Awareness assessment of biophilic design principles application

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Abstract. The green architecture has developed in the last few years, since the sustainable system have evolved specially in buildings construction. The aim is to keep sources of non-renewable energy. With this evolution, a new concept related to the green architecture has been emerged called biophilia, or the living nature which is related to the human inheritance of loving nature. Many studies have proved that the existence of humans in the external environment reduces physiological and neurological distress and makes them feel better. This research deal with definition of architectural biophilic design with relation to the physical and physiological human health; as well as the merging of building interior with nature and their effects on the employee in terms of health and productivity. Moreover, it investigated the applications of the biophilic design inside work place to make it more comfortable and effective for the employee to enhance their productivity. The aim of this paper is to assess awareness about the biophilic design and its impact on employees and their wellbeing in Egypt because it’s too important to apply biophilic design especially at workspaces here in Egypt which had big percentage of unsuitable places to work full of stress and anxiety.

Keywords: Awareness, human health, Sustainability, Biophilia, Biophilic design, Workplace.

1. Introduction
Human health and psychology are one of the most important factors that must be considered in creating an efficient working environment. This building impact on human shall be taken ecosystem in sustainable systems. Even though, biophilia is in consideration as much as we consider about building impact on physical and physiological human health. Although the biophilia has been considered as a new lifestyle and an upcoming trend in the architecture, the foundation of it is not recent at all; since, the nature of the human has always been with preference of being surrounded by and part of nature. However, the awareness of the application of the biophilic design and the way it can influence the human’s health is considered to be limited is a specific part. This paper discusses the warness of enhancing human health and recovery using the elements of biophilic design that should be at workplace among professionals in the Egyptian building industry environment. The aim of this paper is to present the application of biophilic design at work spaces; this has been traced through a survey that measured architects impact when applying biophilic design inside work places.

2. Research methodology
The research investigates the awareness about the biophilic design, this can be reached by examining the architects’ knowledge of it as a modern trend and whether they apply it in their work or not. This
investigation has been performed through a qualitative applied approach, depending on questionnaire to collect the needed information to be analysed and measured and the literature review of biophilic design and its benefits. Online survey has been publicized over a population of comprising of student of architecture department, developer, government officer, project executives and also academicians within the construction discipline. The total number of respondents participated in this survey is 70. The research is designed as follow; sections discuss the Biophilia and the Biophilic Design academically, the third section discusses the direct experience. Whereas the forth section represents the benefits of implementing biophilic design in workspace, and the fifth section. The form of the survey is discussed in the sixth section whereas the last two sections show the conclusion and recommendation.

3. Biophilia
A concept first popularized by Edward O. Wilson in 1984 [1], describes the innate relationship between humans and nature, and concerns the need we have to be continually connected to nature. Plenty of research confirms this human preference for the natural, rather than built, environment [2]. For example, in a 2004 study, when asked to describe their ideal city, people more often chose non-urban characteristics, greenery in particular [3], and in other studies it has been shown that a pleasant and natural view can raise the price of a house considerably.

4. Biophilic design
Biophilic design is a method of designing the places in which we live and work in such a way that satisfies our deep and fundamental need to be connected with nature. Biophilic design encourages the use of natural elements and processes as design inspiration in the built environment [2]. The idea behind this is that exposure to natural environments and features have positive effects on human health and wellbeing, which has been supported in a wealth of research [4]. According to the Biophilia hypothesis, these positive effects of exposure to nature originate in a biological bond between humans and the natural world [2]. These ideas have been taken forward in two theories developed in the Environmental Psychology literature: Attention Restoration Theory [5] and Stress Recovery Theory [6]. Both theories suggest that some environments are stressful, others are not and yet others can actively help people recover from stress and mental fatigue. Environments that evoke positive moods, have properties that draw people’s attention without being stressful or demanding, can help people recover more quickly and fully from mental fatigue and stress are known are restorative environments. According to Kaplan and Kaplan [5] and Ulrich and colleagues [8] natural environments in particular contain elements that promote renewed attention by providing a sense of being away, fascination, extent and compatibility [9]; and by containing elements that promote survival and therefore positive appraisal. Urban environments, on the other hand, tend to be full of demanding, stressful, under stimulating or boring features. Biophilic design then suggests that built environments could be made more restorative by incorporating natural elements in their design. Gifford and McGunn [7] suggest that Biophilic design can be viewed as belonging under a larger restorative design umbrella. Much of the small but growing peer-reviewed literature on Biophilic design often cites research on restorative environments to support the health and wellbeing benefits of Biophilic design [10–11]. Although the concept of Biophilic design is relatively new, the plethora of research on nature and restorative environments makes a strong case for the health and wellbeing potential of incorporating.

