Assessment of Energy Conservation Measures in the Design of Postgraduate Student Hostels in Northern Nigerian Universities

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Abstract:

The environment today is facing challenges as a result of urbanization and has led to the depletion of available resources such as: water, land, air and energy which has in turn changed into an artificial living environment. The rate of energy being consumed in student hostels is daily on the increase with the advancement in technology and student enrolment. The study identified and assessed the designs of postgraduate student hostel buildings, focusing mainly on the energy conservation design measures that were adopted in the designs. The survey adopted a qualitative research method where a scheduled checklist was used to collect data from the selected case studies. Findings from the survey suggests that, mostly owing to trending technologies in design and maintenance, most postgraduate student hostel designs have shaded away from the use of passive design measures and are now focused on achieving aesthetics. The study concludes that passive design measures have not been efficiently utilized in the designs of most postgraduate hostels. As such, the incorporation of energy conservation measures should be made mandatory at design level prior to the approval of any student hostel building plan. This can further reduce the demand for mechanical power which at the moment is inadequate to attain thermal comfort of the occupants.

***Keywords**: Energy, Conservation, Postgraduate, Hostel and Design.*

INTRODUCTION

The core function of a building envelop is to efficiently provide comfort for its occupants in the midst of adverse and variable external environmental conditions. Living in a building that provides an efficient thermal comfort is very important as it ensures occupants' healthy living and enhances the building's performance. According to Adunola, (2011) occupants over time tend to adapt to their living environments however, most of them will prefer to live in an environment that provides comfort rather than enduring in a building that does not. Ismail et al., (2009) stated that a hostel design that ensures occupants' comfort is very important, because a bad thermal condition in a hostel building will affect the productivity and health of the occupants. Yazeed et al., (2018) stated that symptoms such as tiredness, headache and

In recent times, the effect of global warming and climate change has made providing occupants' comfort in a building to become very fundamental and quite challenging. The idea of passive design techniques for energy conservation means that a building will make use of the natural climate in order to sustain a comfortable temperature for its occupants (Hyde, 2000). Passive design tends to maximise the natural means of heating and cooling of the indoor living space for instance, the use of the sun and the cooling breeze (Caitlin, 2013). Passive design can also be series of design measures that seeks to increase the thermal efficiency of the building by giving attention to the utilization of natural ventilation through building orientation, building insulation, window placement and designs (Larsen, 2015). Hyde, Caitlin and Larsen all suggested the use of the natural existing climate as a major factor in achieving a conducive space cooling and heating for occupants of any type of building without the use mechanical

appliances. Therefore, Passive design can also be seen as an effective strategy used in cutting down energy costs as they do not require energy powered devices. Several studies carried out have concluded that, passive design helps to reduce the necessity of a mechanical heating and cooling, which usually accounts for about 40% of the total energy been used in an average building.

The aim of this study therefore is assessing the designs of postgraduate hostel buildings in northern Nigerian universities, focusing mainly on the energy conservation design measures that were adopted in the designs.

STATEMENT OF PROBLEM

The environment today is facing challenges as a result of urbanization and has led to the depletion of available resources such as; water, land, air and energy which has in turn changed into an artificial living environment (Abd'razack, et al., 2012). The energy consumption in student hostel buildings is quite high and is expected to increase as a result of improved technologies and increase in the number of students enrolled into the universities for postgraduate studies. The effect of energy conserved or consumed within the hostel has over time had impacts on the productivity and performance of the students (Abayomi, 2005). Depending on mechanical energy to achieve thermal comfort of students within Nigerian hostel is becoming more expensive and challenging by the day. Therefore, the problems of how to effectively reduce cost in the presence of the rising cost of energy and increasing postgraduate

