

Impact of Biophilic Principles on Transit Centers

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Abstract: *This research paper explores the impact of integrating biophilic principles into transit centers to enhance their appeal and encourage greater public use. Many people avoid public transportation due to its uninspiring and uninviting design. By incorporating biophilic elements such as vegetation, natural light, and views of nature, transit centers can become more attractive, fostering a positive and engaging environment for commuters. This study examines how biophilic design improves user experience, promotes sustainability, and contributes to urban infrastructure by reducing traffic congestion and pollution. Through a review of literature and case studies, the findings highlight how well - designed transit hubs can transform from purely functional spaces into inviting destinations that support well - being, environmental responsibility, and increased ridership.*

Keywords: Biophilic Design, Transit Centers, Public Transport, Urban Sustainability, Passenger Experience

1. Introduction

Transit centers are pivotal components of urban transportation systems, facilitating the movement of individuals between various modes of transit. Traditionally, these spaces have prioritized functionality over aesthetics and user experience. However, emerging research suggests that incorporating biophilic principles into transit center design can yield significant benefits (Beatley, 2011). Biophilic design seeks to emulate natural environments within built spaces, promoting psychological well - being and ecological sustainability (Wilson, 1984). In this paper, we explore the implications of integrating biophilic elements such as greenery, water features and natural light into transit centers. Through a synthesis of existing literature and case studies, we aim to highlight the potential advantages of biophilic design for commuters and the broader community, including improved mental health, increased sustainability, and enhanced urban livability (6 - *Biophilic Design*, n. d.).

2. Benefits of Biophilic Design

The incorporation of biophilic design principles into the built environment has been shown to yield a myriad of benefits for occupants, communities, and the planet at large. From improving human health and well - being to promoting environmental sustainability and fostering a deeper connection with nature, biophilic design offers an integrated approach to creating built environments that improve the quality of life for present and future generations (Law, 2014).

2.1 Physical Health

Studies have consistently demonstrated the positive impact of biophilic environments on physical health outcomes, including decreased levels of stress, decreased blood pressure, and enhanced functionality of the immune system (Ulrich, 1984). Exposure to environment factors such as sunlight, fresh air, and greenery has been shown to promote relaxation, reduce cortisol levels, and enhance overall well - being (Hartig et al., 2003).

Research conducted by environmental psychologist Dr. Roger Ulrich has shown that hospital patients with views of

nature from their windows experience faster recovery times, require less pain medication, and exhibit lower rates of complications compared to patients with views of built environments (Ulrich, 1984). These findings underscore the healing power of nature and the importance of incorporating biophilic design features into healthcare settings to promote patient healing and recovery.

2.2 Mental Well - being

The use of biophilic design have shown considerable beneficial impacts on mental health and cognitive function, enhancing mood, creativity, and productivity (Browning et al., 2015). Exposure to natural light, views of greenery, and access to outdoor spaces have been associated with reduced symptoms of anxiety, depression, and mental fatigue, as well as improved concentration, focus, and problem - solving abilities (Frantz et al., 2017).

A study conducted by environmental psychologist Dr. Terry Hartig found that participants who spent time in natural settings reported greater feelings of vitality, happiness, and overall life satisfaction compared to those who spent time in urban environments (Hartig et al., 2003). These findings highlight the restorative effects of nature on mental well - being and underscore the importance of incorporating biophilic design principles into urban planning and design to promote psychological resilience and emotional well - being.

2.3 Environmental Sustainability

Biophilic design offers an integrated approach to sustainable architecture and urban planning, integrating principles of ecological design, biomimicry, and regenerative development to create built environments that are in harmony with the natural world (Kellert, 2012). By mimicking the efficiencies and resilience of natural ecosystems, biophilic environments can reduce energy consumption, minimize waste generation, and enhance ecological diversity and resilience (Ryan et al., 2014).

3. Case Study

3.1. Singapore Changi Airport Terminal 4, Singapore:

Overview: Singapore Changi Airport's Terminal 4 is known for its innovative design and passenger - centric approach. The terminal incorporates biophilic principles into its architecture, featuring lush indoor gardens, cascading green walls, and abundant natural light (14 - *Changi - T4 CommemorativeBook*, n. d.) .

