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BIOPHILIC DESIGN IN TRANSITIONAL SPACES OF HIGHER EDUCATION BUILDINGS FOR MENTAL WELL-BEING

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***Abstract*— Biophilia has been described as "the innate tendency by humans to focus on life and life- like processes" (Wilson, E. O., 1984). This means that "humans have an instinctive desire to immerse and socialize ourselves in the natural environment and connect with other living organisms". This connection with nature promotes a healthy lifestyle. A healthy lifestyle is not limited to physical well-being but also mental, which in various ways has been complemented by biophilia. Incorporating biophilia in our architectural spaces has been scientifically proven to assist in stress reduction, increase productivity and attentiveness, achieve calmness and mental restoration, and promote positive psychological responses in people. Various moods and behaviors can be induced, enhanced, or eradicated when people are exposed to controlled designs and can help us understand the different patterns of reactions exhibited by people due to their surroundings. A transitional space is one that lies between the indoor and outdoor or between two spaces of different functions. These spaces encourage and support exploration, collaboration, conversation as well as reflection and meditation. Students spend most of their time in their places of education when not at their homes and these spaces give designers the opportunity to contribute to the improvement of their wellbeing.**

Few studies have explored the impact of incorporating biophilic design in transitional spaces of higher education environments. However, many studies have established a positive correlation between biophilia and mental wellbeing in healthcare, office, and hospitality environments and therefore, the incorporation of biophilic design can be seen in these spaces but not extensively in higher education environments. This research aims to link the positive effects of biophilic design and the mental states of the students that occupy the transitional spaces in their place of education to promote the mindful incorporation of biophilia in the design of these learning spaces and encourage further research into the benefits of doing so.

***Keywords*— Transitional spaces, Biophilia, Well-being**

I. INTRODUCTION

A healthy lifestyle is not limited to physical well-being but also mental, which in various ways has been complemented by the incorporation of natural elements in architectural spaces. The incorporation of these elements in architecture have been scientifically proven to assist in stress reduction, increase productivity and attentiveness, achieve calmness and mental restoration, and promote positive psychological responses in people. The influence of natural elements on the users psyche goes way beyond just aesthetics. Various moods and behaviors can be induced, enhanced, or eradicated when people are exposed to controlled designs and can help us understand the different patterns of reactions exhibited by people due to their surroundings. This study will explore how to approach biophilic design can be leveraged to create a meaningful space for its users, using principles and elements of design within higher education facilities.

II. RESEARCH QUESTION

How can biophilic design in the transitional spaces of higher education environments be crucial for the mental well-being of the students and how does it impact their learning behavior?

User Group-

The users identified for this case study are the students occupying the higher educational buildings to understand their response to biophilic design in high stress environments.

Aim-

To identify and analyse the value of biophilic design in transition spaces in influencing the mental well-being and learning behaviour of users of higher education buildings.

Objectives-

1.Define and understand the concept of biophilia and biophilic design.

2.Define transition spaces and establish its importance in higher education buildings.

3.Explore theories and existing studies on the effect of biophilic design on mental well-being.

4.Establish the relation between biophilic design in transitional spaces of higher education buildings and the users' mental well-being.

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Scope And Limitations-

This study is limited to the features and effects of biophilic design on the mental well- being and learning behaviour in the defined user group (students) in the specified building typology (higher education buildings).

