

## The Usage of Green in Office Buildings: An Appraisal of Some Office Spaces in University Of Joss

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**Abstract:** Activities of the construction industry in Nigeria have plagued the country with so many problems that have affected the natural environment adversely. The concept of green building seems to be poorly embraced in a developing country like Nigeria where buildings are poorly designed, blatantly neglecting the long term effects of such buildings on the natural environment and the health of its inhabitants. Buildings play a major role in the degradation of the environment from construction stages to the usage (life-cycle) of the building. The environmental impact caused by buildings accounts for 18% of global emissions today or an annual equivalent of 9 billion tonnes of carbon dioxide. The usage of energy in offices alone accounts for more than 20%, even up to 70% in some cases. Fisher's z-transformation was used to determine the correlation between green features in the workplace and health perceptions of the occupants. Majority of the participants in this study revealed their perception that green features in the work place enhances their productivity and that they also provide a form of therapy to the mind and body. The research rejected the null hypothesis which states that there is no linear correlation between the variables. This study proposes a framework for the usage of green in offices in order to curb the level of degradation to the natural environment, improve workers' health and productivity, and increase energy efficiency.

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### I. Introduction

Despite the huge environmental and energy problem in Nigeria, designers have not seen the need for a shift from their traditional method of designing buildings<sup>18</sup>. The fact that employees are the biggest expense in an office operation has compelled organizations to improve health, well-being, and productivity via optimization of workplace environments: daylighting, natural ventilation, natural view, open space, places of respite, and other comforts<sup>7,8,9,19</sup>. The common objective of green buildings is to reduce the overall impact of the built environment on human health and the natural environment. Going green is a global initiative. Green Buildings are buildings with increased efficiency in the use of energy, water, materials while reducing the impact of construction or operational activities on human health and the environment through better siting, design, construction, operation, maintenance, renovation and demolition<sup>5</sup>. These green features are well articulated: the mission to maximize health, well-being, and productivity outcomes is compatible with or even enhanced by strategies to minimize energy and resource uses<sup>6</sup>.

#### 1.1 Aims and Objectives

The aim of this study is to establish measures to be adopted in existing and new buildings in the Department of Architecture, University of Jos and to reduce the overall impact of the built environment on human health and the built environment by:

- Efficiently using energy, water and other resources
- Protecting occupants' health and improving employees' productivity
- Reducing waste, pollution and environmental degradation

#### 1.2 Energy Efficiency

Energy efficiency is the goal to reduce the amount of energy required to provide products and services. For example, insulating a home allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Installing fluorescent lights, LED lights or natural skylights reduces the amount of energy required to attain the same level of illumination compared with using traditional incandescent light bulbs<sup>13</sup>. Most of the energy we generate in Nigeria comes from the burning of fossil fuel (oil and gas). For every kilowatt of electricity we consume, there is an equivalent emission of greenhouse gases (GHGs). Energy efficiency can help to reduce the emission of GHGs and reduce the reliance on petroleum to drive our economy. The negative environmental impacts associated with the generation of energy will also be reduced if energy is

used efficiently<sup>12</sup>. According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases<sup>11</sup>.

### **1.3 Water Efficiency**

Water efficiency is reducing water wastage by measuring the amount of water required for a particular purpose and the amount of water used or delivered. Water efficiency differs from water conservation in that it focuses on reducing waste, not restricting use. Reducing water consumption and protecting water quality are key objectives in sustainable building<sup>4</sup>. Solutions for water efficiency focus not only on reducing the amount of potable water used, but also on reducing the use of non-potable water where appropriate (i.e. flushing toilet, watering landscape, etc). Examples of water efficient steps includes fixing leaking taps/pipes, taking showers rather than baths, installing displacement devices inside toilet cisterns, and using dishwashers and washing machines with full loads. These are things that fall under the definition of water efficiency, as their purpose is to obtain the desired result or level of service with the least necessary water.

