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Biophilic Design Approach for Improving Human Health in the Built Environment

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Abstract

Biophilic design has contributed to creating built environments within a taste of nature. The tangible features offer the occupants psychological restoration, releasing stress and mental fatigue. To achieve this, previous researchers have found biophilic design amongst a list of many other design approaches to have the potential to contribute to this topic. This research aimed to examine the biophilic design practices in the current built environment in public buildings, homes, and workplaces. The study, therefore, employed a systematic review method alongside a narrative synthesis approach. In this regard, essential inputs from a body of research on the impact of biophilic design on psychology and public health were considered. The research found that elements such as natural daylight, ventilation, and living architecture have been used to develop well-designed buildings capable of improving users' health and well-being. To achieve the status of a restorative-built environment, the study suggests that designers must provide for natural elements such as forest-like landscapes, natural water features, and natural light.

Disciplinary: Architectural Science & Built Environment.

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1 Introduction

Biophilic design aims to satisfy people's demand for a naturally built world. The biophilic design extends the principle of biophilia by recognizing that species on the earth's surface have been evolving for over 99% of their existence in reaction to the natural environment rather than artificial causes [1]. Humans, for example, are organically programmed to interact with nature. This urge is not vestigial; it is vital for people's physical and mental well-being [2]. Today's "natural habitat" is mainly constructed world, where people spend about 90% of their time [3]. In this

case, biophilic design steps in to satisfy the urge to connect with nature in contemporary buildings and cities. Biophilic design aims to provide a pleasant environment for humans as biological beings in contemporary buildings, sceneries, and societies. This goal is, however, conditional. Given that biophilia is about the tendency of humans to evolve, the focus of the biophilic design is on natural elements that contribute to good human health and enhance their level of productivity at work [4, 5]. In this regard, it would be impossible to label nature in the built environment as biophilic design unless it influences the human species' inborn inclinations responsible for promoting their fitness and survival.

As a result, areas that are described as arid or sea environments, and other aspects of nature that cannot be enjoyed by humans are generally not useful when considering their inclusion as part of the biophilic design since they are not capable of providing any long-term advantages to humanity. Another defining element of biophilic design focuses on the total habitable range rather than an isolated natural occurrence [4]. All species live in ecosystems within linked and related surroundings. When the habitat works in a manner that favors the best interest of the organism, the ecosystem as a whole will be more likely to perform better than the sum of its parts. On the other hand, habitats made up of disparate and unconnected materials have minimal advantages for their inhabitants and may even hurt individual members [5]. Thus, merely placing a natural item in a human-built context has minimal influence on the health and well-being of the people using the places if it is unconnected to or it is at odds with other dominating qualities of the setting.

Unfortunately, contemporary society has failed to support the human desire to connect with nature [6]. Society has consistently erected various barriers to a possible satisfying interaction with the natural world and often treats nature as a source of raw material that needs transformation through technology or a pleasant but not inevitable aesthetic amenity. Much of the contemporary farming practices, industries, education, healthcare, and architectural design reflect this growing detachment from nature [7]. The pervasive practice of putting people in artificial environments such as hospitals, office buildings, schools, and shopping complexes–with no touch with nature and stimuli– is evidence enough of the contemporary view that humans no longer identify with nature. Much of today's constructed environment lacks natural materials, air, natural light, plants, environmental patterns, forms, or any other developed affinities for nature [8]. Society is discovering that these ecologically deficient homes promote weariness, illness symptoms, and poor performance. Increasing access to natural sunlight, outdoor perspectives, and flora may improve health and productivity.

Because people spend a large portion of their time within and around buildings, a biophilic design approach has become critical. Even though the topic is currently under investigation, the literature on the issue is quite scant [9]. While the purpose of biophilic design is obvious, its comprehension and execution are not. The current research aims to examine the biophilic design

practices in the current built environment in public buildings, homes, and workplaces. Thus, the paper aims to address the following questions in particular:

1. What may biophilic design concepts be used to improve human health and happiness?
2. What evidence exists to show biophilic design adoption in different built environments?

2 Literature Review

2.1 Nature-Health Relationship

A large collection of recent studies has been concerned with the relationship between the well-being and productivity of humans, and this relationship links to nature [10, 7]. The benefit of having visual access to the natural environment on employee performance, minimizing detrimental occupational stress, and prolonging occupational longevity has been the subject of early research [11]. Connections between work and natural environments were discovered in further studies. However, the majority of this research referred to historical instances for examples. By analyzing the influence of phenomenological architecture on environmental psychology and from a current viewpoint, this research will provide common ground.

