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Impacts of Natural Light on Building Occupants in Yola Metropolitan

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Abstract

The study titled impacts of natural-light on building occupants in Yola metropolitan has summarized findings and benefits that different wavelengths of natural light have on building occupants in Adamawa sunshine state, Nigeria. Centuries back in Nigeria, natural-light was the primary light source in buildings; artificial-lights supplemented the natural-light in recent times. Recently, energy and environmental concerns have made natural-lighting a rediscovered aspect of building lighting design. The physics of natural-lighting has not changed since its original use, but the building design to use natural-light has been changing with time. Natural-lighting is often integrated into building as an Architectural statement and for energy savings. However, benefits from natural-lighting extend beyond Architecture and energy. Thus; the psychological and physiological aspects of natural-light should also be considered. The comforting space and connection to the environment provided to building occupants provide benefits as significant as the energy savings to building owners, building managers, building professionals, and building occupants as instances. The main objective of the study is to determine the impacts of natural-light on building occupants in Yola, Nigeria. Ten specific objectives were used for the study which include: 1. the effects of natural light on building occupants in the offices in Yola. 2. The effects of natural light on building occupants in the schools in Yola. 3. The effects of natural light on building occupants in the retails in Yola among others. Ten research question were postulated to aid the study. Few among them include: 1. What are the effects of natural lights on residential building occupants in Yola? 2. What are the effects of natural light on building occupants in the offices in Yola? 3. What are the effects of natural light on building occupants in the schools in Yola? 4. What are the effects of natural light on building occupants in the retails in Yola? Being examples. Null hypotheses were formulated and tested at 0.05 level of significance, e.g. Ho_1. There is no significant difference in the mean responses of male and female on the effects of natural light on building occupants in the offices in Yola. Random sampling was used for population of one hundred and twenty-six respondents; data was obtained using questionnaire. Mean, standard deviation, and t-test was used to analyse the data with the aid of Statistical Package and Service Solution (SPSS). Based on the findings of the study, natural-lighting has been associated with industrial higher productivity, lower absenteeism, less defects in products, positive attitudes, reduced fatigue, and reduced eyestrain among others. In line with the study findings, conclusion and recommendations were made.

Keywords: *Impacts, Natural, Light, Building, Occupants*

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Background of the Study

This paper presents summary information on effects of natural lighting in buildings on building occupants. Natural light produces heat and colour. These heat and colour come from the radiation given off by the sun (natural-light source). Natural-light impacts are categorized into: Wavelengths, The effects on the body, and on building sections. Building is the techniques and industry involved in the erection of structures, primarily used to provide shelter for man, his properties, and activities NBTE, (2011). Building sections include: Offices buildings, schools' buildings, retail buildings, health care buildings, industry buildings as the case may be.

The sections wavelengths of Lights and the effects of Light on the body help to describe the impact that the natural-light has on building occupants. Each building section has different effect of natural-light on the building section occupant's psychological and physiological phenomenon Kupula, (2013). Information on the use of Natural-lighting in buildings, its effects on occupants, and its potential economic benefits have been compiled in books, periodicals, Internet articles, and even via oral interviews of citizens Habila, (2014).

Literature Review

Before the 1940s, daylight was the primary light source in buildings; artificial lights supplemented the natural light. In the short span of 20 years, electric lighting had transformed the workplace by meeting most or all of the building occupants' lighting requirements. Recently, energy and environmental concerns have made natural lighting a rediscovered aspect of building lighting design (Abdu, 2017). Building refers to a structure that is erected to serve as shelter for mankind, their properties and activities which must be properly planned, designed and erected to provide desired satisfaction from the environment. The factors to be observed include: durability, stability, and adequacy of materials used with the aim of preventing quick dilapidation, failure, and discomfort to the occupants of the building. Other factors are resistance to bad weather conditions, fire outbreak, and other forms of accidents that are associated to building. The styles of building erection are changing with the introduction of new materials and techniques in the design and erection stages of the building due to advancement in science and technology. All these are aimed to meet building occupant's desire for: quality standards, aesthetics, and to reduce the impacts of other forms of disasters such as the effects of natural light on occupants **(**Shittu, 2016). Electrical light sources include cool white fluorescent, incandescent, energy-efficient fluorescent, and full-spectrum fluorescent lighting. Each type has a different level of energy consumption. However, the most important factor affecting building occupants is the different spectrums of light that each source produces. Different wavelengths or spectral distributions of light have different effects on the human body. Most electrical light sources lack the spectral distribution needed for complete biological functions, although full-spectrum fluorescent lighting does come close to that of natural light (Tener, 2016).

