Sosyal Araştırmalar ve Davranış Bilimleri Dergisi

Journal of Social Research and Behavioral Sciences

ISSN:2149-178X

The Impact Of Biophilic Designs On Worker Efficiency[1]

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Abstract

At the core of the definition of productivity is productivity and measurability, which aims is to achieve the maximum output for the benefit of people using resources at one's disposal. We can state that humanity ultimately strives to achieve better for itself and to support the development of others. As part of this, we might define employee performance as those techniques that improve both the performance as well as environment of workers, with the aim of encouraging workers to work both better and harder in order to enhance productivity. Academic literature reveals that factors such wages, working environment/conditions, administration-worker relations, and workplace communication all affect worker productivity. In particular, the impact that working environment can have on worker productivity focuses mainly on either positive or negative physical conditions such as ventilation, lighting, and noise. Many, more recent studies cite that working environments that are intertwined with nature have a positive impact on worker productivity. This notion is a reflection of biophilia. Biophilia puts forth that there is an instinctive bond between human beings and all other living systems. One extension of this is biophilic design, which incorporates natural materials, natural light, vegetation, and natural landscapes into the modern environment. Proponents of this thus quote that work productivity in workplaces increases as much as 8% in such environments. This study will focus on the relationship between biophilic design and worker productivity.

Keywords: Biophilia, Biophilic Design, Worker Productivity, Productivity, Working Environment

Biyofilik Tasarımların Çalışan Verimliliğine Etkisi

Özet

Verimlilik tanımının özünde, üretkenlik ve ölçülebilirlik vardır; amaç insanın yararı doğrultusunda ve insan için, eldeki kaynakları kullanarak, en fazla çıktıyı elde etmektir. Daha iyiye ulaşma çabası, insanın gelişmesini desteklemesi, insanın insan için mükemmeli arama serüveni olarak da ifade edilebilir. Bu serüven içerisinde çalışanların performansı ve çalışma ortamını geliştiren teknikler olarak çalışan verimliliğini tanımlamak mümkündür. Çalışanların daha iyi ve daha çok çalışmaya özendirilmesi böylelikle üretimde verimlilik artışının sağlanması amaçlanmaktadır. Yapılan akademik araştırmalarda çalışan verimliliğinin, ücret, çalışma ortamı, çalışma şartları, yönetici ile ilişkiler, işyeri iletişimi gibi faktörlerden etkilendiği ortaya konulmaktadır. Özellikle çalışma ortamının çalışan verimliliği üzerindeki etkisi, havalandırma, aydınlatma, ses ve gürültü gibi fiziki

[1] This paper has been presented at IV. International Social Research and Behavioral Sciences Symposium held in Antalya, Turkey, October 19-21, 2019.

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şartlarının olumlu ya da olumsuz etkileri üzerine odaklanmaktadır. Son dönemde ortaya atılan doğa ile iç içe olan çalışma ortamlarının, çalışan verimliliğini arttırdığı belirtilmektedir. Doğa ile iç içe olma, biyofilya kavramının bir yansımasıdır. Biyofili, insan benliği ve diğer yaşayan sistemler arasında içgüdüsel bir bağ olduğunu öne sürer. Biyofilinin bir uzantısı olarak biyofilik tasarım, doğal malzemeler, doğal ışık, bitki örtüsü, doğa manzaralarını modern çevreye dâhil etmektedir. Bu sayede işyerlerinde çalışan verimliliğinin yüzde sekiz oranında arttığı belirtilmektedir. Bu çalışmada da biyofilik tasarım ve çalışan verimliliği ilişkisi incelenecektir.

