



BIOPHILIC DESIGN STRATEGIES IN HEALTHCARE BUILDINGS.

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Abstract:

Evidence-based studies have shown the benefits of including nature and its elements in the built environment suggesting that they could have a positive effect on healing and health. The innate emotional attachment of human to nature and the living things in nature is known as “biophilia”. Biophilic design is an approach that integrates nature into the buildings in which people live to foster human-nature relationship. Extensive literature review gives a clear understanding of Biophilic design and confirms a link between patient’s recovery and building with nature. The study is aimed at assessing the extent to which biophilic design strategies is adopted in hospital buildings in Nigeria. Case study methodology was adopted to give critical analysis of existing health facilities and Biophilic design strategy adopted. The Selected hospitals have been evaluated through the 14 Patterns of Biophilic Design strategies defined by Browning et al., 2014 and the results presented descriptively with the use of tables. The findings showed low consideration of these principles in health facilities of Nigeria and further gives pointers on how Biophilic design strategies could be applied in design for positive outcomes.

Keywords: biophilia, biophilic design, healing environment, nature, wellbeing.

Introduction

Research suggests a strong association between health outcomes and the physical environment in which a person lives or receives treatment (Ulrich, 2008; Whitehouse et al., 2001). The main goal of health facilities is to promote the users’ wellbeing, and the technical and professional dimensions of those facilities are essential to reach that goal. The hospital environment, including physical attractiveness and general ambience can influence patients perceptions of the quality of care they receive (Becker & Douglass, 2008) More attractive environments can also be associated with less patient anxiety. Sustainable method to improve healthcare environments can include music, reading materials, and fresh flowers. Although researchers have found that incorporating nature, or representations of nature in the design of spaces play a key role in creating environments that not only support their intended purpose, but promote the mental and physical wellbeing of their occupants (Kaplan, et al., 2010; Heerwagen, 2008; Green, 2012). This is the basic tenet of Biophilic design which is based on the assertion that humans have an innate connection with nature that should be expressed in their

daily lives. It deliberately attempts to translate an understanding of the inherent human affinity to affiliate with natural systems and processes it into the design of the built environment (Kellert, et al., 2008). Its principles entails introducing nature into building designs to help promote health, give a sense of relaxation and avoid tedious scenes. In this context, it will be vital to apply the biophilic design principles that integrate the built environments and nature and create healing environments in hospitals. From this point of view, this study investigates the existence of biophilic design strategies in hospital buildings on samples. Selected hospitals in the study population have been evaluated to answer the question of this research; how biophilic design strategies has been applied in hospitals.

Literature Review

Biophilia and Biophilic design

Kellert (2008) define biophilia as the inherent human inclination to affiliate with natural system and processes, especially life and life-like features of the nonhuman environment. Biophilia is the need for the human to stay connected with nature (Browning, et al., 2014). It is a very important aspect currently because it influences the physical and mental health of people and well-being (Kellert & Calabrese, 2015). Biophilia is a hypothesis (Browning, et al, 2014; Gillis & Gatersleben, 2015) and a theory (Downton, et al., 2017) which shows that the human connection to natural processes and systems is necessary to our health.

The concept of biophilic design comes from the hypothesis biophilia (Browning, et al, 2014, Gillis & Gatersleben, 2015), and it is defined as the effort to express the importance to incorporate in the built environment natural systems and processes, to have a connection with human (Kellert, 2008). A design philosophy that encourages the built environment to use natural systems and processes during the design process (Gillis & Gatersleben, 2015). Providing a sustainable design strategy that helps people to reconnect with the natural environment (Downton, et al., 2017). When the difference of the approach from sustainable design is considered, it is possible to say that, it is more human oriented in terms of providing the opportunity to experience nature directly or indirectly by including the use of natural elements in the architectural space. Furthermore, sustainable design makes an indirect contribution to the human-nature interaction in the space with the aim of minimizing the damage to the environment caused by the building. Therefore, biophilic design has been defined by Kellert as an important link in sustainable design (Kellert, 2008).

