Investigating the Occupant's Perception of Biophilia on the Health and Well-Being in a Hospital Setting.

Unati Kumar Watwani*, Namrata Atul Dhamankar
Dr Bhanuben Nanavati College of Architecture,Pune, India
watwaniunati@gmail.com

Abstract

Individual perceptions are essential while evaluating the well-being benefits of nature. This study predicted biophilia's influences on the occupant's health and well-being in a building. The study was conducted in a healthcare building in the city of Pune- a case of a hospital designed on the principles of biophilia was taken such that a comparison of observation and perception of occupants was analyzed. A biophilic design framework developed by Kellert in 2008 was adopted and a questionnaire was prepared based on the elements and attributes present in the case building based on diligent on-site observation of the whole campus of the case hospital. The survey was conducted with the prepared questionnaire based on the elements and attributes present using a Likert scale of 1 to 5 based on dissatisfaction and satisfaction level where 1 stands for extremely dissatisfied and 5 is extremely satisfied. Perception of 100 occupants is taken by further dividing them into 3 main categories based on their nature and daily workflow, the inpatients; the outpatients and visitors; and the staff. Results reveal 57.7% of the staff,76 % of the outpatients, and 84.36% of the inpatients were satisfied with the presence of biophilic elements and attributes present in the campus and state having improved health and well-being, however, few attributes like connection to place, natural shapes, and form contain mixed reviews due to lack of understanding of the attribute. Also, the results state that each element and attribute are interlinked, and a group of attributes is such a form dividing them into 6 categories. Few recommendations have been suggested based on the elements and attributes for enhanced health benefits. Accordingly, the study recommends that with the successful implementation of biophilic design principles, hospital buildings can be transformed into healing places that will boost and bring many benefits to the occupant's health and well-being.

Keywords - Health and Well-being in the Buildings, Human Physiology and Adaptation, Nature Based Solutions, hospital building, Programmes and policies in health and well-being, biophilia, and Biophilic design.

1. Introduction

In 1950,67% of the world population lived in rural areas while the remaining 33% lived in urban areas. Netter job opportunities and higher living standards in the urban areas led to urbanization. Today 55% of the world's population lives in cities and it is projected that by 2050, 68% of the world population shall live in the cities by the UN [24]. Now, this population spends 90% of the time indoors causing negative effects on the body and the mind due to less exposure to natural light and fresh air leading to adversely affecting mental health, causing sleep troubles, stress, weak immune system, mood swings and anxiety in individuals. To overcome these negative effects of spending more time indoors incorporating nature in the buildings has proven beneficial. Humans and nature have an innate connection. Spending time in nature has proved multiple benefits to physical health and well-being, psychological health and well-being, social health and well-being, and spiritual health and well-being. As per the Nature Pyramid, a person should have exposure to nature on the below scales as per these frequencies and duration as shown in Fig 1. Incorporate health and well-being concepts like, U.S Green Building Council (USGBC)- Leadership in Energy and Environmental Design (LEED), Indian Green Building Council (IGBC), WELL Ratings, Green Building Initiative (GBI), Fitwell, Air Rated for air quality monitoring, the American National Standards Institute (ANSI), American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), General Service Administration (GSA), etc. Of which the International WELL Building Institute (IWBI) is engaged in a global movement to transform health and well-being with our people-first approach to buildings, organizations, and communities using the WELL Building Standard (WELL), a blueprint to design and create spaces to promote enhanced human health and well-being.[14]

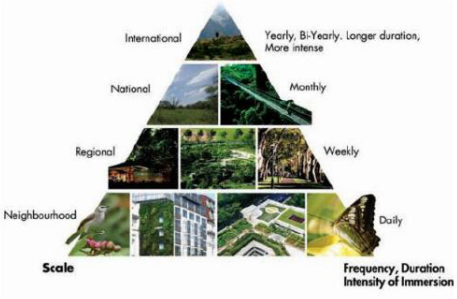

Figure 1: Conceptual diagram of the Nature Pyramid, 2012. (Concept by Tanya Denckla-Cobb and Timothy Beatley, University of Virginia,Illustration prepared by Singapore National Parks [19](Permission to use the figure was granted)

Figure 2: The 12 Impact Topics (Source: International WELL Building Institute) [19](Permission to use the figure was granted)

