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# Assessing workers' productivity through biophilic design as a measure of sustainability in selected office buildings in Lagos state, Nigeria

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**Abstract.** With developers seeking minimalist designs that maximise space with land being at a premium, the quality of life has been neglected amidst the technological advancement and development. Human beings require contact with nature now more than ever to live healthy, productive lives. This affiliation with nature is what is described as Biophilia. Biophilic design is the incorporation of elements of nature into the design of spaces and is regarded as an extension of sustainability. Lagos is often described as the city with the fastest growing economy, which implies a lot of business activities are sprung up and the need for a sustainable working environment cannot be overemphasised. This study assesses the influence of biophilic design strategies on the productivity of users in selected office buildings in Lagos state, Nigeria. The study adopts a stratified random sampling technique to select respondents who are mainly users of the selected buildings. Data obtained from respondents was analysed using regression analysis. Findings reveal that biophilic design strategies has a significant influence on workers' productivity, however the biophilic elements occurred as isolated occurrences of nature as to a culminated effect. The study recommends early-on integration of biophilic design patterns to attain maximum effect, as well as the proper integration of biophilic design elements.

## 1. Introduction

The design of the built environment could have long term effects on quality of life, with the W.H.O (2018) stating: "Whether people are healthy or not, is determined by their circumstances and environment. To a large extent, factors such as where we live, the state of our environment, genetics, income and education level, and our relationships with friends and family all have considerable impacts on health...". The benefits of providing this interaction with nature are more serious than mere employee satisfaction. An increasing body of research has found value in the encouraging benefits that biophilic design offers in terms of well-being, productivity, creativity and acoustics.

The drive towards sustainable design and innovative methods of construction has greatly led to standardized methods of lowering energy consumption and an increase in the efficient and judicious use of resources and building materials. Organisations and buildings have shared mutual benefits from these practices as an opportunity to reduce costs and "balance the books". In recent times, however, there has been paradigm shift that focusing solely on low environmental impact buildings or net zero designs overlook a critical feature required for long-term sustainability and imminent financial growth: people [1]. A significant portion of business costs are spent on staffing and human resource needs. Consequently, investing in people can recover lost productivity and increase profits, and at the same time foster lively, healthy and aesthetically pleasing workspaces.

## 2. Literature review



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Biophilia is the innate human tendency to connect with natural systems and processes, particularly living features of the nonhuman environment [2].

### *2.1. Biophilia*

Human's inclination to interact with nature reflects the certainty of having developed into a largely natural world as to a non-natural or constructed one [3]. Over the years, we as human beings have progressed for larger parts of our history in adaptive response to the natural environment and not to the built or artificial environment. The postulation that human evolution and civilization is independent of nature is a very misleading illusion [4].

Our constructive abilities, critical thinking, and problem solving continue to imitate skills and attributes attained in close association with natural systems and processes that remain critical in human health and productivity. We must understand that contact with nature is a necessity rather than a luxury for attaining lives of wellness and satisfaction [5].

Biophilia explains why certain occurrences in nature affect us the way they do, like how sizzling fires and crashing waves captivate us; why an open view to nature can improve our productivity; why heights and shadows instil a form of appeal and anxiety; and why taking a walk along the park can provide restorative healing benefits [6].

### *2.2. Biophilic Design*

A common delusion is that biophilic design simply involves adding lots of plants and shrubs; it is far more complicated than that. "There is a multitude of possibilities including maximising natural light, using colour and incorporating a mix of natural materials such as wood, metal and stone within the workplace and, of course, introducing plants and features like green or living walls" [7].

Biophilic design has a distinguishing characteristic which highlights the importance of the sum of its parts, as to an isolated representation of nature.

A broad regard of biophilic design is one in which multiple standpoints such as: previous engagements, duration of user experience, context of the design are considered to achieve spaces that are fit to live in, calm, inspire and can be merged with the purpose of the built environment to which it is applied. Biophilic design also seeks to create a sense of place. [8]. The emergence of new concepts and stances has brought about diverse opinions on what acceptable biophilic design is described as. "There is rarely a solution that is universal. Rather, the 'correct' solution, in our view, is one that is locally appropriate and responsive to the situation at hand" [9].

In any design linked process, the cost of implementing certain biophilic strategies could literally be nothing, if they are integrated from the onset and not as an after-thought.

### *2.3. Biophilic design considerations*

Every site is unique in its own way; this provides both a challenge and a chance for ingenuity when applying biophilic design patterns. There are some significant considerations that would be discussed further, which help to guide, and impact decision making in the process of design. However, biophilic design does not inform a designer or developer on what to do, rather what is imperative [10].