The application of biophilic design

There are different ways to apply biophilic design into the built environment. Kellert has identified two main dimensions of biophilic design namely the organic or naturalistic dimensions (the forms of the built environment that refer directly, indirectly or symbolically to nature) and a place-based or vernacular dimension (when the built environment or landscape refer to the

culture of a given territory). The two dimensions are linked to six biophilic design elements (environmental features; natural shape and forms; natural patterns and processes; light and space; place-based relationships; evolved human-nature relationships) which are in turn found in more than 70 biophilic design attributes (Kellert, 2012). This classification is evolving and continues to be enriched by the outcomes of studies conducted in different disciplines (just think of *14 Patterns of Biophilic Design*, Browning et al. 2014), it is an innovative approach with the goal of enriching the concept of sustainability and reconnecting the built environment with the well-being of individuals. For the purpose of the study, we will focus on the three experience of nature and their specific attributes highlighted by Kellert & Calabrese (2015).

The first experience is the direct experience of nature, which focus on the real connection to natural environment features when we are in the built environment, such as natural light, air, plants, animals, water, landscapes. The second experience is the indirect experience of nature, which focus on the human connection to features representing nature, such as pictures, artwork and natural materials. The third is the experience of space and place, which focus on the spatial features of the natural environment that help human health and wellbeing in the built environment, such as prospect, refuge, organized complexity, mobility and wayfinding (Kellert & Calabrese, 2015). Subsequently, these three categories of experience are connected to 24 attributes (Kellert & Calabrese, 2015).

Benefits of biophilic design to patient's health.

Evidence from over three decades of research on the impact of nature on human health and wellbeing can justify the claim that Biophilic design is beneficial to patient's health (Gillis & Gatersleben, 2015). As a biological theory, Biophilia offers an evidence-based methodology for design which draws its techniques from nature. Nature functions in ways that alter the physical environment that people live in, thereby reducing health risks. For example, vegetation can filter pollutants from the air and buffer the urban heat island effect, potentially reducing the prevalence of respiratory infections or heat-related illnesses (Jackson et al., 2013). In addition to such direct effects, nature can also indirectly influence health by mitigating the risks associated with other areas of people's lives or by encouraging positive health behaviours.

Studies have revealed relatively strong associations between exposure to nature and improved healing times (Ulrich, 1984), enhanced social cohesion (Groenewegen et al., 2012), reduced stress (Van den Berg & Custers, 2011), improved cognitive ability (Berman et al., 2008, Han, 2009), increased psychological (Browning et al. 2014), and enhanced happiness (MacKerron & Mourato, 2013). Exposure to nature also have restorative effects, potentially reducing the effects of stress in a person's life. Its basis is to lower stresses on the human body, helping its built-in defences to fight illness and to promote healing (Ratcliffe et al., 2013). The most significant body of research to date has shown a strong positive correlation between exposure to nature and psychological well-being measured in a range of ways, including mental

restoration, self-esteem, attachment, and anger (Barton & Pretty 2010, Dallimer et al., 2012), systolic and diastolic blood pressure and heart rate (Lee et al., 2011) and recovery times (Ulrich, 1984). In conclusion, evidence from scientific sources have shown that re-connecting humans with their surroundings by applying the special geometry of nature helps restore mental, social and physical health. Whether through immersion in nature, through frequent outdoor play or scenic window views, nature helps foster patients' ability to cope with stress, improve attention functioning, social well-being, and psychological health, reduce pain medications, increased patient mobility and independence, and potentially can improve various health outcomes.

Methodology

The research method employed in this research is the qualitative research method. A descriptive research design is employed which is a scientific method that can be used in observing and describing the nature of a subject.

The first phase included a desk study of relevant materials on biophilia and biophilic design. Thereafter, the research adopted a primary source of data collection for the case study stage. This includes the derivation of first-hand information with data obtained through physical observation. The researcher for the physical observation and extraction of data developed an observation guide. This was structured to enable the researcher to collect relevant information for analysis. Desk study for the research covers the review of relevant literature, reports, journals, and manuals as well as literary works from experts on biophilic design and healthcare environment. Elements considered in structuring the observation guide are shown in the figure below.