### **1.4 Waste Reduction**

Waste reduction is the practice of using less material and energy to minimize waste generation and preserve natural resources. Green architecture also seeks to reduce waste of energy, water and materials used during construction. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins<sup>8</sup>. Waste can be reduced by individuals, businesses, institutions such as hospitals or educational facilities, organizations or government agencies. There are several ways individuals can practice waste reduction:

- Reusing products – this could mean reusing file folders rather than throwing them away after one use, refilling water bottles
- Using products more efficiently – this could mean using both sides of paper in printing/photocopying.
- Purchase remanufactured or rebuilt products, or products that can be refurbished.
- Purchase products that use non-hazardous materials. Nonhazardous materials are safer for individuals and landfills.
- Purchase more durable products. Higher quality products typically have a longer life cycle, etc.

## **II. Materials and Method**

### **Literature Review**

The construction of green buildings alone does not guarantee energy-efficient performance because the management of facilities and equipment plays a major role in achieving energy efficiency. Among green building strategies, natural ventilation is usually prioritized as an effective strategy for reducing energy cost and enhancing indoor environmental quality<sup>5</sup>. In addition to fresh air and indoor environmental quality, windows can bring sunlight and views of nature, generating greater work satisfaction and release work-related stress<sup>6</sup>. Lottrup *et al.* found that the employees' physical and visual access to workplace greenery was associated with a positive workplace attitude and decreased level of stress<sup>5</sup>. Leather *et al.* also identified that windows in a workplace brought a view of trees, flowers, and other natural elements, which mitigated the negative impact of job stress on staff turnover rate and promoted effects on general well-being<sup>2,5,17</sup>. Such green practices play important roles in greatly minimizing the amount of energy needed to provide services.

Another study found that architectural and environmental design features and strategies in institutional environments could alleviate stress and promote restoration<sup>6,14</sup>.

Energy efficiency has become the key driver of sustainable development in many economies in the world. there are two important ways we can approach the efficient use of energy. The first one is the technological approach while the second is the behavioral approach. The technological approach entails the need to change the type of technology being used to a more efficient one. A good example of this is replacing incandescent bulbs with energy efficiency bulbs. The behavioral approach entails changing the ways we do things. An example is switching off appliances when not in use. Energy-management strategies have been identified from the literature and tested against current practice. These strategies are tested using case studies to examine the extent to which facilities' management implement energy-efficient measures<sup>7,16</sup>.

The construction industry is guilty of many practices because its activities have adversely affected the environment negatively. It responded with new initiative called Eco / green / sustainable buildings to ensure environmental sustainability<sup>5</sup>.



Figure 1: Typical office settings in the Department of Architecture, University of Jos showing natural ventilation

### Data Collection

Five cases were investigated in the cross sectional questionnaire survey located in the Main Campus and Permanent Site of the University of Jos. The details of the buildings are presented in Table 1

Table 1: General building information of some selected departments in Main Camp and Permanent Site, University of Jos

S/N	Location	Building Certificate	Building Morphology	Mode of Ventilation	Door Sizes	Window Sizes	Office Sizes
1	Main Campus Faculty of Engineering	Nil	Individual building	Mixed ventilation	2.1 x 0.9m	1.2 x 1.2m	4m x 3m
2	Permanent Site (New Arc Dept.)	Nil	Individual building	Mixed ventilation	2.1 x 0.9m	1.8 x 1.2m	6m x 3m
3	Main Campus (MathsDept)	Nil	Building Cluster	Natural	2.1 x 0.9m	1.2 x 1.2m	4m x 3m
4	Main Campus (Pharmacy)	Nil	Individual	Mixed ventilation	2.1 x 0.9m	1.2 x 1.2m	4m x 3m
5	Perm. Site (Geo Planning)	Nil	Individual	Mixed ventilation	2.1 x 0.9m	1.8 x 1.2 m	6m x 3m

The criteria of selection of participants were limited to those occupants who worked daily for eight hours or above and had been in the same workplace for more than a year. 30 participants were selected from each of the departmental buildings listed in Table 1. Out of a total of 150 participants, 61% are between 30 and 50 years old and 88.66% had graduate or postgraduate education. 91.33% reported a healthy status, 4.67% were neutral while 4% reported an unhealthy status.