5. Experiences and attributes of biophilic design
The results of the psychological literature search on the three Biophilic design experiences; some overlap exists between the independent variables (the 24 attributes) explored in research and this was mentioned in the overlapping attributes. For example, water will be seen as being highly restorative in the built environment from both direct and indirect nature experience.

Moreover, different natural elements often feature together in environmental design, making it difficult to distinguish clearly between different aspects of Biophilic design.
Table 1: Experiences and attributes of Biophilic design By Kellert and Calabrese [18].

| Direct Experience of Nature | Indirect Experience of Nature | Experience of Space And Place |
|-----------------------------|------------------------------|------------------------------|
| Light                       | Images of nature             | Prospect and refuge          |
| Air                         | Natural materials            | Organized complexity         |
| Water                       | Natural colours              | Integration of parts to wholes|
| Plants                      | Simulating natural light and | Transitional spaces          |
| Animals                     | air                          | Mobility and wayfinding      |
| Weather                     | Naturalistic shapes and forms| Cultural and ecological attachment to place |
| Natural landscapes and ecosystems | Evoking nature |                            |
| Fire                        | Age, change, and the patina  |                              |
|                             | of time                      |                              |
|                             | Natural geometries           |                              |
|                             | Biomimicry                   |                              |

5.1. Direct Experience of Nature
The direct experience of nature means having a direct contact with nature and natural processes. The eight Biophilic design attributes that are used in this experience are listed in Table 1. The most researched attributes in this experience category in psychological literature are the use of plants in the built environment and natural landscapes and ecosystems.

5.1.1. Natural Light has been promoted by various disciplines as being beneficial for wellness of building occupants, including psychology. From a Biophilic view, humans evolved under natural, diurnal light conditions and therefore natural light and natural light processes should be preferred and most beneficial.

5.1.2. Water has also been found to be restorative, both through views of water [8] and sounds of water. Kaplan and Kaplan [5] note how preferred environments often have a view of water and this was also found in various other studies. In fact, images of the urban environment that contained water were found to be even more preferred than nature images containing no water.

5.1.3. Natural Landscapes and Ecosystems. The view of greenery from a window, which is listed under the natural landscapes and ecosystems attribute, has been shown in several studies as having beneficial effects on the wellbeing of building occupants.

5.2. Indirect Experience of Nature
As direct contact with nature may not be possible in every design situation, such as in certain medical environments, and looks at representation of nature in the built environment. This experience has ten attributes, which can be found in Table 1.

5.2.1. Images of Nature can even be more restorative than the view of real nature, depending on the content of the image and the view of nature. Therefore, images of nature may have a large role in environments where exterior views with lush nature may not be possible, due to seasons, adjacent buildings, or external environment.

5.2.2. Natural Materials The amount and type of material is important for perceived restorative quality and preference. In a study that was made by Nyhrud and colleagues [17] the amount of wood in a patient room that was most preferred was an intermediate amount, with the floor, one wall and furniture being made of wood. An entire wood surfaced room and a room with no wood were the least preferred amongst respondents.

5.2.3. Natural Geometries refer to mathematical properties commonly encountered in nature. These include hierarchically organized scales, sinuous rather than rigid artificial geometries, self-repeating but varying patterns, and more. For example, fractals are a geometric form often encountered in the natural world, where a basic shape occurs in repeated but varied and predictable ways that contribute both variety and similarity to a setting. Other prominent natural geometries include hierarchically ordered scales such as the “Golden Ratio” and “Fibonacci Sequence.”
6. Benefits of implementing biophilic design in the workspace

While employers hope their employees are productive every hour, functioning at 100% efficiency is unlikely. Understanding the drivers of absenteeism and the resulting direct and indirect costs of deficient employee productivity however, can positively influence strategies for workplace design and strengthen an organization’s ability to attract and retain workers. The incorporation of biophilic design elements into the built environment has been demonstrated to produce an abundance of physical and physiological benefits, which, in turn, powers a more productive and innovative workplace.

6.1. Economic benefit of biophilic design in the workspace.

With biophilia originating in the human-nature connection, this is justifiable, and Browning et al. supported this further by pointing out that “today productivity costs are 112 times greater than energy costs in the workplace,” and that by daylighting schemes in offices can “save over $2000 per employee per year in office costs” [18]. The economic gains to be made from environmental benefits such as reduced energy costs, extended building life, and decreased water management costs are apparent.