Humans are affected both psychologically and physiologically by the different spectrums provided by the various types of light. These effects are the less quantifiable and easily overlooked benefits of natural lighting (Sulieman, 2011). Natural lighting has been associated with improved mood, enhanced morale, lower fatigue, and reduced eyestrain. One of the

important psychological aspects from natural lighting is meeting a need for contact with the outside living environment (Collins, 2015). Studies by researchers in Nigeria and indeed the rest of the world have shown that students in naturally-lighted classrooms achieve higher test scores than students in windowless or artificially-lighted classrooms (Mamtal, 2013). Along with better test scores, student health also improves from the increase in vitamin D intake from natural-light (sunlight) as opined by (Zakari, 2015). Likewise, Ott, (2017) evaluated the effects of light on health by evaluating prison inmates with different window views. He found that inmates with windows facing a meadow or mountains had significantly lower rates of stress-related sick calls than inmates with a view of the prison courtyard and buildings. Furthermore, inmates on the second floor had lower rates of stress-related sick calls compared with inmates on the first floor. Reasons for the differences in sick calls included a more expansive view from the second floor, which provided increased positive psychological benefits. Inmates on the first floor had added stress from lack of privacy because of visibility to passersby.

Materials and Methods

The methods and materials used for the study among others include: Questionnaire, Oral interviews, physical observations, laboratory experiment using full-spectrum bright lights, prison inmate, natural and artificial-lights, office workers, students, commercial buildings, and patients. The area of the study will be Adamawa sun shine state. The state is located in North-East Nigeria with her capital city at Yola. Adamawa state is located on latitude 9° 20' N and longitude 12° 30' E with a population of 3,106, 585, and a land area of about 36,917 sq. km (Federal Republic of Nigeria, 2006 Census). The state experiences bright sunshine almost throughout the year while the temperature changes within the ranges of 36°c to 45°c maximum and occasionally 25°c 30°c minimum during rainy season. The map of the area of the study and the twenty-one local government areas therein is shown below:



Figure 1.

The population of the study was one hundred and twenty-six respondents, six respondents were randomly selected from the twenty-one local government areas in the state, the respondents comprised three male and three female in each of the local government headquarters secretariat. Questionnaire was used to collect the data for the study. Mean, and standard deviation was used for the data analysis, while t-test was used to test the hypotheses.

Results/Findings

1. Natural-light provides better lighting environment than cool white or energy-efficient fluorescent electrical light sources because natural-light closely matches the visual response that, through evolution, Mankind have come to compare with all other light.
2. The majority of Mankind prefer natural-light environment because sunlight consists of a balanced spectrum of colour, with its energy peaking slightly in the blue-green area of the visible spectrum.
3. Natural-light has the highest levels of light needed for biological functions.
4. Photo biological action spectra is of greatest importance to Mankind, ranges from 290 to 770 nanometers. Skin reddening and vitamin D synthesis occurs in the range of 290 to 315 nanometers.
5. Vision is the most sensitive to light in the 500 to 650 nanometer range (yellow-green light). Billirubin degradation occurs in response to light in the 400 to 500 nanometer range (blue light).
6. Mankind is affected both psychologically and physiologically by the different spectrums provided by the various types of light. These effects are the less quantifiable and easily overlooked benefits of natural-lighting.
7. Natural-light has been associated with: Improved mood, Enhanced morale, Lower fatigue, and reduced eyestrain.
8. Natural-light stimulates essential biological functions in the brain and is divided into colors that are vital to mankind health.
9. On cloudy day, or under poor lighting conditions, the inability to perceive the colors from light can affect mankind mood and energy level.
10. Light in building, be it natural or artificial, plays a vital role in maintaining mankind health.
11. Light reaching the retina of the eye is converted into electrical signals that are transmitted by the optic nerve.
12. Most of these signals end up in the visual cortex of the brain and produce mankind sense of vision.
13. Some nerve fibers split off from optic nerve after leaving the eye and send signals to the suprachiasmatic nucleus, which is the area of the brain where the main clock for the mankind body resides. Specific benefits in these types of office environments include: better health, reduced absenteeism, increased productivity, among other things.
14. Full-spectrum bright lights building allow day and night workers in industries to adjust their internal clocks or circadian cycles to match their work cycles, improvements in productivity, decrease in accidents, increase in the level of mental performance, improvements in sleep quality, and an increase in morale among night shift workers in building industries have also been attributed to better lighting.

