

Investigation of Biophilic architecture patterns and prioritizing them in design performance in order to realize sustainable development goals

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Abstract

A Biophilia building (Eco-Friendly) with clear objectives to self-sufficiency in energy production, recycling, and operation of renewable energy model can be considered as a generalizable pattern to other sectors of a society. Biophilic architecture has emerged as an attempt to eliminate the gap between modern architecture (today) and the human needs to connect with the natural world. Biophilic design is an innovative approach that emphasizes the importance of maintenance, enhancement and restoration of useful experience on the use of nature in the built environment. In this paper, using survey-based method, we reviewed and analyzed the design principles based on Biophilic architecture in design performance to meet the objectives of sustainable development. For this purpose, first the most important design topics with this approach are studied, and its different patterns have been detected, and then using the Analytic Hierarchy Process (AHP), the approaches and identified patterns of this type of architecture are prioritized. The results showed that in three main approaches of design based on Biophilic architecture, means (1) the presence of nature in the location patterns, (2) the presence of natural analog elements and patterns in the environment and (3) fluidity of spatial patterns, respectively the patterns of visual connection with nature, materials connection with nature in the environment and natural landscape environment has higher degree of importance in the performance design of a Biophilic architecture-based space.

Keywords: Biophilic Architecture, Creativity in Design, Sustainable Development, Analytic Hierarchy Process (AHP)

Introduction

Increasing population, and consequently, increasing demand for energy consumption, reduced fossil fuel resources, increased air pollution, exacerbating the phenomenon of global warming and its side effects are some of the factors which lead-off modern societies to support the clean, sustainable and renewable energy (Douglas and Gordon, 2010). Hence the creation of eco-friendly environments is considered as one of the executive programs that has been in abundance in macro-state program on the agenda of American States in order to protect the urban environment (Olomolaiye et al., 2007). Some schools, universities and other organizations in recent years have carried out scattered activities in this field but unfortunately have not been able to play a significant role in solving the environmental problems and air pollution (Tahersima et al., 1014). In general, due to lack of proper energy productivity culture, modern buildings like the other buildings in the space of contemporary architecture are not designed on the principle of saving energy and protecting the environment (Singary et al., 2013); this in while natural and eco-friendly factors guidance (which have emerged in a new approach called architectural architecture) in the design of buildings can play an important role in improving of quality of achieving sustainable cities and communities that is one of the main objectives of sustainable development (Olson and Stephen, 2003). A Biophilia building

(Eco-Friendly) with clear objectives to self-sufficiency in energy production, recycling, and operation of renewable energy model can be considered as a generalizable pattern to other sectors of a society. Biophilic architecture has emerged as an attempt to eliminate the gap between modern architecture (today) and the human needs to connect with the natural world. Biophilic design is an innovative approach that emphasizes the importance of maintenance, enhancement and restoration of useful experience on the use of nature in the built environment. (Pollack, 2006,21). The so-called environmentalism for the first time is used by Erich Fromm in 1964 to describe the mental attitude towards all living things. This term in terms of the lexical is a name, which in 1979 entered the dictionaries Merriam_Webster, and means human innate ability to interact and cordial ties with other types of life and creatures in nature. Also, the term Biophilia literally means the love of life and living organisms or systems (merriam-webster) Kellert. He has considered Biophilic design as a new model of green architecture, which promised that it can re-connect people with nature (Kellert, 2008). According to Hellman, architecture is combining art and science (technology) in order to create a suitable environment for human needs (Olson and Stephen, 2003). With respect to that, the nature is the source of emotion, passion, joy, fragrances, space and beauty, and given that human is nature-oriented and interested in nature, sohand-made should always be in harmony with nature. (Naseri, 2010). In research conducted by Newman, urban principles are studied with Biophilic design perspective a case study in Singapore. In his research, by collecting the most important paradigms of changing architecture approach to nature-oriented architecture, it is shown that how can implement the principles of this type of architecture in high-density buildings using natural systems on the roof of the buildings (Newman, 2014,47). In research conducted by Clark and Chatto in 2014, Biophilic architecture strategies are evaluated to enhance the sense of health and productivity of individuals (Clark and Chatto, 2014,22). In the study conducted by Ryan et al. , Biophilic design pattern was evaluated to emerge nature according to parameters of health, wellbeing and mental patients in the built environment of departments (Ryan et al., 2014,62).