Methodology-

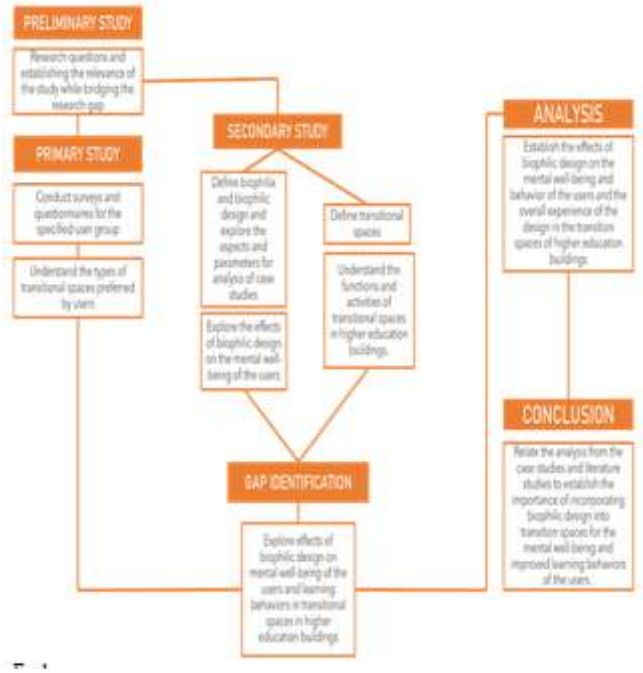

Fig. 1. Methodology of the research paper.

Step 1: Preliminary Study:

Framing the research questions and establishing the relevance of the study to bridge the research gap.

Step 2: Primary Study

Frame and conduct the questionnaire for the specified user group and understand the types of transitional spaces preferred by users.

Step 3: Secondary Study

Define biophilia, biophilic design and explore the effects of biophilic design on the mental well-being of the users to establish the aspects and parameters for the analysis of case studies.

Define transitional spaces and understand the functions and activities of transitional spaces in higher education buildings.

Step 4: Gap Identification

Explore the effects of biophilic design on the mental well-being of the users and learning behaviors in transitional spaces in higher education buildings.

Step 5: Analysis

Establish the effects of biophilic design on the mental well-being and behavior of the users and the overall experience of the design in the transition spaces of higher education buildings.

Step 6: Conclusion

Relate the analyses from the case studies and literature studies to establish the importance of incorporating biophilic design into transition spaces for the mental well-being and improved learning behaviors of the users.

III. LITERACTURE REVIEW-

What Is Biophilia-

Biophilia has been described as the innate tendency by humans to focus on life and life- like processes (Wilson, E. O., 1984). This means that humans have an instinctive desire to immerse and socialise ourselves in the natural environment and connect with other living organisms. This connection with nature promotes a healthy lifestyle.

Population density and movement in India is exponential. Due to this, the increased competition for space is resulting in the creation of more dense areas and high-rise buildings. Increased urbanisation, town planning densification policies, working environments and digital integration are a few aspects that has an influence on the time people spend in natural environments. Despite the obvious advantages of spending time in nature on community health, people spend over 80% of their time in buildings and a large amount of time in an inactive mode, ‘glued’ to screens.

Impact Of Built Environment-

The health and well-being of city dwellers, teachers, and staff in commercial towers has recently received increased scrutiny. Several research conducted at prestigious universities have shown that interacting with natural landscapes, or "green spaces," encourages healthy health and is particularly beneficial in decreasing stress and mental exhaustion symptoms (Grahn, P., & Stigsdotter, U. A, 2003). Excessive time spent in hospitals can lead to Sick Building Syndrome, which can be costly to the city and economy, resulting in job loss and decreased productivity as a result of the illness (Kinman, G., & Clements,, 2011). As compared to naturally ventilated offices, air- conditioned buildings have a greater incidence of symptomatic workers.

Biophilic Design-

Biophilic design can be described as a phenomenon that seeks to mitigate some of the negative effects and repercussions that built environments can have on human health (physiological and psychological health) by promoting changes to building design that prioritize human needs. Health benefits associated with access to and abundance of fresh air, natural sunshine, and views of nature have been clinically shown to increase respiratory health, reduce mental exhaustion, reduce feelings

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of stress, and enhance concentration capability (Berto, R. 2005). Understanding the importance of biophilia and its advantages to building inhabitants will change the way we design buildings.

These values, when combined with other biophilic principles, will significantly change the overall architecture of higher education buildings while both enhancing the emotional and physical well-being of users and promoting educational groups.

Biophilic Design In Educational Buildings-

In the educational environment, biophilic design has proven to be important in the following area:

•SOCIAL AND EMOTIONAL LEARNING: When compared to urban settings, views in and within natural environments have been found to promote greater social and emotional regeneration and vitality, mitigating stress and distress while also fostering a safe and clear mind free of frustration and exhaustion (Baker, L., & Bernstein, H., 2012), thereby assisting students' emotions, behavior, and academic success.