15. Proper use of natural-lighting decreases the occurrence of headaches, sadness, and eyestrain buildings. Stress reduction and attentional focus can be increased by the presence of natural vegetation in the building workspace or through windows of buildings.
16. Reduction in utility costs for school buildings, improvement of students' attendance and academic performance, and less stressful environment for students.
17. Increase in student and teacher attendance, increase in achievement rates, reduction in fatigue factors, improves student health, and enhancement of general development.
18. Natural-lighting eliminates noise and flickering from electric light sources and provides the best quality of light available in classrooms, gymnasiums, and corridors.
19. Students in windowless classrooms are more hostile, hesitant, and maladjusted, less interested in their work and complain more.
20. Retailers use natural-lighting in their stores specifically to enhance their store environment, increase sales, create a more pleasant shopping environment, attract customers, and improve color rendering.
21. Natural-lighting has aesthetic benefits that encourage customers to enter store for shopping.
22. Natural-light in hospitals and primary healthcare centres in communities have reduced the lighting and heating costs as well as improved physiological and psychological states for both patients and staff.
23. Natural-lighting reduces the mental and physical strain of patients, doctors, and nurses.
24. Natural-lighting has been so successful that hospital environments, as part of the patient care program, utilize it.
25. Private healthcare centres also integrate natural-lighting because it provides better light, sense of spirituality, openness, freedom, and intensity that characterize windowless spaces healthcare building facilities.
26. Spatial quality from windows has psychotherapeutic quality by providing pastoral views and natural-light; therefore, an environment becomes more therapeutic with more spatial quality.
27. Windowless factory workers develop health related problems such as headaches, and fatigue, and as a result of that, the workers openly show their negative attitudes towards their work.

Conclusions and Recommendations

First and foremost, since buildings are very paramount in the day in day out life activities of mankind, it is paramount that when designing buildings, be it: Factory, healthcare, residential, commercial, institutional, recreational, and what have you; emphasis should be placed on the construction and maintenance quality costs. So also, due to the fact that real people will occupy these buildings, it is important as well that consideration should be given to people's psychological and physiological well-being. It is so because improved health of building occupants will be of great benefits to employers and building owners because of improved performance. Mankind body uses light as nutrient for metabolic processes similar to water or food. Considering the health-balance, and physiological regulation of mankind body which

are the mankind body's major health keepers; thus, the nervous system and the endocrine system being major control centers of the mankind body are directly stimulated and regulated by light, to an extent far beyond what modern science has been willing to accept. Therefore, with properly installed and maintained lighting systems, natural-light has proved to be more beneficial for the health, productivity, and safety of building occupants. Natural-light helps maintain good health and can cure some medical ailments as proved by this research and probably other researchers all over the world.

Pleasant environment created by natural-light decreases stress levels for office workers. Industrial productivity increases with the improved health of workers, and with better productivity comes financial benefits for employers. Students also perform better academically in classrooms with natural-light.

Natural-lighting also benefits retail stores because of more even light that provides better color rendering. Customers stay in stores longer and employees can identify items faster with better natural-lighting. In health care facilities, natural-light improves patient recovery rates and allows for proper vision for the elderly in assisted living facilities. Hospital staff also benefit from the natural-light because of the amiable environment. Patients will be more at ease when staff is in a better mood, and the staff will be calmer when patients have improved recovery. Productivity increases in industrial environments because of improved color rendering and the better quality of light provided by natural light. Also, safety is increased with better lighting conditions. Thus; the use of natural-lighting decreases utility costs and improves the well-being of building occupants. The effects of natural-light on building occupants should be an important consideration for building design because studies have shown the strong influence light has on people in many different environments. In short summary, natural-lighting can provide satisfaction for both building occupants and owners than an artificial-light.

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