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Conceptual Framework of Biophilic Design Elements (BDE) for Indoor Work Settings

(Rangka Kerja Konsep Elemen Reka Bentuk Biofilik (BDE) untuk Tetapan Kerja Dalaman)

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ABSTRACT

The human tendency to connect with nature existed long ago. Nature and humans coexist since the beginning of time indicating that constant engagement with nature is highly needed. However, due to globalization and rapid development changes has severed this relationship between human and nature. The Industrial Revolution during the 1600s created a huge gap and disconnection between human and nature, which resulted in the depletion of mental and physical well-being as people spend long working hours indoors. The need to stay indoors to work has led to depression and mental health degradation resulting in low performance as employees disengage from their association with nature. The importance of biophilic design elements in reducing depression and mental health degradation prevailed through evidence of research abundance. However, there are still not many studies on the framework tailored to the trend of implementing nature into the indoor working environment. This paper aims to identify, compare and characterize qualitative data from various literature source on the biophilic design elements (BDE), focusing on the indoor working environment. This study will develop a conceptual framework to determine the criteria for the most prominent biophilia elements that can be implemented in indoor settings to efficiently guide professionals in the built environment in preparing the ideal work settings. The parameters from myriad studies encompass a variety of elements that are identified and classified by prominent researchers to reduce the impact of the inability to become in constant contact with nature. To improve productivity and reduce the stress level of the employees working indoors, the application of BDE contributes to the mood, performance and well-being of the employees, thus sustaining organization in the long run.

Keywords: Biophilic; biophilic design elements; indoor work setting

INTRODUCTION

The Twelfth Malaysia Plan 2021-2025, 85% of people are predicted to live and work in cities by 2040 (Economic Planning Unit 2021). The migration could result in several positive or negative impacts on society and the urban landscapes in general i.e. urban expansion. The expansion of urban areas gives room for improving the economic level by providing job opportunities concentrated in the cities resulting in the lack of exposure to natural settings as the spaces are getting scarce and limited. In the context of urban settlers, most of them are unable to spend their time experiencing the outdoors due to reduced freedoms for a more significant factor such as working. According to a survey by ceicdata.com (n.d.), Malaysians spend 43.2 hours a week at work, and Kuala Lumpur is the eighth-most

overworked city in the world, behind Bangkok in third place and Singapore in second (Kisi n.d.). The unhealthy overworked culture forces people to leave their homes early in the morning and spend the rest of their day in cubicles, meetings, and achieving deadlines which compromises their well-being. The environment in the workplace plays a huge role in ensuring the workers can work optimally and be able to avoid burnout syndromes after working for long hours at the office.

The 12th Malaysia Plan indicated the Four City Competitiveness Master Plans (CCMPs) that aim to enhance major cities' competitiveness (Kuala Lumpur, Johor Bharu, Kuching, and Kota Kinabalu). CCMPs target to maximize their contributions as a growth catalyst. It creates pressure on economic sectors and puts extra weight on driving Malaysia towards building a developed nation. The plan also highlights the imbalance of regional development and weak urban development management. On a small scale, the pressure adds to a more serious subject of mental health on workers' well-being as they need to consider many factors such as transportation, housing, safety and security, environment, and health to be able to live in the city where the living cost also increases.

The well-being and life quality of the people is susceptible and may be compromised despite the numerous opportunities and resources available in urban areas such as job opportunities. The total work hours, especially in the offices, reduced people's time to spend outdoors. Architects and interior designers often overlooked the value of outdoor and natural settings and environments to incorporate the features into their designs, especially in workplaces. Creating an environment that could catalyse workers' performances on the job is imperative and beneficial to many parties. In all probability, contemporary architecture is incorporating biophilic designs, to minimise costs and speed up construction. There is no clear framework or stern implementations of biophilic features in built environments focusing on working sectors. This leads to the deterioration of mental health thus affecting the quality of work and productivity.

Mankind has connected, lived with, associated, and evolves with nature since the creation of the Earth. Human utilises the natural environments accordingly to their needs, altering natural landscapes and in some regions, creating cultural landscapes. However, in the 19th century, since the emergence of the Industrial Revolution, the separation between humans and nature becomes prominent (Scharoun & Hoyos 2013; Mohamed 2015). The acceleration of the booming of artificial environment known as the built environment and urban cities is supported by the study of Pranjale and Hejiib (2021). Both of the authors agreed that the evolution of the built environment has never occurred as fast in other human histories. Fukuhara (2018) argued that Industrial Revolution disturbed the balance between humans and natural settings. This massive leap of human intervention towards modernisation, mass production, and exploitation of natural resources has resulted in a massive natural and ecological restructuring, bringing a rather negative notion. The Industrial Revolution is the most prevailing form of anthropocentrism, agreed by Downton et al. (2017), where mankind put themselves as the centre of being and making other creations as mere means of living. Urban settings detached humans from nature, being valued as mere settings to be walked through, compromising the multivariate benefits that can be gained from them.