•MEMORY AND ATTENTION: Experiments to better explain the phenomenon's impact on the human mind have shown that spending an hour in nature increases memory and concentration by 20%. Participants in a study who walked in inner city streets and built landscapes alongside botanical gardens saw a visible increase in short-term memory of 20% as compared to those who walked in the city, which resulted in no improvement (Barker, Roger G.1976).

•FATIGUE: According to the Focus Restoration Theory (ART), when an individual conducts cognitive tasks with directed and undivided attention for a long period of time, their commitment starts to wane (Kaplan, R., & Kaplan, S. 1989). According to the aforementioned hypothesis, nature introduces particular triggers in the atmosphere that aid in the recovery of problems such as concentration fatigue.

Nature is an asset which should be embraced because it can bring aspects such as balance and harmony to the classroom and the lives of the students. Designing from the inside out, by bringing the outside in, can unite the man-made and natural environments. This asset has the potential to transform the nature of new school design by integrating important features of function, form, and the student experience in schools, helping to restore architecture that promotes health and wellbeing in educational environments, especially for those in dense urban locations.

Defining Transitional Spaces-

'Transition' is defined as the movement, or change from one position, state, experience etc., to another. In Architecture, it is defined as the connecting space between two confined spaces. It is also the process which facilitates change. It is the provision of space which allows one to adjust from one experience to another. By transferring from one space to another, there could be a complete change of mood, mental state, or personality of an individual. This change in space might involve anxiety, paranoia, or thrill at one end and serenity or refuge on the other. Transition space involves 3 different aspects, namely, passage/pathway, transition, and arrival. Passage or pathway is the element which enables the transfer between places. Transition would be the space which helps one to adjust in a different space from the previous one. Arrival is the introduction to the space where one wishes to move to (R.Gary Black, 2002).

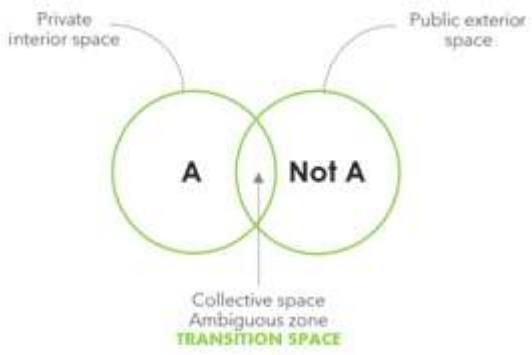

Fig. 2. Emergence of Transitional Spaces

When there is a smooth flow between two spaces, and the transition between these is gradual and creates a sense of comfort, the experience within the building tends to remain in a positive manner and helps one be more productive (Architecture weak, Patterns of Home, Pattern Six — The Flow through Rooms: Arrival, Passage, and Transition, The Taunton Press, 2002)

Fig. 3. Development of Transitional Spaces

Transition spaces tend to greatly affect the mood or the general behavior of an individual. For example, while people are on the street, they tend to behave differently than when they come into a house, they would naturally get rid of their "street behavior" and adopt a style that is more like to settle down within the household. But it would be a difficult task to change one's personality to such a great extent without the provision of transition spaces.

Nature-Design Relationship-

To understand biophilic design patterns, it can be classified into:

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1.Nature in the Space,
2.Natural Analogues, and
3.Nature of the Space

These classifications comprise of 14 patterns that describe the experience of a place and act as a framework that will assist us in understanding biophilic design and to stay mindful of these strategies when incorporating into our built environment.

Nature In The Space-

'Nature in the Space' encapsulates the tangible presence of nature in a place and can be classified into seven patterns:
P[1] Visual Connection with Nature: "a view to the elements of nature, systems and natural processes" (Browning et al. 2014)
P[2] Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that promotes a deliberate and positive user-nature/natural process connection (Browning et al. 2014)
P[3] Non-Rhythmic Sensory Stimuli: Random and short connections with nature that may be analyzed statistically but may not be predicted precisely (Browning et al. 2014)
P[4] Thermal and Airflow Variability: Incorporation or control of air temperature, relative humidity, airflow across the skin, and surface temperatures to resemble that of the natural environment (Browning et al. 2014)
P[5] Presence of water: "an aspect that enhances the experience of a place through seeing, hearing or touching water" (Browning et al. 2014)
P[6] Dynamic and Diffuse light: Incorporation or control of varying intensities of light and shadow to resemble that which occurs in the natural environment. (Browning et al. 2014)
P[7] Connection with Natural Systems: "Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem" (Browning et al. 2014)