3.1.1. Biophilic Design Features:

- **Indoor Gardens:** Terminal 4 has extensive indoor gardens with tropical plants, creating a calming atmosphere for travelers.
- **Green Walls:** Vertical gardens enhance the interior spaces, offering a connection to nature and improving air quality.
- **Natural Light:** The terminal maximizes natural light through large windows and skylights, reducing reliance on artificial lighting and enhancing the ambiance.

3.1.2 Impact on People:

The implementation of biophilic design principles at Terminal 4 has had a significant impact on travelers, creating a calming and stress - relieving atmosphere amidst the hustle and bustle of air travel. Passengers report feeling more relaxed and rejuvenated as they navigate the terminal, with many expressing appreciations for the soothing greenery and natural elements. The presence of indoor gardens and water features has been particularly effective in reducing stress and anxiety, enhancing the overall travel experience for passengers (13 - *Changi*, n. d.) .

3.2 King's Cross Station, London, UK:

Overview: To preserve its architectural legacy while modernizing the historic transit hub, King's Cross Station underwent a significant redevelopment project. The station's user experience and sustainability have been improved by the integration of biophilic design principles (15 - *King's Cross Station*, n. d.) .

3.2.1. Biophilic Design Features:

- **Green Roofs:** The station has a sizable area of green roofs that enhance thermal insulation, promote biodiversity, and lessen stormwater runoff.
- **Natural Ventilation:** Open - air courtyards and passive ventilation systems improve indoor air quality and give people access to fresh air.
- **Daylighting Strategies:** To reduce dependency on artificial lighting, skylights and light wells are positioned strategically to maximize natural light penetration.

3.2.2 Impact on People

The integration of biophilic elements at King's Cross Station has had a positive impact on the well - being of commuters and visitors. Travelers report feeling more relaxed and connected to nature as they move through the station, with many appreciating the abundance of greenery and natural light. The presence of green spaces has also been shown to improve air quality and reduce pollution levels, contributing

to a healthier and more pleasant indoor environment for passengers and staff alike (15 - *King's Cross Station*, n. d.) .

3.3 Fulton Center, New York City, USA:

Overview: Fulton Center, located in Lower Manhattan, is a vital transit hub that links various subway lines and offers access to retail and office spaces. The center underwent a significant renovation focused on sustainability and user comfort, incorporating biophilic design principles throughout its structure (16 - *Fulton Cable Net*, n. d.) .

3.3.1. Biophilic Design Features:

- **Vertical Gardens:** Inside, living walls decorated with native plants enhance air quality and visual appeal.
- **Skylights:** The transit hub is illuminated by large skylights, fostering a feeling of spaciousness and connection to the outdoors.

3.3.2 Impact on People

The implementation of biophilic design principles at Fulton Center has had a transformative impact on the transit experience for commuters and visitors. Travelers report feeling more invigorated and uplifted by the presence of natural light and greenery, which create a sense of openness and tranquility within the station. The Sky Reflector - Net has become a focal point of the transit hub, drawing people together and fostering a sense of community amidst the urban landscape. Additionally, the integration of vertical gardens and living walls has improved air quality and provided habitat for local wildlife, contributing to a healthier and more sustainable urban ecosystem (16 - *Fulton Cable Net*, n. d.) .

4. Literature Review

Biophilic design, stemming from the intrinsic human bond with nature, has gained attention in the architectural realm to enrich the built environment and boost human well - being (6 - *Biophilic Design*, n. d.) . Biophilic design principles stress incorporating natural elements, patterns, and processes into architectural spaces to cultivate environments that support human health, productivity, and overall quality of life (Beatley, 2011) .

4.1 Biophilic Design Principles

Biophilic design principles stand at the intersection of human psychology, ecological sustainability, and architectural innovation. These are an integrated approach to building the built environment not only accommodating the human need but also nurturing the intrinsic human relationship with nature. Its foundation is an awareness of how profoundly the natural environment affects human health, happiness, and cognitive abilities. Biophilic environments try to reproduce the restorative features of natural landscapes by merging elements of nature into architectural and urban design such that they inspire a feeling of calmness, inspiration, and vitality (Wilson, 1984) .

4.2 Direct Experiences of Nature

Biophilic design focuses on the significance of immediate interaction with nature and appreciates that the contact with

natural factors creates powerful physiological and psychological effects in human beings (Ulrich, 1984). These spaces allow occupants to reconnect with the rhythm of the natural world and the benefits that come from it, and are spaces of relaxation, stress reduction and improved well-being (Hartig et al., 2003).