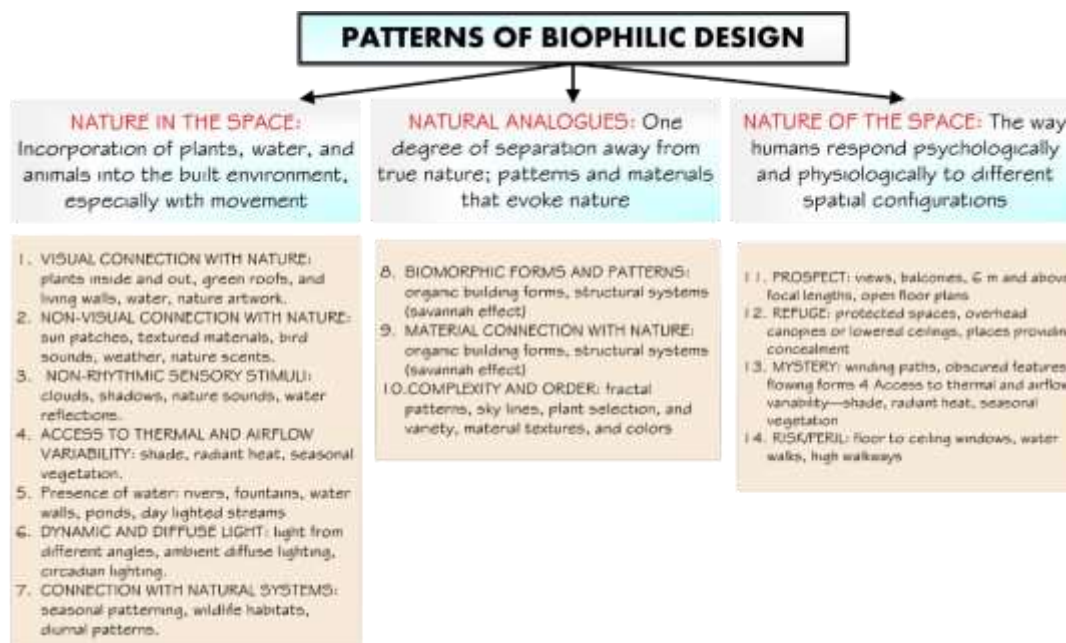


Figure 1: Patterns of Biophilic Design

Source: Browning et al. 2014

Samples in this research were gotten through convenience non-random sampling technique, which refers to a selection of samples based on targeted interest and subjective judgement. These samples were simply selected for physical case studying based on their relevance to the study at hand, out of a list of known hospital in Nigeria. Three healthcare facilities were observed, which were randomly selected across the country. They are; National hospital, Abuja, University Teaching hospital, Ibadan, and the Ahmadu Bello University Teaching hospital Shika, Nigeria.

Results and Discussion

In this section of the survey analysis, the data gotten by the researcher using the observation guide was analysed using the Microsoft excel software. Afterwards, the results were presented using figures and Table.

Case study 1: National hospital, Abuja.

Analysis of biophilic design elements and attributes

Natural ventilation, natural lighting and air are present but only at length of each building block. The public spaces such as waiting areas have no view of the outside. The wards provide a view to a landscape via windows, but this is only present at one length of the ward. The other length faces the walkways giving patient a tedious and noisy view. Although there is provision of varied landscaping around the oncology department, there is no provision of healing garden in the facility.



Plate i: Exterior view Showing Varied landscape of National Hospital, Abuja.

The oncology department is painted using shades of green and white to provide a warm feeling and helps in blending the facility with its natural environment. There are no outdoor spaces provided for patients around the oncology department. There is relatively low provision of

indoor landscaping within the facility. There are no images of nature. No presentation of natural water inside the hospital.



Plate ii: Warm paint of green and white Plate iii: A dome structure showing complexity and order.

Table 1: Nature in the space description – National Hospital Abuja, Nigeria.