Natural Analogues-

This aspect describes the "organic, non-living and indirect evocations of nature" and can be classified into three patterns:
P[8] Biomorphic Forms and Patterns: "Symbolic references to contoured, patterned, textures or numerical arrangements that persist in nature" (Browning et al. 2014)
P[9] Material Connection with Nature: "Materials and elements from nature that undergo minimal processing and reflect the local ecology or geology and create a distinct sense of place" (Browning et al. 2014)
P[10} Complexity and Order: Elements and design that references spatial hierarchies like those encountered in nature (Browning et al. 2014)

Nature Of The Space-

This aspect describes "the spatial configurations in nature" and can be classified into four patterns:
P[11] Prospect: uninterrupted views over large distance, for surveillance, planning and views (Browning et al. 2014)
P[12] Refuge: A retreat from the current environment or the main activity zones, in which the individual is protected from behind and overhead (Browning et al. 2014)
P[13] Mystery: "the promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment" (Browning et al. 2014)
P[14]Risk/Peril: "An identifiable threat coupled with a reliable safeguard" (Browning et al. 2014)

IV. DATA COLLECTION AND ANALYSIS

Data Collection Parameters-

"Biophilic Design Patterns and Biological Responses" (Browning et al. 2014)
14 Patterns of Biophilic Design
The patterns of user experience as outlined by authors William Browning and Jenifer Seal-Cramer.

Case Study 1: School of Design and Environment, NUS, Singapore

Opened in 2019, SDE is an institution that focuses on design, sustainability and education and is the first net-zero energy building in Singapore. It is designed an 8500 sq.m, six storey, multi-disciplinary space. The programme of the building includes "over 1500 sq.m of design studio space, a 500-square-metre open plaza; a variety of public and social spaces; workshops and research centres, new café and library". (Serie Architects)
Location: Singapore: tropical rainforest climate
Area: 8500 sq.m
Year of Completion: 2019

Fig. 4. Source- Rory Gardiner

IDENTIFYING THE TRANSITIONAL SPACES-

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The building incorporates various flexible transition spaces in the design. These spaces have been designed to transform depending on the users wishes.

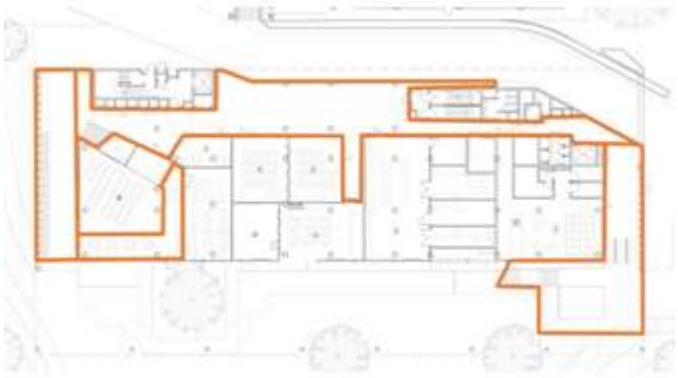

Fig. 5. Base Plan: Serie Architects

Visual Connections To Nature –

The long plan of the building with its transitional spaces configured at its peripheries facilitates the buildings visual connections with nature. These connections are reinforced through the extensive incorporation of open building faces and landscaped balconies and terraces which allows for uninterrupted views of the adjacent forests and on-site vegetation.

Fig. 6. Base Plan: Serie Architects

All the transitional spaces in the building have excellent visual connectivity to the natural elements around the structure. Views of the forests and the city are accessible from every transitional space and the design, itself has incorporated various green spaces and plantings.
Furthermore, the windows and walls are designed to be dismantled and rearranged to the users liking, therefore allowing them to customize the degree at which they can connect to nature.

Fig. 7. Source: Rory Gardiner

Non-Visual Connections To Nature-

The vegetation that the structure has been built around or has been planted adjacently attracts insects and wildlife which, along with the vegetation itself, generates auditory and olfactory stimuli.