LITERATURE REVIEW

According to Bhatia, (2002) a hostel building can be described as a building that is used to provide a temporary and inexpensive accommodation to people (mainly students, workers and travellers). Davies et al., (2008) has described a hostel as an institution that can create cheaper lodging and also food services to both travellers and students. It was further defined as a less profit-driven provision of shared rooms, common areas and other facilities to serve as temporal accommodation for students. Hostels are built putting into consideration some formal or institutional features and to also provide a convenient access to the students' recreational facilities (Olanipekun, 2014). For a building to function as a hostel, the building needs to efficiently satisfy other human needs that ensures comfortability in terms of safety, need for territory, convenience, privacy and accessibility. Sekhar and Goh (2011) stated that a living student environment that does not provide thermal comfort can affect the quality of sleep and in turn affects the performance of students during the daytime. Lack of adequate sleep time can easily result to tiredness, headaches and even aggressive behaviours. The long term effects of all these will lead to loose of concentration in class and eventualy poor overall academic performance. The provision of adequate hostel accommodation can serve as a medium by which the quality of education delivered is been enhanced in most academic settings (Nicol, 2004). According to Perkin and Will (2001), the need to create adequate spaces that can allow active communication, convenience, healthy living and chances for socialization are major factors in the design of student housing in any given college or university design. In addition, it was further affirmed that all the outlined parameters need to be put into consideration along with the adequate spatial requirement for furniture arrangement, incorporation of efficient mechanical network, plumbing, electrical and most of all the safety requirements when designing students' hostel.

In times past, electricity bills and cost of fuel did not directly pose any form of financial threat to the University management as a result of the low rate of electricity tariff, cost of fuel and student enrolment. However, all these have drastically been hiked at an alarming rate mostly as a result of the increasing students' enrolment, cost of energy, infrastructural development, modern technologies and unstable government allocation. Itabor, et al., (2015) carried out a survey to examine the energy saving potentials on the postgraduate hostels at the University of Benin, in an attempt to reduce the rate of energy consumption in postgraduate hostels in Nigeria. Oyedepo et al., (2016) carried out another survey on the assessment of energy consumption in Covenant University in which different buildings within the campus were assessed to the determine energy consumption rates and the results were represented in the chart below as follows;

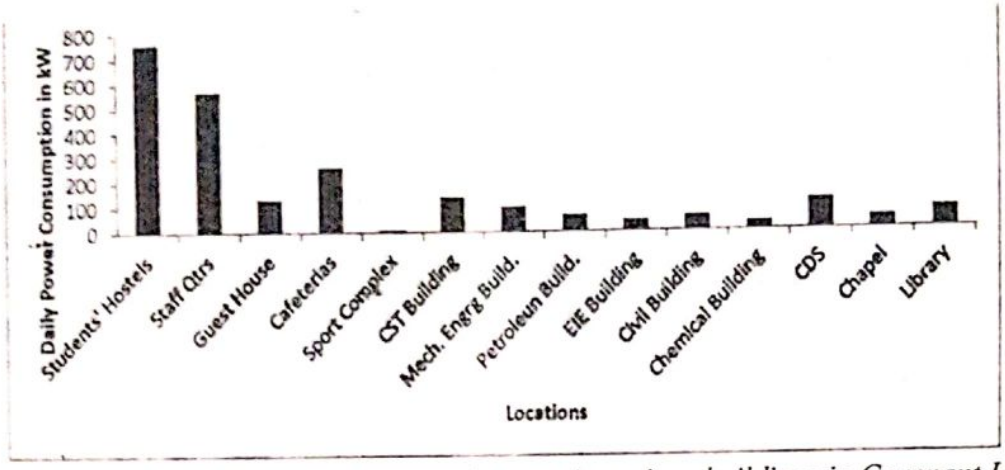


Figure 1: Showing the daily energy consumption rate in various buildings in Covenant University
Source: Oyedepo, (2016)

The study concluded that the heating and cooling systems in student hostels consumes more energy when compared to other buildings within the campus.

Yazeed et al., (2018) carried out a simulation test on Sulieman Hall in Ahmadu Bello University, Zaria with the aim of evaluating the thermal comfort in the university hostels. Findings from the study confirms that the level of thermal comfort in the hostels is unsatisfactory throughout the year. The study concluded that most professionals in the building industry today have side-lined the use of passive techniques to achieve occupants' comfort in the indoor environment and in return have placed focus on the use of mechanical energy to achieve comfort in an enclosed living space.