As sciences such as anthropology, sociology, physiology, and psychology supply crucial knowledge about people's perception of space and how they operate within it and establish their preferences, the work of architects continues to become increasingly difficult. Multidisciplinary research has shown that being exposed to nature boosts productivity in intellectual and cognitive activities at work and in other environments [12]. Other research has shown that an active connection with nature might help us refocus and recuperate from stress and mental exhaustion [7]. Few studies, however, have looked into the architectural qualities and traits of environments used for learning and work that might support cooperation and creativity based on scientific principles. The majority of studies on the significance of biophilic design can be traced back to one or more of three central mind-body systems – cognitive, psychological, and physiological – that are already confirmed to varying degrees to have an impact on the health and well-being of people and the role of the environment as a catalyst.

2.2 Cognitive Functionality and Performance

People's intellectual capacity and memory and the ability to reason, learn and produce rational or artistic judgment form part of cognitive functioning [13]. Many repetitive activities, such as everyday documentation, reading, conducting computations or research, and working in highly interactive surroundings demand a person's concentrated attention. Directed attention consumes a lot of energy, leading to mental weariness and depletion of cognitive resources over time. Strong or consistent relationships with nature have been proven to give chances for mental repair, allowing for the opportunity to engage in higher cognitive processes after rest [14]. Consequently, people will tend to have a higher ability for concentrated activities while relaxed than when exhausted.

2.2.1 Psychological Health

Being adaptable, attentive, focused, emotional, and moody are all examples of psychological reactions [15]. This includes reactions to nature that influence managing stress and healing. Experiments in natural settings, for example, have been shown to produce more emotional healing, with fewer occurrences of tension, anxiety, rage, exhaustion, disorientation, and overall mood disruption compared to urban contexts with fewer natural properties [14]. Past experiences, cultural conceptions, and social conventions contribute to the psychological response mechanism, which may be acquired or passed down through generations.

2.2.2 Physiological Health

Humans' auditory, respiratory, musculoskeletal, metabolic, and overall comfort are all part of the physiological reactions: nature influences muscle relaxation, diastolic blood pressure, and the management of stress levels [15]. Short-term stress with the potential of raising the heart rate and stress levels, such as that experienced while entering an unfamiliar place or staring down from an 8-story stairwell, is thought to be regulated by exposure to the natural environment. In this regard, the natural setting can ensure that the body remains robust and adaptable. Building design may cushion physiological reactions to external stresses, enabling biological resources to be restored before system harm occurs [8].

2.3 Patterns of Biophilic Design

Biophilic design enhances people's physical, emotional, and cognitive well-being when incorporated into the built environment. the views of nature, plants, animals, and outdoor sceneries have the same psychological impact as being outside in a naturalistic setting. People recover quickly, stress levels are lowered, and creativity is boosted when biophilic design features are included. [16] outlined 14 biophilic design patterns that explain how to combine each group into a building, as shown in Table 1. Which patterns to use are determined by the structure's necessities and the inhabitants' personal preferences; while some individuals desire live environmental aspects, others tend to prefer natural forms and sound. The beauty of biophilic design lies in mixing and matching its various components to build one's unique environment.

Table 1: Biophilic Design Patterns (adapted from [17]).

Nature in the Space	1. Visual Connection with Nature 2. Non-Visual Connection with Nature 3. Non-Rhythmic Sensory Stimuli 4. Thermal & Airflow Variability 5. Presence of Water 6. Dynamic & Diffuse Light 7. Connection with Natural Systems
Natural Analogues	8. Biomorphic Forms & Patterns 9. Material Connection with Nature 10. Complexity & Order
Nature of the Space	11. Prospect 12. Refuge 13. Mystery 14. Risk/Peril

For this study, these 14 patterns were simplified into three categories: Daylighting, Living Architecture, and Ventilation.

2.3.1 Daylighting

A biophilic approach to daylighting, together with its combination with artificial light, offers a strategy for promoting the transition from reduced energy consumption strategies to net-positive objectives. It is also for enhancing the health and well-being of the occupants of the built environment, and the planet [17]. It is proven that there is improved human well-being in settings that can access natural light. Additionally, workers were more productive at work and were less likely to become absent [18]. Overall, the occupants of buildings tend to think more clearly, and are engaged while executing various jobs and activities. The connection between humans and outdoor settings is enhanced aesthetically by strategically positioning windows to admit daylight.