In 2019, WELL released the Global Research Agenda: Health, Well-Being and the Built Environment with 12 impact topics for research for the aim of achieving a healthy building concept as shown in Fig 2. Out of these 12 impact topics, Access to nature is one of the impact topics which states that there is an extensive body of research that demonstrates human contact with nature has a host of benefits like improved task performance, enhanced mood, stress reduction, increased focus, increased socialization, and boost in creativity. Various studies conducted on community scales- Parks and Gardens focus on how access to nature, both visual and physical, for building occupants, may have multiple health and performance outcomes. However, specific gaps and opportunities inside the building. [14] Connecting the benefits of access to nature to outcomes such as human performance and mental, physical, and social health may impact health and well-being and performance outcomes. This access to nature can be achieved through biophilia.

Biophilia, or the "philia" (love) of "bio" (life or living things), is understood by Wilson [26,27]as an emotional response that is "innate," "hereditary," and present in the genes. Most of human evolution has taken place in the natural world, where people have thrived. Our ancient dependence on nature for our survival persisted as we transitioned into the modern artificial environment, evolving into a quest for connections with nature that define our "personal identity" today. [15,16, 17].Biophilia's foundation is thus the "evolutionary dependence on nature" for "survival and personal fulfillment" [15,16,17]. Biophilic design has evolved over the years and has multiple benefits of incorporating nature as shown in the timeline of various biophilic interpretations by various researchers like Kelert, Browing, Heerwagen, Hildebrand, etc. as shown in Fig. 3.[2-4,7-12,15-17,27,28]

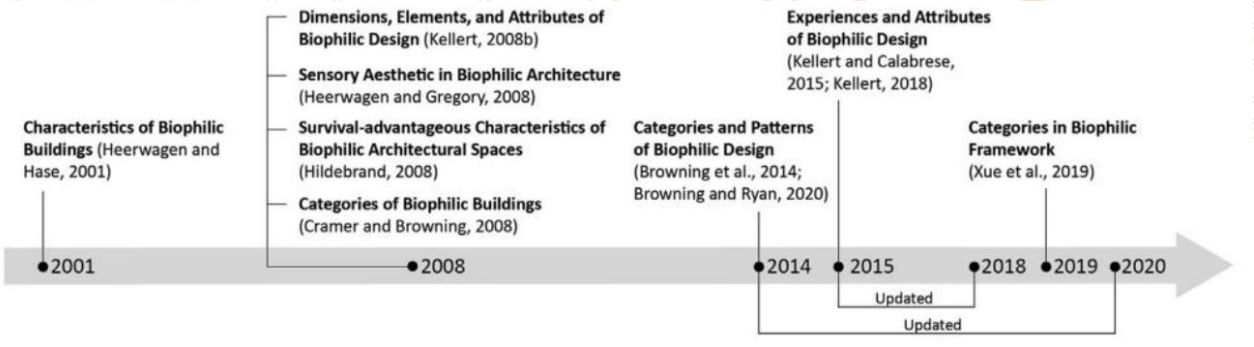

Figure. 3: Timeline of various biophilic design interpretations

The pioneers of biophilic architecture, Heerwagen, and Hase, established eight criteria encompassing habitability, natural elements, and design principles. The book "Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life" [16] further refined these ideas. Kellert's framework introduced two dimensions, six elements, and seventy attributes. Terrapin Bright Green identified fourteen design patterns [2,3,4], while Kellert and Calabrese [15]proposed twenty-four traits. The frameworks have evolved, emphasizing different connections between nature and human well-being.

They guide architectural certifications like LBC, WELL, and LEED. Browning and Ryan[2,3] focus on human-nature interactions, while Kellert's [16] extensive model contrasts with the recent concise approach. Challenges include overlaps and clarifications in categories.

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2. Methods

2.1 Data Collection:

Primary Data:
A survey-based interview approach was utilized to gather insights from 100 occupants at the Symbiosis Hospital and Research Centre, Pune, focusing on their perceptions of the influence of biophilic elements on their health and well-being.
Secondary Data:

- Extensive examination of biophilic design standards.

- Review of biophilia and healthcare-related information from various sources, including journals, websites, books, magazines, and articles[1,5,6,20-23,25].

