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ORIGINAL RESEARCH PAPER

Biophilic design as a new approach in urban sustainability

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ABSTRACT

Despite the clear benefits of maintaining a human relationship with nature, people increasingly live in urban settings. As a result of urbanization, numerous urban communities are confronting social and natural problems, which have genuinely compromised residents' wellbeing and health. Thus, holistic planning and designing are needed to tackle these problems, integrating nature-based thinking into urban environmental development. The aim of this paper is to explore components of a sustainable city and biophilic design patterns and analyze the relationship between them. Finally, the conceptual model of a sustainable city has been proposed based on biophilic design approaches.

KEYWORDS

biophilic concept, biophilic design, biophilic urbanism, biophilic city, sustainable urbanism

1. INTRODUCTION

In the current century, one of the significant problems of modern cities is that it is away from nature [1]. Thus, architects' and planners' concern is to decrease the produced impact of urbanization on the environment and increase human-nature relationships [2]. They asserted that natural elements are required in the build environments, from habitations, schools, and hospitals to neighborhoods and urban configuration, to street and road structures and larger urban- and regional-scale design and planning [3, 4]. Howard, Le Corbusier, and Wright's [1, 4] works reflected ideas of the importance of urban nature and urban designers and ecologists took up the refrain in the second half of the 20th century. In urban design, green spaces ranged from "nature" have been integrated into the urban fabric to "creating lungs for the city" for providing adequate green space in the urban frame, and reducing the visual impact of the built form [5]. Actually, open green spaces have various positive effects on microclimate, energy balance, and also on social and physiological issues [6]. A city with plentiful nature and natural systems that are visual and accessible to urbanites is called a biophilic city [2, 7, 8]. Indeed, the biophilic approach as a biological organism seeks to create good habitat for people in the modern built environment that advances people's health, fitness, and wellbeing [4]. Well-designed cities promote urban parks or rivers, benefiting the well-being of humans and nature. This is why cities have to play a dynamic role in addressing sustainability: the integrated challenge of economic development, ecological integrity, and social justice [9]. Urbanists and city planners have distinct opportunities and unique obligations to advance biophilic city design, utilizing a variety of strategies and tools [10]. They have found, that the connection between people and nature could be restored through the incorporation of six elements of biophilic design, which are: environmental features; natural forms; natural patterns and processes; light and space; place-based relationships; and developed human-nature relationships [2]. Hence, it is important to encourage humans not only to stay in touch with nature but also to be part of and interact with the natural system.

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2. RESEARCH METHODOLOGY

The research to achieve its objective, the qualitative method has been used to figure out the biophilic and sustainable components. Thus, an extensive literature review on the biophilic concept and its design elements, and the sustainable city was done to identify biophilic and sustainable urbanism components. Then content analysis was used to explore independent and dependent variables. In the study, sustainable components were taken as independent variables and the biophilic design components were considered the dependent variables. In addition, the relationships between variables were analyzed. Finally, a concept model of the sustainable city based on the biophilic approach has been proposed.

3. THE CONCEPT OF BIOPHILIC

Biophilia, a term that stems from Greek roots, means "love of life". It was stamped by the social psychologist Fromm [1, 2, 7, 11] and populated in the 1980s, as Wilson spearheaded a modern school of thought centered on this concept, which he defined as "the urge to affiliate with other forms of life". Kellert and Wilson [5, 11] propose that biophilia is the result of a process of cultural and biological co-evolution. Wilson's biophilia hypothesis emphasizes that people need to have contact with nature and with the complex geometry of natural forms, just as they require nutrients and air for metabolism [1, 2, 7]. More specifically, Wilson defines biophilia as - the innately emotional affiliation of human beings to other living organisms. To Wilson, biophilia is a "complex of learning rules" developed over thousands of years of evolution and human-environment interaction [5–8, 12]. Thus, a biophilic community is a place where residents can easily get outside, where walking, strolling, and meandering is permissible, indeed encouraged [4]. The relationship between humans and nature could be clarified through three theories. First is the ecosystem idea, which is concerned with increasing biodiversity, and decreasing the impact of buildings on the natural environment. Second is biophilia concept that encourages human to have a direct connection with nature. Third is the psychological circumstance, when people spent their life in a secure place they would like to reach a more satisfying life [2, 11]. Thus, biophilic has been defined as the type of ecological design capable of satisfying our innate need to connect with life and its vital processes.

