INTEGRATING NATURAL LIGHTING DESIGN APPROACH TO LIBRARY OF PUBLIC UNIVERSITIES IN NORTH CENTRAL NIGERIA

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Library is perceived as the power house of any higher educational establishment. Achieving increase in quality of services provided by the library becomes difficult due to inadequacy in power supply in Nigeria in recent times. The use of natural day lighting by designers to reduce power consumption is investigated in this study as a sustainable approach for energy optimisation. Therefore, the aim of the study is to examine the integration of natural lighting in the design of public universities library with a view to contribute to factors for an energy efficient building. For this purpose, using descriptive-analytic method and library research tool, the effectiveness of natural lighting in a library spaces within north central are investigated, analysis of data through a well-structured observation schedule was used and analysed using tables, percentages and charts. And in the end, a set of strategies for architectural design of natural lighting integration in a library will be presented, by taking the advantage of fundamental concept of passive design approach .It will also reveal that roof light which is one of the most effective means of lighting integration has least application. The paper will conclude that to achieve an optimised day lighting design in library there is need to consider the well-being of building occupant by detail understanding of importance of day lighting.

Keywords: energy, library, natural lighting, optimisation, sustainable.

INTRODUCTION

Lighting is very necessary in our lives. Before the 1940s, daylight was the main light source in buildings; artificial lights become additional to the natural light. In a short span of 20 years, electric lighting had transformed the workplace by meeting most or all of the occupants' lighting requirements. Edwards & Torcellini,(2002). Recently, energy and environmental concerns have made day 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 it has. Ander, G. (2001).Day lighting is often integrated into a building as an architectural statement and for energy savings. However, benefits from day lighting extend beyond architecture and energy. The psychological and physiological aspects of natural light should also be considered. William (2015) the comforting space and connection to the environment provided to building occupants provides benefits as significant as the energy savings to users.

Natural lighting design has recently taken on a new importance, beyond these aesthetic and psychological aspects, with the advent of energy shortages and sustainability concerns. The alternative to day lighting, the use of electric power for library lighting, contributes to the strain on Nation's electric generation capacity as well as the inefficient use of non-renewable energy resources. Darling et al (2008). Furthermore, the cost of lighting a library has become a major burden to institutions and will continue to increase in the future. Daylight, which is free, provides the opportunity to greatly reduce these negative impacts created by the overdependence on electric lighting sources.

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Overtime Energy requirement for building servicing dominate the building sector on a national scale, although lighting does not account for 5% of national energy consumption. Shola, O. (2013). A clearer explanation is that the focus on passive natural lighting activity has been the residential sector and that of lighting as energy consumer in that sector is quite minimal. As interest in the passive natural lighting extends to the public building sector, lighting becomes a significant building load both directly or indirectly by virtue of its impact on cooling loads because approximately 50% of the building resource energy maybe attributable to lighting. Green Building Tech (HK, 2007),

Day lighting or natural lighting can provide substantial energy and cost saving, reduce building peak loads, increase task contrast and visibility, improve overall lighting quality and positively enhance psychological and physiological status of users. The aim of this paper therefore is to examine design consideration in integrating natural lighting in library of tertiary institutions with a view to contribute to factors for energy efficiency of the building. The scope of this study and all it content is limited to states and federal universities within north central Nigeria. The research is based on findings gathered from observations and study of related literature on natural lighting, which can be summarized as:

1. The types of natural lighting strategy integrated in the design of those buildings as relates to openings and sizes.
2. How natural lighting is optimized.

Principles of Natural Lighting

Light is a form of energy manifesting itself as electromagnetic radiation and is closely related to other forms of electromagnetic radiation such as radio waves, radar, microwaves, infrared and ultraviolet radiation and X-rays. The only difference between the several forms of radiation is in their wavelength. Hafer, F. (2013). "Natural lighting or Day lighting" refers to the use of sunlight, moonlight, skylight, and overcast sky illumination to provide functional interior lighting that is appropriate to specific programmatic areas and comfortable to substantial energy savings. Thermic (1994)

There are challenges of adapting natural lighting design on a building. Firstly, it is the responsibility of designer to consider the design of the building for the day lighting design adapted to every construction process and design stages. Next is an obstacle of daylight to come deep inside of the building section. Obstacle of daylight shading can affect the building where terrain or trees is one of the obstacles for low to mid rise project, while obstruction for large building always comes from other adjacent large building. Heat loss during cold weather from windows and overheat during summer cause from larger opening reducing thermal comfort in the building. Lastly is glare and contrast problem cause by daylight that entering the building.