Anahtar Kelimeler: Biyofili, Biyofilik Tasarım, Çalışan Verimliliği, Verimlilik, Çalışma Ortamı

1. Introduction

The word biophilia is derived from two Greek words "bio", meaning life, and "philia", meaning "love" or "lover of". The psychologist Eric Fromm was the first to introduce the concept. Biophilia, thus, can be defined as the "love for all things living" (Bayraktaroğlu, 2014: 10). In his book The Secret Garden of Nature, the American biologist Edward O. Wilson defined biophilia as "the in-born tendency towards life and life cycles" (Wilson, 1996: 165). Biophilic design, thus, draws attention to the emotional side of human beings, and states that people adapt better in environments where there are elements and designs that are one with, or reflect, nature. An evolutionary theorist and biologist, Wilson (1984) takes the view that biophilia is "the in-born tendency towards life and life cycles." In this sense, working areas that receive natural sunlight, where employees can access nature, and where there is extensive flora in order curb noise and clean the surrounding are, not only affect worker productivity, but they also transform workplaces into green buildings. Human beings work not only more efficiently, but also learn better, and are generally healthier in structures that grant them the opportunity to interact with nature. Many schools, hospitals, and office spaces have begun to embody the basic principles of biophilic design. Therefore, we, too, can define biophilia as an instinctive bond that brings living systems together.

That is to say, it is an intrinsic tendency bonding man with nature. The result of human beings having transitioned from living amongst nature to living in enclosed spaces, means that we have become forced to live in artificial buildings and cities in the name of modernity. This, in turn, has removed us from nature, and revealed the need for us to establish our relationship with nature. This is where biophilic design enters into the picture, in that it finds an architectural solution to that need. Architects use natural materials, natural light, and natural landscapes in order not only to enhance human health and productivity, but to also offer people an alternative way of living, given that modern life cuts people off from nature.

Houses, workplaces, hospitals, schools, shopping centres, where people spend most of their time are, more often than not, built without natural light, natural materials, or upon the principals of natural architecture. However, for the health and welfare of people, we can establish a link between nature and man-made structures through biophilic design. Oliver Heath states that, "*biophilic design does not bring nature indoors. Rather, it connects many aspects of nature, and strengthens those connections"* . Therefore, we need to discuss biophilic design within the framework of how natural light and natural materials heal people (Erbay, 2018: 23).

2. Biophilic Design

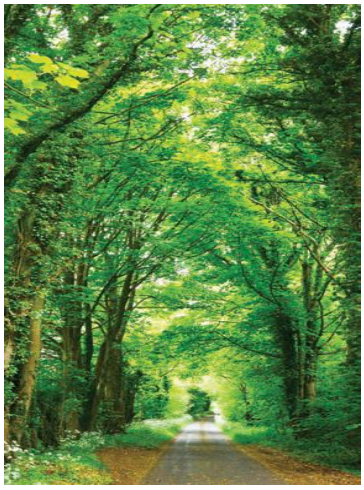
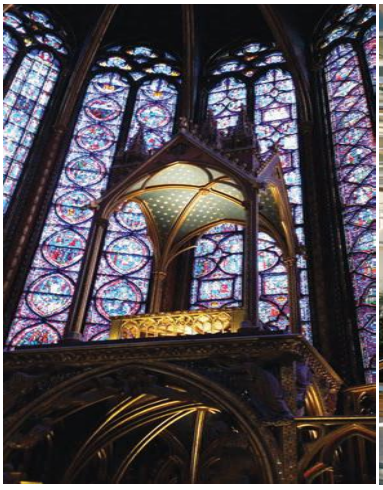
Edward O. Wilson's book Biophilia has gained tremendous currency in recent years. Now that people have transitioned from living in natural habitats to living closed and artificial habitats, the need for us to re-connect with nature has once again emerged. Therefore, now is the time to discuss biophilic design, as it aims to combines our need to re-connect nature with our need to live in modern buildings. In doing so, it focuses on how living naturally can enhance both human health and productivity, namely by integrating natural light, natural materials, and natural landscapes into the modern world. Urbanization has caused us to lose our relationship with nature. One indicator of modern life is that structures like homes, schools, workplaces, and shopping malls, within which most of us spend a large portion of our lives, are designed using artificial light, artificial ventilation, and artificial materials. This in turn threatens our health, welfare, and level of productivity. Biophilic design heals people and motivates their performance and productivity through environments that are connected to nature (Erbay, 2018: 23). Biophilic design may also be referred to as healing architectural design. Biophilic primarily focuses on hospitals, schools, and work places in order to enhance healing/recovery, learning, and productivity (Dünya, 2014).

