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Exploring Benefits of Integrating the Bio-philic Design Patterns In Office Buildings

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Abstract
Egypt is an urbanizing faster country than anywhere else in the world as a consequence of overpopulation and land shortage in urban cities. The tall buildings were meant as a solution to exploit the land and helped to separate us from the surrounding environment. So, we are not being provided with the nature contact we require in order to meet our innate bio-philic needs. Offices of recent era were designed as open floor plan to be self-sufficient, but that affects negatively and creates more physical and physiological problems related to our human being. The workplace is not just a container in which work is carried out, it also reflects on our health and work itself. The intent of research is to articulate the benefits of integrating bio-philia in our office building spaces through analysis case studies from national office buildings where we could increase productivity and performance of workers. Determining the quality of office buildings in terms of health, comfort and well-being (healthy building) added to that is quality of building amenities.

Key Words: Bio-philia, Resilience work place, Physiological Considerations

1. Introduction

Cities are not only responsible for environmental and health problems but also they hold the key for a greener economy and a sustainable future. The tall buildings affect negatively the environment and create more problems including reducing citizen access to fresh air and natural sunlight. That affects our mental health in two distinct ways; by physical changes; through changes of the amount of natural sunlight we get which affecting serotonin correlating with increased stress, Secondly, these changes begin to weaken our sense of interactivity. It is necessary to go beyond a standard sustainability agenda with a design approach that could reduce human stress, enhance human creativity and clarity of thought, improve human well-being and expedite both human and nature's ability to heal, adapt and survive. Egypt has a workforce of about 28.9 million people in 2018. More than a third works in offices, mostly eight hours a day, five days a week, that work environment could have a major influence on their health and well-being. Buildings are constructed for human occupation that makes sense to focus on the occupants' health and productivity. So, the relationship between people and the building where they are working is vital, but the majority of businesses are missing the benefits of this relationship. [1]

It became obvious that workers health, satisfaction and comfort were affected by the quality of the space. Office building design has been connected with work absenteeism and the prevalence of the so-called "Sick Building Syndrome". A number of poorly designed offices with low ventilation rates, non-operable windows, and lack of potential for direct daylight and views affect their productivity and health. The health and human affected by good indoor air quality, thermal comfort, high quality views, daylight, good acoustics and indeed location and amenities. Workers need to feel their indoor built environments in functional building with spaces that could make them more comfortable where they could work, play, eat, or sleep in a functional building. The aim of research is to outline some interventions in the workspaces as Bio-philic need to overcome some of these challenges in workplace and enhance productivity and performance.

2. Historical background

Over the last decades of the twentieth century, the design of office buildings developed with diversity in styles. Workers' interests and needs defined the advancement of the workplace as a space of working in addition to entertainment and social interaction. Requirements of privacy, acoustic control, individually control their work environments became progressively

significant. So, first we have to look at office buildings over the recent modern history to define its design considerations.

Economic evolution and the growth of the needs for office buildings was proved in the period from the late 18th until the 20th century when office improvements were straight-lined, linked with a dynamic corridor, or designed around a central space or atrium. The staff was located in large shared rooms where persons with upper administrative positions worked individually. Separated space-use particularly distinct the office building of the late 18th and more inspired the office design of the 19th century. [2] By the mid of 1920s, the high-rise building developed with extended the clear height depending on Mother Nature to deliver natural lighting and fresh ventilation. At the end of the twentieth century, several modernisms in interior workplace design influenced by diverse workplace philosophies and new workplace theories. Office design has become a place that promotes the workers interaction and information exchange, Also it become a much more cultured process with an increasing focus on creating workplaces that center around the individual, and that promote not only productivity and efficiency but also creativity and wellbeing. [3]

As consequence of increasing workers power in world and working for hours at night to accomplish their tasks, they became suffer more from work-related Stress, depression and mental health disorders. The challenge is applying and balancing the office buildings' requirements for both communication and concentration, and providing spaces that can generate and catalyze the very complex process of social collaboration at workplace. In this research, we investigate the modern workplace and identify factors and design strategies that optimize effectiveness, experience, and performance. Today's workplace is an ecosystem, and the best workplace experiences are built on variety, choice, and autonomy. The open-plan workplace is considered as a source of tension and conflict; it purportedly noisy, distracting, and destroying our ability to focuses and collaborates, but it makes us more physically active and less stressed.