Louv (2005) claimed that humans spend more time indoors than in the past, resulting in 'nature-deficit disorder'. 'Nature-deficit disorder' could contribute to severe physical health problems and behavioural issues, especially among children. Connection to nature with the children is important, where the parents play a huge role as suggested by Louv. Built environment impacts and affect the way of thinking, culture, and mobility of communities. The building or built environment has impacted health and well-being by a huge margin as people spend almost 90% of their time indoors (European Commission 2003; Roberts 2016). In the last decade, the direct consequences of the indoor environment on mental and physical health have grabbed the attention of ecologists, planners, architects, designers, and policymakers. It sparks a turning point as they struggle to achieve a drastic solution to ensure the safety, well-being, and life quality improvement of the people. In ensuring the restoration of human health, repeated and sustained engagement with nature is paramount. In an attempt to reduce the gap and disengagement between humans and nature, natural architecture or biophilic architecture has emerged. Biophilic architectures focus on the elements and attributes of nature in response to human physiological and psychological aspects while biomimicry incorporates bio-inspired designs where the subsets include biomimetics (replicates nature's form and function), biomorphic (replicates nature's features) and bioutilisation (using nature's elements as part of the product).

This article aims to identify, characterise and frame the biophilic design elements (BDE) that suit indoor working environment especially office workplace with the considerations from restorative environmental design theories that could improve productivity and reduces stress for the building or space occupants. The research and studies on BDE have been done through various literature encompassing many branches of knowledge and fields. The elements will be identified from literature reviews done by researchers mainly in the range of 10 years between the years of 2012 until the year 2022 through extractions of attributes and content analysis. Several

pieces of research from earlier dates need to be considered so that the study is comprehensive and thoroughly studied. The categorisations of the elements will be examined and tabulated, to be integrated into a conceptual framework to be able to guide the researchers in assessing the elements of the office workplace.

BIOPHILIA

Biophilia is essentially nature-loving. The term was coined by Erich Fromm, a philosopher-psychologist in 1973, and was later developed Edward Osborne Wilson, a biologist in 1984. He referred to biophilia as a human's intuition to need nature. Human seeking life and natural processes are predetermined, one of the profound definitions of the biophilia hypothesis as claimed by Wilson (1984). Griffin (2004) discusses that Wilson (1984) highlights biophilia as a form of a sense of place, where the natural environment and human response to it coexist. Ostner (2021) stated that human is a part of nature thus the inclination to it is requisite. Biophilia should be a lifestyle, while adapting and adopting nature to the importance of reverting to nature, even on the smallest scale. Beneficial relation with nature, with a more positive impact on humans, can be achieved by implementing biophilic elements into human functioning environments. Biophilic elements encompass valuable natural environments, including living organisms and non-living things such as animals and trees and temperature, wind, and light. The essence of biophilic architecture or biophilic design is by the application and adaptation on the characteristics of nature into the built environment. Zhong et al. (2021) highlight that biophilic design is more than just greenery to buildings, but also involves spiritual sense and physical embodiments including shapes and characters ensuring the survival and liveability of people. Kellert (2008), in his renowned work "Biophilic Design-The Theory, Science, and Practice of Bringing Buildings to Life," underlines the importance of complete and in-depth understanding on biophilia or biophilic design since it will be labelled a weak biological propensity. He also emphasises the importance of reverting to nature, even on the smallest scale. Beneficial relation with nature, with a more positive impact on humans, can be achieved by implementing biophilic elements into human functioning environments. Biophilic elements encompass valuable natural environments, including living organisms and non-living things such as animals and trees and temperature, wind, and light. Adopting the characteristics of nature into the built environment is the essence of biophilic architecture or biophilic design. Zhong et al. (2021) highlight that biophilic design is more than just greenery to buildings, but also involves spiritual sense and physical embodiments including shapes and characters.

BIOPHILIC DESIGN (BD)

Demand for nature increases as people spend time indoors due to work duties (Unal & Ozen 2021). Barbiero and Berto (2021) stated that biophilia is a part and a form of human evolution (Panagopoulos et al., 2020) as humans will try to adapt to changes for the survival of the species. Biophilic design is an artificial environment that aims to imitate nature as near as possible thus providing an almost similar positive effect on human health and wellbeing. Designers should be able to mediate the connection between the built environment with nature through the application of biophilic design (Downton et al. 2017; Chity 2021; Totaforti 2020) and consequently comply with the United Nations Sustainable Goal Development (UNSGD) (Panagopoulos et al. 2021), where Ozen and Unal (2021) and Gillis (2020) argues that the BDE integration should be placed in the early stages of buildings of spaces' design process. Nature-loving environment participants performed better by 14% than those who did not (Kavathekar & Bantanur 2021). Biophilic design integrates nature into the functioning-built environment. Zare et al. (2021) presented their work "A Review of Biophilic Design Conception Implementation in Architecture" in the Journal of Design and Built Environment stated the timeline of Biophilic Design interoperation that brought out two main principles defining biophilic design: creating a positive environmental impact and creating a good habitat. This could be referred to as a 'place-making', 'place of well-being', and 'genius loci' as a community with a higher-quality environment possess a quality of life and sense of ownership (Panagopoulos et al. 2021). Implementing biophilic elements into a design process is a form of strategy that can help improve workability, performance, and liveability, especially in the indoor environment, whether in the education sector, residential or neighbourhoods, and the working industry.

Biophilic design can be annotated as healing landscapes or an environment where a myriad of benefits is recorded in various literature. Various research found that enhanced quality of life, improved productivity, improved psychophysiological and physical health, and improved well-being can be obtained through constant engagement and connection with a multisensory natural environment. In addition, in terms of the building itself, sustainability, cost-benefit, low-environmental impact, and energy-saving applications can also be achieved through biophilic design. Other than that, Yassein and Ebrahiem

(2018) also found that biophilia is discussed through a multitude of branches of knowledge including the built environment, green materials, public health, environmental science, medicine, horticulture, sociology, urban studies, and marketing and business. Thus, it showcases the importance of biophilic design in the human living environment.