4. BIOPHILIC DESIGN ELEMENTS AND PATTERNS

One of the most significant impediments to the positive experience of nature today is the prevailing paradigm of the design and development of today's modern built environment [13]. In 2011 Beatley [3] published his book to expand the concept of biophilic design beyond the field of architecture buildings, sites, and cities.

The successful application of biophilic design necessitates consistently adhering to certain basic principles [7, 13]. These principles represent fundamental conditions for the effective practice of biophilic design:

- Biophilic design requires repeated and sustained engagement with nature;
- The biophilic design focuses on human adaptations to the natural world that, over evolutionary time, have advanced people's health, fitness, and wellbeing;
- The biophilic design encourages an emotional attachment to particular settings and places;
- The biophilic design promotes positive interactions between people and nature that encourage an expanded sense of relationship and responsibility for the human and natural communities;
- The biophilic design encourages mutual reinforcing, interconnected, and integrated solutions.

Therefore, the fundamental goal of biophilic design is to create an effective habitat for people as biological organisms inhabiting modern structures, landscapes, and communities [11]. The biophilic design further seeks to sustain the productivity, functioning, and resilience of natural systems over time. Alteration of natural systems inevitably occurs as a result of major building construction and development [7, 13]. Thus, the biophilic design should instead promote ecologically interrelated design solutions at multiple scales from distinct interior spaces, the building as a whole, the surrounding landscape, to the urban and bio-regional scale [2, 7, 8, 13], as it is shown in Table 1. Browning et al. [5] proposed 14 patterns of biophilic design within a framework that relates human biological science and nature to the design of the built environment. These patterns vary from environmental to physical and psychological patterns. While, Kellert and Calabrese [2, 13] in their book introduced three categories of nature experience that include 24 attributes and experiences, as it is shown in Table 2.

From the aforementioned, it is concluded that since the human race comes from nature, they tend to their origins. This tendency engenders their innate love for nature and natural order. That is why engineers and designers emphasize and maintain this connection, enhancing it through improving neighborhood aesthetics or minimizing the visual impact of the built environments. Therefore, biophilic design, with its elements and patterns, may provide useful strategies for linking efficient urban systems management with individual and collective human well-being.

5. BIOPHILIC URBANISM

Some of the early designs of Olmsted [14] used water features in urban parks to remediate water pollution, and his advocacy of parks as "lungs" to counter pollution. Besides, water bodies have the ability to adjust the surrounding microclimate [15]. One notion of a biophilic city is mimicking, and is modeled after natural systems in its functioning. Cities might also be viewed as more biophilic if their buildings and built

Table 1. The biophilic design elements across scales [8]

Scales	Biophilic design elements
Building	Green rooftops, sky gardens and green atria, rooftop garden, green walls, daylight interior spaces
Block	Green courtyards, clustered housing around green areas, native species yards and spaces, low impact development (LID).
Street	Green streets, urban trees, vegetated swales and skinny streets, edible landscaping, high degree of permeability.
Neighborhood	Stream daylighting, stream restoration, urban forest, eecology parks, community gardens, neighborhood parks/pocket parks, greening grey fields and brownfields.
Community	Urban creeks and riparian areas, urban ecological networks, green schools, city tree canopy, community forest, religious forests, greening utility corridors.
Region	River systems/floodplains, riparian systems, regional, greenspace systems, greening major transport corridors.