The alteration of the daylight pattern serves two purposes. The first is to give users with eye-stimulating lighting option, and the second is to keep users' attention in a way that elicits a pleasant psychological reaction. The objective should not just be about establishing uniform lighting across a room. Even though there are limits, the capacity of the human eye and brain to process light and pictures can adapt to a wide variety of environments. While significant lighting variations may be appropriate in specific locations, they are not appropriate in workstations [18].

Figure 1: Providing natural lighting for users in different built environments [2].

However, the light and shadow movement on a surface may draw our attention. For example, the shadow cast onto a window by a tree's canopy or the reflections from flowing water on a wall. The brain will tend to be adapted to moving fractals. In this regard, lighting supports biological health. by leveraging the opportunities for illuminance fluctuation from daylight, the eye tends to be stimulated by the light color variability without causing discomfort, thus improving the quality of the user experience, as shown in Figure 1.

2.3.2 Living Architecture

The goal of linking living architectural patterns to natural features is targeted at increasing both awareness of biophilic designs and, ideally, the environmental sustainability in which these properties exist. Working with living architecture might be as easy as engaging in daily activities while looking at nature [19]. On the other hand, achieving it might also be a more complicated

system integration, where architects have to demonstrate to the users of the spaces the link between the occupant behavior and the capacity of rainwater infrastructure, for example. The temporal component is generally the most important feature in living architecture in any instance. This includes the induction of a greater understanding of a healthy environment. The immediate presence of nature within the built environment in Figure 2, all examples of the standard features of living architecture [20]. The most powerful experiences are created through direct connections with these natural components, especially via variety, mobility, and multi-sensory interactions.

Figure 2: The immediate presence of nature within the built environment [19].

When considering biophilic design, most people will think of adding living architecture within indoor or outdoor spaces [20]. Plants in an indoor setting increase the quality of air and the aesthetic sense of the space. Living architecture has been demonstrated to assist cut thermal expenses by reducing the glare and heat buildup caused by direct sunlight. Certain plants also help lower the amount of Volatile Organic Compounds produced into the air, leading to lung problems or stress [19]. Plants may help relieve stress, increase comfort, and boost employee performance. However, it is argued that single or isolated plants seldom have a significant positive impact. It means that plants in buildings should be in plenty, ecologically integrated, and favor native species over foreign and invasive ones. For example, a 3,000-square-foot vast green roof outside COOKFOX Architects' New York offices changes color depending on the season [21]. Other familiar scenes in the areas include sights of hawks attacking little birds that trigger employees to begin seeing their green roof as a functioning ecosystem rather than a beautiful garden.

2.3.3 Ventilation

The comfort of building occupants and employee productivity both benefit from natural ventilation. Adjustments in the air flow, humidity, temperature, and barometric pressure are likely to improve the impression of natural ventilation in buildings [22]. These circumstances may be created via simple techniques like moveable windows or more complicated technical and engineering solutions. Everyone's senses are enhanced by being able to access windows and being guaranteed fresh air in the space [17]. In this regard, the occupants of a building will rush to open the windows as the first act during a bright sunny day and after being confined indoors for lengthy periods during winter. This explains the extent to which the location of windows and natural ventilation systems impacts the circulation of air to result in a cooler interior atmosphere and lower total energy expenditures.

Natural ventilation patterns are designed to offer an atmospheric condition where users can sense variations in airflow and thermal conditions. The users of built spaces will also get an opportunity to regulate thermal conditions through access to changing ambient temperatures within a space. However, contemporary thermal design only establishes a restricted target region where the humidity, temperature, and airflow are controlled while limiting fluctuation [23]. A different method for achieving biophilic designs through natural ventilation systems enables open-air combinations of humidity, airflow, ambient temperatures, and human control by manually opening windows. Hospitals with trees in their compounds, for example, bring in fresh air from the courtyards [16]. The chilly air helps preserve thermal comfort, which explains why patients' rooms feature large moveable windows, giving them more personal control.

2.4 Design Consideration

Biophilic designs acknowledge that the mind-body systems are responsible for people's health and well-being based on the local aspects of nature that they respond to [24]. A good biophilic design takes into consideration a variety of factors, including sociocultural expectations, health conditions, previous experiences, the severity and type of occupant experience, the rate at which the occupants encounter the design, and the possible perception of the occupants [25]. In this regard, architects tend to develop inspiring, regenerative, and healthy spaces while not ignoring the functionality and ecosystem in which the construction is situated. Biophilic design is becoming more important throughout a spatial continuum, from existing and new buildings to campus and regional planning, due to more crowded urban settings and growing land prices. Each environment provides a foundation for a wide range of integrated biophilic design options and the popularization of sustainable building practices.