*2.3.1. Weather, ecosystem, locality.* Architecture unique to its surrounding environment, with structures and created landscapes that are attached to their place of inhabitation. [11]. Over time, people have built places of abode from locally available materials that reflected the genius loci of its immediate environment; form and use were dictated by topography and climate. The use of resident wood, environment friendly design and drought forbearing plants to create landscape designs that affiliate with the conditions of the nearby landscape is an effective biophilic strategy.

*2.3.2. Disposition and size.* In rural environments, there is ample contact between people and nature, and this consistent exposure to the natural environment has curative qualities that might be taken lightly. In contrast, urban environments have limited land which comes at a premium; hence it might be impractical to imitate features apt to rural environment in terms of scale or profusion. As such, depending on the climate, zone, availability of land, possession, and topography biophilic design strategies would differ.

### *2.4. Biophilic design and sustainability*

After realising the opposing effects, the modern built environment had levied. The green design strategy was instigated to mitigate these effects but were found to be largely insufficient.

The Brundtland Commission (1987) came up with the definition of sustainability as meeting the needs of the present without compromising the capacity of imminent generations to meet their own needs,

but this hinges on the condition that people remain invested with the structure and develop an affinity to the space/structure in question. Everyday there are new innovations on technology with low environmental impact that retain a level of pertinence until a new solution is created, and then people resort to erecting new structures that serve their current needs. Sustainability entails preservation of buildings while retaining functionality as it is about coming up with new low impact efficient designs. This is where biophilic design comes in as it is meant to foster an affection of place.

Sustainable design highlights the effect of buildings on the environment as in the case of biophilic design that considers the social effects of buildings by bringing in elements of nature into a space to enhance wellbeing among people. Hence the idea that biophilic design is said to be an extension of sustainability is not far-fetched because a fundamental change in underlying assumptions of designing the built environment from just a mere consideration of the environmental impact of buildings (sustainability's mantra) to rational thinking and understanding how the built environment affects occupants' wellbeing has been attained [12]. In 2015, Fenner and Elser described biophilic architecture as simply taking into account the human factor in sustainable design [13].

### *2.5. The office ecosystem*

This consists of three major elements: the user, the organization, and the building.

*2.5.1. Designing for the user.* Design alterations are dependent on the needs and wishes of the user. Concepts in design are intended to create a better environment for the users where they can thrive. Recent studies have reiterated the significance of engagement and workplace satisfaction in generating greater output among workers.

*2.5.2. Designing for the organization.* The needs of the organization dictate the type of design decisions made, with organizational dynamics taken into consideration as to the type of work being performed in a space, use of the space, user interactions and management style. Diverse office layouts are generated to meet up with the requirements of definite tasks in different kinds of workplace settings. As is the case with activity-based working, designing for the organization must be in close association with working for the user [14].

*2.5.3. Designing for the building.* With land at a premium, a good building design should make utmost use of available space, reduce maintenance needs and impact the environment positively. A well-designed building can help contribute greatly to employee satisfaction and company culture by helping to develop a sense of attachment resulting in increased engagement.

### *2.6. Productivity*

The factors influencing worker productivity are divided into physical and environmental factors. Of the physical factors, spatial layout, architectural elements, aesthetics and furniture were identified, and of the environmental factors, Lighting, air temperature and quality, and sound were also identified to be factors influencing worker productivity [15]. This study focuses on the influence of the physical factor of spatial layout on worker productivity.

This paper has identified four factors to link to the term productivity. Citing the study carried out by [16], this paper identifies these factors as: Job satisfaction, worker engagement, Motivation to work and career engagement. These factors were then itemized and studied in order to bring better understanding on how they can be measured. While it is acknowledged that spatial arrangement is not the only determining link in the achievement of any of these factors, the relationship between these factors and the physical work environment is what was studied.

## **3. Methodology**

Qualitative and quantitative strategies of inquiry were employed in this study. Data was obtained from users of the selected buildings using structured questionnaires while an observation guide was developed for an independent analysis of the buildings being looked at.

### *3.1. Sampling method*

Two methods of sampling were used for this study, one for the case study and another for the survey. The purposive sampling method of the non-probability method was adopted for the qualitative data that deals with the selection of high-rise office buildings. This method was used in order to assess all categories of high-rise offices relevant to the scope of the study. The selection of respondents for quantitative data was done by stratified sampling because the population in these offices is heterogeneous.