Table 2. The experiences and attributes of biophilic design [13]

Direct Experience of Nature	Indirect Experience of Nature	Experience of Space and Place
Light	Image of nature	Prospect and refuge
Air	Natural materials	Organized complexity
Water	Natural colors	Integration of parts to whole
Plants	Simulating natural light and air	Transitional spaces
Animals	Naturalistic shapes and forms	Mobility and way finding
Weather	Evoking nature	Cultural and ecological attachment
Natural Landscapes, ecosystem	Information richness	
Fire	Age, change, and the patina of time	
	Natural geometries	
	Biomimicry	

environments reflect the shapes and forms of nature [8]. Biophilic city is also about nature and other forms of life, which can be expressed in the budget priorities of a local government as well as in the lifestyles and life patterns of its citizens [1, 4, 7]. Indeed, biophilic urbanism is emerging as a planning and design approach for holistic improvement of urban spaces with a combined focus on physical setting, urban design, and lifestyle [3, 12]. According to Beatley, a biophilic city seeks to foster a closeness to nature while finding new ways to insert nature into the streets, buildings, and urban living environments [14]. Beatley proposes a number of indicators for what might constitute a biophilic city, which includes considerations for the amount of green space within a city; and how to access it that might be included the existence of organizations and activities that encourage contact with nature [3, 5]. Thus, the main goal of biophilic urbanism is to improve the contemporary urban disconnect with nature, making the experience of the natural world a more integral part of ordinary city life [3]. It is important to recognize that biophilic cities are not simply green cities. The presence of abundant nature is a necessary, but not sufficient condition [8].

The benefits of biophilic urbanism ecosystem services [12, 14] can be summarized as follows:

- Reduces urban heat island effect. Peng and Jim [14] found that extensive green roofs reduced pedestrian-level air temperature by 0.4–0.7 °C, and intensive green roofs by 0.5–1.7 °C;
- Reduces building energy use for cooling;
- Reduces storm water runoff, flood control, and improvement of water quality in cities;
- Sequesters carbon and reduces greenhouse gas emissions;
- Preserves urban biodiversity;
- Food production;
- Improves air quality;
- Enhances visual amenity for overlooking buildings;
- Can create valuable, viable space for building occupants.

It can conclude that the conditions of a biophilic city will go a long way in helping to foster social, and landscapes, in the face of climate change, natural disasters, economic uncertainty, and various other shocks that cities will face in the future.

6. URBAN SUSTAINABILITY

The modern age has precipitated a sustainability crisis reflected in enormous loss of biological diversity, natural resource depletion, environmental pollution, and atmospheric degradation [13]. In 1970, sustainable development is proposed by the Brundtland Commission [3, 4]. It is more focused on enabling all its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living conditions of other people, now or in the future. Sustainability is understood as a holistic frame of reference for helping cities to reduce their ecological footprints and resource needs, to deepen connections to landscape and place, and to enhance the quality of life while expanding economic opportunities [8]. Sustainability principles can navigate societies towards ecologically integrated, socially just, and economically viable futures. It also helps to guide the vision that neighborhoods want to develop and how to prepare for their journeys. Cities might be the abyss of today's societies, yet they also offer effective levers for change, which can enable societies to build the urgently needed bridges to sustainable futures of urban environments

[9]. Sustainable urbanism is also green urbanism. The purpose of green and sustainable urbanism is urban design with nature and creating better communities. In current years, in order to achieve sustainable development biophilic architecture and design were appeared [3]. Furthermore, the concept of biophilia it is claimed complements the sustainable design and biophilic design as advocated by Kellert et al. and Beatley [5] offers a sustainable urban design strategy that incorporates the reconnection of people with the natural environment. Thus, to design sustainable urban area is to integrate the design into the ecology of the place the flows of materials and energy residing in the community [4].

