces that can be incorporated into spatial layouts. Terrapin Bright Green outlined fourteen patterns of biophilic design based on these categories (Browning et al., 2014). Kellert and Calabrese (2015) further expanded the framework, introducing twenty-four attributes within three categories. These frameworks have been revised and updated by their proponents (Browning and Ryan, 2020; Kellert, 2018). Xue et al. (2019) highlighted the connections with nature from individual and societal perspectives. Three representative conceptual frameworks (Browning and Ryan, 2020; Kellert, 2008b, 2018) have been selected for comparative analysis and serve as the basis for establishing criteria in architectural certifications such as LBC, WELL, and LEED. They have also been applied in various studies on biophilic design (Abdelaal and Soebarto, 2019; Aye et al., 2019; Gillis and Gatersleben,

Table 2. Theoretical basis of defining of biophilic design

Heerwagen and Hase, 2001	They were among the first people to address the features of biophilic design in the built environment. - The use of biophilic design in buildings and the avoidance of biophobic elements are two necessary conditions for achieving green design	1 . Prospect (the ability to see in distance). 2 . Refuge (a sense of enclosure or shelter). 3. Water (either inside or in the landscape). 4 . Biodiversity. 5 . Sensory diversity. 6 . Biomimicry.
Kellert (2008)	- Biophilic design has two fundamental dimensions: "organic or natural" and "place-based or indigenous." - The organic dimension involves "shapes and forms in the built environment that directly, indirectly, or symbolically reflect humanity's inherent connection to nature."	The biophilic design framework, according to Kellert (2008), includes two dimensions, six elements, and seventy-two features. 1- "Organic or natural" dimension includes four elements: a)environmental features, b) natural shapes and forms, c) natural patterns and processes, d) light and space.

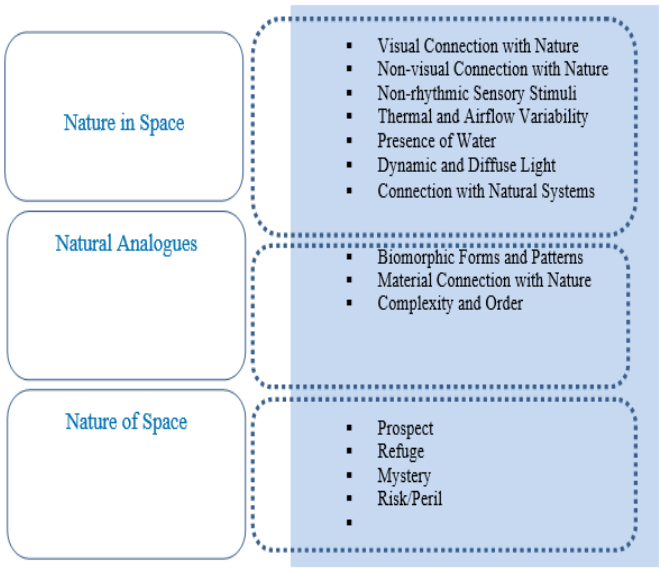


Diagram2- Biophilic design patterns , (Browning & Ryan,2020)

	They categorized biophilic strategies into six different categories.	a) Visual connection.b) Non-visual connection c) Thermal comfort and airflow **Regulation and biophilic performance**: a) Biomorphic form and patterns,b) Color and natural materials **Transportation connectivity:** a) Public transportation facilities, b) Bicycle system facilities, c) Navigation and wayfinding design **Integration of work-life-play**: a) Shared spaces and amenities, b) Maintenance and management **Green space placemaking:** a) Permanent programming b) Temporary programming.
Browning and Ryan (2020)	They divided various physical, metaphorical/representational nature and the emotional reactions of nature into three categories.	1.nature in the space 2.natural analogues 3. naure of the space