Source: Author, (2022)

| s/no. | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|-------|--|--|---------------------|-----|-----|----|
| | | | Ab | Low | Med | Hi |
| 1 | Visual Connection With Nature | - Provision of varied landscaping and vegetation | | | | ✓ |
| | | -Unrestricted views of nature and vistas from the interior | | | ✓ | |
| | | -Provision of healing gardens | ✓ | | | |
| 2 | Non-Visual Connection With Nature | -Access to nature sound over urban sounds | | | ✓ | |
| | | -Integration of natural ventilation and presence of water | ✓ | | | |
| 3 | Non-Rhythmic Sensory Stimuli | -Use of warm colours for sensory stimulations | | | ✓ | |
| | | -Clouds, Shadows, Water reflection. | ✓ | | | |
| 4 | Thermal Airflow & Variability | -Design with respect to sun and wind orientation | | ✓ | | |
| | | | | | | ✓ |

| | | | | |
|---|---------------------------------------|--|--|--------|
| | | | -Placement of windows to allow natural ventilation | |
| 5 | Presence Of Water | | -Use of water as a landscape element (Fountain & aquarium). | ✓ |
| 6 | Dynamic & Diffuse Light | | -Placement of windows to capture dynamic and diffuse light within the interior of the building -Use of reflective surface to enhance lighting and mitigates glare | ✓ ✓ |
| 7 | Connection With Natural System | | -Provision of visual to existing natural system within the site | ✓ |

Table 2: Natural Analogues description –National Hospital Abuja, Nigeria.

Source: Author, (2022)

| s/no | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | | Av |
|------|--|---|---------------------|-----|-----|----|----|
| | | | Ab | Low | Med | Hi | |
| 1 | Biomorphic Forms & Patterns | -Use of botanical interior motifs -Applications of organic shapes in building exterior | | ✓ | | | |
| 2 | Material Connection With Nature | -Use of sustainable building materials -Use of natural colour pallet like green within the interior spaces | ✓ | ✓ | | | |
| 3 | Complexity & Order | -Complex architectural expression and landscape planning -Integration of buildings parts into whole | | ✓ | | | ✓ |

Table 3: Nature of the space description –National Hospital Abuja, Nigeria.

Source: Author, (2022)

| s/no. | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|-------|------------------------------|--|---------------------|-----|-----|----|
| | | | Ab | Low | Med | Hi |
| 1 | Prospect | -Orienting building, fenestration or corridor to optimize visual access to outdoor vistas -Designing around existing or planned savannah-like ecosystem | | | | ✓ |
| 2 | Refuge | -Change in light levels within the interior | | ✓ | | ✓ |

| | | | |
|-----------|----------------|--|---|
| 3 | Mystery | - Provision of low maintenance garden with winding path -Preference of curve edges than sharp corners within the interior spaces. | ✓ |
| 4. | Peril | -Floor to ceiling windows, high walls. | ✓ |

Case Study 2: Ahmadu Bello University Teaching hospital.

Analysis of biophilic design elements and attributes

The environment surrounding department is rich in well planned landscaping and vegetation. More so, the spatial configuration of the hospital environment coupled with the strategic placement of windows makes it easy to have a direct visual access of outside views from the interior spaces. Although there is provision of varied landscaping around the oncology department, there is absolutely no any healing garden provided for the patients.



Plate iv: Exterior view Showing Varied landscape of National Hospital, Abuja.



Plate v: Potted plant for the interior.

The orientation of the structure was placed with the longer axis almost facing north and south which is idle for the orientation of sun path and the prevailing winds. More so, there is extensive placement of windows to allow natural ventilation. The facility incorporates no water features, like fountains and aquarium, which will help in capitalizing on the multi-sensory attributes of water in a manner that is soothing to the patients. The differing orientation of windows provided in the facility allows light to penetrate at variable levels of diffusion which created an enhanced patients experience. The design of the structure employs symmetry with repetitive order, and the surrounding landscape is well planned. The extensive networks of covered walkways linked the various facilities together into a whole structure.



Plate vi: Placement of windows in courtyard Plate vii: A Low maintenance garden.