A designer must comprehend the intent of a project's design, which incorporates the health and well-being of the intended users [26]. Therefore, project teams need to develop an understanding of the health or performance requirements of the target users to propose design strategies and solutions that reestablish or promote well-being. One strategy involves designing the most biophilic spaces worth thinking of. The second issue concern is whether biophilic design may increase performance indicators used by the building owners or employers, such as perceived comfort, absenteeism, health-care claims, or ticket sales [27]. An understanding of health-related objectives can assist in limiting the design process since many biological reactions to design happen concurrently (such as lowering physical signs of stress and boosting mental well-being). There are also endless combinations of architectural concepts and interventions—the mix of architects. Employers and homeowners are all interested in the health benefits of biophilic spaces because they inform long-term predictions of best practices in urban planning.

Biophilic design trends are adaptable and repeatable methods for improving user experience that may be used in various settings. Biophilic design approaches focus on the interests of a given group of people in a specific space [28]. They are generated from a sequence of evidence-based design principles, preferably with subsequent monitoring and assessment for effectiveness. For

example, a project team may choose living architecture to improve the working experience for office fit-outs. The aim is to increase viewpoints and introduce plants into the space. This can be achieved by putting up a green wall, positioning workstations to optimize outdoor views, and establishing desk plant stipends. Another factor to consider is for each workstation in the portfolio to have a different level of detail and implementation of the initiatives [29]. A project team tasked with lowering stress among emergency department nurses, for example, may assist by substituting abstract art with paintings and drawings of landscape features and creating a small garden and sitting space in the adjacent internal courtyard. While this research likewise employs the living architecture, the chosen treatments focus on stress reduction for nurses who work in a shared space.

3 Materials and Method

While the biophilic design has received substantial attention from professionals and academicians, the evaluation of existing methods in the built environment is still insufficient. This study employs a systematic review method alongside a narrative synthesis approach. In this case, great care was taken in finding all relevant studies with quality evidence, both published and unpublished. The explanation of the biophilic design dimensions, features, and qualities defined by [5] guided the search, with the search being limited to sources published between 2018 and 2022. As a first stage the search terms 'built environment' and 'biophilia' or 'biophilic,' a search was conducted on four electronic databases: Springer, Science Direct, ProQuest, and Scopus. All papers that matched the inclusion phrases were included in the selection phase of the literature search. The researcher manually reviewed the bibliographies of already identified articles to locate more relevant sources. Only 22 evidentiary papers were examined for this study. The reviewers established quality evaluation metrics for the sources considered appropriate for inclusion in the second phase of the review framework. These papers were then evaluated for quality by answering the review questions using the following three criteria:

- **Transparency**: All papers were required to have clear, thorough, and simple information regarding the processes used to collect and analyze data to measure the quality of the outcomes. The process used to choose, appraise, and assemble secondary sources must be documented in works based on secondary sources.
- **Accuracy**: All documents were required to have accurate procedures for collecting data that would result in a credible dataset. It is also expected that the data analysis methodologies would result in accurate and truthful findings.
- **Completeness**: All papers were checked if they contained enough information (completeness) to guarantee credible, cohesive, and persuasive arguments. This was initiated from the design stage and progressed to data collection, analysis, and conclusions.

The papers were initially categorized by the setting of the built environment that incorporated the biophilic design. 'Out of scope' papers that elaborated on the nature and types of biophilic design were also included for data extraction. These papers did not mention specific

building types. After data collection, the papers were examined, and extracted data addressed biophilic design applications and implications.