Due to the foregoing, the aim of this study was to review and analyze Biophilic architecture-based design principles to achieve sustainable development goals. Therefore, some cases of topics related to designing with this approach which are essential in building design, are studied and then using the analytic hierarchy Process (AHP) approaches are prioritized and identified patterns of such architecture are discussed.

Research Methodology

As previously stated, the purpose of study is to review and prioritize Biophilic architecture patterns in design to achieve sustainable development goals. The main idea is that research is that the role of the environment using Biophilic architecture is very consistent in the realization of sustainable development goals. The content analysis method and logical reasoning were used in order to do research in the studies stage and clarification of this, and in the reasoning stage, a survey research method was used. Accordingly, first the most important approaches and original patterns to planning and design have been studied based on Biophilic architecture approach, and then necessary simulations have been done to prioritize the most important criteria using AHP method and comparative comparison. After verifying the accuracy of the proposed model, with an average rating criteria from five architectural experts, paired comparison technique, the priorities of identified factors were determined, finally by doing paired comparisons of criteria and calculating the rate of incompatibility, the research problem was analyzed to prioritize the criteria. In general, applying Biophilic architecture design principles have affected conceptual intelligent system consists of five senses in order to understand and experience, and made enable some creative behaviors, such as curiosity, imagination, flexibility, freshness, extend, combine, analyze, organize and complexity. So,

reviewing these elements when designing architectural space can have a significant role in achieving the goals of sustainable development. Accordingly, research questions of this study are described as follows:

- ✓ What is the role of utilizing the elements of nature with Biophilic architecture approach in achieving the goals of sustainable development?
- ✓ What are the approaches and design patterns with Biophilic architecture approach?
- ✓ Which of Biophilic architecture design principles have the highest priority to achieve the goals of sustainable development?

Analytic Hierarchy Process (AHP)

AHP was first developed by Saaty. This method is based on a hierarchical structure and helps analyst to handle critical aspects of the issue within a hierarchical structure like a family tree. This method reduces complex decisions into a number of simple comparisons and ratings; and extracting results not only helps the analyst to make the best decision, but also provides a clear rationale to choose. Analytic hierarchy process aims to identify preferred options and also determine rank of alternatives by taking into account all decision criteria (Saaty, 2000). Analytic hierarchy process is an effective and operational approach which is able to consider unstructured and complex decisions. This method was chosen due to characteristics of the issue as well as advantages and disadvantages of other methods of decision-making. AHP typically includes following six steps (Lee et al, 2008):

- 1- Defining the problem non-structurally and expressing objectives and expected results clearly
- 2- Changing a complex problem into decision-making elements (expressing details of criteria and alternatives).
- 3- Using paired comparisons between decision-making elements in order to create comparison matrices
- 4- Utilizing special vector method to estimate relative weights of decision-making elements
- 5- Calculating rate of incompatibility of matrices to ensure compatibility of decision-makers' judgments
- 6- Integrating weighted elements to obtain final ranking of alternatives.

Priority of elements is determined in each level after creating a hierarchical structure (the element refers to each member of the hierarchy). Preferences are quantified through a 9-point scale.

Table 1. Scale of preferences between two elements for pair wise comparisons (Saaty, 2000)

Preference weights / importance level	Definition	Description
1	Equal preference	Refers to a situation where two activities provide the same contributions into an objective.
3	Moderate preference	Refers to a situation where experiences and judgments tend to moderately prefer one activity over other activities.
5	High preference	Refers to a situation where experiences and judgments tend to highly / particularly prefer one activity over other activities.
7	Very high preference	Refers to a situation where an activity is very highly preferred over other activities.
9	Extreme	Refers to a situation where an activity is extremely

	preference	preferred over other activities.
2,4,6,8	Transitional preference	Refers to preferences falling somewhere within the range limited by above extremes.
Inverse		The inverse of each case refers to inverse comparisons.