Fig. 8. Source: Base Map: Serie Architects

Fig. 9 Source: Rory Gardiner

Non-Rhythmic Sensory Stimuli-

Leaves rustling in the wind; auditory stimuli from insects and wildlife.

Thermal And Airflow Variability-

The faces and plan of the design is open, allowing for the constant natural ventilation for over 50% of the total area. Furthermore, windows and walls can be dismantled and rearranged to allow for cool airflow.

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Fig. 10. Source: Base Map: Serie Architects

Dynamic And Diffused Light-

Tree canopies create dappled light; interesting plays of light and shadow filtering through the aluminum panels in the east and west facades; daylight penetrates the building from all angles. Artificial lighting used is warm and appropriate to regulate circadian rhythms. There is variety of accent, task and general lighting.

Fig. 11. Source: Rory Gardiner

Connection With Natural Systems-

The open design creates opportunities to observe interactions between wildlife, landscape, and vegetation.

Biomorphic Forms And Patterns-

Aluminum screens used to reduce solar heat gain are designed using symbolic references to the honeycomb pattern.

Fig. 12. Source: Rory Gardiner

Material Connection With Nature-

Use of timber in the staircases, stone for flooring and wall cladding creates warmth and connections to local context. Materials such as steel, perforated metal and concrete are incorporated in a way that celebrates their raw and natural characteristics.

Risk/Peril-

The walkways, due to their open nature and low glass railings provide a moment of excitement and thrill. These areas provide views of the lower storeys and dramatic views of the adjacent landscapes.

PROSPECT-

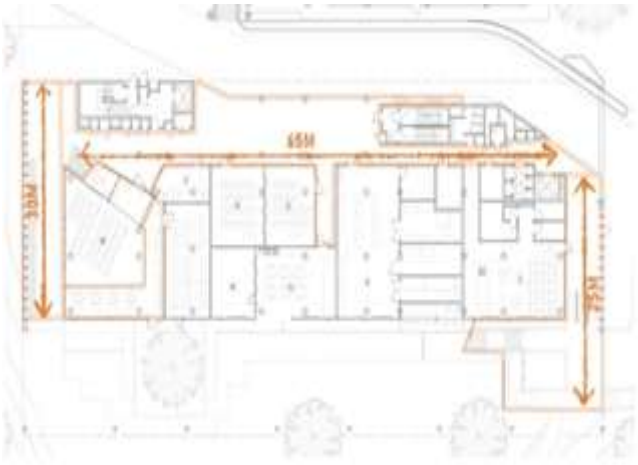

Fig. 13. Source: Base Map: Serie Architects

V. RESULTS-

The extensive use of biophilic design and patterns in the School of Design and Environment in Singapore creates an environment that promotes mental restoration, and have the following potential mental well-being responses.

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1.Maintaining abundant visual connections with nature has research that proves that in doing so, blood pressure and heart rate can be lowered, mental engagement and attentiveness can be improved, and attitude and overall happiness can be positively impacted.
2.Incorporating biomorphic forms and patterns results in observed view preference.
3.Designing to include elements that promote the aspect of "risk/peril" has observed decreased diastolic blood pressure, improved creative performance, and improved comfort.

Case Study 2: Kroon Hall, Yale University

Kroon Hall is Yale's greenest framework and a depiction of the school's principles and beliefs. In February 2010, Kroon Hall was awarded the LEED Platinum certification.
The Context
Kroon has developed a community on Science Hill by linking the various parts of the campus through courtyards in the north and south, which have been landscaped with
nearly 25 native organisms. The south courtyard is a green roof, which features the Mars Pond, where aquatic plants clean water from the building's roof and grounds.

Location
195 Prospect Street, between Sage Hall and Osborn Memorial Laboratories

LEED Rating LEED Platinum

Fig. 14. Site Plan

Features-

•A 218-foot-long wall on the south increases solar heat gain in the winter and provides daylighting all year.
•The building's narrow plan (57 foot wide) permits daylight to penetrate the interiors.
•Interior lighting adjusts to the amount of people in the room as well as the amount of light coming in from the outside. In unoccupied rooms, lights switch off after a few minutes and vary in intensity based on ambient light.
•Manually opened windows allow for natural ventilation.
•Briar Hill sandstone used in façade was quarried within 500 miles of campus.
•Red oak paneling sourced from Yale-Myers Forest.