### 3.2. Sampling size

The sample size that was studied is four high-rise office buildings based on researcher's selection. This involved a purposive sampling of eight high-rise office buildings on the availability of the facilities that were required in the study.

**Table 1.** Sampled high-rise office buildings

	Buildings	Location
1	Nestoil towers	Lagos
2	Heritage place	Lagos
3	Kings tower	Lagos
4	Civic centre tower	Lagos
5	Sterling house	Lagos
6	KPMG tower	Lagos
7	UBA house	Lagos
8	Union bank	Lagos

## 4. Findings and Results

A total of 120 questionnaires were administered with 58 respondents obliging to the study. The data was processed and analysed using regression analysis method with the use of statistical package for social science (SPSS) software. Regression analysis is a powerful statistical method that allows you examine the relationship between two or more variables of interest. They also observe the influence of one or more independent variables on a dependent variable.

The independent variables are the biophilic design strategies while the dependent strategies are designated metrics that have been identified to influence workers productivity and have been discussed in the literature review.

**Table 2.** Regression analysis carried out between the job satisfaction data recorded and biophilic design strategies

	Model	Sum of squares	df	Mean square	F	Sig.
	Regression	4.959	15	.331	1.922	.115 <sup>b</sup>
1	Residual	2.408	14	.172		
	Total	7.367	29			

a. Dependent Variable: Job satisfaction recorded

b. Predictors: (Constant), placement allows passive cooling, spatial arrangement takes advantage, presence of natural materials, open views of the plants, exterior plants, daylighting is optimised, open view to the exterior, enough openings that enhance ventilation, living walls, building doesnot get uncomfortable, interior plants, control over the amount of natural light, paintings/pictures of nature , adequate solar shading, materials that mimic nature.

**Table 3.** Coefficients table

Model	Unstandardized coefficients		Standardized coefficients		Sig.
	B	Std. Error	Beta	t	

**Table 4.** Regression analysis carried out between the motivation data recorded and biophilic design strategies

	Model	Sum of squares	df	Mean square	F	Sig.	
1	Regression	1.137	1	1.137	5.681	.021 <sup>a</sup>	
	Residual	11.004	55	.200			
	Total	12.140	56				
	(Constant)		-3.609	2.750		-1.312	.211
	Exterior plants		.053	.210	.048	.255	.802
	Interior Plants		.025	.113	.046	.224	.826
	Open views of the plants		.453	.185	.594	2.448	.028
	Living walls		.314	.196	.290	1.604	.131
	Presence of natural materials		.192	.139	.237	1.379	.190
	Materials that mimic nature		.419	.224	.454	1.865	.083
	Paintings/pictures of nature		.205	.122	.371	1.684	.114
	Optimisation of daylight		.461	.169	.576	2.731	.016
	Control over entry of natural light		-.039	.140	-.061	-.277	.786
	Adequate solar shading		.024	.175	.032	.140	.891
	Thermal comfort		-.048	.106	-.088	-.448	.661
	Functional spatial arrangement		-.002	.147	-.003	-.013	.990
	Open view to the exterior		.106	.183	.140	.578	.572
	Adequate openings		.108	.152	.142	.707	.491
	Passive cooling		.107	.152	.151	.702	.494

The analysis, bearing a significance score of +0.115 shows that the extent of use of the identified biophilic design strategies were not significant to user job satisfaction across the sampled users of the workplace facilities. However individual biophilic patterns like open views to the plants (0.028) and Optimisation of daylight (0.016) had significant values in the productivity measures of users.

This regression analysis investigates the influence of the biophilic design strategies on the factor of motivation. The analysis is termed to be significant ( $F=5.681$ , Sig. change=0.021). This implies that the biophilic design strategies identified had an influence on workers' motivation.

**Table 5.** Regression analysis carried out between the engagement data recorded and biophilic design strategies

	Model	Sum of squares	df	Mean square	F	Sig.
1	Regression	2.782	1	2.782	7.833	.007 <sup>a</sup>
	Residual	19.534	55	.355		
	Total	22.316	56			

This regression analysis investigates the influence of the biophilic design strategies on the factor of engagement. The analysis is termed to be significant ( $F=7.833$ , Sig. change=0.007). This implies that

	Unstandardized coefficients	Standardized coefficients
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the biophilic design strategies identified had an influence on workers' engagement.