Kruegle (2007) stated that natural light sources comprise the sun, moon (mirrored stars, and thermal (heat).The sun is the source of energy that lights the outside scene source, it would save cost and electricity used for lighting Görgülü & Ekren, (2013).

Openings that allow daylight in to building interiors are important for the vision and extension they provide with the outdoors. Daylight is very important for its quality. Reviews of person's response to indoor environments recommend that natural lighting is required because it fulfils two basic people's requirements: to be able to look at both a task and the space well. Boyce (1998),

The level and distribution of natural light within a space depends primarily upon the following three factors: The ratio of openings to geometry of the space, the location and orientation of window and other opening and the characteristics of the internal surface are the factors that determine the level and distribution of natural lighting at the building. Rayman.P. (2012) Daylight design prepared enough light suits with activities carried out in the building following the requirement for room space, design and aesthetic of the buildings. Buildings such as Office building usually only needs lighting that lights throughout the floor where the height of the floor to the ceiling not too high and the window opening usually elongated along the wall. While for residential building, it only need light that is sufficient just only for a room even though it only has one window because it only need lighting from one or two directions. Robertson, (2002).Public buildings such as tertiary institution generally requires relatively deep or deep floor plan with a relatively high floor to ceiling height, with windows usually along one wall only. Industrial buildings generally try to provide high levels of Omni-directional light to all parts of spaces that often have large

internal volumes and relatively high ceilings. Residential buildings usually have many relatively small rooms with exposure in only one or two directions. The aim is to provide adequate light levels even if the only window, for instance, faces away from the sun.

According to Ferna,(2012). Natural lighting design is an important issue for sustainable buildings which includes both setting natural and artificial lights as well as meeting energy distribution goals. The availability and the characteristics of the daylight are depending on latitude, climate, weather, time of the year and time of the day. In some climates the daylight can be predictable in other climates very unpredictable.

Library of Public Universities in North Central

North Central Nigeria (also known as the Middle-Belt region) is located with the gps coordinates of 9° 53' 24.8064" N and 8° 52' 44.1372" E. It consists of the seven states situated geographically spanning from the west, around the confluence of the River Niger and the River Benue. These states are: Kogi, Nassarawa, Benue, kwara, plateau states and the federal capital territory Abuja with a population of about 20,306,336 according to 2006 national population census.

It has a wide variety of public universities which are spread across the States; these institutions are both federal and state government owned with academic activities on temporary and permanent sites. Also, it has two of the newly created federal universities located in kogi and nassarawa states. Therefore, north central Nigeria was selected due to the climate and wide variety of public universities which are spread across the States, thereby providing a mix combination of library buildings both on permanent and temporary sites that will be considered in this study.

RESEARCH METHOD

In this study, it is considered to formulate recommendations and considerations for designing naturally light users spaces in a library with passive design approach and tried to incorporate factors influencing the design principles to be evaluation criteria and after analysing the information obtained, we reach the recommendations for the design of energy efficient spaces of library building. According to the study, the methodology requires manner that we can cover all sides of the issues. Therefore, the methodology in this research is descriptive, survey one and the method of gathering information over the description and in the survey sections would be study of related literature and checklist for field, respectively.

A structured observation schedule was developed and administered on respective library buildings selected from five public universities out of a study population of 13 public universities and it was done on the basis of observing and documenting what is obtainable on site while comparing to the laid down requirement according to natural lighting design considerations. The data was collated, sorted out based on the institutions and entered in for analysis purposes while the results are presented in tables and charts. Pictures of some selected design variables presented as plates to explain further the issues within the discussion of results with the view of establishing recommendations of the research.