Table 4: Nature in the space description – Ahmadu Bello University Teaching hospital.
 Source: Author, (2022)

| s/n o. | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|-----------|--|---|---------------------|-----|-----|----|
| | | | Ab | Low | Med | Hi |
| 1 | Visual Connection With Nature | - Provision of varied landscaping and vegetation -Unrestricted views of nature and vistas from the interior -Provision of healing gardens | | | | ✓ |
| 2 | Non-Visual Connection With Nature | -Access to nature sound over urban sounds -Integration of natural ventilation and presence of water | | | ✓ | |
| 3 | Non-Rhythmic Sensory Stimuli | -Use of warm colours for sensory stimulations - Clouds, Shadows, Water reflection. | | | ✓ | |
| 4 | Thermal Airflow & Variability | -Design with respect to sun and wind orientation -Placement of windows to allow natural ventilation | | | | ✓ |
| 5 | Presence Of Water | -Use of water as a landscape element (Fountain & aquarium). | ✓ | | | |

| | | | |
|----------|---------------------------------------|--|---|
| 6 | Dynamic & Diffuse Light | -Placement of windows to capture dynamic and diffuse light within the interior of the building -Use of reflective surface to enhance lighting and mitigates glare | ✓ |
| 7 | Connection With Natural System | -Provision of visual to existing natural system within the site | ✓ |

Table 5: Natural Analogues description – Ahmadu Bello University Teaching hospital.
 Source: Author, (2022)

| s/n | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|-----|--|---|---------------------|-----|-----|----|
| | | | Ab | Low | Med | Hi |
| 1 | Biomorphic Forms & Patterns | -Use of botanical interior motifs -Applications of organic shapes in building exterior | ✓ | | | |
| 2 | Material Connection With Nature | -Use of sustainable building materials -Use of natural colour pallet like green within the interior spaces | | ✓ | | ✓ |
| 3 | Complexity & Order | -Complex architectural expression and landscape planning -Integration of buildings parts into whole | | | ✓ | ✓ |

Table 6: Nature of the space description – Ahmadu Bello University Teaching hospital.
 Source: Author, (2022)

| s/no | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|------|------------------------------|--|---------------------|-----|-----|----|
| | | | Ab | Low | Med | Hi |
| 1 | Prospect | -Orienting building, fenestration or corridor to optimize visual access to outdoor vistas -Designing around existing or planned savannah-like ecosystem | | | | ✓ |
| 2 | Refuge | -Change in light levels within the interior | | | ✓ | |
| 3 | Mystery | - Provision of low maintenance garden with winding path | | | ✓ | |

| | | |
|-----------------|---|---|
| | -Preference of curve edges than sharp corners within the interior spaces. | ✓ |
| 4. Peril | -Floor to ceiling windows, high walls. | ✓ |

Case Study 3: University college hospital, Ibadan.

Analysis of biophilic design elements and attributes

General wards for surgery is naturally cross ventilated and aerated within array of window and doors along its length. The chemotherapy ward has natural air coming in through windows which are one sided and consequently the ventilation is not crossed. The private wards, separated from other wards are well ventilated. The surgery wards provide a view out for all patients on both ends, one length gives a view of plain greenery, the other gives a view of a tedious and busy scene of walkways, roundabout and carparks. The chemotherapy ward also has the same arrangement, with patients in the middle part of the ward having no view.



Plate viii: Exterior views of wards and treatment spaces. Plate ix: Public ward showing window for natural air.

Most public spaces are open and well ventilated. Most circulation spaces provided are in form of verandahs/balcony. At the center of the hospital building is an atrium which throws in little light but not effective to the lower floors and their circulation spaces. Sparse vegetation in the environment, no outdoor spaces, no façade greening. The colour scheme of the hospital is bland and uninviting. The shape and form of the buildings are regular rectangles. The design has ample provision of lifts, ramps and staircases for vertical movement in all major spaces and these facilities are easily sighted. Lobbies, verandahs and terraces bound all spaces for ease of movement throughout the hospital.



Plate xi: Atrium for effectiveness of circulation spaces. Plate xii: showing transitional spaces of staircase.

Table 7: Nature in the space description – University College hospital, Ibadan.