6.1.1. Increased worker productivity. The biophilic design further seeks to sustain the productivity, functioning, and resilience of natural systems over time. Alteration of natural systems inevitably occur as a result of major building construction and development. Moreover, all biological organisms transform the natural environment in the process of inhabiting it. The question is not whether ecological change occurs, but rather will the net result over time be a more productive and resilient natural environment as measured by such indicators as levels of biological diversity, biomass, nutrient cycling, hydrologic regulation, decomposition, pollination, and other essential ecosystem services. The application of biophilic design can alter the environmental conditions of a building or landscape in the short term, but over the long run, it should support an ecologically robust and sustainable natural community. The successful application of biophilic design should also result in a wide spectrum of physical, mental and behavioural benefits. Physical outcomes include:

- Enhanced physical fitness
- Lower blood pressure
- Increased comfort
- Satisfaction
- Fewer illness symptoms
- Improved health

Mental benefits range from increased satisfaction and motivation, less stress and anxiety, to improved problem solving and creativity. The positive behavioural change includes better coping and mastery skills enhanced attention and concentration, improved social interaction, and less hostility and aggression.

6.1.2 Health promotion programs. The willingness of employers to invest in programs that are oriented to prevention, to enhancing wellness, and to educating employees with respect to health issues is hardly surprising. The assumption is that such health promotion efforts will generate cost savings, and that the savings will be greater than the expenses incurred in offering the programs [19-20-21].

6.2 The psychological benefit of biophilic design in the workspace.

First, the mental benefits to those who work in nature-focused offices are worth noting. When a person’s surroundings are congruent with their biological desires, the following results occur:

- Stress levels decline
- Motivation increases
- Creativity flows
- Ability to concentrate improves

Furthermore, physical improvements also take place, including speedier recovery times after sickness and fewer stress related illnesses. If all that isn’t enough to convince people that biophilic design is
worth the investment, think about running an organization where employee’s quality of life improves – as a direct result of the environment they work in.

6.2.1 *Wellbeing*. It seems clear that urban life, with its disconnection from the natural world, stimulates a desire for contact with nature that needs to be satisfied. A key factor in maintaining positive well-being is reducing levels of stress. Research has identified that visible connections to nature can have a positive effect on an individual’s reported stress levels. In a review of numerous studies looking at the effects of different landscapes on health, it was found that natural landscapes had a more positive effect compared to urban landscapes [26]. In fact, in some cases, urban landscapes had a negative effect.

6.2.2 *Productivity*. Feeling good often equates to being able to do more. In addition to the abundance of research that confirms the relationship between well-being and productivity [27] there is also clear evidence directly linking biophilia with an organization’s output. One of the more recent, and most relevant, research studies looking at these effects was carried out in the UK (a study called ‘The relative benefits of green versus lean office space: Three field experiments’) [28], where university researchers in Cardiff compared the levels of productivity of two groups of office workers who were exposed to different levels of nature contact. They found that those who worked in offices with natural greenery saw a 15% rise in productivity over a three month period, in comparison to those working with no greenery or natural elements within their immediate environment.

6.2.3 *Creativity*. The impact of biophilic design on the individual’s ability to act, behave and perform creatively within the context of their role is something that has received less focus within the realm of research into biophilic design.

7. *Questionnaire*

This section discusses the results of the online survey that aims to understand how the professionals in construction industry react toward four of the most important biophilic design attributes that can help to achieve a successful biophilic designed work space (natural light, quite workspace, indoor planting and colours indoor).

Online survey is selected as it is a fast and easily reachable method to get feedback from the professionals. The survey was posted online for 44 days; the survey is divided into 4 sections. The first the demographic section which collects data related to the gender of the respondents, age, educational level, occupation, and the years of experience, as well as the geographic location of the respondents. The three other sections examine the independent variables through different examples about the biophilic design. Each of them divided into 6 subsections each covers an attribute of the biophilic design dependent variables. The professionals in built environment industry were chosen as they are the major parties involved in applying biophilic design philosophy in workspaces. Therefore, their opinions may affect the direction of biophilic design development in future. The professionals were categorized based on their field to understand the different views among them. The targeted population of this research comprise of student of architecture department, developer, government officer, project executives and also academicians within the construction discipline. Since it’s really hard to reach every single one of the population; the research is based on a sample of the 70 respondent, and are categorized into groups shown in Table 2.

| Occupation     | Sample size | Percentage of Sample (%) |
|----------------|-------------|--------------------------|
| Interior Designer | 14          | 20                       |
| Architect      | 10          | 14.3                     |
| Academic       | 29          | 41.4                     |
| Developer      | 12          | 17.1                     |
| Student        | 5           | 7.2                      |
The number those who answered survey questions in accordance to their respective fields is unequal. Based on the findings, the highest respondents group is the academician 29 respondents in the Academician discipline forming 41.4% of the responses. Then, come the developer and the architect groups in the second and third ranks, with number of respondents 12 and 10 respectively; forming 17.1% for the developer and 14.3% for the architects. Whereas the lowest number off the respondents group is student with only 5 forming 7.2% of the responses.