Table .1.0: Institutions Studied

Name of Institution
University of Abuja
Nassarawa state university,Keffi
University of Illorin
Federal university of Agriculture Makurdi
Benue state University

Source: Authors' fieldwork, 2017

RESULTS AND DISCUSSION

The main question of this study: what are the design variables to be considered appropriately for integrating natural lighting in library for tertiary institutions with architectural passive approach? To answer the main question, it should be known that what are those design variables and their effect in the design of library spaces? And what are principle requirements and considerations established by Passive design approach.

According to Loe (1999), openings can be categorized into four basic types. These include: side windows, clerestory windows, roof light and borrowed light. This provides bases for establishing design variables shown in the table 2.0 below.

Table .2.0: design variables according to observation schedule.

Name of institutions	External window(side window) n	clerestory	High level	Skylight	Roof light	courtyard	Borrowed light opening	Screen wall	Corner windows	Solar shading
University of Abuja	x	o	x	x	x	x	x	x	o	x
Nassarawa state university Keffi	x	x	x	o	o	o	x	x	o	o
University of Ilorin	x	o	o	o	o	o	x	o	o	x
University of agriculture Makurdi	x	o	x	o	o	o	x	o	o	x
Benue state university	x	o	x	o	o	x	x	o	o	x
total	5	1	4	1	1	2	5	2	0	4

Source: Authors' fieldwork, 2017

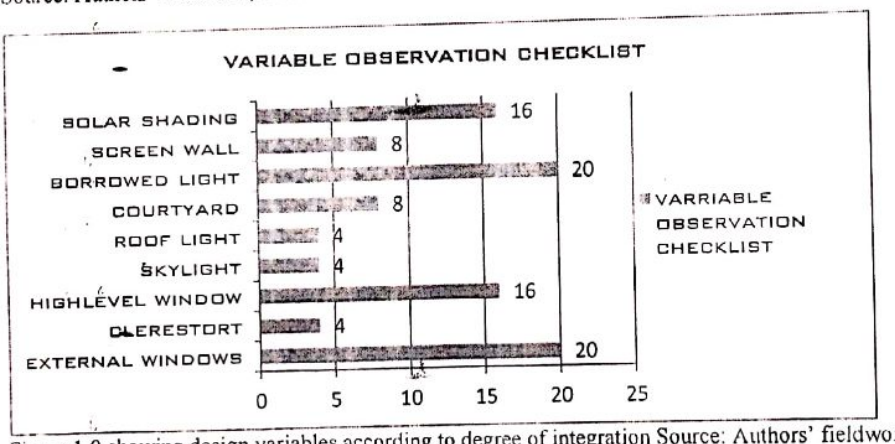

Figure 1.0 showing design variables according to degree of integration Source: Authors' fieldwork, 2017

It can be observed from figure 1.0 that majority of the building studied apply external windows and borrowed light respectively while roof light which is one of The most effective means of lighting integration according to Green building Tech, (HK, 2007), has one of The least application. Solar shading control was also widely adopted this is because natural lighting integration is never complete without appropriate solar control techniques due to changes in sun movement which occurs at different time of the day.

Table .3.0: window openings to sizes.

Name of institutions	900x900(mm)0	1200x1200	1500x1500	1800 and above
University of Abuja	x	x	x	x
Nassarawa state university Keffi	0	0	0	x
University of Ilorin	0	0	x	x
University of agriculture Makurdi	x	0	x	x
Benue state university	0	0	x	x
total	2	1	4	5

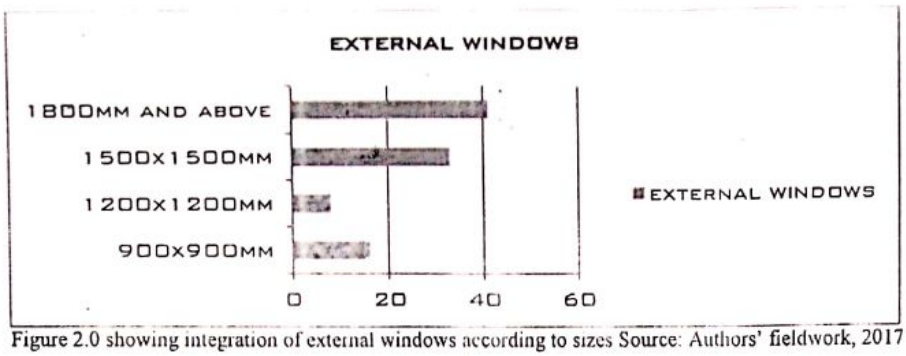

Figure 2.0 showing integration of external windows according to sizes Source: Authors' fieldwork, 2017