Source: Author, (2022)

| s/no | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|------|--|---|---------------------|-----|-----|--------|
| | | | Ab | Low | Med | Hi |
| 1 | Visual Connection With Nature | - Provision of varied landscaping and vegetation -Unrestricted views of nature and vistas from the interior -Provision of healing gardens | | ✓ | | |
| 2 | Non-Visual Connection With Nature | -Access to nature sound over urban sounds -Integration of natural ventilation and presence of water | | ✓ | ✓ | |
| 3 | Non-Rhythmic Sensory Stimuli | -Use of warm colours for sensory stimulations - Clouds, Shadows, Water reflection. | ✓ | | ✓ | |
| 4 | Thermal Airflow & Variability | -Design with respect to sun and wind orientation -Placement of windows to allow natural ventilation | | | | ✓ ✓ |
| 5 | Presence Of Water | -Use of water as a landscape element (Fountain & aquarium). | ✓ | | | |

| | | | |
|----------|---------------------------------------|--|---|
| 6 | Dynamic & Diffuse Light | -Placement of windows to capture dynamic and diffuse light within the interior of the building -Use of reflective surface to enhance lighting and mitigates glare | ✓ |
| 7 | Connection With Natural System | -Provision of visual to existing natural system within the site | ✓ |

Table 8: Natural Analogues description – University College hospital, Ibadan.

Source: Author, (2022)

| s/no. | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|----------|--|---|---------------------|-----|-----|----|
| | | | Ab | Low | Med | Hi |
| 1 | Biomorphic Forms & Patterns | -Use of botanical interior motifs -Applications of organic shapes in building exterior | ✓ | | | |
| 2 | Material Connection With Nature | -Use of sustainable building materials -Use of natural colour pallet like green within the interior spaces | | ✓ | | |
| 3 | Complexity & Order | -Complex architectural expression and landscape planning -Integration of buildings parts into whole | ✓ | | | ✓ |

Table 9: Nature of the space description – University College hospital, Ibadan.

Source: Author, (2022)

| s/no. | Patterns Of Biophilic Design | Attributes | Level Of Reflection | | | |
|-----------|------------------------------|--|---------------------|-----|-----|----|
| | | | Ab | Low | Med | Hi |
| 1 | Prospect | -Orienting building, fenestration or corridor to optimize visual access to outdoor vistas -Designing around existing or planned savannah-like ecosystem | | | | ✓ |
| 2 | Refuge | -Change in light levels within the interior | | | ✓ | |
| 3 | Mystery | - Provision of low maintenance garden with winding path -Preference of curve edges than sharp corners within the interior spaces. | ✓ | | | |
| 4. | Peril | -Floor to ceiling windows, high walls. | ✓ | | | |

The result demonstrate that nature in the space patterns are more favoured in the design of a health care setting which provides spaces that promotes healing and ease psychological

stress. These patterns are evident in most of the cases studied through the provision of varied landscaping and vegetation, utilisation of unrestricted view of vistas from the interior spaces and presence of healing gardens. More so, there is use of warm colours within the interior spaces for sensory stimuli and proper design of the facilities with respect to sun and wind orientation. Conclusively, most of the facilities incorporates extensive use of glazing to provide visual access to the existing system and provide natural ventilation within the facility.

Conclusions

The case studies pointed out ways in which biophilic design strategies could be fitted into the built environment. Findings from the case studies indicated a very low adoption of the principles of Biophilic design. The health facilities are machinelike in design, serving the purpose of clinical care but paying little attention to the environment and how it affects patient restoration.

Recommendation

It is recommended that Architects and planners should be working on a method of meaningful integration of biophilic design strategies to hospital which can be:

1. Water: as water walls, fountains, aquarium, paintings of ocean life which has positive impact on the space to improve human health, wellbeing and performance like relieving stress, promoting satisfaction.
2. Plants: the indoor plant life, even in terms of few plants can improve the interior environment quality and bring the natural outdoor greenery life closer. The different shapes like potted plants, hanging plants and living walls according to the function of the place can be used.
3. In-patients' rooms the different images of nature can be considered.
4. Providing naturalistic spaces within health care settings allows the patients the opportunity to harness the healing properties of nature and surrounds themselves with one of the most basic needs, connection to life.

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