Olanipekun, (2014) carried out a study to evaluate the thermal comfort and occupants' behaviour in a naturally ventilated hostel in the Warm-Humid Climate of Ile-Ife, Nigeria using the female hostel in Obafemi Awolowo University, Ile-Ife, as a case study. The major findings deduced from the study showed that none of the hostels studied were in compliance with the thermal conditions stipulated by ASHRAE. The study also revealed that in an attempt to

during hot season in Ile-Ife may be quite difficult.

The findings from these studies amongst several of their kinds have led to the introduction and adoption of energy conserving materials and techniques to build, having in mind that one of the key function of a building envelop is to protect its occupants against severe outdoor

environment and to provide a comfortable and healthy indoor environment that will conserve energy.

Hostel configuration

The various configuration of student hostels differs from one another in the design forms and height of the buildings. The blocks can be straight or form a geometrical figure such as the T, U, and L shape. The various hostel rooms are arranged sequentially in a linear pattern adjacent to a corridor and stair case while, toilets are situated around the end corners or even middle. The straight or I-geometrical plan shapes are usually too long, forming a monotonous elevation and due to the open configuration of the hostel shape, it gives a little or no privacy.

Energy conservation measure

The concept of energy conservation design can be said to be when a building takes advantage of natural climate to sustain a calm internal temperature for its occupants (Michael et al., 2013). This further suggest that there will be a reduced rate in the use of mechanical powered device to heat and cool the indoor environment of the occupants. Applying energy conservation techniques during the design stage of a building is highly recommended. Also, from an economical perspective, it is quite easier to implement such measures before the actual construction of the building. However, considerable and simple renovation works can be done to any existing building and the process can also give a cost-efficient channel to improving the thermal well-being and in turn conserve energy. These processes may require much studies and creativeness from the architects because any error at the design stage can attract some consequences to the building. According to Caitlin, (2013) the identified energy conservation measures are; building orientation, material, texture and colour, landscaping, courtyard techniques, window openings, shading, and thermal mass.

METHODOLOGY

This study adopted a qualitative research method where a scheduled checklist was used to collect data from the selected case studies. This process involved a study of some selected postgraduate hostel buildings in northern Nigeria, evaluating the degree to which the building designs were able to adopt the energy conservation measures. The energy conservation measures deduced from the literature review were used as parameters to assess the postgraduate hostel buildings that were studied.

Study area

The research was conducted in three selected postgraduate university hostels in northern Nigeria. The universities are namely; Abubakar Tafawa Balewa University (ATBU)

Population and sample selection

This research population comprises of postgraduate hostels in northern Nigeria. A purposive sampling method was adopted to select three (3) postgraduate hostels. The research selects with intent individuals and sites to learn or comprehend the central phenomenon (Creswell, 2012). The areas selected comprises of prototype room designs of a single room ensuit and one-bedroom ensuit. A total of 5 units of single rooms were picked at random from each of the selected postgraduate hostel which were carefully examined.

DATA COLLECTION

The methods that was used are; visual survey and the checklist. The objective of this instrument is to collect data based on the level of adoption of the energy conservation measures in the selected hostel buildings. The outlined variables were used to assess the energy conservation measure during the survey. The relevant aspects suitable to achieve the aim of this study deals with the close observation of the followings variables; thermal mass, landscape, courtyard, Shading, materials colour and texture and other external features.

RESULTS AND DISCUSSION

Landscape

The hostels that were studied in the course of this research work mostly had adequate spaces and landscape designs. Grasses, trees and shrubs were mostly adopted in 25%, 75% and 25% respectively as the major elements of landscape. These clearly shows that the concept of energy conservation through landscape is a paramount measure that needs to be adopted to achieve thermal comfort and aesthetics. Other observations made included the poor maintenance of the landscape elements that was created.