	- The place-based dimension is defined as "buildings and landscapes that are defined by the culture and ecosystem of a place or geographic region.	2- "Place-based or indigenous" dimension includes two elements: a) place-based connections, and b) evolved human-nature relationships.
Hirohigen and Gregory (2008)	They explored how architecture can incorporate the qualities of nature through the use of light, air, materials, color, spatial definition, motion patterns, openings and enclosures, and connection to the outdoors.	1. Sensory richness 2. Movement and motion 3. Serendipitous discovery 4. Diversity within the familiar 5. Flexibility 6. Sense of freedom 7. Vision and refuge
Hildebrand (2008)	He also believes that beneficial life qualities found in preferred habitats can be incorporated into building design.	1. Coruplexity 2. Prospect and refuge 3. Deception and intrigue 4. Hazard 5. Shelter
Kramer and Browning (2008)	proposed three categories for defining biophilic buildings.	1. Nature in space 2. Natural analogs 3. Space and place
Kellert (2018)	He updated the previous framework by adding 25 features in three categories. updated the previous framework by adding 25 features in three categories.	**Direct experience:** 1. Light, 2. Air, 3. Water, 4. Plants 5. Animals, 6. Views, 7. Water and air, 8. Landscapes, 9. Fire **Indirect experience:** 1. Images, 2. Materials, 3. Textures, 4. Colors, 5. Forms and shapes, 6. Richness of information 7. Change, age, and patina of time 8. Natural geometries, 9. Simulated natural light and air, 10. Biomimicry **Experience of space and place:** 1. Views and refuge, 2. Organized complexity, 3. Movement 4.Transitional spaces 5. Place, 6. Integration of parts into the whole
Xue et al. (2019)	In their recent study, Xue et al. (2019) have proposed the connection with "nature" from both individual perspectives (user health and well-being) to societal perspectives (public health).	He proposed six categories for biophilic strategies. **Biophilic infrastructure:** a) Biophilic ratio.b) Biophilic management **Sensory design:**

2015; Park and Lee, 2019; Peters and D'Penna, 2020). Given Browning and Ryan's (2020) focus on the biological responses and their impact on mental and physical health, physiological well-being, and cognitive performance, their perspective on biophilic design patterns has been chosen as the framework for this research (2022, al et Zhong). In the following sections, we will examine the biophilic design patterns according to Browning and Ryan. These patterns are grouped into three main categories: "patterns of nature in space," "patterns of natural analogies," and "patterns of space configuration" (Diagram2)

3-3- Biophilic design for well_being

Biophilic design plays a crucial role in promoting well-being, which is a universal goal for individuals and societies worldwide. Well-being encompasses multiple dimensions, including physical, economic, social, emotional, and psychological aspects (Center for Disease Control and Prevention, 2013).

Figure 1- Aspects of Well-being, Source: mecteam.blogspot.com

The positive effects of biophilic design on well-being have been acknowledged, emphasizing the integration of nature into architectural spaces (Heerwagen, 2009). Interactions with nature have been shown to facilitate healing, enhance cognitive abilities, and foster a sense of community (Kellert, 2005). Biophilic design is rooted in the concept of biophilia, which proposes that humans have an inherent connection and attraction to nature (Wilson, 1993).

3-3-1- Biophilic Design and Mind-body Impacts

The impact of biophilic design extends beyond promoting well-being and encompasses significant effects on both the mind and body. Frederick Law Olmsted, an American landscape architect, recognized the rejuvenating effects of natural scenery on mental and physical health (Olmsted, 1993). Well-being is shaped by the interplay of physical, mental, and spiritual needs, with the environment playing a pivotal role in fulfilling these needs (Maslow, 1962; Day, 02b). Environmental psychologists emphasize the reciprocal relationship between humans and their surroundings, highlighting how the environment can stimulate and influence human responses (Ojamaa, 2016). Positive environmental qualities, such as light, sound, and vegetation, have a beneficial impact on human health and well-being (Kopec, 2006). People naturally gravitate towards environments that offer positive attributes and neurological nourishment, which contribute to their overall well-being (Salingaros & Masden, 2008; Biederman & Vessel, 2006).

3-3-2- Cognitive Functionality and Performance

Cognitive functionality and performance are vital aspects of human mental agility. Engaging in tasks that require focused attention, such as reading, calculations, and analysis, can lead to mental exhaustion and depletion of cognitive resources (Kellert et al., 2008; Van den Berg et al., 2007). Nonetheless, interactions with nature offer opportunities for mental rejuvenation, leading to enhanced cognitive performance (Browning et al., 2014)

3-3-3- Psychological Health and Well-being

Interactions with nature have an impact on psychological health and well-being, influencing aspects such as concentration and emotions. Research indicates that experiences in natural environments contribute to higher emotional restoration and lower occurrences of negative emotions when compared to urban environments (Alcock et al., 2014; Barton & Pretty, 2010; Hartig et al., 2003). The psychological response mechanism is influenced by factors such as past experiences, cultural influences, and societal norms (Browning et al., 2014).