IMPORTANCE OF INDOOR BIOPHILIC DESIGN FRAMEWORK

The pursuit of nature is unavoidable because it has infiltrated the human conscience. The biophilic design emerged as a possible solution as people have been driven away from nature due to urbanisation. The therapeutic essence of nature has been proved in various studies (Khozaei et al. 2022; Hartig & Staats 2006; McNeel 2021; Shosha 2021). Yin et al. (2020) also Hinds and Sparks (2011) mentioned that human needs to be near nature to be psychologically healthy as they provide a large restorative effect towards the productivity impacts on anxiety level. People spend 90% of their time indoors (European Commission 2003; Roberts 2016) and with the presence of nature indoors, the gap between humans and nature can be reduced. The conception of an indoor biophilic design framework could serve the purpose of gathering more information on producing the best interior design spaces that cater to the needs of mental health and well-being of the occupants. The indoor biophilic design does not only focus on visual stimuli and nature-based or green-based approaches but also focused on comfort, safety, and psychological welfare including other factors such as acoustic comfort, privacy, and thermal comfort that could also contribute towards energy-saving and cost-effective building design.

RESEARCH FINDINGS ON THE BDE AND RESTORATIVE ENVIRONMENTAL DESIGN THEORIES

Table 1 provides the pinnacle and foundation of theories in relation to restorative, improved productivity, and stress reduction theories, with the integration of biophilic design elements for indoor working settings. Emphasis on employees' comfort and well-being is the main purpose of biophilic design, especially in an office environment where productivity and focus is the most needed element at work. The study on biophilic design is not recent. The components and their elements have been researched for an extended period and the completion can be considered needless because this is a longitudinal and continual process, in order to achieve an optimal and functioning environment for people. Focusing on the aim of this paper is to provide a framework for optimum indoor biophilic design to improve productivity and reduce stress, by implication, able to assist designers in providing a working space that caters the mental health needs, improving productivity and reducing stress. This is essential to ensure that the proposed framework covers and identifies all related features on the biophilic design spectrum and studies. These strategies are paramount in building a concise, firm, and structured indoor biophilic design thus contributing to many benefits encompassing economic perspectives for the building and the occupants, psychophysiological and physical health progression, and sociocultural impacts towards the occupant.

TABLE 1. Key findings on the BDE and restorative environmental design theories

Theory	Author(s)	Findings
Pioneer Biophilic Design Elements	Kellert (2008)	Outline the baseline for most adopted BD patterns across myriad literature; 72 attributes are present namely the environmental features which is basically the elements of our natural surroundings, the existing natural conditions. Secondly is the natural shapes and forms which is an indirect characteristics of our natural environment, that may mimic or influenced from the earth products. The third category is the natural pattern or processes that could be formed from the conditions of the natural settings or things related to the changes of the environment. This category also includes the size and magnitude of the natural conditions that may affect the feelings of the space users. Light and space, which is the fourth category proposed by Kellert is consists of light characters such as the bending of natural light or artificial lights and also space characters such as spaciousness and spatial variability and harmony. The fifth category of BDE is place-based relationships which revolves around the elements that connects to spiritual characters of the place or space, accordingly to the subjective preferences of the users such as geographical, historical, ecological and cultural embodiment of the space. The final category of the BDE is psychological characters of space that can be considered as biophilic as it may or may not impacting the users such as the security, complexity, control that be felt by the space users.

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The study involves physiological and psychological factors, 14 attributes from 3 categories	Browning et al. (2014)	Browning, Ryan and Clancy proposed several attributes of biophilic design characters with 3 categories such as nature in the space, nature analogues and nature of the space. They incorporates locomote or with-motion materials such as plants, water and animals into the building elements. They suggested that biophilic design can be experienced through the sensorial perspectives such as visual characters and non-visual characters of the elements, including the stimuli, thermal characters and the airflow, the availability of water, light characters and the natural systems that occurs on the daily basis. The elements also consists the imitations of nature's natural patterns such as figurative, forms, and the quality including the material itself. The third category is the nature of the space which can be annotated as the intangible or the presence of the space as whether it provides sense of calming, sense of gradeur, safety, etc.
Outlines the most adopted BD Patterns across literature; consists of 24 attributes	Kellert and Calabrese (2015)	Proposed the more simplified elements of biophilic design elements that can also be used to assist in designing the interior part of buildings. Three components with 24 attributes is presented which firstly the direct experience with nature, the indirect experience with nature and thirdly is the experience of space and place. The first category focused on the natural environment elements where the direct contact is highly encouraged. Second category highlights on the imitation of nature which may followed the natural forms such as the images, color, patterns, shapes whether it contains richness of characters and information, the weathering of it or even the geomorphological characters of the natural settings. Third category is rooted in the apprehension and impression of the users to the spaces.
Attention Restoration Theory (ART)	Kaplan (1989, 1995)	Devised a concept that suggests the application of nature into human-built and living environments can improve focus and reduce mental fatigue. To be able to restore attention, especially in an over-stimulating and overwhelming environment such as an indoor working space, nature should have several characteristics such as (1) extent: being immersed in the environment, (2) being away from usual activities, (3) soft fascination that is able to unconsciously grabs attention and (4) compatibility where the individuals should have favoured the environment or the nature itself. Nature should be able to psychologically restore attention in an indoor environment thus expanding to the performance, motivation and health of the people. Based on this theory, mental fatigue and unnecessary negative emotions and influence should be removed in order for people to be attentive through an effortless natural environment.
Stress Reduction Theory (SRT)	Ulrich (1983)	Theorise that people with stress, when being exposed to natural and landscapes that contain vegetation and water, could receive a positive and calming effect. The natural environment exerts a huge amount of helpful and accommodating stimulus towards the recipients, directly or indirectly. Myriad literature has supported this hypothesis with a range of greenery and natural settings being studied, that confirms the benefits of having natural environments in one's settings. This theory is crucial as it revolves around the occupants' psychological health and stress reduction, especially in enclosed space such as working area, where focus and productivity is the priority to produce good outcomes. Visual perception influences psychological response and being exposed to nature improves one's mental.
Indoor Environmental Quality (IEQ)	Mujeebu (2019)	Developed aimed to foster the health of the building occupants. The main factors of IEQ highly depended to dampness, cleanliness and ventilation of the individual buildings (NIOSH). The components of Indoor Environmental Quality are the air, water and sound quality, ergonomics, microorganisms, odour, lighting comfort, hygiene, electromagnetic radiation, thermal comfort and vibration. Reduced building operation costs, improved quality of life and mood of occupants and efficiency could be achieved through the implementation of IEQ.

