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THE DETERMINANT FACTORS OF BIOPHILIC DESIGN STRATEGIES AND OCCUPANTS' PSYCHOLOGICAL PERFORMANCE IN OFFICE BUILDING

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ABSTRACT

Urbanization can result in the changing of climate change, global warming, threatens biodiversity, and decrease access to the natural environment. Hence the current lifestyle and urban living make people distance themselves from the natural world, especially during working hours. Therefore, biophilic design strategies function to eradicate the void between modern design, urbanization, and human needs. This paper is a review of the literature to investigate the predictors for biophilic design strategies in office buildings. It also examines the occupants' perceived psychological performance as the dependent variables for this study. Hence this paper aims to review previous literature related to biophilic in office buildings. This paper concludes that the three main predictors for biophilic strategies are: direct experience of

nature; indirect experience of nature and experience of space and place. As for the dependent variables of this study, the Literature Review analysis concludes that there are five main outcomes related to occupants' perceived psychological performance in office building namely productivity, emotions, cognitive functions, reduce stress as well as the well-being of the occupants. A conceptual framework was developed based on the research variables that are to be tested later in green-rated office buildings in Malaysia and Indonesia. It is hoped that this research will bring benefits for biophilic implementation in both countries.

Keywords: *Biophilic Design Strategies, Occupants Psychological Performance, Office Building*

RESEARCH BACKGROUND

In this globalization era, the majority of the building sector is undergoing a green transformation (Gou et al., 2013). The broad use of the term sustainable construction is sometimes equated with the ways of how the developers design, develop, construct and manage a project that can produce fewer negative impacts on the environment and society (Abidin et al., 2013). In another way, sustainable construction challenges the industry to provide better building and infrastructure by stimulating green building practice. A lot of definitions have been made to elucidate what is sustainable building. According to World Green Building (2016), a sustainable or green building refers to a building that would produce positive impacts on the climate and natural environment in its design, construction or operation stage. There are a lot of features to produce a sustainable building which includes the use of eco-friendly materials, improve energy consumption by harvesting natural light, the use of volatile organic compound materials, and many more.

Biophilia advanced the idea that humans hold a biological need for connection with nature and this connection can contribute to people's well-being, societal relationships, and performance (Browning et al., 2012). Based on Kellert and Calabrese (2015), successful application of biophilic design can increase comfort and satisfaction, improve productivity, lower

blood pressure, reduce sick building syndrome, improved health, increase motivation, and many more. Therefore, it is important to implement biophilic within the built environment as it can help to provide a good working environment. Smith and Pitt (2009) use the term healthy working environment to refer to an environment that will produce fewer negative health contaminants, minimum safety hazards and it can contribute to staff feelings of well-being. According to Cripps (2016), nature plays a vital role in generating a positive physical environmental influence on office employees, and integrating nature into the workspace, can affect employees and organizational performance including the employee's satisfaction, organizational cost, and productivity. Therefore, this study intended to identify the determinant factors of Biophilic Design Strategies in Green Rated office buildings in Malaysia and Indonesia.

PROBLEM STATEMENT

Malaysian occupants spend most of their time in office buildings. Previous studies expressed that current occupants are depressed with their working culture where they need to complete heavy workloads. A survey conducted by AIA Vitality in the office showed 53% of the occupants were overworked and overstressed, which eventually can lead to less productivity and could give an impact on occupants' health and emotions (Hui & Bahauddin, 2019). Additionally, today's environment at the office is much worse for occupants' psychology if compared to the past generations (Hui & Bhauddin, 2019). Besides that, a full day working schedule in a compact structure of working conditions will lead to stress-related illnesses and is predicted to be the primary cause of sickness by 2020 (Bokankar, 2019).