Nature originated in the earliest human history such as artificial animals that characteristic of the Egyptian sphinx, or the acanthus leaves adorning of the Greek temples. Illustrations of flora fauna have been used as a decorative and symbolic ornamentation. Cultures around the world have brought nature features into their homes and public spaces. Traditional examples include the courtyards and gardens of the Alhambra in Spain, using porcelain fish bowls in ancient China, the aviary in Teotihuacan (one of ancient Mexico Cities), homes at bonsai in Japanese, papyrus pools in the homes of Egyptian nobles, the cottage garden in medieval Germany, or the elusive hanging gardens of Babylon. The correlation between people and the building is vital and always dynamic where they are spending most of their time, so it need to be more regenerative to respond to our bio-philic needs for connection with nature.**[4]**

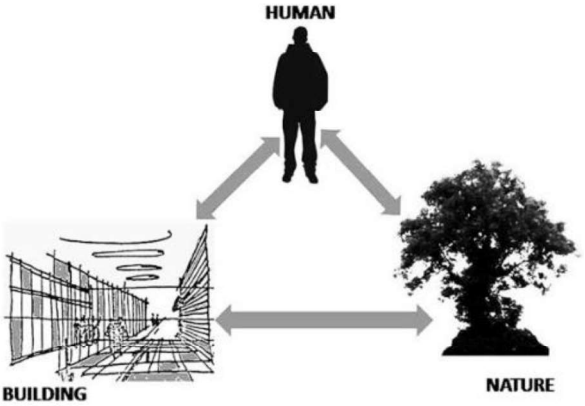

Figure (1): The dynamic correlation between Building, Human and Nature

3. Previous studies

Many studies have indeed shown the positive effects of nature on the human body and mind in general. Among these effects are stress reduction, increased cognitive performance, positive emotions and mood. Exposure to nature has been associated with stress reduction, increased cognitive performance, positive emotions and mood, lower blood pressure, increased learning rates, enhanced mental stamina and focus. Lack of exposure to nature is associated with physiological and depressive symptoms. Disturbance of the circadian clock is related to numerous medical disorders in individuals, including depression, cardiovascular disease, insomnia and cancer. Office workplace with natural lighting, ventilation and other environmental features lead to improve employee performance, lower anxiety and increase motivation. [5] In a previous study in United States about 23 % of office employees experienced common signs of Sick Building Syndrome (SBS) as respiratory complaints, allergies and asthma. The effect has been generally translated to sick days, lower performance and medical expenses; however the economic impact is vast, with an estimated drop in productivity about 2 % nationwide, causing in an annual budget to the United States of around $60 billion.[6]

Kaplan in 1989 stated in the attention-restoration theory that the mental fatigue and stress could be healed by direct interaction with nature. The dynamism and characteristic variety in nature is rich enough to stimulate the mind. Nature need to have three main qualities: ***distract*** the viewer from immediate surroundings, ***compatible*** with the individual's personal

desires for restoration, ***rich*** and ***quiet*** complex to provide the viewer with the sense of curiosity. [7]

Bio-philic design strategies and patterns for the requirements of addressing issues related to human health and well-being inside the built environment and each one supported by Economic, Physical and Psychological benefits (Creativity, Productivity and Wellbeing). Stephen Kellert classified the Bio-philic design into two dimensions; the naturalistic dimension and the place based dimension. These two fundamental dimensions linked to six elements and 70 attributes of bio-philic design elements. Kellert outlined the eight bio-philic principles which classified into; Attraction, Affection, Aversion, Dominion, Exploitation, Intellect, Spirituality and Symbolism.[8] Bill Browning then developed the 14 patterns of bio-philic design which was divided into major three levels of patterns defined as; Nature in the Space Patterns, Natural Analogue Patterns, and Nature of the Space patterns.[9] The patterns developed through interdisciplinary researches that sustained by empirical evidence in addition to previous works by Christopher Alexander, Judith Heerwagen, Rachel and Stephen Kaplan, Stephen Kellert, Roger Ulrich, and many.