3-3-4- Physiological Health and Well-being

Exposure to nature has been proven to be effective in reducing stress and promoting restoration, with both physiological and psychological responses playing a role. Physiological benefits include lowered blood pressure, decreased stress hormone levels, improved mood, and increased relaxation (Ulrich et al., 1991; Grahn et al., 2010). Natural environments offer opportunities for mental disengagement from stressors and facilitate psychological rejuvenation (Hartig et al., 2003). Biophilic design, incorporating nature into the built environment, has demonstrated positive effects on various aspects of well-being, including cognitive functionality, psychological health, stress reduction, and restoration. These findings underscore the significance of considering nature and

biophilic design principles when creating environments that promote human well-being and enhance overall quality of life.

Studies have examined the physiological effects of biophilic design on various human body systems. Interactions with nature have been found to have positive impacts on the auditory, musculoskeletal, respiratory, circadian systems, and overall physical comfort (Park et al., 2009). Exposure to nature elicits physiological responses such as muscle relaxation, as well as reductions in diastolic blood pressure and stress hormone levels (Park et al., 2009). Short-term increases in heart rate and stress hormone levels, which can occur when encountering unfamiliar but information-rich spaces, may actually have beneficial effects on physiological health (Kandel et al., 2013). Design interventions can mitigate physiological responses to environmental stressors, facilitating the restoration of bodily resources and preventing harm to the system (Steg et al., 2012). Moreover, apart from the physiological benefits, biophilic design has been linked to stress reduction, enhanced cognitive performance, and improvements in emotion and mood (Browning et al., 2014). However, assessing the effectiveness of biophilic patterns and ameters poses challenges due to the complex nature of variables, shifting baselines, and the intrusive nature of certain data collection techniques (Ryan et al., 2014).

Ikemi (2005)	Creating mystery through the arrangement of trees and object	objects enhances preference for space or facade in housing
Leslie (2008) Friedman (2017)	Designing open and unrestricted spaces that represent prospect	Provides sense of security to the occupants
Renalds et al. (2010)	Integrating plants in internal environments	reduces the perception of stress..
White et al. (2010)	Increasing the visibility of aquatic spaces	enhances preference for those areas.
Alvarsson et al. (2010)	Implementing small or momentary interventions that engage non-visual senses	provides physiological and psychological relief
Almusaed (2010)	Presence of natural or transparent light.	has a positive psychological effect, promoting a flow of positive emotions and enhancing creativity
Mehta el al. (2012)	Natural sounds such as birds, winds, and rustling leaves	Enhanced creativity
Tsunetsugu et al. (2013)	Taking a visual connection with nature for 5 to 20 minutes	reduces stress.
Van Wieren and Kellert (2013)	Elements with unprecedented organic growth like planters and shrubs.	Acts as natural modulators of fear and surprise for the pedestrian.
Benfield et al. (2014)	Natural sounds	Recovery from stress, wounds and sickness
Browning et al. (2014)	Establishing a strong connection with ongoing natural processes and systems through biomorphic designs and patterns	promotes relaxation, nostalgia, enlightenment, and anticipation while minimizing stress and creating visually preferred environments
Ryan (2015)	Clouds, shadows, natural sounds and water reflections.	Generates interest and acts as natural energiser
Song et al. (2016)	Being in natural environments	Reduces chance of heart diseases, balances pulse rate and blood pressure, reduces secretion of cortisol and enhances parasympathetic nervous system
Lee and Park (2018)	Including accessible hideout spaces in library design, which can provide a view of natural systems.	Psychological stability: tranquillity and safety in an unfamiliar environment.
Yin et al. (2018)	Short exposure to biophilic indoor environment.	Lower systolic and diastolic blood pressure and skin conductance.

4-Data analysis

In the first step of the research, a review of the theoretical background and literature revealed that the components and indicators of biophilic architecture have a significant impact on individuals' well-being. These components consist of three main aspects: "Nature in the Space," "Nature Analogue," and "Nature of the Space," each with its unique indicators. In the second step, to prioritize the components and indicators and compare their influence on well-being, a researcher-developed questionnaire was provided to specialized experts. After analyzing the data, the findings presented in Table 4 were extracted.

Table 3. The impact of biophilic design on human well-being.

Authors	Strategy	Benefits
Edwards and Torcellini (2002)	modifing daylight mechanism, adjustable throughout the day	Artificially generated mood and enhance creativity for workplaces and habitats.
Van den berg et al. (2003)	Natural movement of water.	reduces Stress.
Diette (2003)	Incorporating natural sounds and murals inspired by nature	reduces the degree of pain experienced by patients during medical procedures

Table 4. Order and ranking of component and indicator.