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Restorative Environmental Design (RED)	Nousiainen et al. (2016)	- A strategy to benefit the health of building occupants with an integration with sustainable building design. A restorative environment should nourish all senses such as visual, smell, hearing, and tactile and this can be achieved with the presence of a multi-sensory environment: nature. - Healthy lighting, the form and clarity of an environment, healthy indoor air and nature connectedness as primary elements in designing a space that could restore and improve many psychological branches of human health such as well-being, quality of life, moods and spirituality of building occupants.
Biophilic Quality Index (BQI)	Berto and Barbiero (2017)	Newly emerging rating systems aimed to improve and provide insights into restorative approaches focusing on the occupants. BQI listed 5 main categories with their own individual sections. Firstly is the network: the building in the context, followed by the individual spaces within the building, opportunities for visual contact with nature, the presence of a garden, terrace or patio, non-visual contact with nature and sustainability.
Psychophysiological Stress Recovery (PSR)		Heavily influenced by ART by Kaplan (1989) and SRT by Ulrich (1983)
Indoor Air Quality (IAQ)		A subset of IEQ that has several components such as specks or particles, odours, gases, bio-pollutants, temperature, humidity and comfort. DOSH (2010) formulate the Industry Code of Practice of Indoor Air Quality 2010 and also included ventilation in the criteria.

The study proposed a conceptual framework of Restorative Indoor Biophilic Design Elements in Figure 1 that comprises the key elements and components of Biophilic Design, Attention Restoration Theory (ART), Stress Reduction Theory (SRT), Indoor Environmental Quality (IEQ), Restorative Environmental Design (RED), Biophilic Quality Index (BQI), Psychophysiological Stress Recovery (PSR) and Indoor Air Quality (IAQ). The framework points out the fundamental elements in modelling imperative design elements for interior spaces, especially in a stressful environment such as workplaces.

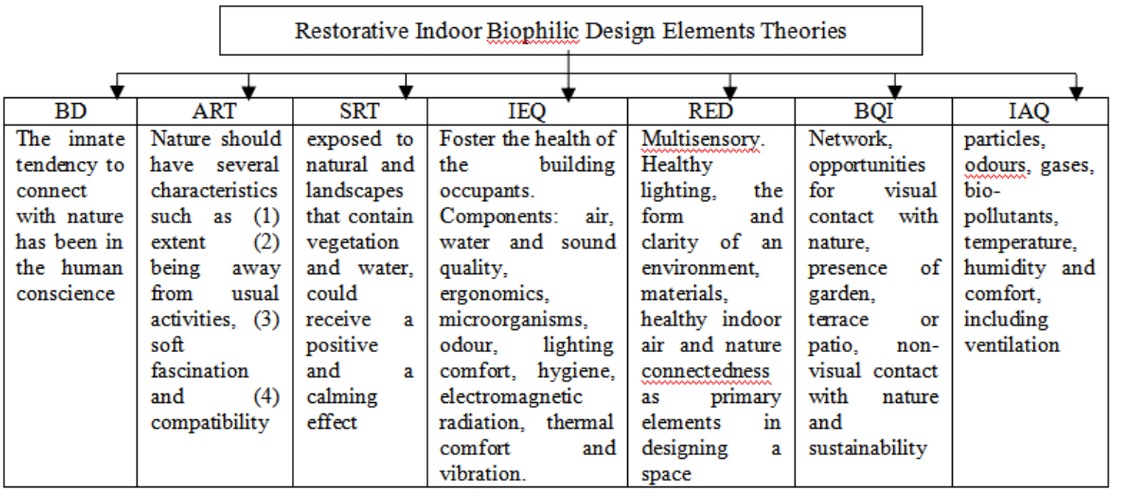

FIGURE 1. Proposed framework for restorative indoor biophilic design elements theories

BIOPHILIC DESIGN ELEMENTS (BDE)

Table 2 presented the biophilic design elements (BDE) identified across numerous literature searches, with different approaches and methods, examined and experimented on different site studies and a variety of user types. Based on the table provided, the elements mostly discuss the experiences and factors that could improve and restore the psychological factors of indoor occupants including the natural elements, the biomorphic and mimicry forms of the natural elements and the indirect effects that can be obtained from the features. The study also found that other factors such as the spirit of place, historical and cultural factors and a sense of security and control need to be acknowledged as a part of designing indoor biophilic spaces. The inclusion of human factors into the design process such as activities that encourage many physical activities and comfort also needed to be put into

consideration. These findings suggest that the indirect experience of nature or factors that suggest the improvement of psychological well-being need to be integrated into the framework.