Pair wise comparisons include study of a matrix of relative ranks at each hierarchical level. Number of the matrixes depends on the number of elements at each level. Moreover, rank of the matrix at each level relates to the number of elements at the lower level. Once finished with forming all of the matrixes and performing pair wise comparisons, eigenvectors or relative weights (relative importance of the elements), e.g. ultimate weights, and maximum eigenvalue (λ_{max}) were calculated for each matrix (Expert Choice, 2000).

One of the important advantages of AHP is its ability to measure and control consistency of each matrix and decision. Acceptable range of inconsistency within each system depends on decision maker. However, generally speaking, Saaty suggests that, if incorporated inconsistency into a decision exceeds 0.1, the decision maker is better to revise his/her judgments (Hajkowicz *et al.*, 2000). Inconsistency index (II) is defined as follows:

$$I.I. = \frac{\lambda_{max} - n}{n - 1}$$

where λ_{max} represents maximum eigenvector of the matrix and n denotes the matrix length. For each matrix, the result of II divided by the II of a random matrix (IIR) of the same dimension represents a proper measure of inconsistency referred to as inconsistency rate (IR). If the IR is smaller than or equal to 0.1, the system consistency is recognized as acceptable, otherwise, one should revise the adjustment (Asgharpoor, 2008). It is worth noting that, IIR refers to the inconsistency index of the random matrix which can be obtained by calculating values of inconsistency index for matrixes whose elements' values are fully randomly assigned. The value of this index for a matrix of n dimension is given in Table 2.

Table 2. Inconsistency index of random matrixes (Saaty, 2000)

<i>N</i>	1	2	3	4	5	6	7	8	9	10
<i>IIR</i>	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.45

Findings

Biophilic architecture and its patterns

Biophilic or eco-friendly design is an attempt to eliminate the gap between modern architecture and the human need to connect with the natural world. Biophilic design is an innovative approach that emphasizes the importance of maintenance, enhancement and restoration of useful experience of nature in the built environment (Pollack, 2006, 12). In other words, the use of natural elements in an environment is called "Biophilic Design" and this particular concept actually increases the individual productivity and has a positive impact on their thinking. This design, unlike modern one (that separates man from nature) highlights the relationship between man and nature (Kellert, 2008). Overall, Biophilic design is a careful effort to understand the inherent need of human for solidarity and connection with the natural world and its impact on the design and construction of suitable environments for life. Kellert considered the Biophilic design as a new model of green architecture that has promised to reconnect people with nature (Kellert, 2008). There are many observations that show the environments inspired by nature help people to be less stressed, to control it and visualize the productivity, creativity, job satisfaction, a proper environment for

mental and physical development and finally convenience (Kellert, 2008). Overall, Biophilic design follows 3 approaches and 14 models that are set out in Table 3 (Browning et al., 2014).

Table 3. Approaches and patterns affecting the performance of the design of a space based on the principles of Biophilic architecture

Row	Approaches	Reliability coefficient	No	Patterns
1	Presence of nature in space models (C1)	0.848	1	Visual connection with nature (M1)
			2	Non-visual connection with nature (M2)
			3	Uneven sensory induction (M3)
			4	Thermal diversity and presence of fluid flow of air (M4)
			5	Presence of water (M5)
			6	Presence of dynamic and viral light in the environment (M6)
2	Presence of natural analog models and elements in environment (C2)	0.832	1	Association with natural systems (M7)
			2	Application of biomorphic models and forms in the environment (M8)
			3	Connection of materials with nature in the environment (M9)
			4	Numerous complexities beside the order and availability of environment (M10)
3	Fluidity of spatial models (C3)	0.916	1	Natural landscape of environment (M11)
			2	Creating a shelter and territory in the environment (M12)
			3	Enigmatic nature of environment (M13)
			4	Instilling a sense of dread and fear in the environment (M14)

Research effective variables (reviewing the principles of Biophilic architecture in the realization of sustainable development objectives)

In the following, the article tried to analyze the approaches and the design patterns in Biophilic architectural style, and prioritize the importance of each of these criteria in the realization of the objectives of sustainable development by AHP analysis method. Various researches concerning the physical effect of spatial structure design in this environment show that some factors have a significant impact and one of them is headlines related to design based on Biophilic architecture as below.