For example, the “Salk Institute for Biological Studies in La Jolla, Calif., designed by Louis Kahn”, is an example of the principle of direct engagement with the nature; the building, by its courtyards and very large ocean views, allows its occupants to interact directly with the outdoors. The biophilic design features described above have increased productivity and increased sense of connection to work environment according to researchers and the staff at the Institute (Ryan et al., 2014).

4.3 Indirect Experiences of Nature

Biophilic design also includes indirect experiences of nature that mimic the nature's essence. The goal can be reached with natural materials, textures, colors, and patterns that replicate the appearance and touch of nature. It does this by adding elements like wood, stone, and water features to the design of architecture, which enables the architecture to emit a sensory experience that is home to our biophilic instincts that give our feelings and emotions feelings of comfort, security and tranquility (Law, 2014).

Designed by architect Frank Lloyd Wright, the Fallingwater residence is a good example of the indirect experience of nature through the use of natural materials and organic forms. Locally sourced stone, exposed timber beams and large windows that enclose different views of the surrounding forest merge the boundary between built and natural landscape by blurring the boundary between indoor and outdoor spaces (Kellert, 2012).

4.4 Natural Analogues

The concept of ‘biophilia’, or the desire to be close to other living systems, shapes biophilic design and biomimicry that is the emulation of natural forms and processes. Desired adaptive strategies and efficiencies are to be inspired from natural ecosystems, where designers can learn by studying these natural ecosystems (Browning et al., 2015). The structural efficiency of honeycomb to the fractal patterns of leaves, nature provides a variety of design solutions that could be used in architectural and urban design problems (Frantz et al., 2017).

For example, the “Eastgate Centre in Harare, Zimbabwe designed by architect Mick Pearce” is an example of the usage of biomimicry in architecture as it has an innovative ventilation system inspired from termite mounds. Passive cooling strategies capable of controlling airflow and temperature while decreasing energy consumption while maintaining internal climate comfort without using mechanical air conditioning are proven effective nature driven design solutions (Ryan et al., 2014).

5. Application in Transit Centers

Urban transportation systems rely on transportation centers for transit to connect various ways of moving around. With the integration of the biophilic design principles into the transit center development, it represents a unique opportunity for creating such an enhanced user experience, betterment of their well-being and environmental sustainability (Beatley, 2011).

5.1 Enhanced Passenger Experience:

One way transit centres can be transformed to welcoming and inviting places for passengers to use is by applying the principles of biophilic design. Greens, natural light and water features, which are inducted, help create the feeling of calm and liveliness of nature within the urban environment (Law, 2014).

For instance, the Southern Cross Station, Melbourne Australia has been designed with biophilic elements such as expansive glass walls, timber ceilings and landscaped atriums which provides the commuters a sense of a visually stunning and comfortable place during the journey (Ryan et al., 2014).

5.2 Stress Reduction and Well-being

Living under the stress of commuting can be cut through by biophilic design which can contribute to mitigating stress and promoting mental well-being for transit users. Access to nature, such as indoor gardens or outdoor green areas provide relaxed and reinvigorated comfort during the journey (Hartig et al., 2003).

In London, public plaza at King Cross St. Pancras International has lush vegetation, seating areas, and water features making the place full of verdant for commuters to nurture in among urban landscape (*15 - King's Cross Station*, n. d.).

5.3 Environmental Sustainability

Green infrastructure, energy efficient systems and renewable materials all integrated into the design, green infrastructure, can be used to minimize environmental impact for biophilic transit centers to serve as models of sustainable design. Features like rainwater collection, living walls, and green roofs help reduce the impacts of urban heat islands, improve overall condition of air, and support biodiversity (Ryan et al., 2014).

The sustainable design features of the “World Trade Center Transportation Hub in New York City” such as natural ventilation, daylight harvesting, high performance glazing reduce the energy consumption and enhance the occupant comfort while minimizing the environmental footprint (*16 - Fulton Cable Net*, n. d.).

6. Conclusion

Integrating natural elements like light, greenery and biomimetic materials, biophilic design in transit centers improves the user well-being/quality, sustainability and

surrounding urban quality of life. Although it has been shown to have physical and mental health benefits, costs, maintenance, and regulations are some of the challenges. These are things that can only be overcome through collaboration and innovation. Prioritizing biophilic design at transit centers allows them to become more welcoming, efficient, and environmentally responsible, a more attractive option for public transport use, and for help easing the urban congestion problem.

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