According to Roelofsen (2002), it is very significant to provide a workplace that positively influences the workforce and research has shown that improving the working environment, can improve performance, reduce complaints and absenteeism (Smith et al., 2011). Based on Ayuso et al. (2018), research conducted by Professor Ikaga reported that the biophilic design features are the main key driver of well-being and performance in the workplace. Based on Browning and Cooper (2015), global research found that there are five elements preferred by the employees in the office building which are natural light (44%), indoor plants (20%), quiet working

space (19%), view of the sea (17%) and lastly is bright colours (15%). The authors stated that the majority of the workers agreed that they do not acquire any indoor plants and natural light within their workspace. This proves that there is a disconnection between humans and nature and a huge number of organizations are failing to provide a good working environment with the presence of nature for their workers. However, according to Gillis and Gatersleben (2015), due to urbanization and lifestyle, human interaction with nature is often lacking. Smith et al. (2017) stated that most of the building occupants are linked to several adverse consequences such as poor indoor air quality. The authors advocated that poor indoor air quality inside the building could lead to health issues such as headaches, mucosal irritations, and many more. Furthermore, based on Piko (2006), when workers spend most of their time doing their work, they tend to feel stressed and they will face a high level of anxiety, depression, presenteeism, and absenteeism which can lead to low performance, improper behaviour, become violent, and higher suicide possibility. The performance of an organization is influenced by the working environment (Garg & Talwar, 2017). The authors stated that a healthy working environment can help to increase the employees' motivation and results in better performance. However, working in an environment that does not incorporate nature may lead to the degradation of workers' performance.

LITERATURE REVIEW

Theory of Biophilia

It is necessary here to clarify exactly what is meant by "Biophilia". The term bio is defined as "life or living things" while philia means "love". Therefore, the term biophilia is generally understood as 'love to life'. In 1964, the term biophilia is rooted in theory from a German social psychologist, psychoanalyst, humanistic philosopher, and democratic socialist, Erich Fromm's book, 'The Heart of Man'. It describes a psychological orientation of being attracted to all that is alive and vital. In 1984, the term biophilia then became popular when Edward Osborne Wilson who is a renowned Harvard Biologist with many published works devised the term "biophilia" as a way to describe the deep bonds that humans have with nature and

concerns the need we have to be continually connected to nature (Dias, 2015). This is supported by Browning and Cooper (2015), which stated that most of the research confirms this human preference for the natural, rather than built environment. For instance, in a 2004 study, when people were asked to describe their dream city, the majority of them chose non-urban characteristics, especially in terms of greenery.

Furthermore, the concept of biophilia implies that humans hold a biological need for connection with nature on physical, mental, and social levels and this connection affects our wellbeing, productivity, and societal relationships (Dias, 2015). According to Kellert et al. (2008), philias are the positive feelings and attractions that people have toward certain habitats, activities, and objects in their natural surroundings, unlike phobias and fears that people have of things in the natural world. According to Kellert and Heerwagen (2008), the biophilia theory and sustainability theory are quite similar, as it discusses the environment and human relationships. The only difference is that sustainability focuses more on the effects of humans on nature, mitigating environmental impact in the built environment while biophilia focuses more on the effects of nature on humans, creating a sustainable and reciprocally beneficial relationship.

The concept of biophilia indicates that humans hold a biological need for connection with nature on social, physical, and mental levels. The bond between humans and nature will affect productivity, personal well-being, and societal relationships. Biophilia has many uses that help transform mundane settings into stimulating environments whether by engaging with nature, by interacting with animals, by walking at a park, or by just having a view of greenery from home or workplace (Browning et al., 2012). The interest in biophilia has grown largely over the last decade due to the rapid urbanization of the modern world and over the last 60 years, global figures show the amazing shift in populations moving into urban areas. Thus, it is clear that people are moving from rural to town areas and cities and in fact, the United Nations estimate that by 2030, 60% of the world's population will live in urban environments (Browning & Cooper, 2015). Therefore, it is momentous to consider how the bond and connection between humans and nature can still be provided in their environment.