**Table 2: Building Composition**

S/N	Location	Building Morphology	Design	Floors	Roofing	Ceiling Type	Materials
1	Main Camp Faculty of Engineering	Individual building	Offices, studio, classrooms	1	Steel Trusses	Ceiling boards	Cement/sand concrete blocks
2	Permanent Site (New Arc Dept.)	Individual building	Groundfloor: Studio/Offices 1 <sup>st</sup> Floor: Offices partitioned with polished plywood	3	Long span aluminum roofing sheets guage of 0.55mm silver plated	Ceiling boards	Cement/sand concrete blocks
3	Permanent Site	Building Cluster	Offices, classrooms	1	Steel trusses	PVC	Cement/sand

	(MathsDept)					Ceilings	concrete blocks PVC Ceilings
4	Main Camp (Pharmacy)	Individual	Groundfloor: Offices/Laboratories 1 <sup>st</sup> Floor: Classrooms	2	Steel trusses/Long span aluminum	Ceiling boards	Cement/sand concrete blocks
5	Perm. Site (Geo Planning)	Individual	Offices, studio, classrooms	1	Steel trusses	Ceiling boards	Cement/sand concrete blocks



Figure 2: An array of offices, Permanent Site University of Jos



Figure 3: Faculty of Environmental Sciences showing the natural environment

Figure 3: Faculty of Environmental Sciences showing the natural environment

Table 3: Demographic information of Participants (n=150)

Demographic information	Number	Percentage (%)
Location		
Main Campus	63	42%
Permanent Site	87	58%
Gender		
Male	94	62.67%
Female	56	37.33%
Age		
29 years and below	23	15.34%
30 – 50 years	91	60.66%
51 and above	36	24%
Health Status		
Healthy	137	91.33%
Unhealthy	6	4%
Neutral	7	4.67%
Education Level		
Secondary	17	11.33%
Graduate	76	50.66%
Postgraduate	57	38%

A 5-point Likert scale Questionnaire format (Strongly Agree =5, Agree=4, Neutral/Undecided=3, Disagree=2, strongly Disagree=1) was used to obtain the various perceptions of the participants. Frequency and percentage count tables, Mean item score and Fisher’s z-transformation statistics were used for data analysis.

This research measures health perceptions using three categories: personal sensation, sensorial assumptions, and healing performance (Table 4). Personal sensation represents the physical and psychological well-being relevant to the status of overall health<sup>5</sup>. Secondly, sensorial assumption indicates the appreciation of human perception in the built environment of everyday life. It queries the perceived healing perceptions of sensorial stimulations, including the visual connection with nature, landscape aesthetics design, auditory design, olfactory design<sup>6</sup>, and thermal comfort design. Thirdly, healing performance reflects the quality of spatial merits and requirements from occupants. The function of meditation and relaxation in the healing environment were included to define the therapeutic environment<sup>18</sup>. Therefore, healing space could be integrated into the daily workplace, which helps distract occupants from negative sentiments and pressures, and fosters mind restoration and emotional well-being<sup>7</sup>. The survey used a 5-point Likert scale, where 1 was “no concern” and 5 was “strong concern”. “Concern” means something that aroused their attentions and should be improved. So, the higher concern, the more negative the perception<sup>5</sup>.

Table 4: Structure of questionnaire of health perceptions for office workers in the University of Jos

Category	Questions	Measurement
Personal Sensation	Physical feeling	1 No concern to 5 Strong concern
	Psychological perception	1 No concern to 5 Strong concern
Sensorial Assumptions	Visual Connection	1 No concern to 5 Strong concern
	Aesthetics	1 No concern to 5 Strong concern
	Olfactory perception	1 No concern to 5 Strong concern
	Auditory perception	1 No concern to 5 Strong concern
Healing Performance	Thermal comfort	1 No concern to 5 Strong concern
	Meditation and relaxation	1 No concern to 5 Strong concern
	Healing efficacy	1 No concern to 5 Strong concern

### III. Results

Fisher’s z-transformation was used to identify the correlation between health perceptions and green features. The p value was set at the 0.05 level to indicate statistical significance. The quantitative data was processed and analyzed using IBM SPSS Statistics Version 23.0.