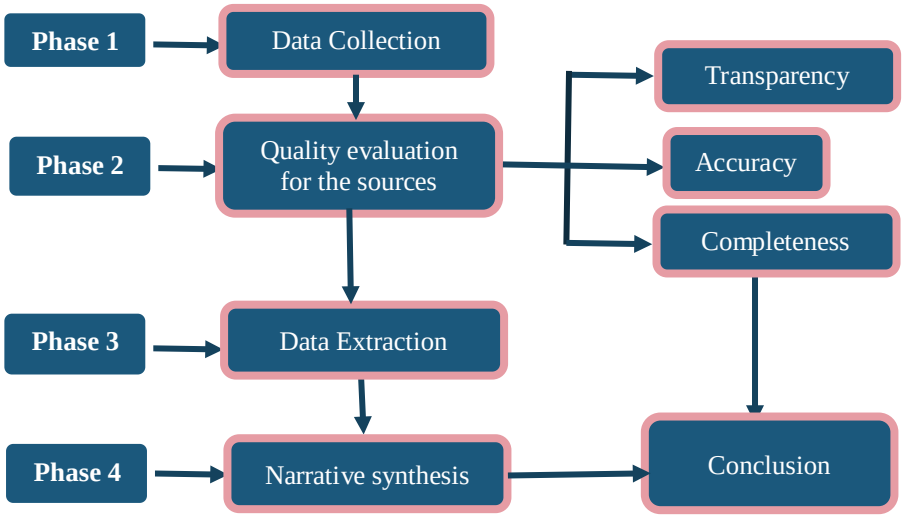

Figure 3: Research Methodology.

The researcher discovered multiple papers that explored the same topic or came to the same conclusion when selecting the body of literature. Instead of incorporating all of the publications in the review, the researcher felt it was important to summarize the results. This did not preclude the researcher from using duplicate papers in other review parts. In the discussion, the researcher summarized and consolidated literature with similarities. The extracted data were analyzed using narrative synthesis methodically and completely. In this case, the final analysis was based on the six publications that satisfied all of the inclusion requirements.

4 Result and Discussion

Biophilic settings in work and home spaces may give psychological therapeutic moments by relieving mental weariness and lowering stress levels. Thus, biophilic components should be addressed in urban work and living spaces to benefit more individuals. The social and cultural characteristics of spaces and people's interactions within the built environment are now the center of biophilic design study. Architects are therefore pushed to create decent structures and to regard public spaces as well-being drivers in which all users may participate in various ways.

Biophilic design has linked the idea of well-being to a state of satisfaction status individuals achieve in both private and public spaces. It is an indication that this discipline is dedicated to improving health, well-being, and an awareness of its urban components. The majority of studies on well-being in living and workspaces focus on how individuals comprehend, feel, and interpret a space due to its usability. There are two ways humans sense the environment and connect to it. The built environment is a consequence of its physical qualities. Yet, the richness of the living or work area can also be defined by culture, social concerns, and age, which also influence people's views. These factors help identify the impact of a building on the occupants, who might then react favorably or adversely to their surroundings.

The utilization of natural elements inside developed spaces has been recognized as providing good outcomes at various phases and for varied reasons as a consequence of these findings and to increase people's well-being. The biophilic design may be thought of as a new design concept. The low-impact technique prevents harm to the natural environment while having a beneficial effect or providing health advantages to humans. This concept has two components. The first is a naturalistic dimension, which involves shapes and forms used in the built environment and reflects the inherent human affection for nature. The other dimension is place-based, which considers the influence of cultural factors and the ecology of the specific geographical location, thus making up architectural design's social and ecological aspects. The circumstances of modern living hinder people's capacity to focus on everyday tasks. On the other hand, the built environment may improve health and well-being by establishing social links that help people recuperate from mental exhaustion.

5 Conclusion

Starting with the subject of the impact of public spaces on mental health, the paper digs deeper into aspects of psychology to better understand how occupants interact with buildings. In this context, biophilia refers to the idea that people have an innate desire to associate with nature. Biophilia refers to people's strong attachment to plants and other species. According to the findings, how the built environment form and space fit with the human senses, human body, and appropriate dimensions is intimately linked to the feeling of comfort and well-being. It is also worth noting that achieving a healthy building means meeting the conditions necessary for the relationship between design and health, especially when considering the significance of trees as part of the public health infrastructure. By incorporating biophilic design patterns, architects have proven the ability to concentrate their attention on how to connect people, health, performance, and aesthetics from an architectural standpoint.

This study demonstrates how buildings constructed with nature may help the occupants in terms of their mental, health, and social well-being and the importance of having responsible public architecture. The biophilic design strategy takes a holistic view of well-being and the built environment, resulting in healthier spaces. The science behind biophilic design still lies in the infancy stage. In this respect, it might be said that the current study confirms the intuitively evident findings. Unfortunately, most contemporary architectural designs ignore this fundamental knowledge. It is known how vital it is to have a connection with nature. When selecting a vacation spot, the vast majority mention somewhere outdoors to renew themselves. So, designers must continue working to restore the human-nature link within the built environment. Furthermore, a thorough grasp of the interaction between people and the environment might require multidisciplinary methods to minimize the risks posed by contemporary design proposals.

6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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