Biophilic Design

According to Kellert and Heerwagen, (2008) the term biophilic design is defined as an innovative approach that aims to enhance, maintain and restore the beneficial experience of nature in the modern built environment. The authors also stated that, through the implementation of biophilic design, the modern built environment can have a more harmonious environment with nature and it can also help to improve people's health and wellbeing. There are three biophilic design frameworks which are:

i.The Kellert Framework: Pillars of Biophilic Design
ii. Terrapin Bright Green Framework: Fourteen Patterns of Biophilic Design
iii. Kellert and Calabrese Framework: Three Categories of Experience of Nature

•The Kellert Framework: Pillars of biophilic design

The framework of the biophilic design was first introduced by Stephen R. Kellert in 2008 which consists of two basic dimensions of biophilic design. The two basic dimensions of biophilic design are related to six biophilic design elements which are then broken into more than 70 biophilic design attributes (Kellert et al. 2008). According to Kellert et al. (2008), the two basic dimensions of biophilic design are organic dimension and vernacular dimension. The term organic dimension refers to shapes and forms in the built environment that reflect the affinity for nature either directly, indirectly, or symbolically. Direct experience can be defined as relatively unstructured contact with self-sustaining features of the natural environment such as plants, natural light, natural habitats, and ecosystems whereas indirect experience is known as contact with nature that involves ongoing human input to survive such as aquarium or water fountain. The term symbolic or known as vicarious experience does not need actual contact with the real nature but it requires the representation of the natural world through video, image, picture, metaphor, etc. Based on Kellert et al. (2008), the second basic dimension of biophilic design is a place-based or vernacular dimension. The term place-based or vernacular dimension tends to be used to refer to landscapes and buildings that link to the culture and ecology of a locality or geographic area.

Table 1. The Kellert Framework

Dimension	Biophilic Design Elements	Biophilic Design Attributes
Organic or Naturalistic	Environmental features	•Colour •Water •Air •Sunlight •Plants •Animals •Natural materials •Views and vistas •Facade greening •Geology and landscape •Habitats and ecosystems •Fire
	Natural shapes and forms	•Botanical motifs •Tree and columnar supports •Animal (mainly vertebrate) motifs •Shells and spirals •Egg, oval and tubular forms •Arches, vaults, and domes •Shapes resisting straight lines & right angle •Simulation of natural features •Biomorphy •Geomorphology •Biomimicry
	Natural patterns and processes	•Sensory variability •Information richness •Age, change, and the patina of time •Growth and efflorescence •central focal point •Patterned wholes •Bounded spaces •Transitional spaces •Linked series and chains •Integration of parts to wholes •Complementary contrasts •Dynamic balance and tension •Fractals •Hierarchically organized ratios and scales

Place-based or Vernacular	Light and space	•Natural light •Filtered and diffused light •Light and shadow •Reflected light •Light pools •Warm light •Light as shape and form •Spaciousness •Spatial variability •Space as shape and form •Spatial harmony •Inside-outside spaces
	Place-based relationships	•Geographic connection to place •Historic connection to place •Ecological connection to place •Cultural connection to place •Indigenous materials •Landscape orientation •Landscape features that define building form •Landscape ecology •Integration of culture and ecology •Spirit of place •Avoiding placelessness
	Evolved human-nature relationships	•Prospect and refuge •Order and complexity •Curiosity and enticement •Change and metamorphosis •Security and protection •Mastery and control •Affection and attachment •Attraction and beauty •Exploration and discovery •Information and cognition •Fear and awe •Reverence and spirituality

Source: Kellert et al. (2008)

•Terrapin Bright Green Framework: Fourteen patterns of biophilic design

In 2014, the Terrapin Bright Green developed three pillars that consist of fourteen patterns of biophilic design to improve health and well-being in the built environment. The three pillars of biophilic design are nature in the space, nature analogues, and nature of the space (Terrapin Bright Green, 2014). According to Terrapin Bright Green (2014), nature in the space is defined as incorporating nature into the built environment which includes plant life, water, and animals such as fish tanks and pets. Potted plants, aquariums, water features, courtyard garden, green walls, vegetated roof as

well as views to nature from the inside building also fall into this category. Nature in the space encompasses seven biophilic patterns which are the visual connection to nature, non-visual connection to nature, non-rhythmic sensory stimuli, thermal and airflow variability, presence of water, dynamic and diffuse light, and connection with natural systems.