In this study, the correlation between health perceptions and green features out of a sample population of n=150 and the sample correlation coefficient as -0.9786. Using 0.05 level of significance, the researcher tested the null hypothesis which states that there is no linear correlation between the variables.

$$H_0: \rho = 0; H_1: \rho \neq 0$$

$\alpha = 0.05$

$N = 150$

$r = 0.8$

Fisher's Z – statistic =  $[Z - \mu_z]/\sigma_z = [1/2\ln(1+r)/(1-r) - 1/2\ln(1+p/1-p)]/(N-3/30)^2$   
 $= (150 - 30)/3\ln(1+(-0.9786)/1-(-0.9786)) = -6.67$

$Z < Z_{0.025} (= -2.06)$  The null hypothesis is therefore rejected.

Based on the data analysis, it is observed that there is a correlation between health perceptions and green features. This study is in conformity with the findings of Feiet *al.*, 2016 who reported that for the commercial company and research institution, the perceived health evaluation of the occupants might be analogous to each other as far as the computer-based workplace is concerned. Previous researches in this field have interpreted the benefits of building and nature integration and the interrelations between indoor and outdoor domains; however, some indecisive issues of the current work place studies required further exploration<sup>5,18,19</sup>.

Majority of the participants in this study revealed their perception that green features in the work place enhances their productivity and that they also provide a form of therapy to the mind and body. As such, this study recommends that the University of Jos, and other institutions – not necessarily academia – embrace the concept of green buildings. This does not only improve the productivity and health of occupants but also saves energy on the other hand thereby sustaining the natural environment.

#### IV. Discussion

Embracing green or sustainable concept in design is aimed at reducing energy, operation and maintenance cost, reduce building related illnesses, increase the productivity and comfort of building occupants, reduce waste and pollution and increase building and component durability and flexibility<sup>20</sup>. It is important that the focus of green concept be embraced from the early stages of building, planning and construction<sup>22</sup>.

Minimum Energy Performance Standards (MEPS) Minimum Energy Performance Standards (MEPS) is also referred to as “standards” or “efficiency standards” in some countries. MEPS are specified minimum energy efficiency levels products must meet before they can be legally sold in any country<sup>11</sup>. Here, specific energy standards are set before products are allowed into a country and sold. For example, a country may decide to set a standard that refrigerators consuming more than 400kwh will not be allowed into the country. MEPS are mandatory standards and are done in a manner that they balance technical possibility with economic viability and the competitive force within a particular market. The practice of retrofitting homes and public buildings is now practiced in many parts of the world to reduce energy consumption<sup>20</sup>. Owing to the fact that many homes and public buildings have been built a long time ago and are equipped with all kinds of inefficient appliances, it is now a common thing for owners of home and government to replace this old equipment with newer and more efficient ones. In other parts of the world, these are many ways individuals are improving the energy efficiency in home.

The study validates that the associations of the green features in the corresponding urbanscape could significantly impact perceived health evaluations in workplace settings<sup>5,6</sup>. Remarkably, the criteria of ventilation mode could significantly affect the occupant's concern of personal sensation, sensorial assumption, and healing performance<sup>5</sup>. The mixed-mode ventilation system is recommended for the workplace, rather than the air-conditioning ventilation system as it provides a better perception and also reduces energy consumption as appliances such as air conditioners are rarely used. Most importantly, the perception of natural ventilation has endowed people the circadian rhythm from outdoor space through the sound of birds and the wind, and the changes of weather and time<sup>6,13</sup>. Furthermore, the enhanced landscape and greenery regulations in the green buildings could significantly alleviate the negative perception of microclimate conditions in the environmental perception, more so than the non-green building<sup>10,14</sup>.

#### V. Conclusion

In conclusion, this study proposes a framework for the construction of green buildings to preserve the natural environment, improve employees' productivity and health. Majority of participants in this study perceived green buildings improve the wellbeing of occupants. They felt that the natural environment had a therapeutic effect on the amount of stress encountered in the workplace.

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