Pattern 1: Visual Connection with Nature

Development of environmental creativity for designing are realized in connection with natural spaces and the spaces activates the intuitive sense of the designer (Mahdavinejad, 2005). Nature provides the design a sense of timelessness and space lessens, and his intuitive understanding of nature is completely different from the indoors spaces. The presence of difference in the appearance of natural elements (water, light, plants, etc.) can raise questions in the inquiring mind of the designer and makes him curious which is one of the stages of the creativity process (Ittelson et al., 1974). Therefore, the variability of natural elements or visual connection with nature has a considerable impact in promoting the creativity of designers.

Pattern 2: Non-Visual Connection with Nature

Non-visual connection with nature can be done through hearing, touching, smelling or tasting that creates positive emotions to nature in design. So, we can say that small or instant interventions of nature with non-visual sensory stimuli can have a positive sensory impact on the design from the natural space around (Sullivan et al., 2004). This positive sense of space is associated with a peace that provides imagination and revelation in him (Kellert, 2008). Using ambient noise moderately based on the sounds of nature is an effective approach in the growth of designer creativity that of course, maximization of the potential of this type of positive response of space, through non-visual communication with nature simultaneously and with preference of sounds of nature to urban sounds in the environment, can be frequently felt and touched.

Pattern 3: Non-Rhythmic Sensory Stimuli

Natural environment follows curiosity, imagination, visualization and finally creativity. Also a sense of curiosity is influenced by the curious environment and uneven stimulation of the environment. Curious space should evoke curiosity. On the other hand, mobility is under the influence of stimulation and free activities, because free activity also increases risk-taking (Kellert, 2008). Mobility in the natural environment is known as one of the bases for physical, mental development and even mind of designer and UNESCO statements emphasize that mobility can meet the creativity development needs in all physical, cognitive, social and emotional areas (Egnatia, 1994). The need to stimulate emotions and the pleasure of experiencing new and favorable spaces are related to the quality of discovering space (Cele, 2004). Discovering in an environment is a strong incentive that ensures the designer to enter a new space and move to find other spaces and his imagination in environments that can discover it also develop more and somehow the sensory stimulation will be uneven.

Pattern 4: Thermal & Airflow Variability

Thermal diversity, natural ventilation and air flow is one of the factors in causing thermal comfort of the buildings. In the contemporary era, given the importance of renewable energies including fossil fuels as well as increasing environmental pollutions, the role of natural ventilation in buildings is very important in terms of environmental compatibility of the building (Cele, 2004). So, one of the main tasks of the designer in designing a building, is taking into account the conditions of thermal diversity and embedding an air conditioning for that building that the formal approaches in Biophilic architecture using the power of nature, will have great compatibility with it (Kellert, 2008).

Pattern 5: Presence of Water

The presence of water is a condition that increases the space experience through seeing, hearing and touching the water. In Biophilic architecture, the presence of water pattern is understandable through preference of visual connection with nature that leads to positive emotional responses to the environment with water component (Cele, 2004). Reduced stress, increased relaxation, decreased heart rate and blood pressure, improved concentration and memory by natural fluctuations of visual stimuli caused by water in a natural environment and enhanced proper cognitive and physiological reaction, when multiple senses are stimulated simultaneously, are easily obtainable (Olson and Stephen, 2003). Each of these factors in turn have an important role in improving the process of innovation growth in the designer. In this state, water which is a normal factor, is stimulus and therefore the aforementioned feature is called natural elements stimulation.

Pattern 6: Dynamic & Diffuse Light

Light is one of the architectural principles in providing visual comfort in space which psychological effects on designers is different. Research has shown that natural and transparent light has a positive impact on the senses of designer and leads to his vitality, naturally if the natural light

is originated from the sun glittering, the effectiveness of positive emotions from nature will be increased in his mind and causes creativity in him (Al-Musaed, 2004). Since transparency is associated with light, it should be expected that the most important work in architecture in a dynamic environment is done by light, as it is, light is not something accidental in architecture, but it is associated with its truth and nature. Adequate and appropriate lighting of sun during the day (with no conflict) in an environment, increases tendency and thus accuracy and concentration of senses, eye health and their vision power in the environment (Egnatia, 1994). Moreover, the different colors of the light spectrum, and its aspects that are a natural factor, can be a driving force in the creation of a unique design.