The second pillar is nature analogues. Based on Terrapin Bright Green (2014), nature analogues are one-degree separation away from real nature or in other words, it is said as man-made elements that mimic nature. There are four types of nature analogues which are ornamentation, representational artwork, biomorphic forms, and the use of natural materials. The example of nature analogues is furniture with organic rather than geometric shapes, pictures of trees and waters, visible wood grain, and building elements mimicking shells and leaves. Many benefits can be reaped from nature represented in artwork but it is less effective than benefits derived from real nature. Nature analogues encompass three patterns of biophilic design which are biomorphic forms and patterns, material connection with nature, and complexity and order. The third pillar is the nature of the space. The broad use of the term nature of the space is sometimes equated with the ways humans respond physiologically and psychologically to different spatial configurations. The greatest Nature of the Space experiences can be achieved through the creation of deliberate and engaging spatial configurations commingled with patterns of nature in the space and natural analogues. The nature of the space encompasses four biophilic design patterns which are prospect, refuge, mystery, and risk or peril (Terrapin Bright Green, 2014).

Table 2. Patterns of biophilic design

Pillars	Specific Patterns	Attributes
Nature in the Space	1. Visual Connection to Nature	•View to elements of nature, living Systems, and natural processes such as windows with a garden or sea view.
	1. Visual Connection to Nature 2. Non-Visual Connection to Nature	•Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature
	3. Non-Rhythmic Sensory Stimuli	•Stochastic and ephemeral connections with nature that may be analysed statistically but may not be predicted precisely such as the gentle sway of grasses or leaves.
	4. Thermal and Airflow Variability	•Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.
	5. Presence of Water	•A condition that enhances the experience of a place through the sense of sight, auditory, or touch the water.
	6. Dynamic and Diffuse Light	•Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
	7. Connection with Natural Systems	•Awareness of natural processes, specially seasonal and temporal changes characteristic of a healthy ecosystem.
Nature Analogues	8. Biomorphic Forms and Patterns	•Symbolic references tcontoured, patterned, textured or numerical arrangements that persist in nature.
	9. Material Connection with Nature.	•Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place
	10. Complexity and Order	•Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.

Source: Terrapin Bright Green, (2014)

•Kellert and Calabrese Framework: Three categories of experience of nature

In 2015, Kellert and Calabrese updated the framework based on Kellert's first framework. The Kellert and Calabrese framework of biophilic design consists of three categories of experience of nature which are direct experience of nature, the indirect experience of nature, and the experience of space and place (Kellert & Calabrese, 2015).

According to Kellert and Calabrese (2015), the direct experience of nature is defined as the real contact with environmental features in the built environment. Examples of direct experience of nature are plants, water, air, natural light, landscapes, and many more. The term indirect experience of nature refers to contact with nature through pictures including images of artwork, natural materials such as woolen fabrics, and ornamentation inspired by forms and shapes occurring in nature. Lastly is the experience of space and place. Experience of space and place may be defined as spatial features characteristic of the natural environment that contributes to human health and well-being. Examples of experience of space and place are organized complexity, prospect and refuge, mobility and wayfinding, and many more.

Figure 1. The Kellert and Calabrese Framework
Source: Kellert & Calabrese, (2015)

According to Kellert and Calabrese (2015), all of the biophilic qualities can be experienced through a variety of human senses such as smell, taste,

movement, sight, sound, and touch. The visual sense is the dominant way people perceive and respond to the natural world. The authors also stated that when people have connections with plants, landscapes, and other natural features, a variety of physical, emotional, and cognitive responses are triggered. Furthermore, people also react to indirect visual contact with nature, such as the image and representation of nature, natural materials, and others. Aesthetically attractive nature particularly captures people's interest, curiosity, imagination, and creativity. By contrast, when people get lack visual contact with nature, such as a windowless space, they tend to experience boredom, fatigue, and in worst cases physical and psychological abnormality.

Moreover, other sensory responses to nature such as touch, sound, smell, taste, and motion are also of great significance to people. Hearing the sound of water, touching the plants, smelling flowers, sensing the movement of the air often moves people emotionally and intellectually. Multi-sensory encounters with nature in the built environment can greatly enhance comfort, satisfaction, enjoyment, and cognitive performance.