Kellert (2005) states that biophilic design has two basic orientations: organic and regional design. Inspired by biology, organic design refers to forms found in nature, including water, trees, plants, landscape, and the like. All of these have the ability to affect people's productivity, emotional state, and ability to recover and learn. Regional design, in contrast, refers to the interaction between culture, history, and ecology, and is tied to one's sense of appreciation towards nature. The process of one becoming detached from nature often emerges into the process of one becoming detached from them themselves, and thus trying to

satisfy that detachment with power. Biophilia exists therefore exists in order to help us find and fulfill our need for satisfaction and security within nature itself (Bayraktaroğlu, 2013: 37).

Kellert and Calabrese's "The Practice of Biophilic Design" describes that we experience biophilic design in three ways: (1) directly experiencing nature, (2) indirect experiencing nature, and (3) experiencing space. Directly experiencing nature refers to our direct contact with nature (e.g. the direct incorporation of natural light, air, flora, animals, and natural scenery in artificial spaces). Indirectly experiencing nature refers more to representing and/or giving off the appearance of nature in spaces through figurative means, such as landscape paintings and other nature-themed works of art, natural colours, natural materials, and natural shapes. Experiencing space enables human beings to connect with nature and make them feel safe within spaces through the presence of visual transitions linking space and nature. We can further divide these three experiences into 24 sub-experiences (Erbay, 2018: 24).

Table 1. Experiences in Biophilic Design


Directly experiencing nature	**Indirectly experience nature**	**Experiencing place and space**
Lighting	Images of nature	Expectations and housing
Air	Natural materials	Order and complexity
Water	Natural colours	The integration of parts into a whole
Plants	Simulating natural light and air	Transition spaces
Animals	Natural shapes and forms	Mobility and navigation

Weather conditions	Calling nature	Cultural and ecological attachment to space
Natural landscapes and ecosystems	Wealth of knowledge	
Fire	Age, change, and traces of time	
	Natural geometry	
	Biomimicry 	

Source: Kellert and Calabrese, 2015: 10.

Biophilic design has two main dimensions: organic or natural, and spatial or regional. The organic, or natural, dimension of biophilic design symbolically demonstrates whether human beings are either directly or indirectly tied to the environment around them. Direct experiences emphasize the direct relationship between man with nature, i.e. through daylight, plants, and animals. Indirect experiences, symbolically bring human contact with nature through elements like potted plants, fountains, and aquariums. We can define the space-based or regional dimension, as our transposing the ecology and culture of a particular region or geography onto both buildings and landscape elements. This dimension aims to transform inanimate objects into living objects, with particular emphasis on social identity. These two basic dimensions of biophilic design include seventy features detailed under six titles (Boz & Cengiz, 2019: 35).

Table 2: Features of Biophilic Design

Environmental characteristics	**Natural shapes and forms**	**Natural patterns and processes**	**Light and space**	**Space-based relationships**	**Human-nature relationships that have developed over time**
Colour	Floral motifs	Sensory diversity	Natural light	Link between geography and space	Accommodation and vigilance
Water	Trees and vertical supports	Wealth of knowledge	Filtered and diffused light	Relationship between history and space	Order and complexity
Air	Animal Motifs	Aging, change, traces of time	Light and shadow	Ecological link with space	Curiosity and excitement (appeal)
Daylight	Sea shells and spirals	Growth and reproduction	Reflected light	Relationship between culture and space	Change and transformation
Plants	Oval and elliptical shapes	Central focal point	Light pools	Local materials	Security and protection
Animals	Arches, vaults/squinches, domes	Integrative patterns	Warm light	Geographical features that shape space	Domination and control
Natural ingredients	Flat and non-right angular forms	Restricted spaces	Formal light	Culture and ecology	Emotional intimacy and commitment
Landscapes	Simulation of natural properties	Transitional spaces	Spaciousness	The spirit of a space	Appeal and beauty

Vertical greening	Biomorphology[3] 	Interlinked series and chains	Spatial diversity	Avoidance of spacelessness	Discovery and exploration
Geology and landscape	Geomorphology	The integration of parts into a whole	Formal space		Knowledge and understanding
Habitat and ecosystem	Biomimicry	Complementary contrasts	Spatial harmony		Fear and fascination
Fire		Dynamic balance and tension	The relationship between indoor and outdoor space		Respect and spirituality
		Fractals[4] 			
		Hierarchically organized ratios and proportions			

Source: Kellert Boz and Cengiz, 2019: 36.