Pattern 7: Connection with Natural Systems

Areas related with natural systems in relation to other regions can include multiple locations and in which the objective is natural area in the design, adaptation and coordination of all areas with the architectural perception in the concept of biophilia which can be regarded as a useful tool. Stabilizer forms related to natural systems that are the result of an accumulation of separate elements, are able to be recognized by developing themselves and combining with other forms (Cele, 2004). Topographic maps that create a natural area in relation to other areas from the perspective of a designer, must be formed based on the nature, interactions between elements, forms and also the peer configurations to avoid uniformity and bore domin plan (Egnatia, 1994). In design approach based on Biophilic architecture, combination of a sense of unity with diversity is ideal and allows varied forms and spaces of an architectural element in designing to be existed in a preset, integrated and coordinated whole unit perceptually and conceptually (Fisher and Pedersen, 1996).

Pattern 8: Biomorphic Forms & Patterns

Biophilic architecture is a part of an innovative vision in architecture in which the use of nature patterns and biomorphic forms can create a sense of vitality and novel speculations in mind of a designer so that the building he designs, in addition to habitability, be also associated with vitality, and can have a positive response to limitations and mutual respect between man and the environment (Minke, 2001).

Pattern 9: Material Connection with Nature

In designing and creation of a work, some form of a natural environment are caused by isolation and reducing a volume from the initial volume of nature and some others by connecting one or more forms to the natural raw volume. However, a system should be applied by the designer to coordinate the meanings and can provide distinct Biophilic architecture perception in its design (Kellert, 2008). Accordingly, to connect materials with nature in an environment, the designer can provide the process through various ways, including the interaction between physical and natural framework, interaction by spatial pressure model (consistency of components based on proximity of forms and their share in a visual property), interaction by edge-to-edge contact (dividing pictorial form and a common space into two halves), interaction by the face-to-face contact (two-regional form with dichotomous levels parallel to each other) and interaction by interconnected levels (forms' penetration in levels of each other without having to split the visual identity) (Minke, 2001).

Pattern 10: Complexity & Order

A stable level of complexity, novelty, freshness, variety and excitement is essential in the space is to adhere the designer to the events of the environment. Presence of some ambiguity, complexity and ability to search and discover will have a favorable impact on it. (Olson and Stephen, 2003). Creativity in design is not a function of a certain time and the designer needs continuity, focus and peace to do his best to create the design (Fisher and Pedersen, 1996). The complexity of those environmental factors brought about curious space and on the other hand, adds

on the stimulation of the environment. In addition, presence of some ambiguity, complexity and ability to search and discover, increases this effect in space. Pattern of complexity and order is easily understandable through fractal geometric designs and geometric complexities in nature patterns (Minke, 2001). Fractal geometric patterns are developed through repetition, which means that the frequent occurrence of deformation depends on the design starting position, and results in inducing the feeling more. Applying the fractal geometry principles in space is a mathematical expression of the nature architecture. Geometrical fractal structures with cubic repeatability, have a large impact on body and soul of the environment (Kellert, 2008).

Pattern 11: Prospect

Landscape pattern is a spatial feature that is created by freely exponential presence from a far distance to monitor and plan. This pattern can be achieved through the visual communication of space and the human psychological characteristics in architectural analysis (Minke, 2001). Presence of the natural landscape in an environment should directly lead to reduce environmental stress and lower boredom and tiresome in mind and increase comfort at the same time.

Pattern 12: Refuge

Everyone is extremely sensitive to environmental threatening factors. Although this factor at first glance is associated with fear and anxiety, but over a limited time, makes him seek solutions for the development of talents (Minke, 2001). Lack of a favorable physical and mental realm and a sense of congestion prevents proper interaction between the person and environment. Hence, the sense that the designer has always a shelter and territory for his activities in the environment, is a way of interacting with the environment for the growth of his creativity.