From figure 2.0from the chart it is shown that windows sizes of 1800mm and above was widely used for natural lighting and ventilation follow by 1500x1500 mm. Therefore, a geometric size of openings determines the quality of natural lighting distribution. Rayhman (2012)

Design Considerations for Natural Lighting Design in Library

The use of natural light, or day lighting, has traditionally been a desirable building feature and a hallmark of good design. When skilfully introduced, daylight creates an ambience of quiet contemplation and visual comfort, and links the modern library user psychologically with the pre-technological past Dean. E. (2002).Memorable library spaces for centuries have been characterized by volumes and surfaces illuminated with natural light, providing glare-free light in reading Spaces

The light in a library must be adequate for the user to see a particular task, usually reading a book or the text on a computer screen. The efficacy and heat content of daylight require careful control of the daylight aperture size, wherever it is located. The three fundamental design issues in daylight design are:

- Sun control, to mitigate any increase in the cooling load and to control direct glare
- Glare control, to create and maintain comfortable brightness distribution, including no direct views of the bright sky in the normal direction of view.
- Variation control, to avoid any user perception of insufficient local light levels.

Based on Green Building Tech, (HK, 2007), there are two most efficient types of daylight strategies which is lighting from side and lighting from the top. Lighting from the side and from the top are the main categories of the strategies. The system of day lighting will depend on the orientation and the layout and the building surroundings. Lighting from side is a technique that let the sunlight penetrates into a room opening located at the wall perimeter. Lighting from top is a technique that provides daylight from the upper part of the building. It gives an evenly illuminance to the entire interior floor area of a building. . Lighting technique from building top comprises the use of roof monitors, saw tooth roofs and skylights.

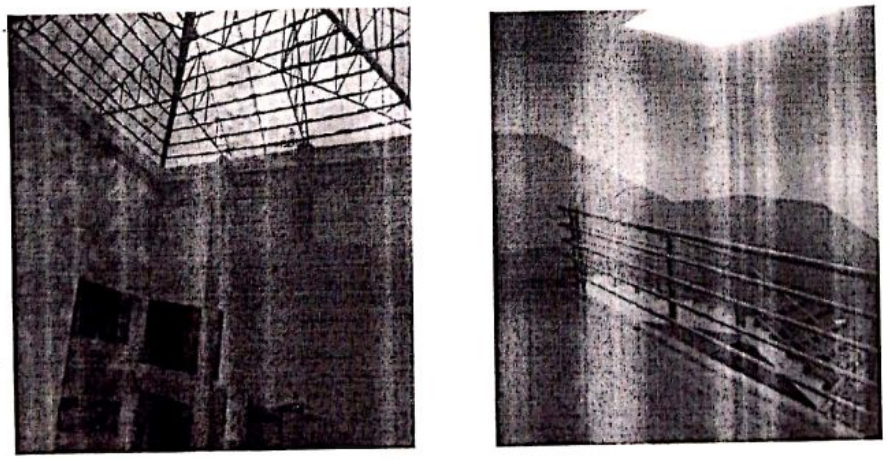

Plate 1.0 interior illumination by skylight and roof light.
Source: Authors' fieldwork, 2017

Skylights can have many forms including dome, pitched and flat panels that are placed in the plane of the building's roof. Horizontal skylights can be an energy complication because they obtain solar heat directly at the noontime. Integration of louver window arrangements can control solar heat gain and glare in skylight. Also, sunlight glazing is placed as near to

the ceiling as possible for bouncing sunlight deep into the room by the ceiling. In this way, higher visible transmission glazing can be used in the sunlight opening.