**Table 6.**Regression analysis carried out between the work environment data recorded and biophilic design strategies

	Model	Sum of squares	df	Mean square	F	Sig.
1	Regression	4.546	15	.303	.580	.847 <sup>b</sup>
	Residual	7.321	14	.523		
	Total	11.867	29			

a. Dependent Variable: workenvironmentrecorded

b. Predictors: (Constant), placement allows passive cooling, spatial arrangement takes advantage, presence of natural materials, open views of the plants, exterior plants, daylighting is optimised, open view to the exterior, enough openings that enhance ventilation, living walls, building doesnot get uncomfortable, interior plants, control over the amount of natural light, paintings/pictures of nature , adequate solar shading, materials that mimic nature.

**Table 7.** Coefficients table

Model	B	Std. Error	Beta	<i>t</i>	Sig.
(Constant)	4.189	4.795		.874	.397
Exterior plants	.059	.366	.041	.161	.874
Interior Plants	.269	.197	.388	1.362	.195
Open views of the plants	-.141	.323	-.146	-.438	.668
Living walls	.575	.341	.419	1.685	.014
Presence of natural materials	-.180	.243	-.175	-.741	.471
Materials that mimic nature	-.189	.391	-.161	-.482	.637
Paintings/pictures of nature	-.085	.212	-.122	-.402	.694
Optimisation of daylight	-.037	.294	-.037	-.127	.901
Control over entry of natural light	.290	.244	.355	1.185	.256
Adequate solar shading	-.149	.305	-.156	-.489	.632
Thermal comfort	-.140	.185	-.203	-.753	.464
Functional spatial arrangement	.092	.257	.103	.359	.725
Open view to the exterior	-.113	.319	-.118	-.353	.729
Adequate openings	-.121	.265	-.125	-.455	.656
Passive cooling	-.140	.265	-.156	-.529	.605

The analysis, bearing a significance score of +0.847 shows that the extent of use of the identified biophilic design strategies were not significant to user work environment across the sampled users of the workplace facilities. However, the living walls variable had a significant value in the productivity measures of users (0.014).

**Table 8.** Total productivity

	Model	Sum of squares	df	Mean square	F	Sig.
1	Regression	3.001	15	.200	1.648	.178 <sup>a</sup>
	Residual	1.699	14	.121		
	Total	4.700	29			

a. Dependent Variable: productivity recorded

b. Predictors: (Constant), placement allows passive cooling, spatial arrangement takes advantage, presence of natural materials, open views of the plants, exterior plants, daylighting is optimised, open view to the exterior, enough openings that enhance ventilation, living walls, building doesnot get uncomfortable, interior plants, control over the amount of natural light, paintings/pictures of nature , adequate solar shading, materials that mimic nature.

**Table 9.** Coefficients table

Model	Unstandardized coefficients		Standardized coefficients		
	B	Std. Error	Beta	<i>t</i>	Sig.
(Constant)	.781	2.310		.338	.740
Exterior plants	-.020	.176	-0.22	-.112	.912



Interior Plants	.035	.095	.080	.369	.718
Open views of the plants	.306	.155	.502	1.967	.049
Living walls	-.067	.164	-.077	-.406	.691
Presence of natural materials	.062	.117	.096	.529	.605
Materials that mimic nature	.247	.189	.335	1.308	.212
Paintings/pictures of nature	.081	.102	.183	.789	.443
Optimisation of daylight	.045	.142	.071	.318	.755
Control over entry of natural light	.172	.118	.335	1.461	.166
Adequate solar shading	.042	.147	.070	.285	.780
Thermal comfort	.208	.089	.482	2.331	.035
Functional spatial arrangement	.066	.124	.117	.535	.601
Open view to the exterior	-.228	.154	-.378	-1.482	.161
Adequate openings	.152	.128	.251	1.190	.254
Passive cooling	-.233	.128	-.412	-1.824	.090

A significance value of +0.178 reveals that the selected biophilic patterns alone are not directly responsible for increased productivity in coworking users. However, open views of plants had a significant value in the productivity measures of users (0.049).

## 5. Conclusion and recommendations

From the results it can be implied that biophilic design strategies had a significant level of influence on the productivity of workers, but it could also be said that the strategies implemented were insufficient. Studies conducted on the buildings reveal that the biophilic strategies occur as a single experience of nature rather than an integration of various approaches that would yield the desired effect. The successful implementation of biophilic design strategies hinges on the incorporation of the sum of its parts to form a whole concept. It is also recommended that biophilic design strategies are integrated into buildings from the onset and not as an afterthought, this helps to cut costs on the long run and ensure the efficiency of these strategies.

Biophilic design is a concept that is well-known and practiced in developed countries and has been accompanied with much praise as a result of its significant influence on well-being & productivity. Lagos is at the centre of a vast developing economy and would benefit highly from the application of biophilic design.

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