Pattern 13: Mystery

Mystery is a spatial condition characterized by information obtained in the presence of a relatively important sights or other sensory stimuli in the environment that creates this impression in person in a natural environment who is attracted and induced to go and discover (Kellert, 2008). The mystery pattern an environment refers to the fact that people in an environment basically need two factors: discovery and understanding (Fisher and Pedersen, 1996). This model features are taken from a visual connection with nature and a sense of fear and danger in the environment and are obtained through research on appropriate responses to the anticipated situations. The mysterious nature of the atmosphere of an environment causes a favorable response from the mental faculties in brain that can predict and guess the same mechanism (Minke, 2001). Therefore, the presence of quality conditions and enigmatic nature of the space of an environment does not cause fear reaction, including parameters that can adequately provide this pattern in an environment space, creating landscapes with an average to high depth and creating two-dimensional lines of spaces and courtyards.

Pattern 14: Risk/Peril

Generally the possibility should be in designing a space. In environments where multiple activities are done in it, there is the possibility of revelation through the environment by creating distinct and recognizable boundaries and fields (Fisher and Pedersen, 1996). So presence of signs of dread and fear in an environment should be so that it launches designer's imagination and modifies shortcomings of his imagination or environmental signs to apply needed changes by the imagination in his plan in environmental irritability process.

Explaining the research model

In this paper, the criteria are considered as the main criteria for determining priority of factors affecting the design of spatial structure of an environment based on the "Biophilia theory"

and after determining their reliability coefficient based on the opinions of architects and designers, indices of each of these criteria are specified as the following table.

According to what has been stated, this study suggests a relationship among the three effective approaches to spatial structure designing of an environment ((1) the presence of nature in space patterns, (2) the presence of natural analog elements and patterns in the environment, (3) fluidity of spatial patterns) associated with headlines of design based on Biophilic architecture that considering these criteria in designing space can have an effective role in improving the process of achieving the goals of sustainable development. To determine the priority of identified criteria and indicators, the hierarchical structure is presented as shown in Figure 1.