[3] This concept, which picks up where so-called "biological formation" leaves off, transposing nature onto structures in terms of form by enlisting the support of both technology and biology (Uç Zeytün, 2014: 3). As technology advances, we will se projects that incorporate certain types of micro-organisms into the systems of structures as well as that integrate living DNA into coating materials and carrier systems (Uç Zeytün, 2014: 45).

[4] These emerge from the continuous repetition of simple geometric shapes into an art form that explains complexity that exists within the order of nature. The term fractal comes from the Latin "fract-", meaning broken. (Young, 2019: 1).

3. Strategies in Biophilic Design

We can put forth biophilic design-based solutions using different scales that already are in use in urban design. Wilson (2008) identifies strategies these being a different design scale in and of themselves:

Table 3. Biophilic Design Strategies

GENERAL	
The concept of biophilia during the early stage of the design and planning process	Considering biophilic design strategies in the early stages of the design process will provide us with opportunities for building layout, architectural form, interior, and exterior design.
Including biophilic design in all buildings---especially those meant for children, the elderly, and the sick	Natural elements help calm children down, better acquaint people with nature, reducing patient discomfort, and accelerating their road to recovery.
Integrating the teaching of ecology into buildings	Signs and indicators about natural elements and features enable people to understand and value what they see.
Integrating biophilic design into both existing as well as new buildings	Most biophilic strategies can be applied to existing buildings, albeit not to the extent that they can be utilized new buildings.
Helping spread biophilic design criteria	We need to make an effort make society, educational institutions, and health care services about the importance of biophilic design.
Designing landscapes and buildings that create a sense of mystique	Designing mystical landscapes and buildings encourages users to explore, discover, and learn about the complexities of nature.
Developing and strengthening the bond between man and space	Ensuring an ecological, historical, and cultural connection between man and the space helps users/inhabitants to better connect to that space. Doing so inspires them to want to protect the area, as well as ensures significant that they become loyal to, responsible for, and manage that space.
LANDSCAPE DESIGN AND FIELD USE	
Provision of open spaces around buildings	In order to heighten our contact with nature, we must increase the number of open, naturalized, and

	landscaped spaces surrounding buildings. We must also support the ecosystem by weaving as much natural vegetation as possible into these spaces as well.
Preserving existing vegetation and natural landscapes	Preserving existing trees and natural landscapes during land development and construction is one of most effective ways in which we can create natural landscapes.
Arranging plants around buildings and creating natural environments	Well-designed landscaping areas need to be a visible part of buildings. There should be as many windows as possible overlooking vegetation and water elements.
Establishing passageways in natural and regulated areas	Walking and cycling need to be established along restored landscapes in both residential and commercial areas.
Using various plants in place of impermeable surfaces	Vegetation not allows rain and snow to melt and penetrate into the soil, but contributes positively to the environment, transforming spaces in areas that people want to see and explore.
Creating green facades	Green facade bring nature to the space, which is important for the interaction between people and nature.
BUILDING DESIGN	
Providing a view of nature	Architects/designers should design and position windows in such a way that they allow people to easily look outside.
Creating a transition between a space's interior and exterior	Wherever possible, living and working areas should open up to outdoor areas such as terraces, courtyards, balconies, and gazebos, being set up in such a way that they ensure that people use these areas.
Uninterrupted line of view	When designing glass systems, deck railings, and other elements interrupt the nature landscape, it is imperative that the view be obstructed in any way.
Penetration of daylight	Practically-speaking, glass not only allow users to