TABLE 2. Research findings on biophilic design elements

Authors	Findings
Radha (2021)	• Discussing biophilic components with sustainability 11 components • Dependent variables: biophilic activities, biomimicry, plants, animals, greenery, air, natural materials, sense of place, affiliation • Independent variables: liveability, reduction, resilience, variety, identity
Brand and Augustin (2021)	• Biophilic Design is an environmentally responsible construction, place attachment related to well-being, psychological comfort
Yin et al. (2020)	•Different biophilic environments cater to different restorative effects: Indirect experience with nature has impacts on physiological stress while direct experience with nature caters to anxiety recovery.
Gillis (2020)	• The implementations of biophilic design are densely applied in higher-end sectors which may not utilise a more comprehensive experience.
Minucciani and Onay (2018)	• Well-being and quality of life can be achieved through biomimetics and biophilic design as it strongly facilitates the human-nature connection. Concerns more on the health aspect and productive habitats. The biophilic design revolves around 2 domains: naturalistic and vernacular.
Mohamed Aly (2021)	• Biomorphic elements and forms have a limited effect on users' satisfaction. Occupants preferred biophilic attributes such as colour (indirect experience of nature). The study suggests designers consider mass morphology, building envelope and infill elements. Good views enhance biophilic quality. To increase productivity, the study suggests existing buildings envelope with large windows, accessible vegetated roofs and skylights, infill with comfortable furniture and colourful interiors blue themed. For new buildings, the study suggests the same factors with additional components: mass morphology with narrow plans and patios (courts).
Ibrahim et al. (2020)	• Study on communal space, building selected incorporated nature and biophilic design. Emphasis on visual connection to nature with climatic context: vernacular architecture
Aduwo and Akinwole (2020)	• Stated that BD is an extension; of the passive sustainability strategy. The optimisation of daylight is the most present element while the green wall is the least present.
Nitu et al. (2022)	• Outlines 3 main components: biophilic elements, use in building design and energy design strategy
McGee and Park (2022)	• Designers focuses on engagement with colours, and researcher focuses on natural materials. • Designers focuses BDE light elements: on natural light while researcher focuses on experience • Designers focuses on natural materials while researcher benefit from plants and abstract nature images
Tu (2022)	• Hypothetical discusses that cultural settings also influenced biophilic tendencies. People desire to connect with an environment that catalysts a sense of place, and emotional attachments such as a sense of security, safety, territorial and conservation. Nature influences the social and cultural character of the community.
Gillis and Gatersleben (2015)	• Auditory and olfactory senses are the new branch of research that can be explored apart from visual sense in providing a restorative environment to people.
Sahu and Jha (2021)	• Highlights on the importance of orientation of building form to exert most daylight and thermal comfort is a vital consideration to newly designed environmental buildings
Khozaei et al. (2022)	• Underpins Ulrich's Stress Recovery Theory (SRT) on the reduction of stress can be achieved with the presence of nature, and a heightened good mood. View of nature boosts creativity.

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Aristizabal et al. (2021)	• Experimenting multisensory approach from BD attributes encompassing no biophilic input as the constant variable. Visual input, auditory and the combination of both are tested.
Persiani et al. (2021)	• 'Light and views' as the main variable of the BD attributes with Indoor Air Quality (IAQ)
Yassein and Ebrahiem (2018)	• Developed a contextual map on BD and indoor environment literature, divided into 3 themes: (1) design and building management (2) Occupants' needs (3) Technology. Sustainability and Biophilic Design and Indoor Built Environments are two large subsets reviews apart from the three said themes.
Unal and Ozen (2021)	• Adopting BD at different scales with different approaches ecologically, culturally and historically and visually can help protect the built environment
Hinds and Sparks (2011)	• Suggest that psychological well-being is divided into two: hedonism which discusses positive and negative life satisfaction, and subjective well-being; and eudemonia, which revolves around more in-depth, feeling-related matters such as inner peace, and contemplations, and focuses on a meaningful existence.
Afify et al. (2022)	• Listed criteria of cutting-edge biophilia or biophilic systems to improve productivity in working spaces in the buildings, and encourage the application of technology. Some of the smart biophilic systems are virtual skylights, responsive acoustic ceilings and preserved moss panels.
McGee and Marshall-Baker (2015)	• Provide recommendations for designers in designing interior biophilic design, incorporating the most prominent features such as water and animals, colour and bounded spaces.
Mollazadeh and Zhu (2021)	Highlights on the Virtual Environment where the natural elements are the most mentioned elements due to their impact to the users.
Mohamed (2015)	Emphasised on the 4R strategy of Reduce, Reuse, Recycle and Renewable, that focuses on the quality of the spaces rather than the aesthetical purposes. The characters of free flow interior to exterior spaces also being highlighted as well as water and sensory richness of characters. In terms of sensorial perspective, the focused is on the imagination and exploration of designs.
Candido et al. (2019)	Human-centered approach while applying the components of BDE principles is the main focus for perceived productivity, health and overall comfort. Open floor plans with IEQ considerations.
Gray and Birrell (2014)	Adopted Browning et al. (2014) and Almusaed and Asaad (2006) design principle to produce a high performance workspace by the implementation of natural light and plants that could reduce dark or unwelcoming surrounding area to improve social availability and work relationship or collaborations
Wallmann-Sperlich et al. (2019)	To promote a more 'active' office environment, the encouragement of physical movement through biophilic design is conducted where the study focuses on the views, plants, ventialtion, natural lighting, use or recycled or non-synthethic materials, and open plan office layout.
Awada et al. (2022)	The most important building attributes for healthy buildings (impact from Covid-19, assessing the health impact on building occupants) are the ventilation and indoor air quality, from the perspectives of professionals. The most researched topic highlighted by the author is the temperature of the surrounding and the quality of lighting environment and air.
Al-Dmour et al. (2020)	Matrix the relationship between Indoor Environmental Quality (IEQ): office layout, air quality, thermal environment, lighting environment, and the acoustic environment with two research scopes (1) objective parameters and (2) subjective parameters and biophilic design elements
Aduwo et al. (2021)	BD attributes tested: the biophilic experienced in one way rather that various implementation. The visual connection towards nature or specifically towards plants is significant (ie. living wall)
Lei et al. (2022)	Outlines 9 attributes through POE methodology where the users prefers comfort with direct experience of nature for a healthy working environment such as thermal comfort and airflow with greenery and natural light.
Norton et al. (2021)	• Biophilic design is a basic approach to green ergonomic open-floor offices (OFO), in achieving the well-being and health of the office occupants thus help to reduce environmental impacts. Natural visual stimuli, minimal ambient noise for conversation privacy, presence of 'office plant' and designs that encourage physical activity for OPO.