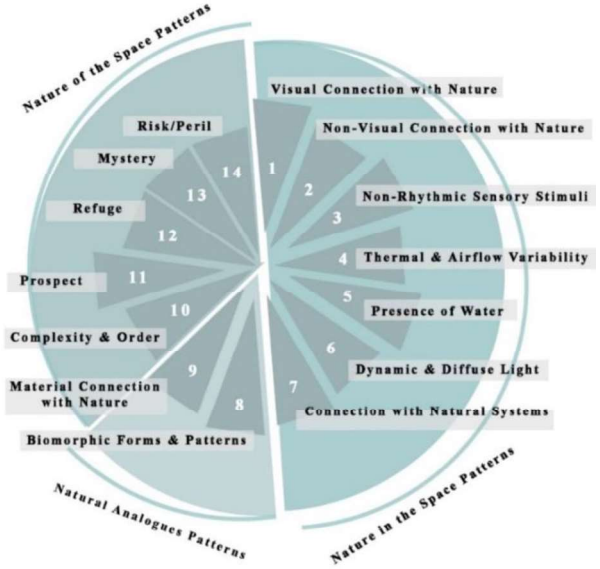

Figure (2): The 14 pattern of bio-phlic design by Bill Browning [10] (Edited by Researcher)

4. Bio-philic Design Considerations in office buildings - Case studies

Many of researches and publications on bio-philic approach have been defined to uncover useful patterns to architects of the built environment. The significant need to this research is that most of previous studies in Egypt are related only to energy efficiency, POE and Indoor air quality without investigations into other factors of workers' satisfaction and comfort at workplace. In Cairo, the office building was developed to follow the international style; highly glazed facades to enhance transparency with poor shadings and opaque parts, ignoring the local context. In the light of the awareness of sustainable development in Egypt, office buildings' owners concerned about enhancing the green image of their companies through applying innovative environmental solutions into buildings. The last two decades, there are many of open-plan offices in the world that argued for its innovative design, by integrating the first of the three levels of patterns of bio-philia by bringing real elements of nature into workplace.

The flexible working environments and optimizing the use of working space have been the key solutions for the future of regenerative office buildings by managing different spaces without increasing the used space. For instance, The Silicon Valley, Google's Googolplex they have integrated environmental features as green rooftops and courts between its nine cubical and horizontally bent buildings, Amazon's huge glass domes are built in Seattle, Apple's spaceship headquarters in Silicon Valley at San Francisco, Facebook's campus that extent for a bout single mile-long is considered as one of the most argued open-plan workplace in the world. Microsoft has referred to workers' desire to work outdoor and the importance of bio-philia to be integrated. [11]

Bio-philic design features could have contradictory effects on workers in each country. For instance, in Spain, the providing of greenery in the office as plants or green walls, was related to better levels of creativity. Water was significant to the productivity of workers in Brazil's office buildings by providing window views to outdoor water or integrated water features into the workplace. Office color is vital for creativity in countries, particularly in India where the combination of the color red linked to enhance levels of creativity. In the UK, the Netherlands and the Philippines, it was shown that the indoor plants were positively linked with productivity. In contrast, employees' productivity in India and Indonesia was related to the presence of green colors. In Germany, the use of stone elements was most strongly linked to workers' performance. In Australia, the use of wood within the workplace and furnishings improve the levels of productivity. As a consequence, Poorly-lit environments which lack colors and nature features dampen down our creativity. [12]

The EDGE office building, Amsterdam, the Netherlands sets innovative global standards for modern office building environments as one of world's most recent sustainable office building. The Edge affords everything to its workers with complicated design generates a comfortable indoor environment. The north façade facing atrium comprises 70% glass, allowing the interior

to benefit from indirect sunlight without overheating besides dampen noise from the motorway around the building.

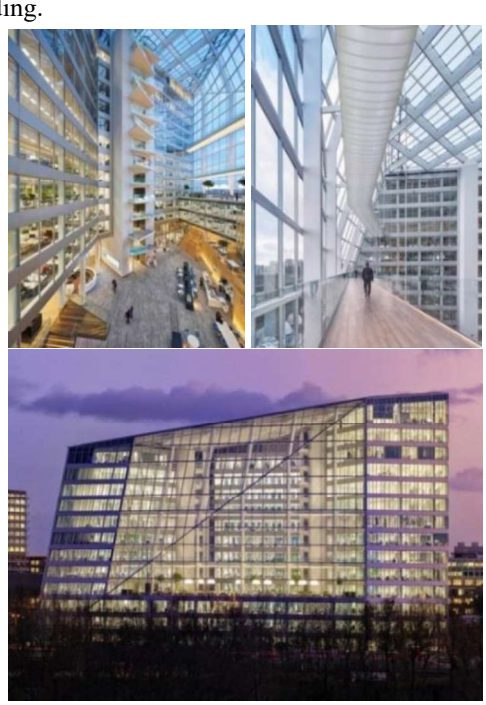

Figure (3): North-facing atrium at the EDGE office building (Photo: Ronald Tilleman)
Source: (http://www.plparchitecture.com/office---headquarters.html)