	look outside, but they do so in such a way that they sync with the natural flow of light and shadow.
Providing functional windows	Those occupying the space should be able to take in the scent of the surrounding flora and to access clean air.
Creating green roofs	Low-pitched roofs should be transformed into green roofs, thus providing both visual and physical access.
Landscaping atrias and interior spaces	The main idea of planting atria is bring nature into buildings and to create a relaxing indoor environment for users. Atriums in hospitals, for example, seem both to promote patient healing as well as reduce patient stress. The atriums of such structures can be multi-storied, and should also contain walking paths.
Using green walls and other similar systems to treat air and water in buildings	Green wall systems remove air pollutants. Similarly, many buildings feature living systems that treat wastewater.
Adding water elements into buildings	Water elements can provide numerous visual and acoustic benefits.
Creating a sense of complexity in building design	The single most important element of biophilic design is the relationship between complexity and diversity within the natural structure.
Considering both spaciousness and shelter in building design	Architects/designers can create spaces with mimetic exteriors and places of shelter by alternating ceiling height, just as Frank Lloyd Wright's had done in many of his buildings.
Using organic forms in buildings	Architects/designers can integrate shapes and forms that integrate nature in order to add depth and diversity to spaces.
INTERIOR DESIGN	
Using potted plants in interiors	Using potted plants indoors allows users become more in touch with certain elements of nature.
Providing natural materials and natural art in spaces	Especially in cases where nature cannot be brought into the space, architects/designers might want to

	incorporate natural building materials and pictures/paintings depicting nature.
Setting up office spaces that provide users with a view of natural landscapes	Architects/designers should position work desks in offices in such a way that employees can see windows as well as make the most of natural light and other biophilic features.
Emphasising biophilic elements as part of the interior	From the angle of management and intelligibility, it is important that architects/designers draw upon signage and other makers in order to explain to users biophilic elements.

Source: Wilson. Boz and Cengiz, 2019: 40.

4. The relationship between biophilic design and productivity

We can group the main factors that contribute to the biophilic effect under eight headings: light, colour, gravity, fractals, curves, detail, water, and life. Light refers to the need for natural sunlight. Natural light moreover is essential for three-dimensional vision and depth perception. Receptors send colour directly to our brains, and in turn connects directly with our emotions. Likewise, our brains associate grey and colourless surfaces with negative emotions in the brain, thus ultimately negatively affecting our ability to work effectively. Gravity refers to all objects being in balance with one another. Heavy elements in natural structures sit at the bottom while lighter elements sit higher up. Fractals refer to complex systems containing geometric structures. Humans respond to fractals positively because we have the same structural properties in our bodies as well. Curves include the types of curves that we perceive in nature; curves and symmetry generally stir our sensations. Details like the veins on stones or tree ring are the details that we instinctively want to see. Due to its healing properties, water expresses man's desire to be close and to see things. Life refers to our bonding with natural forms, thus expressing the full definition of biophilia (cf. from Salingaros Şenozan, 2018: 33-35).

The key to leading a good life is to reduce stress. Establishing a connection with nature can contribute significantly to this. Natural elements in the working environment also contribute to increasing productivity by making employees feel good. For example, when you look out the window, your level of stress is on par with that of nature. Natural tones such as green, blue, and brown make the employees feel at ease, where gray generally has the opposite

effect. Similarly, the use of live plants and foliage in office environment also has a positive impact on workers' over all well-being as well. Illumination and spaciousness, too, heightens workers' sense of well being, whereas non-spacious environments, as one might expect, have the opposite effect (Velarde, Fry & Tveit, 2007).

The ING Bank building in Amsterdam had succeeded in reducing workday loss by 15% by introducing basic biophilic principles in 1987. Perakende, likewise, had increased its own profits by around 40% by taking similar steps. They also managed to save as much as 2.6 million dollars worth of energy by using an energy system that paid itself off in 3 months (Trenddesk, 2013: 10).

Figure 1: ING Bank, Amsterdam, Netherlands.