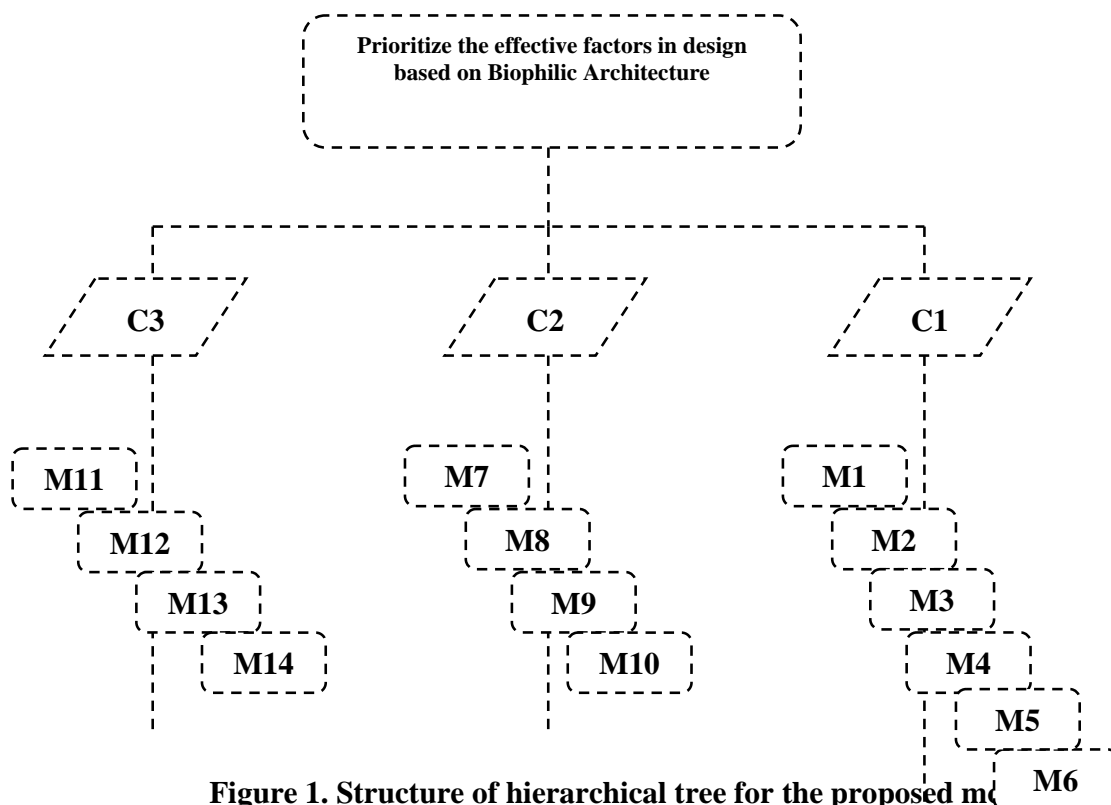


Figure 1. Structure of hierarchical tree for the proposed model

Results and discussion

The weight of main criteria was initially decided and the hierarchical structure of research of three main criteria were determined based on Biophilic architecture model with points of five specialized architects and their comments were averaged and the matrix was formed. Then, the relative weight of main criteria than the main goal was calculated which was determining the priority of criteria effective on design performance based on the Biophilic architecture model and as well as the relative weight of related indices to each criteria compared to the related criteria which results are presented in Table 4.

Prioritizing different design criteria based on Biophilic architecture approaches relative to the three main criteria mentioned in Figure 2 is provided. The results of paired comparisons between the three main approaches indicate that the approaches of nature's presence in space patterns, natural analog elements and patterns in the environment, and fluidity of spatial patterns are prioritized respectively.

Table 4. Weight of approaches and models to determine the priority of effective factors in the performance of designing based on Biophilic architecture

Approaches	Weight of Approaches	Patterns	Weight of Patterns
Presence of nature in space models (C1)	0.229	Visual connection with nature (M1)	0.224
		Non-visual connection with nature (M2)	0.189
		Uneven sensory induction (M3)	0.166
		Thermal diversity and presence of fluid flow of air (M4)	0.197
		Presence of water (M5)	0.218
		Presence of dynamic and viral light in the environment (M6)	0.205
Presence of natural analog models and elements in environment (C2)	0.203	Association with natural systems (M7)	0.192
		Application of biomorphic models and forms in the environment (M8)	0.198
		Connection of materials with nature in the environment (M9)	0.214
		Numerous complexities beside the order and availability of environment (M10)	0.177
Fluidity of spatial models (C3)	0.197	Natural landscape of environment (M11)	0.206
		Creating a shelter and territory in the environment (M12)	0.186
		Enigmatic nature of environment (M13)	0.172
		Instilling a sense of dread and fear in the environment (M14)	0.163

In addition, in Figures 3 to 5 the results of paired comparisons between models identified in three main approaches and their prioritization have been proposed. The results show that in first approach (C1), M1 pattern i.e. visual connection with nature, in second approach (C2), M9 pattern i.e. connection with nature and in third approach (C3), M11 pattern i.e. the environment natural perspective are more important in the performance design of a space based on Biophilic architecture.