4.1. Control over indoor environment

Workers are identified to be further accepting of variations in workplace comfort aspects when they have the control over indoor environment. Architects assumed that openable windows in an office building are a bad idea that allows conditioned air to escape and unfiltered air, noise, rain and insects to enter. Based on the interviews done by Attia in 2017 on Al Bahar twin tower with its dynamic solar skin (computer-controlled) that respond to optimal solar and light conditions. Results revealed that all respondents were annoyed and discomfort by the regular opening and closing of the skin which is accentuated by their passivity toward their indoor environment control and does not allow them to interact with the facade. [13]

Figure (4): A Close view of the mashrabiya and curtain (photo courtesy: Terry Boake).

Hot desking system at the EDGE office Permits workers to locate their coworkers and find free workstations, and it are made-up to promote new relations, chance interactions, and enhance the use of workplace. Workers are not allowed for keeping their single locker for all working days around the week. According to the het nieuwe werken theory in the Dutch is to separate people apart from their locations and rigid methods of thinking. Workers are no longer linked with only a one workstation, that provides them to work everywhere in the office building in variable levels of sociability. They have the opportunity to choose between different working styles and conditions; there are work-booths, concentration rooms, sitting desks, standing workstations or a balcony workstation. Workers can connect to the building via a smartphone application to find a parking, modify temperature and light at their workstation.[14]

Also, Privacy and Acoustic Control is significant and could be achieved by low density work spaces and integrated different types of workstations as Linear, Cluster, Single seater, Single pentagon and Cubicle workstations. Phone booths could provide a personal space that meets the four pillars of privacy: sound, visual, territorial, and informational. It could be Introducing adequate sound absorption and noise friendly finishing and furniture into the space, by using high-density fiberglass ceiling panels with high noise reduction coefficient (NRC) ratings and floor with sound-absorbing tiles. That also could be achieved by well-placed plants, greenery and green walls with its sound absorption coefficient 0.40 besides its benefits of aesthetic and impact on air quality. [15]

4.2. Natural ventilation quality and Thermal Variability

The Atrium is the gravitational center of office's solar system and floods the workplaces with natural daylight. It acts as a buffer between the workspace and the external environment and provides a sound isolation from surroundings and affords a healthy indoor climate for workers. For instance at the EDGE office have heat recovery ventilation systems: Natural ventilation and mechanical ventilation that contributes to get an intelligent ventilation system. The excess of air ventilation from the offices is reused to cool the atrium, and then exhaled from the top of the atrium by creating a circle of natural ventilation. That generates a Slight heat deviations and air exchanging make the worker at the space sense the outdoors environment. Water walls at Dar Al Handsah office, smart villages in Cairo have a thermal effectiveness as it could increase humidity in interiors and produce a healthy indoor climate. A thin water film flows over a vertical wall and through passive evaporation; water is released into the indoor air, which prevents excess humidity in the workplaces and the formation of undesirable mold. [16]

4.3. Direct connection with nature and Natural Sunlight

Visual interest and its dynamic sunlight pattern geometry in office buildings is a multisensory phenomenon to enhance workers' comfort and promote their connection with the outdoor nature. The dominance of fractal patterns in our nature has affected the human visual system to be familiarized to efficiently process. Fractal patterns prompt relaxing and restorative special effects, visual favorite, in addition to stress recovery benefits. A study found that remote views received poorer visual discomfort levels than near views. The continuous pathway of vegetation could split the working spaces from view out of a workplace placed at overcrowded urban environments and provides an ecological corridor that catalyze animals and useful insects to be stacked up discreetly into the outdoor landscaping that support several species of solitary bees to buzz around the plants on the open terrace. [17]

4. 4. Indirect connection with nature

Creatures have five basic senses: sight, hearing, touch, smell and taste. The sensing tissues associated with each sense that direct information to the brain to help us to perceive the world around us. Interventions could be experienced by integrating visual with non-visual connections with nature. Using diversity of natural materials and simulate natural texture promoting the tactile variability sensation and increasing the sensation for physical connection with nature. That could be by using materials and features from nature that with minimal processing that could reflect the local ecology or geology for creating a distinct sense of indoor work place. Trend Micro office at downtown in Cairo is considered as a good instance of a miscellaneous application of natural material that Connected with nature. They use stone with rough surface, cooper and wood as natural materials that could growth, change and patina of time.