7.1. Form
The survey form has a total of 56 questions; 8 are open-ended questions while the rest are close-ended. The questionnaire is divided into four sections. The first section of the survey questionnaire is the demographic section designed to identify and categorized respondents. This section aims to determine whether the respondents are familiar with Biophilic design and whether they have already implemented the design elements in their previous project. The rest three sections of the survey questionnaire aim at identifying whether our local professionals are aware of the benefits of applying Biophilic design elements into work-space, by comparing three different case study qualities. Each section consists of four sets of questions that will deal with the presence of the following Biophilic design elements (daylight, quiet workspace, planting indoor and colours indoor). Respondents were also asked to share their opinion about how to implement these elements more efficiently within the case studies if possible.

7.2. Result and discussion
Table 3 indicates the response percentage rate for each biophilic design element either if it is desirable in space or not and the factors that may affect them.

| Table 3: The response rate for each biophilic design element |
|---------------------------------|---|---|
|  | Yes | No |
| Natural illumination | 96.6% | 3.4% |
| Effect of space plan design in light efficiency | 83.5% | 16.5% |
| Building orientation | 73.1% | 26.9% |
| Façade treatment | 83.5% | 16.5% |
| Workstation | 34.5% | 65.5% |
| Cubicle Office | 55.2% | 44.8% |
| Plants existence | 100% | 0% |
| Colours appropriate | 100% | 0% |
| Effect of colours in work and productivity | 84.4% | 15.6% |

[Chart 1: The response rate for each biophilic design element.]
96.6% of the respondents preferred natural illumination in workspace, while only 3.4% preferred artificial illumination. This could be due to the fact that professionals’ desire to keep the illumination level standard.

As for factors that affect natural illumination quality in space, 83.5% of the respondents agreed that space plan design and façade treatment can improve natural light in space while 16.5% disagreed.

73.1% of the respondents agreed about building orientation role in controlling light quality versus 26.9% who thought not.

55.2% of the respondents preferred cubicle office on the contrary 34.5% who didn’t mind workstation as a quiet workspace.

All respondents (100%) have preferred indoor planting in workspace, as well as the existence of appropriate light colours in workspace. However, only 84.4% of the respondents thought it can affect positively on employees productivity in compared with 15.6% who found it unnecessary.

8. Conclusion

The compilation of 30 green roof projects from the survey shows that intensive green roof is the most common green roof being constructed in the country. While the common type of building where most intensive green roof are used is residential. The survey findings suggest that most of Malaysian professionals in built environment industry are aware of green roof technology. However, due to certain barriers including lack of knowledge and technical expert, expensive cost of green roof and green roof application techniques are not widely disseminated or spread among professionals led to less interest to use the system. Malaysian professionals involved in the construction of green roof need to import construction materials from abroad, in particular, the western countries. However, the cost of green roof construction could be decrease if we have our own green roof supplier and manufacturer in the country.

Research must be done to find potential local resources to be tested and further utilize usage for green roof construction in Malaysia. The product may be more durable to the harsh tropical climate condition and also be more compatible with the nature of our native plants. Therefore, all parties in the industry and government body have the responsibility to promote green roof system as one of the approaches for green technology application in the country. Thus in return, it could help to accelerate the marketability and progress of green roof in the country.

Although the biophilic design is considered as modern trend in architect in specific and a modern life style in general, the awareness about it is extremely wide and not only among those on the architect discipline but among the public as well. However, the knowledge about the biophilic design and how it can be applied effectively and how it can be applied expensively or in an efficient cost reduction way is only available to a specific party within the architect discipline (as mentioned earlier the academician).

The research has focused on the application of the biophilic design within the workspace and its impact on the employees’ health and productivity. The main measure used in this research is a qualitative measure through an online survey. The results show that the appearance of the Biophilic design elements in the completed projects can be applied to other workspaces. The survey findings reflect that academicians are the highest group of the respondents that has awareness about the Biophilic design movement. Professionals involved in the construction of workspace need to be aware more about importing Biophilic design in workspaces and how it can impact employees’ health. Government body has the responsibility to promote Biophilic design movement as one of the approaches for sustainability in the country. Thus in return, it could help to accelerate the marketability and progress of Biophilic design in the country.

1. Biophilic design is the missing link between a healthy built up environment and human need for nature.

2. A review of Biophilic design from a restorative environment perspective yielded many results demonstrating the benefits of Biophilic design for human wellbeing.

3. There are three applications to apply biophilic design:
   - Direct experience of nature
   - Indirect experience of nature
Experience of space and place

4. The majority of work on Biophilic design refers to environmental restoration theory as an underlying basis.

5. This paper focused on psychological literature examining the evidence for the restorative qualities of being Biophilic attributes, or the extent to which the presence of such elements in a workspace can help foster recovery of stress and mental fatigue, and how it can impact economically.

6. The survey shows that most of respondents found the Biophilic design elements were useful to make a workspace more efficient and liveable.

7. Like many design philosophies, Biophilic design strategies need to be employed in consideration with the building occupants, location, and function.

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