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Huntsman and Bulaj (2022)	Signifies on following the circadian rhythm and therapeutic indoor environment focusing on residential interior designs which include design of lighting, the room of contemplation, design that facilitates movement, design that involves smell sensory and improved sleep quality.
Andreucci et al. (2021)	Summarise the relationship between nature and mental health through several steps, orderly with the depletion of stress, design that promotes physical activity and social collaboration including the ventilations.
Hidalgo (2014)	Propose that in order to increase the wellbeing of the people, promoting social intreration with sensible design with abundance of attractiveness and beauty, well-maintained, safe with abundant greenery and privacy is highlighted
Al Horr et al. (2017)	Listed 6 factors affecting the occupants' productivity which are the IAQ, comfortable lighting and daylighting, with proper thermal or ventilations, noise and acoustic characters with comfortable views and connection towards nature.
Ebrahimpour (2020)	Proposed a framework integrating BDE with the local climate context (hot and dry) of Iran and its architectural principles.1st sections compromises the sensory factors such as playfulness, imaginative design and safety, followed by the 2nd sections of the indirect characters of the natural environments which is the biomorphic and the 3rd section is awareness that involves the relationship between cultural and historical characters towards the environment.
Lee and Park (2020)	Listed the combination of natural biophilia experience with smart home service contents which are the light optimisation usage, comfortable and simulating temperature and air, light and air movement, the presence of flora and fauna, ample views and weather, nature in AR or VR, nature-immersed and collaboration system.
Tekin et al. (2022)	Listed critical biophilic design elements for clinical environments. In terms of staff perspective, the privacy-refuge and quietness are placed first as the most important features followed by fresh air, natural light, prospect, thermal comfort, view, multisensory environment and greenery and water. Suggested maximising the use of natural materials, natural colours, views of nature and outdoors, fresh airflow, natural light, safety and security, protection from overstimulation, creating non0clinical visual, auditory, olfactory and tactual feelings, and ease of movement: maximisation of accessibility and removal of barriers
Peters and D'Penna (2020)	Tested BD components on restoring universal learning environments. Suggestions: Improving vegetation on campus, paths, and transitions, proper ventilation and abundant of natural environment such as lighting and greenery, activities planning (study breaks), consider indoor/outdoor transition spaces, the context of environmental and cultural which encourage place attachment in the outer part of the faculty, building and classroom orientation size and positioning for daylight and views, spatial configuration, restorative corridors and wayfinding and biomorphic forms
Xue et al. (2019)	Outlines 6 main categories of biophilic strategies for GBRT (1) Place that consists of natural, ecological and ample biodiversity, management of water, IEQ consideration, health consideration, sustainable material and good transport, movement and wayfinding including building management in general.
Marte et al. (2020)	• Tested McGee and Marshall Baker BIDM on urban residential playrooms

Based on the research findings in Table 2, the light (Kellert et al. 2008, Browning et al. 2014; Kellert & Calabrese 2015; Radha 2021; McGee & Park 2022; Persiani et al. 2021), water (McGee & Marshall-Baker 2015; Radha 2021; Hinds & Sparks 2011), daylight (Aduwo & Akinwole 2020; Griffin 2004), visual stimuli (Norton et al. 2021; Xue et al. 2019), colour (Mohamad Aly 2021; McGee & Park 2022); and indoor environmental design (Mollazadeh & Zhu 2021; Mohamed 2015; Candido et al. 2019; Gray & Birrell 2014; Al-Dmour et al. 2020; Awada et al. 2022; Aduwo et al. 2021; Al-Horr et al. 2017) features are the most mentioned elements for the biophilic design attributes. Human psychological health and well-being are highly dependent on their environment and the biophilic environment is one of the most fitting solutions to secure health as well as benefiting humans' livelihood such as productivity, stress level, mood and focus, especially in time-consuming activities such as working. Focusing on the indoor working environment, sets of BDE from various studies needed to be analysed and understood by researchers, designers and policymakers as to ensure a conducive space can be created for the employees or the building occupants. Radha (2021) pointed out that positive and constant engagement with nature is required where

designers should focus on the adaptability of humans in the scope of emotion, health and well-being with BDE. Mollazadeh and Zhu (2021) suggested the usage of a Virtual Environment (VE) to properly understand and utilise BDE in designs. Including vernacular or locality as one of the BDE is pointed out by Minucciani and Olay (2018), Ibrahim et al. (2020) and Ibrahimpour (2020) while adding climate context also could bring out the sense of identity, place attachment (Peters & D'Penna 2020; Brand & Augustin 2021; Mohamed 2015) and the sense of place (genius loci) (Radha 2021; Tu 2020) as it heightens the space users' mood and wellbeing.