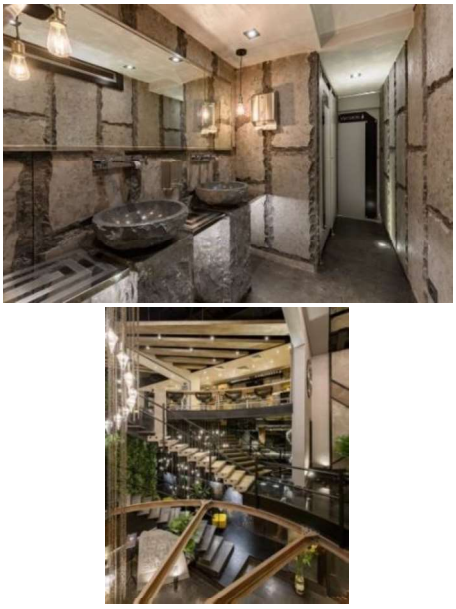

Figure (5): Using of cooper and wood at Trend Micro office building (Photo by Nour El Refai)

Researches stated that the Prioritize is to natural sounds compered to urban sounds or office noises; improve physiological and psychological restoration up to about 37% faster. [18] Experiments observing the consequence of integrating of the color green on the psychological function of occupants, the results defined that exposure to a green color before starting a task could facilitate their creativity performance. [19] Olfactory system processes effect directly in the brain and could connect it with previous powerful memories. Some Traditional cultures have used plant oils to energize individuals. For touch sensitivity, the act of touching further natural elements as natural plant versus artificial plants, water features, raw materials has induced relaxation through a modification in blood flow rates and health consequences. [20] Olfactory Variability related affective feelings and also the Use of Olfactory Stimulants to Improve Indoor Air Quality. Plants Olfactory need to be connected with our culture as it connected to our ecological nature and geographical zone. As using Jasmine Oil as natural olfactory stimulants in office buildings in Egypt.

Interiors at workplaces are fostering the connections with nature where there are mimic shapes, patterns and forms found in nature; by Symbolic representations within the design of the patterns, shapes, textures or

numerical arrangements originate in our nature. For instance, At Dar Al Handasah smart village, Natural shapes and patterns have been integrated into the design of the building by mimicking the white Egyptian lotus at the outer cladding skin of the multi-story atrium. White Egyptian lotus which connected to our culture and history is considered as the symbol of the symbol of existence and creation.

Figure (6): White Egyptian lotus as the symbol of existence and creation
Source :(https://nourelrefai.photoshelter.com/image/I0000drx1TjBvDkM)

4.5. Allow Prospect View with Long vistas

Building form and site selection is significant as workers could hardly affect the prospects of viewing out. The floor depth of the workplace is recommended in numerous measuring as about 8m from the furthest workstation to the external view, besides the size of the opening that will impact on the efficiency of the effect of viewing. When designing an external natural view with attractive and changing prospect, architects need to evaluate and balance between different environmental factors, as heat gain and loss, visual quality, glare control, and variability in daylight and availability. [21]

Designing the optimum accessible view on each building side is need to be related to the workers' need and activity in those spaces. For example if the external view is extremely dynamic then it could cause distraction rather than stimulation which effect on productivity level as the worker is distracted visually. Surrounding environment not is always good and may be so poor to contact with, at this case we need to promote the natural connection with indoor environment. Creating central courtyards, atriums, shared sky gardens, with natural trees and plants as a solution to afford an effective and quality prospect view out of a workplace placed at overcrowded urban environments. Building's rooftop or terrace gardens could be integrated as a solution for quality view out.