Biophilic Design Certification System

Living building challenge

The Living Building Challenge (LBC) is an international sustainable building certification program that was launched in 2006 by International Living Future Institute (ILFI) which is a non-profit organization that offers green building and infrastructure solutions at every scale from small renovations to neighbourhoods or whole cities. It is a philosophy, certification, and advocacy tool for projects to move beyond merely being less bad and to become truly regenerative and the mission of the ILFI is to guide and support the transformation toward communities that are socially just, culturally rich, and ecologically restorative (International Living Future Institute, 2019). There are five certifications of Living Building Challenge which are Zero Carbon Certification, Zero Energy Certification, Core Green Building Certification, Petal Certification, and Living Certification. The types of projects that can be certified include new or existing buildings, institutional buildings, single-family residential, multi-family residential, commercial buildings, medical and laboratory buildings, and more

(International Living Future Institute, 2019).

Based on International Living Future Institute (2019), Zero Carbon Certification is for projects that focused on impacting climate change through materials and energy, and for the project to achieve the Zero Carbon Certification, the project must prove the actual net zero carbon operations based on twelve-month performance period. A targeted energy efficiency level and a reduction in the embodied carbon of the primary materials of the project are also required. In addition, the total embodied carbon emissions impacts associated with the project's construction and material must be disclosed and offset. Next is Zero Energy Certification. The International Living Future Institute's Zero Energy Certification is for projects that targeting on achieving net-zero energy through the on-site production of renewable energy. International Living Future Institute defines net-zero energy as one hundred percent of the building's energy needs on a net annual basis must be supplied by on-site renewable and no combustion is allowed.

The third certification is Core Green Building Certification which is a simple framework that outlines ten core imperatives that a building must obtain to be considered a green or sustainable building. Core Green Building Certification or Core Certification is for projects that aim for a high aspiration certification that is verified, readily achievable, and holistic. Next is Petal Certification. Petal Certification focuses on projects that want to go in-depth into one specific issue area, or petal of the Living Building Challenge. Petal certification requires at least three out of seven petals, one of which must be either energy, materials, or water. Last but not least is Living Certification. Living Certification focuses on projects that want to achieve the highest level of sustainability and regenerative design. For a project to achieve Living Certification, the project must meet all imperatives applicable to its typology (International Living Future Institute, 2019).

WELL building standard

The WELL Building Standard is the leading global rating system and it focuses exclusively on individuals' health and well-being in the built environment. The WELL Building Standard can be applied for new buildings and existing buildings and is currently piloting the second version. The second version consists of eleven concepts which are air, water, nourishment, light, movement, thermal comfort, sound, materials,

mind, community, and innovations. The concept of biophilia is integrated within three features under the Mind Concept which are access to nature (M02), restorative spaces (M07), and enhanced access to nature (M09) (International WELL Building Institute, 2018).

According to International WELL Building Institute (2018), access to nature (M02) requires the integration of nature into the project's interior and exterior through design elements that support direct access and indirect access to nature. Direct connection to nature must achieve at least two of the following which is light, plants, nature views, or water while the indirect connection to nature can be achieved through the use of natural materials, patterns, images, or colours. Lastly is the space layout. Addressing placement of natural elements along circulation routes, workspace, shared seating areas, and rooms to enhance occupant exposure. Next is restorative spaces (M07). Restorative spaces require projects to provide spaces that can give a restorative environment and encourage relief from stress and mental fatigue. Restorative spaces consist of two parts which are indoor spaces and outdoor spaces. International WELL Building Institute (2018) advocate those spaces must be designated exclusively for contemplation, relaxation, restoration and not for the purpose of work; adhere to accessible design, have dimmable lighting levels, incorporate sounds from nature such as water feature or natural sounds, thermal comforts such as availability of both sun-exposed and shaded areas, incorporation of nature, visual privacy and use calming colours, textures, and forms.