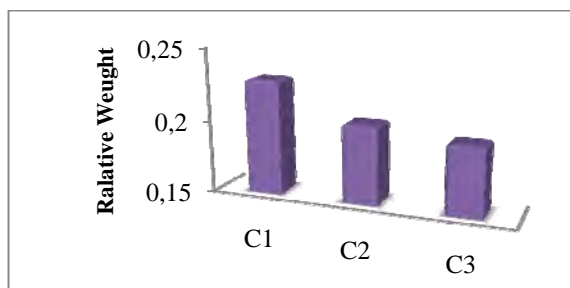


Figure 2. Priority of main approaches in Biophilic design

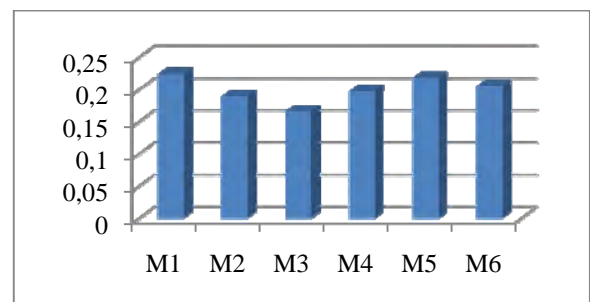


Figure 3. Priority of patterns with respect to the main criterion C1

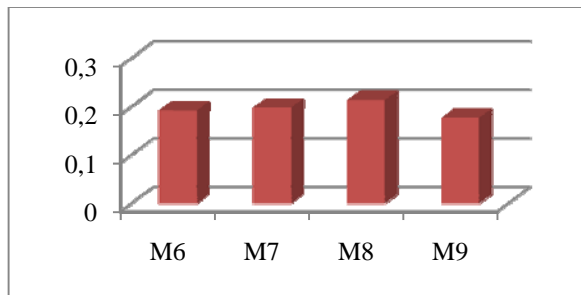


Figure 4. Priority of patterns with respect to the main criterion C2

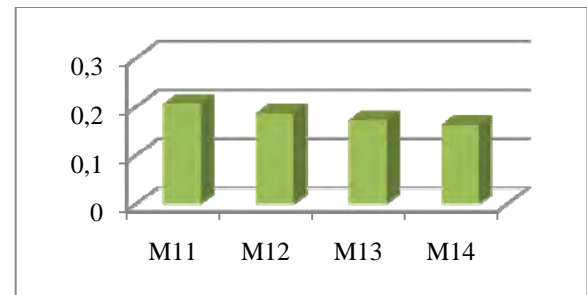


Figure 5. Priority of patterns with respect to the main criterion C3

Also to evaluate the identified criteria, matrix of pair wise comparisons related to each criterion was calculated for different approaches and patterns in Table 5.

Table 5. Weight of patterns compared to each other than the general purpose i.e. performance design of spaces according to Biophilic architecture in realization of sustainable development objectives

Sub criteria	C1	C2	C3
M1	0.161	0.216	0.186
M2	0.189	0.219	0.206
M3	0.225	0.259	0.149
M4	0.186	0.207	0.207
M5	0.208	0.240	0.326
M6	0.156	0.242	0.183
M7	0.178	0.226	0.192
M8	0.193	0.215	0.200
M9	0.192	0.226	0.199
M10	0.172	0.275	0.225
M11	0.208	0.234	0.222
M12	0.204	0.214	0.250
M13	0.162	0.197	0.251
M14	0.174	0.229	0.265

Conclusion

Biophilia (eco-friendly) structures, with clear objectives to achieve self-sufficiency in energy production, recycling materials and utilization of renewable energy can be a model generalized to other sectors of a society. Biophilic architecture is an attempt to eliminate the gap between modern architecture and the human need to connect with the natural world. Biophilic design is an innovative approach that emphasizes the importance of maintenance, enhancement and restoration of useful experience of nature in the built environment. In this paper, we review and analyze the principles of Biophilic-based architecture or biodiversity-friendly to realize the objectives of sustainable development. So some cases of design topics, with this approach that are essential in the design of buildings, were initially studied and then using the Analytic Hierarchy Process (AHP), the approaches and identified patterns of such architecture were prioritized. The main idea of the article is that the role of environment is very consistent with using Biophilic architecture in realizing the objectives of sustainable development. To do this research, content analysis method and logical

reasoning have been used to clarify the issue and in the argumentation stage, a survey research was used. Accordingly, the most important approaches and patterns of planning and design based on Biophilic architecture approach has been studied and then simulated to prioritize the most important criteria using AHP method and comparative comparison. The results of paired comparisons among the three main identified approaches showed that approaches of nature's presence in space patterns, presence of natural analog elements and patterns in the environment, and fluidity of spatial patterns were prioritized respectively. Based on the results of the sub-criteria, we can see that in first approach, visual connection with nature, in second approach connection with nature and in third approach, the environment natural perspective are more important in the performance design of a space based on Biophilic architecture.

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