2.2 Study Design:

The study aimed to assess how occupants at the Symbiosis Hospital and Research Centre in Pune perceive biophilia's impact on their health and well-being. This was accomplished through a Google Forms survey that incorporated responses alongside biophilic design standards to evaluate the effects of biophilia.

The study comprised three main components:

1. Exploration of fundamental biophilic design concepts, definitions, historical context, and frameworks.

2. On-site observations to identify biophilic design attributes, followed by the creation of a questionnaire for the selected building.

3. Interviews with hospital occupants to gain insights into how biophilia affects their health and well-being.

2.3 Participants:

Based on similar environmental psychology studies with a crossover design, 100 participants were selected to ensure statistical significance. The sample included hospital staff (doctors, paramedical, and allied staff), inpatients, outpatients, and visitors. Two distinct questionnaires were designed—one for staff and inpatients, and another for outpatients and visitors- due to varying exposure levels to biophilic elements

Table 1: Socio-demographic profile of the sample (n=100)

	Type	% (n)
Gender	Female	**38**
	Male	**62**
Age Group	18-34	**25**
	35-64	**33**
	65=>	**42**
Type of occupant	**Category**	
Doctor	Staff (40)	**15**
Paramedical		**15**
Allied Staff		**10**
Inpatients	Inpatients (25)	**25**
Out-Patients	Out-Patients	**25**
Visitors	And Visitors (35)	**10**

(Note: Here n = number of samples collected. As it is 100 so the number of sample=the percentage of the Ntotal sample)

2.4 Environmental Exposure:

The survey was conducted in physical settings during the month of April between 9 am and 6 pm. Outpatients and visitors were the primary focus during OPD hours (9 am-1 pm), while staff interviews occurred during their lunch break (1-2 pm). Inpatient interviews were conducted later in the day. A Google Form tool was employed to allow participants to objectively rate biophilic elements according to the Kellert framework. The questionnaire was structured based on Kellert's comprehensive framework from his book "Biophilic Design" [16] and encompassed questions regarding participants' perceptions of elements such as plants, airflow, lighting, materials, biomorphic forms, and views. Details of some of the survey questionnaires can be found in Appendix 1. Responses were recorded and subsequently analyzed.

2.5 Framework Used:

The first framework in the fig by Kellert in 2008 is used and analyzed based on the elements present and correlated with the standards. The questionnaire and analysis of the data is done based on the highlighted attributes only, as and when the questionnaire is modified and a question for a combination of attributes is asked collectively. While some elements are not applicable are not considered. Only the highlighted attributes as shown in Table 2.
are considered as per Kellert's framework of 2008[16].

2.6 Perception Survey:

A perception survey was conducted for the onsite present biophilic elements and attributes. The occupants were interviewed in the form of a questionnaire such that they had to rate their perception and satisfaction level on a Likert scale of 5,
1– Extremely Dissatisfied 3-Neither dissatisfied nor 4- Satisfied
2-Dissatisfied Satisfied 5-Extremely Satisfied,
Thus, each participant's entry was recorded and compared with the onsite observation of that attribute further helped in analysing and recommending the necessary measures needed to be taken. Also based on the literature review of Bowings the health benefits were also mentioned for better understanding [2,3,4].

3. Questionnaire Results

A survey comprising 30 pertinent questions was undertaken, scrutinizing 24 distinct attributes. Some of these attributes necessitated multiple inquiries to ensure comprehensive comprehension. This survey meticulously adhered to the prescribed methodology and accounted for various occupant categories, as delineated in the methodology section. Table 3 provides an intricate overview,

offering on-site observations of each attribute, coupled with a comprehensive analysis of occupant perceptions. Additionally, it furnishes indispensable recommendations for integrating these findings. Furthermore, Table 3 synthesizes the health advantages associated with each attribute, drawing from the existing literature [2,3,4].In Table 4, we present stacked graphs that dissect each attribute, revealing satisfaction levels across all three occupant types in meticulous detail. Strikingly, 20 out of the 24 attributes closely align with the on-site observations and the perception results. However, attributes such as natural materials, organic forms, and textures and patterns received a neutral response. This was primarily due to the occupants' limited awareness and knowledge of these elements, compounded by their relatively subdued presence within the environment. Notably, when assessing the attribute of water, the perception analysis focused solely on occupants with access to and visual engagement with this element. Nevertheless, Table 3 advocates for the incorporation of a water feature to ensure universal access across all occupant categories. Interestingly, while the ecological aspect of the connection to place attribute was evident in the building's design, occupants lacked a profound understanding of this element, leading to a collective perception that it was absent. This contrasted with the on-site observations. Elevating awareness and fostering an appreciation for this facet can effectively bridge this perceptual gap.