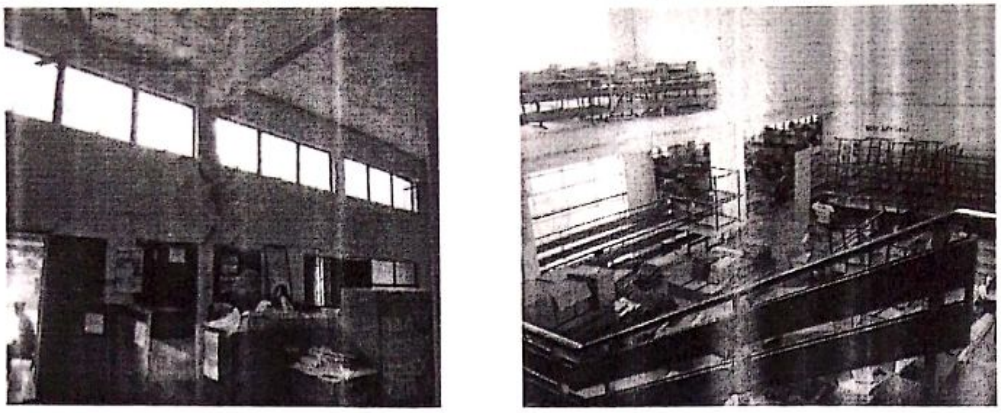

Plate 2.0 fully illuminated interior achieved by the application of side or external windows. Source: Authors' fieldwork, 2017

According to International Energy Agency, (2001), first thing to control is the amount and distribution of daylight entering a space, the window size and position of the façade determine mostly the utilization of daylight. Secondly, the transmission characterization of the glazing determines the transmittance a day lighting system based on window size. It is then being dimensioned. A day lighting system is an adaptation of the window aimed at improving the amount and distribution of daylight in the space.

CONCLUSION

When designing buildings, emphasis is placed on construction and maintenance costs. However, real people will be working in these buildings, so consideration should be given to their psychological and physiological well-being. The improved health of building occupants benefits employers and building owners because of improved performance.

Therefore, in assessing the potential role of natural lighting in energy conserving structures and specifically passive daylight building, two observations can be drawn, from one perspective the potential saving are enormous, and day lighting as a design strategy has the power to act as a major form and design determinant in the building. Not only are the energy saving potentially large, but peak energy requirement may be reduced and lighting quality may be increased. Balancing this optimistic view is a long list of qualifiers and real obstacles which must be overcome before actual savings can be realized. Day lighting design is a complex multidisciplinary design problem. Most architects will do no better in introducing a well daylit interior than an ordinary builder can do. In both cases a grasp of the fundamental is not sufficient to guarantee good design and performance as the current daylight design in Nigeria is low, interest in day lighting is increasing at a rapid rate according to international energy Agency 2001. Therefore, a detail understanding of the important subtleties is necessary to achieve good result particularly in our public or institutional buildings.

REFERENCES

Ander, G. (2001). A Telephone Conversation with Chief Architect of Southern California, Edison.

Boyce, P. (1998). *"Why Daylight?"* Paper presented at the Proceedings of Daylight '98 International Conference on Day lighting Technologies for Energy Efficiency in Buildings, Ottawa, Ontario, Canada.

Darling, J., K. Hoyt. N.Murao, O.K., and Ross.A (2008) the energy Crises of Nigeria an overview and Implication for the future. University of Chicago Publication.

Dean, E. (2002) Energy management strategies in public Libraries. A publication of the California state Library. Los Angeles: Balcony press.

Edwards, L, & Torcellini, Paul A. (2002). A Literature Review of the Effects of Natural Light on Building Occupants a Literature Review of the Effects of Natural Light on Building Occupants.

Ferna, Eduardo. (2012). Computers & Graphics Inverse lighting design for interior buildings integrating natural and artificial sources. *Computers & Graphics, 36*, 1096-1108.

Hafer, F. (2013) Physical Geography Laboratory.5 IEA (2006) International Energy Agency. Light"s Labour"s Lost. IEA Publications, France.