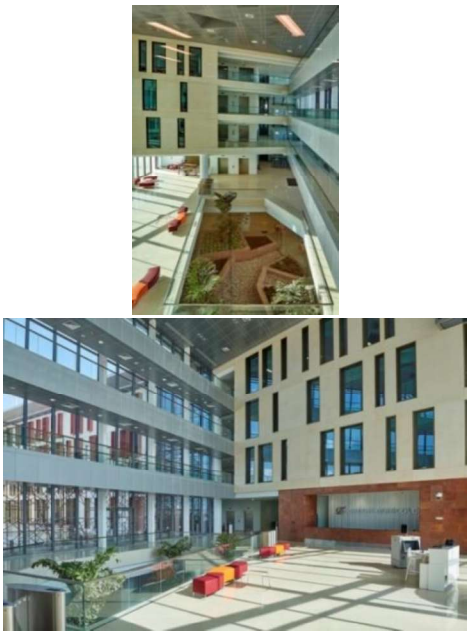

Figure (7): The multi-story atrium at Credit Agricole headquarter, Newcairo
(Source: https://www.skyscrapercity.com/showthread.php?t=1150463)

Countries where there is a high degree level of solar radiation as Egypt would be desirable where the natural view is provided 'internally' with a large shaded, lively and 'decorated' courtyard. The Atrium is considered as a substantial design element for office buildings. For instance, the huge atrium at credit Agricole acts as the vital "piazza" for workers. The Atrium provides sunlight down onto floors and generates a sense of spaciousness. This satisfying integration of space can be observed by a central focal point that occurs either functionally or thematically. This appeared efficiently in the main entrance grand lobby at credit Agricole.

4.6. Prospect-Refuge zones

Prospect-Refuge theory asserts that humans are attracted to spaces that afford prospect, opportunity, refuge and safety. Prospect is defined as vast, open spaces, around which the individual have opportunities to escape from threats. Work spaces need to integrate distinct areas with plants and other greenery that could provide feel of safety, and Refuge where the individual could hide or situate himself. Psychological effect of viewing surrounding nature with feeling safe is desired as 'refuge-prospect' pattern which is considered as a significant desire to control worker's environment. The existence of windows, doors viewing out from their 'workstations' fulfillment their satisfaction of feeling safe, comfort, more less stress and distracted. [22]

The need to do something for recreation is a critical factor of human biology and psychology. Countless activities may be considered as a work for one person

and recreation for another and over time recreational activity may become work, and vice versa. For instance at TM buildings, employees have many relaxation and recreational zones with different activities and choices to spend their break time as watching movies together, reading books, drink or eat something at trend's coffee or relaxed out the building in the surrounding green area. Also provides spaces for social interaction between their workers and for Physical Activities as show in the figure (8).

Figure (8): Some of recreation zones for break time at TM office (By researcher)

4.7. Historic and Cultural Connection (Spirit of space)

As Stephen kellert defined that without the positive benefits and associated attachment to buildings and places, people rarely exercise responsibility or stewardship to keep them in existence over the long run. Office buildings spaces need to have some features from history or culture to robust the relation between workers and their working space. As it found in TM office building at downtown, the building have integrates features from History by using the ancient Egyptian language and engraved it on stones at each corner at the workplace. As it show also by integrated the logo of the corporation at its branch in Egypt with iconic symbol in ancient Egyptian as eye of Horus.

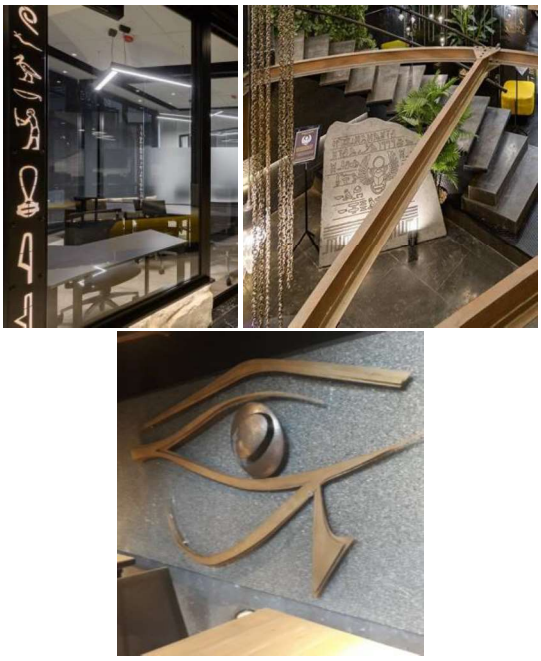

Figure (9) features of Historic and Cultural Connection at TM office building
(Photo by Nour El Refai)