In the case of the building under scrutiny, it stands as an exemplary model of biophilic design. Post-survey analysis reveals that, when averaging all attributes, 57.7% of the staff expressed satisfaction, 76% of the outpatients reported satisfaction, and an impressive 84.36% of the inpatients were satisfied. These findings underscore a notable improvement in recovery rates and a multitude of health and well-being benefits attributed to the presence of biophilic elements within the building. As a result of this survey, it is evident that the staff areas and offices would benefit from additional biophilic features. Elements such as potted plants, organic forms, patterns, and natural materials can be seamlessly integrated into the interior design, yielding a profoundly positive impact on the health and well-being of all occupants. Also after analysis, it is seen that the attributes are interlinked and categorized into six groups as shown in Fig. 4.

Table 2: A list of elements and attributes of biophilia as per Kellart's framework of 2008[16]:

Environmental features	Natural Shapes and forms	Natural Patterns and Process
Colour	Botanical motifs	Sensory variability
Water	Tree and columnar supports	Information richness
Air	Animal motifs	Age, change and the patina of time
Sunlight	Shells and spirals	Growth and efflorescence
Plants	Egg, oval and tubular forms	Central focal point
Animals	Arches , vaults, domes	Patterned wholes
Natural materials	Shapes resisting straight lines and right angles	Bounded spaces
Views and vistas	Biomorphy	Transitional spaces
Façade greening	Geomorphology	Linked series and chains
Geology and landscape	Biomimicry	Integration of parts to whole
Habitats and ecosystems		Complementary contrasts
Fire		Dynamic balance and tension
		Fractals
		Hierarchically organized ratios and scales
Light and Space	Place -Based Relationships	Evolved Human Relationships
Natural Light	Geographic connection to place	Prospect and refuge
Filtered and Diffused Light	Historic connection to place	Order and complexity
Light and Shadow	Ecological connection to place	Curiosity and enticement
Reflected light	Cultural connection to place	Change and metamorphosis
Light pools	Indigenous materials	Security and protection
Warm lights	Landscape orientation	Mastery and control
Light as shape and form	Landscape features that can define building form	Affection and attachment
Spaciousness	Landscape ecology	Attraction and beauty
Spatial variability	Integration of culture and ecology	Exploration and cognition
Space as shape and form	Spirit of place	Fear and Awe
Spatial harmony	Avoiding placelessness	Reverence and spirituality
Inside-outside spaces		
(Note: The elements and attributes that are present on site in the case of this hospital are highlighted using this:)		

Table 3: A representative sample of Observation, Analysis, Recommendation, and Health Benefits of a few Attributes.