A study conducted at the University of Texas revealed that the use of indoor plants not only reduces worker stress, it also increases work efficiency by 12 percent (Trenddesk, 2013: 10).

Located right in the heart of nature in Madrid, the Selgas Cano Architectural Office is one of the finest examples of biophilic design. Employees work along a massive windowsill in an environment surrounded by nature. A 2 cm-thick curved window enables the northern wall to run along the length of the building. The southern wall, on the other hand, is 11 pains of glass thick, and made of fiberglass and polyester, and thus prevents exposing office workers to

direct sunlight and to overheating. The hinged opening is a attached to a weighted pulley system, and allows varying degrees of natural ventilation (Şenozan, 2018: 22).

Figure 2: Selgas Cano Architectural Office, Selgas Cano, Madrid, Spain.

Two important effects of biophilic design in work environments include productivity and creativity, meaning that it contributes significantly not only to worker productivity, but also to worker well-being as well, therefore confirming the relationship between feeling good and productivity. One study conducted in the UK and the Netherlands also links biophilic design to productivity. Titled "The Relative Benefits of a Green Versus a Non-Green Office: Three Field Experiments", the study examined two different groups of workers who had different levels of contact with nature. What it found was that the productivity of the group of employees whose offices were filled with plants had jumped 15% over a three-month period (Nieuwenhuis, Knight, Postmes, Haslam, 2014: 210).

Another study dating back to 1993 and featuring 1,200 office workers discovered that workers who were able to view nature from their windows had generally experienced less discontent, and were more motivated to work. In 1994 The Rocky Mountain Institute published a study that found that energy-efficient systems for lighting, heating and cooling enhance worker productivity, curb absenteeism, and improve quality of output. The level of productivity in particular resulting from this shift in design had increased by between 6 and 16% (Cramer and Browning, 2008: 345).

Those who work in office spaces lacking windows generally incorporate more window-oriented decor into their offices than those working in offices with windows. The logic behind is that workers attempt to circumvent that lack of nature (Heerwagen and Orians, 1986: 623).

Similarly, a lack of windows in an office space, excessive use of grey tones, and/or a lack of plants and/or other natural elements also all have a negative impact on creatively and creative output as well. In contrast, the presence of plants, sunlight, and the like make office workers 15% happier, 15% more creative, and 6% more productive.

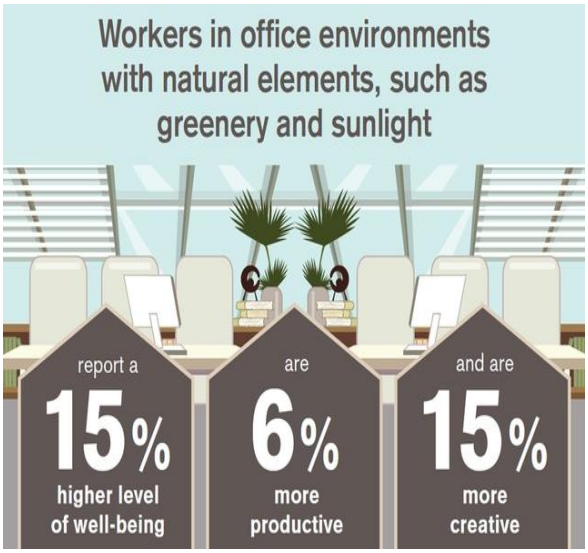


Figure 3: The impact that natural elements have in office spaces

5. Conclusion

Biophilic design expresses a love for life and living systems. Thusly, the main purpose of biophilic design is to create hospitals, schools, and work places in order to enhance healing/recovery, learning, and productivity.

Biophilic design and its principles go beyond enhancing worker productivity and creating environmentally friendly spaces that conserve water and energy, in that they also curb the impact of our carbon footprint on the planet as well (Trenddesk, 2013: 10). Were we to apply these principles both to existing as well as new building via interior design as well as landscaping, we can ultimately create positive results throughout many a work environment.

In essence, increasing well being of the employees, reducing their overall levels of stress, and creating efficient work spaces will also have an outstanding impact on worker productivity as well.

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