Last but not least is enhanced access to nature (M09). Based on International WELL Building Institute (2018), enhanced access to nature requires the integration of natural and natural elements into the exterior and interior of the project, along with the provision of nature views and nearby nature such as blue and green spaces. For enhanced access to nature, projects must achieve at least two of the following which are indoor access to nature, outdoor access to nature, nearby nature, and nature views. Outdoor access to nature must be at least 25% of the exterior site area to include landscaped grounds or other natural elements, plant and natural elements must be at least 70%, and a narrative that describes the access to nature must be included. Indoor nature access through indoor plants and water features are within a direct line of sight of a minimum of 75% of occupied spaces, water safety must be addressed by using ultraviolet sanitation or other technology only

if water features are included, and a narrative that describes the access to nature. Nature views are available within a direct line of sight of at least 75% of occupied spaces and a narrative that describes how the interior project's design encourages occupant access to nature. Lastly, nearby nature must consist of a minimum of 1.25 acres for green spaces and within 1,000 ft. walk distance from the project must have at least one blue or green space. A narrative that describes how occupants are encouraged to access nearby nature must be included.

Occupants' Psychological Performance

Performance psychology can be defined as examining the psychological factors that influence human performance and to improved and maintain from various psychology perspectives such as emotions, productivity, cognitive, action, and perception (Raab, Hoffman, Loinger & Pizzera, 2015). Hence, the factors that can influence occupants' performance are motivations, personality, leadership, and work environment (Singh, 2017). The office environment plays an important factor in occupants' performance either they can produce positive outcomes or negative outcomes. Moreover, a good office environment could give a greater impact on occupants' lifestyle, work-life balance, and health fitness (Naharuddin & Sadegi, 2013). According to Lerner and Stopka (2016), the way to improve and restore occupants' cognitive function is by exposing them to natural elements, which can automatically increase productivity. Previously Rachel and Stephen Kaplan who are environmental psychologists have developed a module called "Attention Restoration Theory (ART)" which stated that direct contact with the natural environment can improve the occupant's ability to focus their mental capacity after working strongly for a period of time. A study by DeJosephine and Bahauddin (2019) also affirmed that the existing biophilic design patterns do enhance co-workers' emotional well-being significantly. Nevertheless, this study also aims to be conducted and tested in green-rated buildings where the psychological aspects of the occupants are measured during the Post Occupancy Evaluation (POE) phase (Saidin et.al, 2020) for better research findings in Malaysia and Indonesia.

CONCLUSION

Hence based on the above Literature Review discussion, the following is the conceptual research framework that consists of determinant factors of; 1. Direct Experience of Nature, 2. Indirect Experience of Nature and 3. Experience of Space and Place as the Independent Variable of this research framework. Hence, the Occupants' Psychological Performance in aspects of productivity, emotions, cognitive functions, reduce stress, wellbeing, and many others were chosen as the dependent variables of this study. Subsequently, this framework will be tested later in Malaysia and Indonesia green-rated office buildings with the following hypothesis. This study is intended to produce a guideline for the designers to apply the biophilic design strategies for their upcoming projects since now both Malaysia and Indonesia are working towards green buildings, and it can enhance the green building strategies.

H1: There is a relationship between Direct Experience of Nature with Occupants Psychological Performance in Green Rated Office Building

H2: There is a relationship between Indirect Experience of Nature with Occupants Psychological Performance in Green Rated Office Building

H3: There is a relationship between Experience of Space and Place with Occupants Psychological Performance in Green Rated Office Building

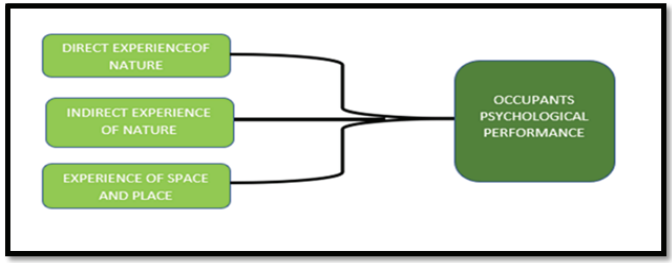

Figure 2. Conceptual Framework

Source: Author

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AUTHORS CONTRIBUTION

All authors have participated in the conception, analysis and interpretation of the data, drafting the article or revising it critically for important intellectual content and approval of the final version.

CONFLICT OF INTEREST

This manuscript has not been submitted to, nor is under review at, another journal or other publishing venue. All authors declared that they have no conflicts of interest.

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