Candido et al. (2019) and Hidalgo (2014) expressed that BDE should consider human-centred design such as privacy and designs that encourage physical activities (Andreucci et al., 2021; Hinds & Sparks, 2011). Open-plan office design (Wallmann-Sperlich et al. 2019; Candido et al. 2019) is beneficial to provide extra space for comfort (Huntsman & Bulaj 2022), airflow and the amount of light in the working area. Sensory richness or multisensory application of natural elements has been proposed by Mohamed (2015), Gillis and Gatersleben (2015), Khozaei et al. (2022), Aristizabal et al. (2022); Tekin et al. (2022) therefore necessary attention could be considered by the designers. In addition, in terms of building designs that could influence the interior spaces, building orientation (Sahu & Jha 2021; Peters and D'Penna 2020), the integration of technological input (Yassien & Ebrahiem 2018; Afify et al. 2022; Lee & Park 2020) by the mean of providing virtual aids to the occupants such as virtual skylight, augmented nature and responsive acoustic ceiling can be implemented in accordance with efficiency, energy-saving and proper maintenance (Candido et al. 2019; Gray & Birrell 2014). The presence of light, air and water and vegetation with their components such as daylighting, directions and orientations are highly paramount in designing office settings to ensure the maximum exposure to views and experiences. Visual, thermal (air quality and ventilation) and acoustical comfort also should be the main focus for designers.

The collaboration between nature and the built environment through the application of biophilic design is imperative and necessary in order to ensure the improvement of health, quality of life and work and also well-being. This practice of implementing nature to our daily lives could benefit both natural surrounding and human as both of living environment complement each other. The concept may be typical or not new but a continuous assessment and engagement with the elements is highly needed. BDE proposed by many researchers in providing the most resilient and livable indoor designs could facilitate the necessary actions by users, practitioners and academicians to practically apply nature in livelihood and work environment. The integration of natural values and experiences of nature itself provides comfort and ease of contact towards not only the environment but towards the community as well. In the context of reducing stress and improving the productivity of space users, the subjective interpretation towards biophilia is different however in terms of connectivity and experience, a generalisation can be made so that a collective approach can be strategies.

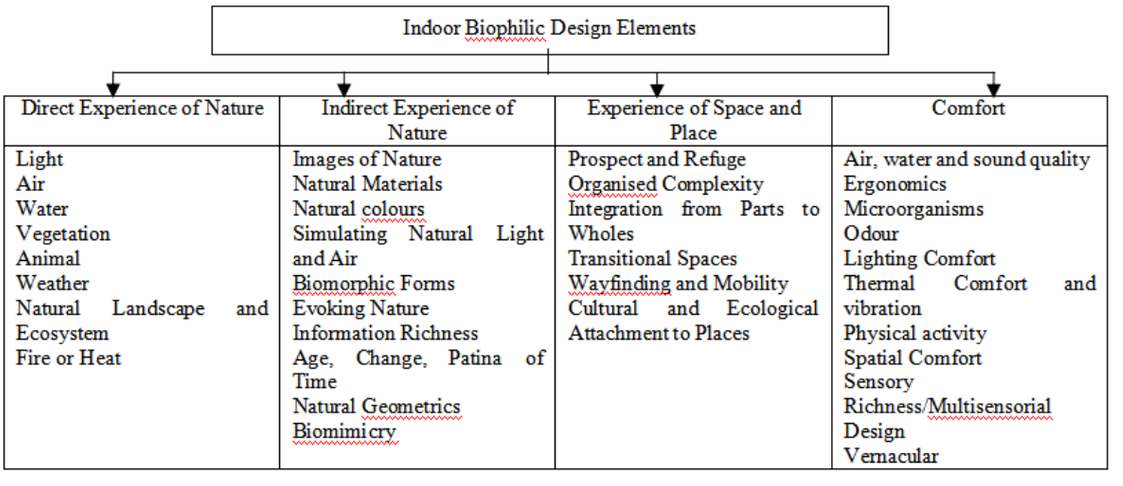

FIGURE 2. Biophilic design elements for indoor working environment

Biophilic design promotes interaction between people and natural elements. The provisions of natural resources and integration with vernacular, cultural, historical embodiment in the indoor working spaces could create and encourage place-making thus improving the mood and quality of work by the occupants. Office settings with an appropriate ventilation, proper mobility and movement for the office workers could improve productivity and physical well-being. It could also create interaction with fellow colleagues which can elevate psychological health and boosts positive relationships in the working settings. Visual, acoustic and tactile stimuli is highly recommended as to provide constant engagement with nature that could improve health and focus.