Based on the prior mentioned, it can be concluded that the design theories, which focused on the topic of community health and well-being, are three models that seem to have received the most attention. The first is a preference for landscapes. The second is sustainability, and its purpose to eliminate negative environmental impact through skillful design. The third is the hypothesis of biophilia, which is a rising star in the field of environmental design.

7. DETERMINE RESEARCH VARIABLES FROM PREVIOUS STUDIES

Through reviewing and analyzing previous studies, the author has identified two main variables: the variables used in the biophilic components and the variables used in sustainability. Variables that are used in biophilic components are *biophilic activity* (people and nature interaction; relaxation, walking, hiking, bicycling), b*iomimicry* (natural shapes, forms, and patterns, fractal characteristics), *biodiversity* (natural light, natural landscape, plants, animals, air, water "moving water, symbolic form of water" greenery "green wall, green roof, green street"), *natural materials* (wood furnishings and woolen fabrics, clay, stone), *sense of place* (distinctive place, commitment to place/home), and *affiliation* (nature affiliation, ecological affiliation, urban affiliation, social affiliation), as it is shown Fig. 1.

While the variables that are used in sustainability are *livability* (mobility, and walkability, safety, participation,

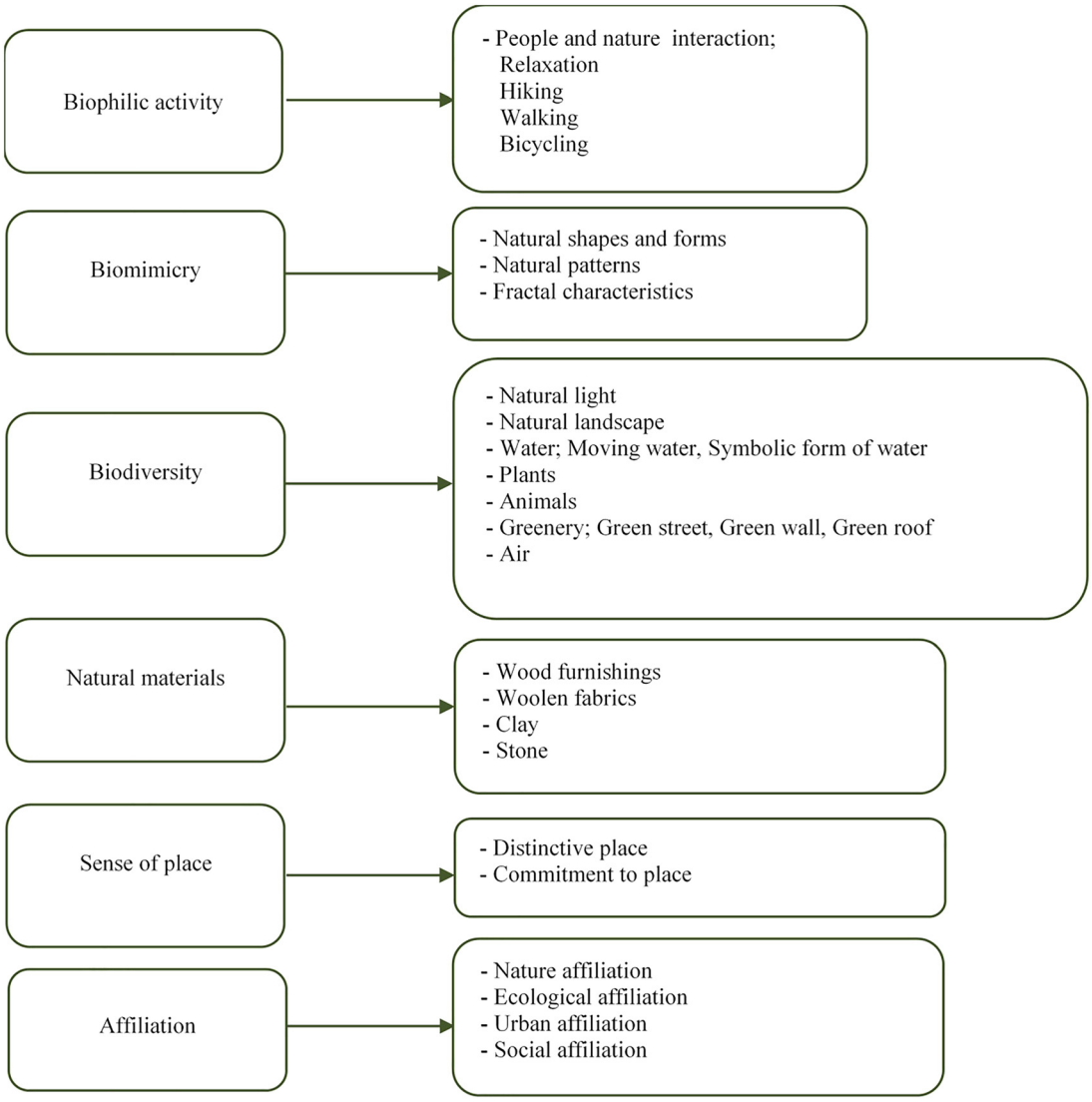

Fig. 1. Biophilic components dependent variables (*Source*: Author).

educational opportunity, jobs opportunities, cultural life, and entertainment), *reduction* (natural resource reduction, ecological foot print reduction, greenhouse gas emissions reduction, ecological damage reduction), *resilience* (accessibility, adaptation, flexibility, absorption, changeable), *variety* (variety uses, variety buildings "mixed land use", variety activities "functions" variety forms), and *identity* (social identity, culture identity, historical identity, local identity), as it is shown in Fig. 2. In this study, sustainable components were taken as independent variables and the biophilic design components were considered the dependent variables.

8. RESULTS AND DISCUSSION

To achieve a conceptual model for a sustainable city based on the biophilic approach, the relation between sustainable and biophilic variables was analyzed. The sustainable variables include livability, reduction, resilience, variety, and identity. While biophilic variables include biophilic activity, biomimicry, biodiversity, natural materials, sense of place, and affiliation. In order to determine the most effective variable for proposed model, a virtual digital value from (0–2) was estimated. Thus, 0 is mean there is no relation, while 2 represent a strong relationship.