5. The Observation and Surveying

A lot was noticed from walking through the case studies of office buildings in Cairo via conducting several interviews and questionnaires to their workers. Data represents a part of survey conducted among multiple office buildings in Cairo some have LEED certified and other are considered as ones of most innovative work place design that target workplace investment on the amenities to deliver the highest impact of productivity to their workers. The respondent samples are accounts 60 from a range of diverse categories of office buildings. The surveying examines worker's perception and dissatisfaction with their work environment that might influence productivity in office buildings. Respondents were asked to compare between the most significant bio-philic patterns according to their preferences to the factor of satisfaction at work place, by placing them in order of preference by assigning integer values to each one from (0 -10). From responses results, an average ranking is calculated to define and evaluate the weight of the most preferred factors that could increase the comfort and satisfaction in workplace, as is shown in figure (10).

Results reveal that the first priority and the most significant need from workers' perspective is natural sun light and shadow with average weight (8.1). The second priority in work place is the indoor air quality and fresh air (7.3). That followed by thermal comfort & regulation (6.8) and then visual connection with nature (6.6). The respondents weighted some factors of satisfaction at workspace with low average weight of preferences such as connection with natural materials get (3.8),

connection with natural analogues (3.6) and non- visual connection with nature (3.5). Historic & Cultural Connection to some extent get the same priority to natural materials with average about (3.9). Natural features & greenery get average (5.2), which means that is important but not significant.

Table (1). Factors of sense of satisfaction at your work place

		Average (out of 10)
A	Natural sunlight & Shadow	8.1
B	Indoor air quality & Fresh air	7.3
C	Thermal comfort & regulation	6.8
D	Natural features & Greenery	5.2
E	Physical connection with outdoor nature	6.2
F	Visual connection with nature	6.6
G	Connection with natural materials	3.8
H	Connection with natural analogues	3.6
I	Non- visual connection with nature	3.5
L	Historic & Cultural Connection	3.9

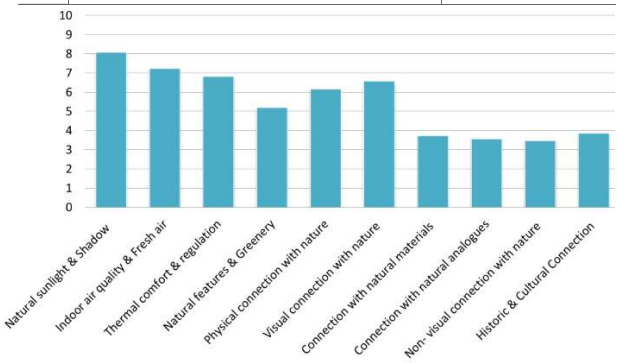

Figure (10) Factors of comfort and satisfaction at your work place

The previous results reveal that the workers are aware and have a well-known background to the significant importance need for nature and bio-philic design workplace. Respondents indicate that only Visual connection with nature have more priority than Physical connection with outdoor nature. Results indicate that ventilation necessity and Good air quality with operable windows are the base factors of comfort workplace where workers could have the ability to control their working environment. Our observation reveal that most of national office building are missing to have recreation and activities zones in office buildings to promote social interaction and happiness between workers where they could meet, celebrate and share their life events and do some activities within a worthy break time. Office buildings are missing to incorporate refuge zones where workers could get their individual space when they need to be more focusing at the open floor workplace or alone.

6. Conclusion

The surveying findings highlight the most significant impacts and considerations that could simply be incorporated in work spaces and make workers being more creative and productive, to motivate organizations to redirect the whole attentions to their workers' needs and take effective actions in including nature approaches. In order to thrive as human beings and working for long hours, we need meaningful relationships, adequate daylight and fresh air, physical exercise and adequate relaxation. That is mean that our work spaces need to generate active working environment and breaking the long hours issues and integrate the work-life balance into work place. Bio-philia have cultural differences and preferences in elements of bio-philic design that influence workers in a positive way that leads us to increase the amount of researches related to bio-philia in the office buildings.

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