Component	Indicator	Very low	low	Moderate	High	Very high	Mean
Nature in the Space	1. Visual Connection with Nature	0	0	4	8	17	4.2
	2. Non-Visual Connection with Nature	1	1	6	7	14	4
	3. Non-Rhythmic Sensory Stimuli	6	6	3	5	7	2.8
	4. Presence of Water	0	0	5	7	15	4.1
	5. Thermal and Airflow Variability	5	5	7	5	9	3.2
	6. Dynamic and Diffuse Light	1	1	6	7	10	3.6
	7. Connection with Natural Systems	2	2	5	8	12	3.8
Natural Analogues	8. Biomorphic forms and patterns	9	10	3	4	4	2.4
	9. Material connection with Nature	8	9	4	2	7	2.7
	10. Complexity and Order	8	10	3	4	5	2.6
Nature of the Space	11. Prospect	9	11	3	2	5	2.4
	12. Refuge	8	11	6	2	3	2.3
	13. Mystery	11	10	4	3	2	2.1
	14. Risk / Peril	11	10	3	2	4	2.2

The results indicated that the component of nature in the Space has the most significant impact, and the indicators of visual connection with nature, presence of water, non-visual connection with nature, connection with natural systems,dynamic and diffuse light, thermal and airflow variability, non-rhythmic sensory stimuli have been assigned the highest scores in that order. In the third step, the influence of indicators of the nature in the Space component through the well-being was analyzed using successful case studies to show how indicators of nature in the Space component affect the enhancement of residents' well-being (Table3)

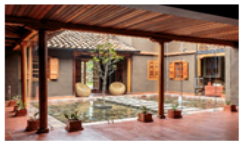
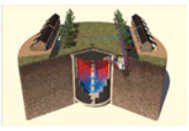
Table 6. The indicators of the "nature in space" component and provides design strategies to promote well-being

Indicators	Design strategy	Impact on well-being
Visual Connection with Nature  	-Incorporate diverse natural habitats like constructed wetlands, grasslands, and forests into the design. -Provide opportunities for indoor and outdoor experiences through features like balconies, courtyards, and colonnades. -Opt for window views that showcase natural landscapes, changing plant seasons, and diverse natural scenes. -Establish a connection with the natural world through paintings, photographs, videos, and fabrics depicting nature. -Prioritize real nature over simulated nature. -Ensure views of seasonal changes in plants. -Emphasize biodiversity rather than just focusing on the area. -Proximity to green spaces and opportunities for physical activity should be considered. -Recognize the benefits of spending time daily in nature (Abdel-Aziz et al., 2023; Ryan et al., 2014; Van den berg et al., 2003; Biederman and Vessel, 2006; Fuller et al., 2007; Kahn et al., 2008; Fuller et al., 2007; Barton and Pretty, 2010; Tsunetsugu et al., 2013; Kellert, 2018; Schweitzer et al., 2004)	-Stress reduction -Higher preferences -More pleasure receptors in the brain -Positive impact on mood and self-esteem -Stimulated heart rate variability and parasympathetic activity - Restoration (Simarmata,2023; Brown et al, 2013; Tsunetsugu & Miyazaki, 2005; Van den Berg et al, 2007; Biederman & Vessel, 2006; Barton & Pretty, 2010)

4-1- Biophilic design approaches and elements

This study presents an optimized framework for biophilic design, aiming to incorporate "nature" into architecture to promote well-being. The framework comprises three essential design approaches and encompasses fourteen key elements (as shown in Diagram2). We interpret these design approaches and elements to provide a more tangible understanding of the concept of biophilic design for architects and other design professionals. Through careful analysis, we extract the most significant biophilic design elements from various forms of "nature" that have been identified. In terms of biophilic design strategies and examples, proponents of this approach have proposed numerous strategies, priorities, and considerations. These have been discussed at different scales including city
planning, indoor environments, and specific buildings. In this study, we present a selection of design

strategies that can be employed to implement diverse biophilic designs in architecture.