Fig. 15. Briar Hall

The walls on the north and south facades of Briar Hill are thick and have operable, high-performance windows, surrounded to provide shade from the heat. A barn- style roof is elevated above the walls and covered by laminated Douglas fir arched frames. A third-floor loft is created by the red oak roofline.
The structure is a modernist fusion between a cathedral nave and a Connecticut barn, with openings for heat from above and below ground, sunshine, and ventilation, as well as outdoor spaces for functional and artistic reasons. Kroon is linked to his colleagues on the main campus by external walls made of Ohio sandstone. Fir louvres have been designed for the building's glass ends and establishes a modern and utilitarian aesthetic. The golden-brown colored Kroon brightens up its surroundings with a large inviting outdoor lobby that faces the highway, while a neighboring walkway draws a large number of people into an open courtyard, one of two modern greenswards that serves as a green roof over a new service node for the entire campus. A hardwood canopy to the east, welcomes visitors into the center of the science campus.

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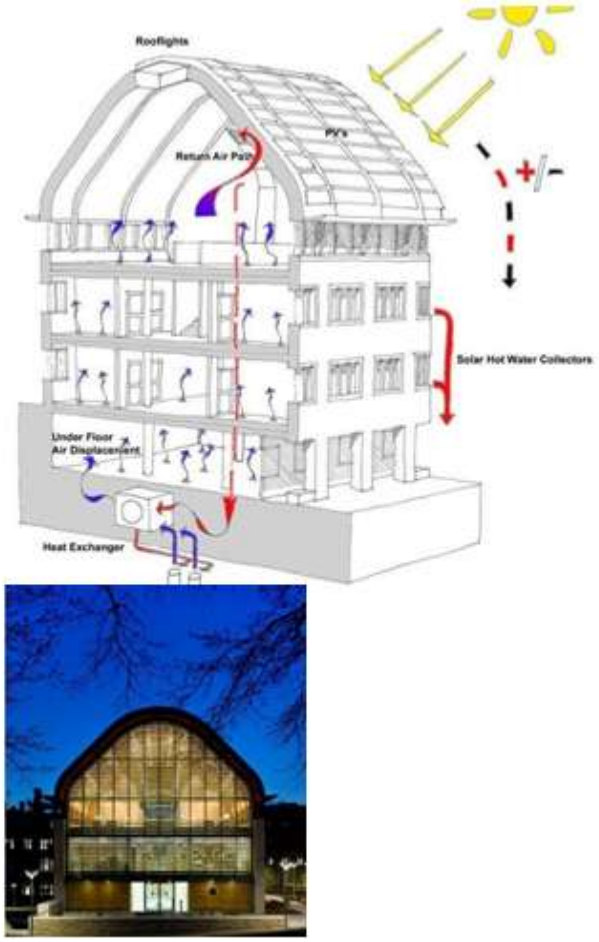

Fig. 16. Ventilation Systems

The displacement ventilation system, which pushes air through a plenum and into inhabited spaces through diffusers in the raised floors, is an integral part of the house. The basement's low-velocity fans help to keep the air flowing nearly unnoticeably. Fresh air is fed into the house by this mechanism during the summer and winter months, but in the spring and autumn, the mechanisms are turned off, and the windows are operated for ventilation.

Rainwater is collected from the roof and grounds and channeled to a greenhouse in the south courtyard, where aquatic plants flush out sediment and toxins. Stack- effect airflow between floors is possible thanks to the open central stair.

Fig. 17. Stack effect airflow between floors and collection of rainwater

Case Study 3: MSAP building-

Survey

EXPECTED OUTCOME

1.The questionnaire will help in analyzing the users inclination towards nature.

2.Analyzing the effect of biophilic design on mental well-being and learning behavior in the transitional spaces in the MSAP building.