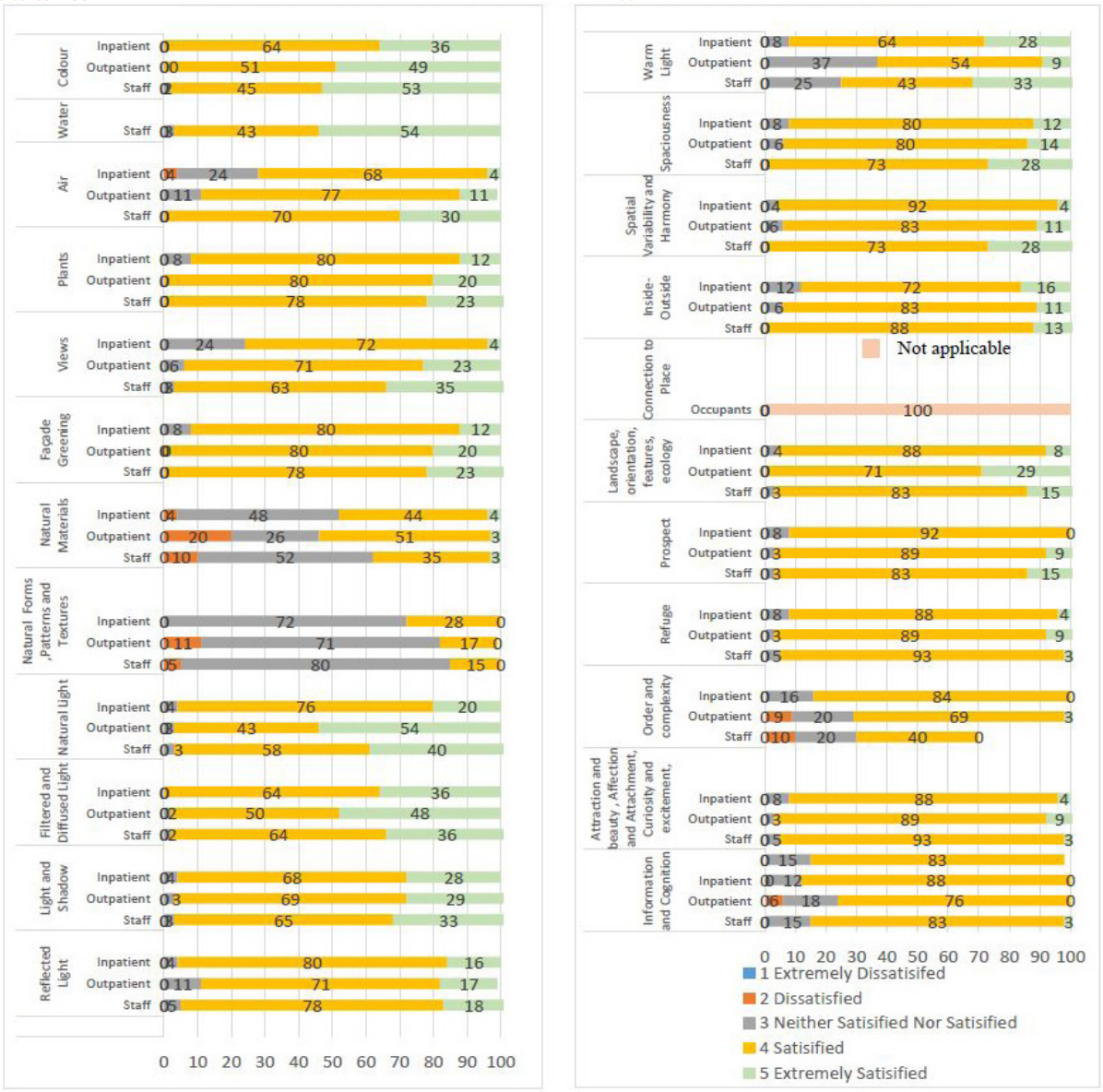
1	**Colour**	**Observations**	**Analysis**
	 **Fig. a.** *Image of the hospital wards showing the colour scheme (Source: Author)*	The ward rooms are designed with warmer and subtle hues of colours that are complemented with teak laminates. Encouraging wayfinding, the nurse stations are highlighted with shades of warm yellow/orange to be identifiable from any side of the long corridor	The colour scheme is as per the colour psychology and the occupants are majorly satisfied with the colour scheme. **64% Inpatients are satisfied. 51% Outpatients and Visitors satisfied. 53% Staff are totally satisfied.**
		Recommendations	**Health Benefits**
		---	Positively impacted perceptual and physiological stress responses and improved comfort.
2	**Water**	**Observations**	**Analysis**
	 **Fig. b.** *Image of the water fountain at the skill centre entrance. (Source: Author)*	The use of water features of fountains creates a sense of tranquility, mask noise, provide a visual focus for outdoor spaces, and acts as a grandeur entry of the skill center.	The water feature is only accessible to the staff members; thus, the inpatients and outpatients do not get the benefits from the presence of the water feature. **54% of Staff are totally satisfied**
		Recommendations	**Health Benefits**
		A water body or water feature can be incorporated into the central courtyard; thus, the presence of water can create a therapeutic experience that would be visually accessible to all.	Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure. Enhanced perception, psychological responsiveness, and positive emotional responses
3	**Connection to place**	**Observations**	**Analysis**
	 **Fig. c.** *Image of the nature views around the campus seen from the cafeteria. (Source: Author)*	Connection to place could be: • Geographical connection • Historical connection • Ecological connection • Cultural Connection The building design incorporated courtyards and green landscape areas to develop an ecological connection	The building design incorporated courtyards and green landscape areas to develop an ecological connection, however, it is not perceived by the occupants. **0% of Occupants could perceive a connection to place.**
		Recommendations	**Health Benefits**
		Awareness and connection with place should be made by marking and making display boards with relevant related information.	Positively impacted perceptual and physiological stress responses