Non-Rhythmic Sensory Stimuli  	-Create a refreshing environment and energize individuals with non-rhythmic sensory stimuli like clouds, shadows, nature sounds, and water reflections. -Employ cast shadows to highlight the 3-dimensional form of objects and accentuate space. -Integrate clouds, through roof or wall openings, to offer restorative views from interior spaces. (Simarmata,2023; Ardiani et al.,2020; Peters & Verderber, 2022)	-Enhancing concentration and restoring memory. -Measurable improvements in attention and exploration behaviors. -Positive effects on heart rate, systolic blood pressure, and sympathetic nervous system activity. (Beauchamp et al, 2003; Li, 2010; Park et al, 2009; Ulrich et al, 1991; Windhager et al, 2011)
Peresence of water  	-Prioritize a multi-sensory water experience with features like fountains, constructed wetlands, ponds, and water walls. -Opt for naturally fluctuating water movement over predictable patterns. (Ardiani et al.,2020; Browning et al., 2014; Kellert, 2018, Ozdemir, 2010)	-Reducing stress levels. Increasing feelings of tranquility. -Lowering heart rate and blood pressure. -Restoring skin conductance after exposure to water features. -Improving concentration and memory. -Enhancing perception and psychological and physiological responsiveness. -Eliciting positive emotional responses. (Alvarsson et al, 2010; Biederman & Vessel, 2006; Pheasant et al, 2010; Alvarsson et al, 2010; Biederman & Vessel, 2006; Alvarsson et al, 2010; Hunter et al, 2010; Barton & Pretty, 2010; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Karmanov & Hamel, 2008; Ruso & ; White et al, 2010; Windhager et al, 2011)
Dynamic and Diffuse Light  	-Maximize natural light through glass walls, clerestories, skylights, atria, and reflective colors/materials. -Replicate the spectral and ambient qualities of natural light by incorporating multiple low-glare electric light sources, diffused ambient lighting on walls and ceilings, and daylight-preserving window treatments (Madias et al, 2023 Sharifi & Sabernejad, 2016;Chang & Chen, 2005; Kellert, 2018)	-Promoting a flow of positive emotions. -Enhancing creativity. -Improving the accuracy of senses. -Increasing feelings of calmness. -Influencing circadian system functioning. (Choi & Park, 2020; Beckett & Roden, 2009; Figueiro et al, 2011; Kim & Kim, 2007)
Connection with Natural Systems 	-Integration of rainwater collection, treatment, and utilization techniques within landscape design, taking into account the specific characteristics of the monsoon season and effectively managing surface run-off. -Emphasizing visual access to natural systems as a practical and cost-effective approach. Alternatively, incorporating design elements that are responsive, resilient, and adaptable in terms of land formations and structures to ensure desired levels of mobility. (Kinkade-Levario, 2007; Lin, de Dear & Hwang, 2011).	Enhancing positive health responses; Shifting perception of environment (Kellert et al, 2008)

5- Conclusion and further research

Biophilic architecture is an approach that combines nature with the built environment in a harmonious way. It acknowledges the connection between humans and nature, recognizing how nature affects our well-being, productivity, and overall quality of life. Biophilia has always been an essential part of human habitats, and recent research has reaffirmed its importance. The Biophilia hypothesis, pioneered by Kellert, and the 14 patterns proposed by Browning, Clancy, and Ryan, have laid the foundation for the development and exploration of biophilic design. By following these principles, architects and designers can create spaces that promote a sense of calm, vitality, and connection to nature. To understand the components of biophilic architecture and their impact on well-being, a mix of qualitative and quantitative methods was used. The research included data collection through a literature review and the distribution of a researcher-made questionnaire to specialized professors in the fields of architecture, psychology, health, and the environment. The collected data were analyzed using SPSS software and the one-sample t-test to measure the effectiveness of the components on well-being. The study also analyzed the impact of each direct component of biophilic design on well-being through successful samples. Based on the findings, design solutions were proposed to enhance well-being by incorporating the direct components of biophilic design. However, there are still unanswered questions regarding the application of biophilic design in architecture. Despite its relatively recent implementation of about two decades, the concept of biophilic design is rarely interpreted using architectural language such as typology, order, and context. To advance the field, future research should analyze biophilic buildings from architectural perspectives, considering elements such as tectonics, form, technology, and representation. Key inquiries include how biophilic design enhances architectural forms, how it can be explained typologically, how it influences spatial organization and order, and how it relates to the site and context. Currently, the biophilic design framework lacks explicit design strategies and guidelines for translating these approaches into architectural design. Existing literature only provides general strategies and considerations. Additionally, interdisciplinary knowledge is crucial for linking design strategies and benefits, while collaboration between professions and financial considerations needs further exploration. Building technology plays a vital role in materializing biophilic architecture, necessitating investigations into construction techniques and addressing potential defect

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