QUESTIONS-

1. Which space(s) do you prefer to spend time in and utilize most frequently?

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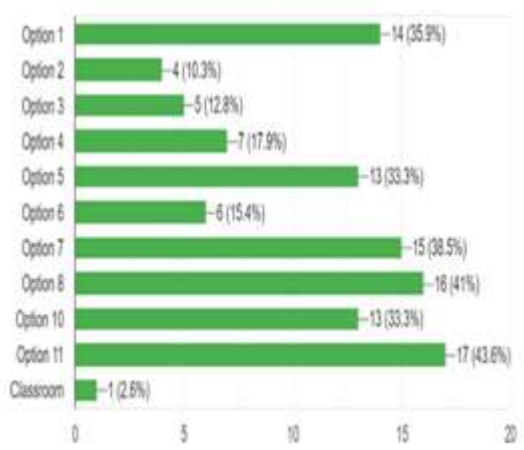
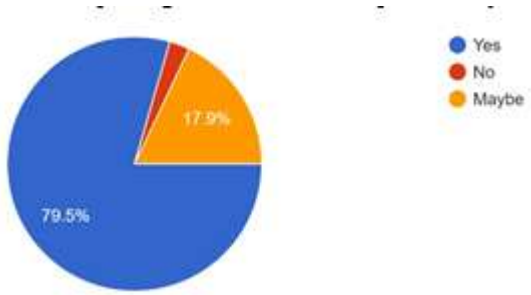


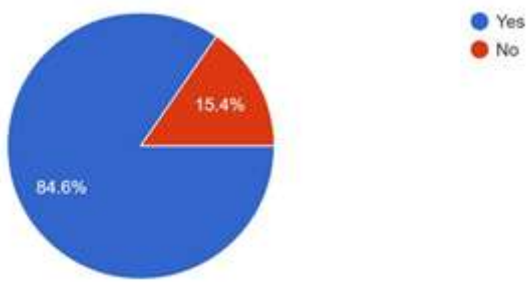
VI. ANALYSIS AND CONCLUSION-

Results indicate that users prefer to spend their time in spaces that provide visual connections to natural elements, have natural ventilation and daylighting and spaces that are in close proximity to their classrooms.
(Design Strategy: Attempt to incorporate biophilic design in all transitional spaces since users tend to occupy spaces depending on proximity to classrooms)

2. Does spending time in the selected space affect your mental well-being positively?



3.Do you feel more connected to nature in these spaces than the other spaces on the campus?



Analysis-

86% of respondents answered that they feel less stressed in spaces of their choice mentioned above if they are incorporated with biophilic design elements,
74% of respondents also mentioned that working or relaxing in spaces with a natural inclination improves their attention span and concentration in class and other works.

Inference-

Users are more inclined towards transitional spaces with large circulation areas, provide opportunities for different privacy settings and those which incorporate natural elements through green interventions, abundance of daylighting, use of natural materials and biomorphic forms

VII. CONCLUSION

By virtue of this research, the authors have a more profound understanding of biophilic design and its effect on mental well-being and learning behaviors of the users of transitional spaces in higher education buildings. A good design is when there is a balanced composition of various spaces within the site or the building itself. This results from the synthesis of the spaces which connect any space to each other. Therefore, transition spaces become an essential part in the design. Understanding the potential of these spaces to improve mental wellbeing through the incorporation of biophilic design is important to promote healthy learning behaviors. The ‘14 patterns of Biophilic Design’ is an ideal collection of paraments that can be incorporated when designing for biophilia and can be referred to for improvement of human perceptions and behaviors in these spaces.
By means of the live case study and questionnaire, it is concluded that surveyors are more inclined towards nature and therefore establishes that incorporating natural elements such as biomorphic forms and patterns, visual and non-visual connections, natural lighting, and ventilation, etc. within the transitional spaces of higher educational buildings will greatly benefit the users. Even though the users may not be aware of it, nonphysical manifestations of natural elements such as auditory, olfactory, and other sensory stimuli also contribute to the improvement of their psyche.
In conclusion, further research should be conducted to explore the effects of the incorporation biophilic design in transition spaces in higher education buildings on the mental well-being of students to establish the potential improvements on their learning behaviors. Furthermore, it is suggested that measures should be taken to incorporate biophilic design in these transition spaces for which the ’14 Patterns of Biophilic Design’ by Terrapin Bright Green LLC could be an ideal set of parameters.

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