4. Discussion

Thus, based on the study, Table 3., shows a few examples of the observations, analysis, recommendations, and health benefits of some of the attributes present on the site whose survey was done. For example, the color scheme is as per the IGBC Green Healthcare Facilities Rating System [13]. The hospital building has the colour scheme as per the color scheme and tones suggested in the standards. Also, the inpatients were perceived to be satisfied by 64%, the outpatients and visitors by 51% and the staff by 53%. As the colour scheme was apt as per the standards and the occupants were satisfied with it there were no recommendations suggested. However, based on the literature review[2,3,4], the health benefits specific to the attribute were noted for a better understanding of the benefits of the attribute, in the case of color as per Browings[2,3,4]. The colour scheme positively impacted perceptual and physiological stress responses and also improved comfort. For water as an attribute, the water feature was only accessible and visible to the staff so only their perception is noted, rest of the occupants did not answer the survey question related to water as only those questions whose elements and attributes were accessible and visible to the occupants were answered and noted and further analyzed. However, a recommendation of another water as an attribute was made in the recommendation table. The perception of all the occupants is mentioned in the stacked graphs shown in Table 4. For example, for Views, 72% of the inpatients were satisfied with the views, while 71% of outpatients and 63% of staff were satisfied with the views of nature and

with the views, while 71% of outpatients and 63% of staff were satisfied with the views of nature and suggested that nature views available to them had a positive impact on their health and well-being. (Refer to table 4.) Similarly, all the 25 attributes were analyzed. One of the interesting attributes was a connection to the place where the occupants were asked if they felt any connection to the place, (refer to Appendix 1 Q.8), however, none of the occupants could perceive the ecological connection to the place so the suggestion of awareness of this attribute was recommended. The space-wise analysis is done stating that the building is designed as a part of access to nature however few areas such as the common lobbies, waiting areas, and corridors can incorporate biophilic elements like potted plants and natural décor and material treatments. So, the study recommends that with the successful implementation of biophilic design principles, hospital buildings can be transformed into healing places that will boost and bring many benefits to the occupant's health and well-being.

Table 4: Stacked graph with percentage responses of Perception of Occupants



5. Conclusion

In conclusion, the study at Symbiosis Hospital in Pune presents compelling evidence of the tangible benefits of biophilic design in healthcare settings. Notably, 57.7% of staff, 76% of outpatients, and an impressive 84.36% of inpatients expressed satisfaction with the biophilic elements, affirming their positive impact on well-being. The study aligns with Kellert's framework, revealing a nuanced

understanding of how specific design attributes, such as colour schemes and water features, contribute to occupant satisfaction and have multiple health benefits. However, the research identifies a gap in occupant perception concerning certain biophilic elements, like connection to place, indicating a need for increased awareness. Biophilic elements can be used as a design strategy for improved health, faster recovery, relaxation, and stress relief measures. Incorporated natural as well as simulated, artificial representations of nature will have multiple health benefits. The findings conclusively assert that the successful implementation of biophilic design principles transforms hospitals into healing environments, fostering improved health outcomes.