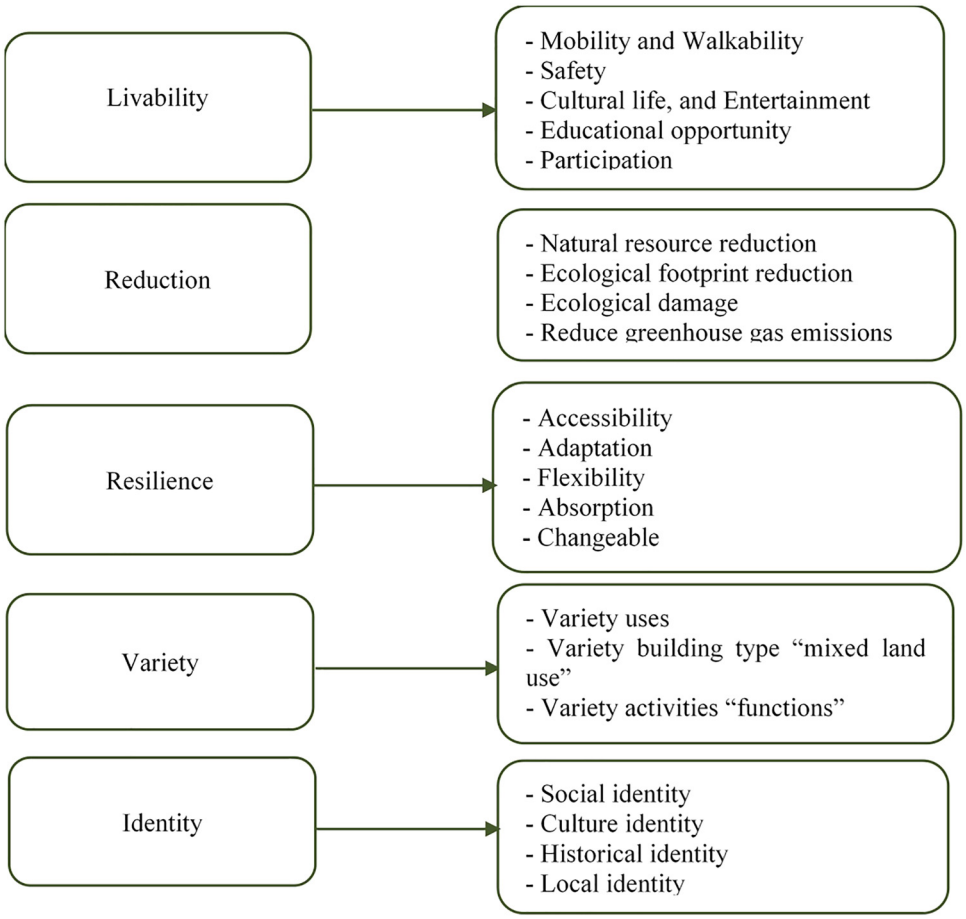

Fig. 2. Sustainable components independent variables (*Source*: Author).

Table 3. Inter-correlation matrix of independent and dependent variables (*Source*: Author)

Biophilic components	Sustainability components					
	Livability	Reduction	Resilience	Variety	Identity	Sum
Biophilic activity	●	○	●	●	◒	7
Biomimicry	◒	○	●	●	◒	6
Biodiversity	●	○	●	●	●	8
Natural materials	●	○	●	◒	●	7
Sense of place	●	○	●	●	●	8
Affiliation	●	○	●	◒	●	7
Sum.	11	0	12	10	10	

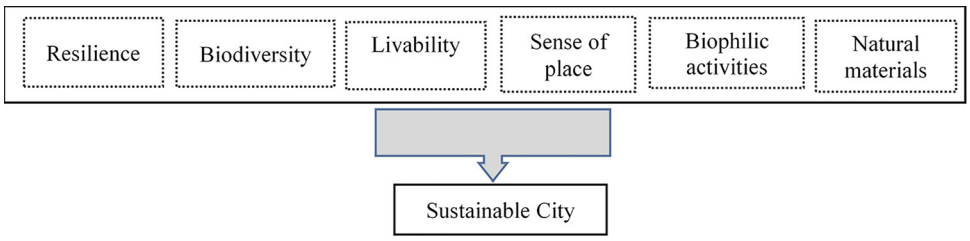

Fig. 3. The concept model of the sustainable city based on biophilic approach (*Source:* Author)

In addition, Table 3 shows the results of the relations between sustainable and biophilic variables. According to the results, resilience had the highest score, indicating that it had the most significant relationship with biophilic components among other sustainable variables. Livability had the second-highest score, hence the second most significant relationship with biophilic components. Variety and identity had equally significant relationships with biophilic variables, while reduction was found to have no relation.

After analyzing the relations between biophilic and sustainable components, the concept model of the sustainable city has been proposed based on biophilic design elements, as it is shown in Fig. 3.

9. CONCLUSION

There are many ways in which access to nature that will make communities healthier, and more social connections, that should make such cities more resilient. Resilient cities can promote well-being and sustainable growth, and increase the likelihood of successful adaptation to the future. To gain a sustainability improvement in a city, planners, and urban designers will need to provide solutions to development based on all aspects of a sustainable city, including resilience, vitality, affiliation, identity, and accessibility. Biophilic planning and designing components appear to have a potential way of providing an indication of the sustainability impacts of an urban environment. It appears that biophilic design and planning led to achieving sustainable cities. According to the qualitative methods concept model of a sustainable city has been proposed based on biophilic components.

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