CONCEPTUAL FRAMEWORK FOR INDOOR BIOPHILIC DESIGN ELEMENTS FOR WORKING ENVIRONMENT

Based on the conceptual framework formulated in Figure 3, it was found that BDE should be comprehensive that covers many aspects of human psychological and physiological health, especially for indoor working environment. It requires integrating biophilic design elements with restorative environment theories, as a strategy to improve the productivity, focus, health, comfort and well-being of the employees. The proposed conceptual framework will help reduce stress in the challenging office environment. It should also take the consideration of human comfort as to be able to gain the restorative impacts of the designs, directly or indirectly. Mohamed (2015) highlights that the biophilic attributes does not necessarily provide style but emphasis on the quality of the habitable space that can also be applied on work settings. Furthermore, the BDE not only improved the quality of work by the occupants but also cost-beneficial towards the building itself. Incorporating BD into the early stages of designing process is necessary and crucial as biophilic design focuses on the mental and physiological well-being of the building occupants compared to other sustainability design approaches that use energy-saving buildings. The framework could benefit the workspace users as it does not neglect the visual connection towards the natural elements but also considering the other sensorial needs for the office settings to improve the attention span thus contributes towards the productivity of workers. The interior spaces design with the application of biophilia not only gives economic advantage but also a beneficial economical investment towards human resources, energy-saving efforts and cost reduction, as the nature itself is free eventhough the mimicry might require some changes in order to be adaptable into indoor environment.

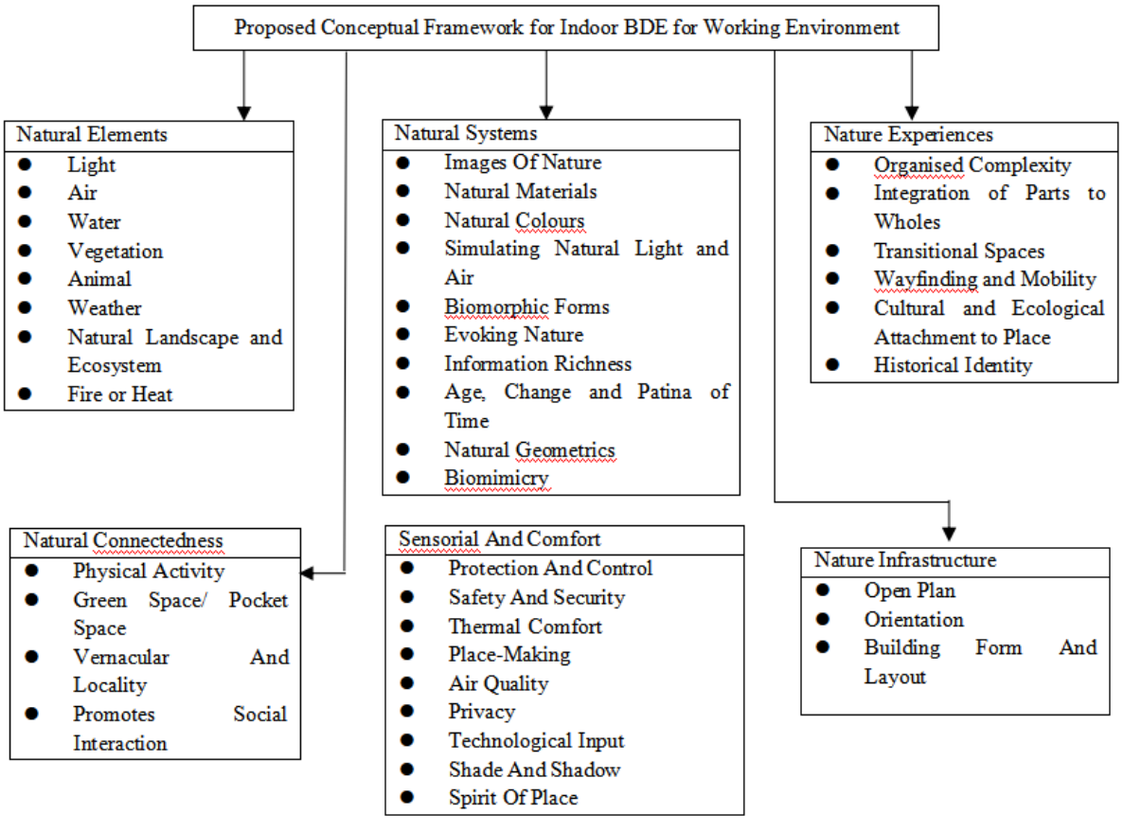

FIGURE 3. Proposed Conceptual Framework for Indoor Biophilic Design Elements for Working Environment

CONCLUSION

Urbanisation and life culture have made people become detached from nature. People have focused most of their time on working, especially indoors. This has caused mental and physical degradation leading to poor performance and productivity. Due to natural human evolution for the species' survival, the intrinsic needs towards the natural environment are salient. Imposing the natural environment into the built environment has myriad benefits encompassing psychological aspects, physiological aspects, economy, health and well-being of the people and the organisations themselves. To perform optimally at work without compromising health, the office environment should integrate ergonomics and nature into the design process. In the challenging office environment and working pressure, the implementation of nature by applying the biophilic design elements with the consideration of restorative environment theories could improve work culture and the psychological and physical health including the life quality of office workers. Understanding the importance of the application of biophilic design in the built environmentcould benefit many parties starting from individuals thus contributing towards the performances of societies and stakeholders such as planners, landscape architects, interior designers and administrators as a whole. Biophilic features support sustainability and low-environmental impact designs. This framework may be used as a foundation for the higher officials in formulating frameworks or introducing biophilia as one of the main features in workplaces or built environments especially planners, designers ad policymakers.

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