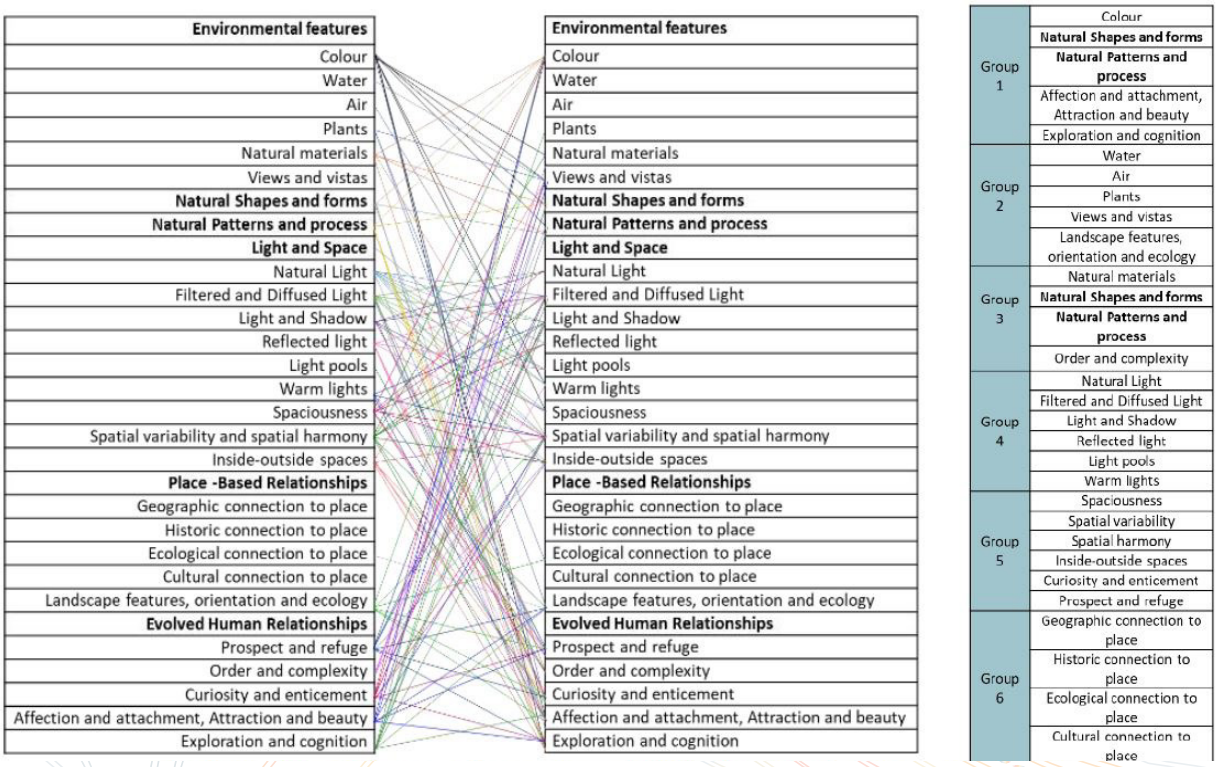


Figure 4. Inter-linkage and connection of all the biophilic features and categories

6. Future Research

The study conducted can be further explored in the hospital setting by actual measurement of occupants' blood pressure, heart rate, stress test, etc. And the benefits of improved health can be quantified accordingly. For well-being and health and safety, perception surveys are conducted, so the research can be a part of the ESG framework.

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8. Appendices

Appendix 1: Sample of a few Survey Questionnaires.

1. Type of Occupant:
o Inpatient
o Outpatient
o Staff

2.Gender
o Male
o Female

3.Age
o18-34
o35-64
o64=>

4.To what extent are you satisfied with the colour scheme of this hospital?
o 1– Extremely Dissatisfied
o 2-Dissatisfied
o 3-Neither dissatisfied nor satisfied
o 4- Satisfied
o 5-Extremely Satisfied

5. What is your satisfaction level with the presence of water feature creating a positive mood & reducing your stress levels? Rate on a scale of 1 to 5

6.What is your satisfaction level with the variety of spaces in the waiting areas, landscaped courtyards, green features in the cafeteria? Rate on a scale of 1 to 5.

7.What is your satisfaction level with the use of courtyards and large corridors to the wards contributing to connection to nature? Rate on a scale of 1 to 5.

8.Does the building have any of the below connections or relevance?
oGeographic
oHistoric
o Ecological
o Cultural
o Not applicable

9. What is your satisfaction level with design creating curiosity, exploration, and discovery of nature? Rate on a scale of 1 to 5.

10. What is your satisfaction level with the lighting layout in the corridors helping in wayfinding and easy movement? Rate on a scale of 1 to 5.

11. What is your satisfaction level with the use of cooler light in the morning and warmer light in the evening in creating a positive impact on your mood and well-being? Rate on a scale of 1 to 5.