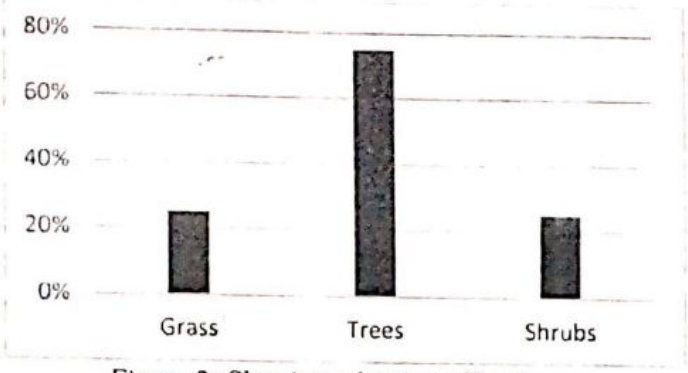
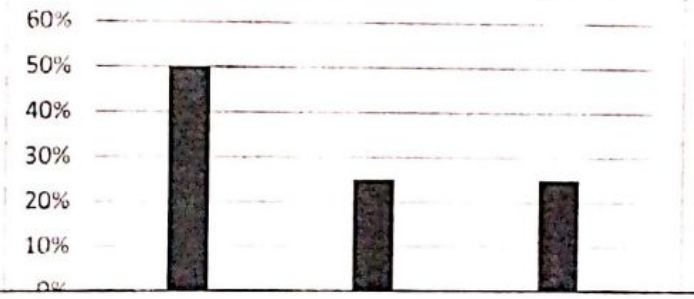


Figure 2: Showing adoption of landscape
Source: Author's Fieldwork (2019)

Courtyard

The concept of courtyard was adopted in most of the buildings that were studied.



Source: Author's Fieldwork (2019)

However, the most effective means which involves the use of soft landscape is rated 25%, while hard landscape and mixed landscape were 25% and 50% respectively. Courtyards used in some of the buildings were very narrow or tunnel-like, which has significantly reduced the rate sufficient air flow into and from the building.

Material, colour and texture

The external walls of the buildings mostly had smooth and light colours on their surfaces. Smooth and light colour for exteriors of buildings can help to reflect the solar radiation without allowing heat to be transmitted unto the inside of the building. As observed, this measure was adopted to achieve aesthetics and serve the major function of a building's envelope (wall) which is to control excessive energy gain or loss.

Window openings

The type of windows used mostly adopted the passive design techniques as regards opening type, sizes and unit number. The casement window which allows 100% free flow of air through the window opening had 75% level of adoption while sliding and fixed windows recorded 25% and 50% respectively.

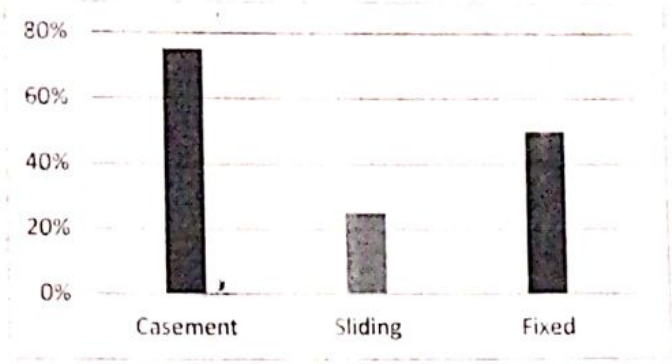
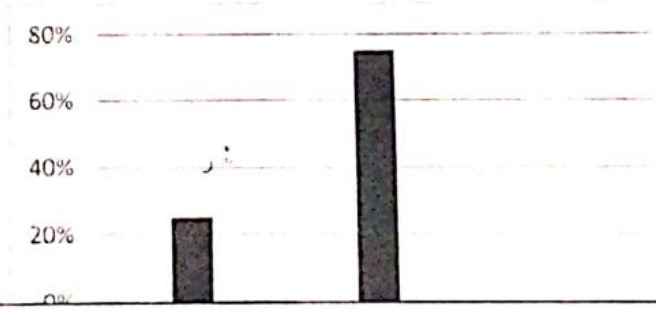


Figure 4: Showing adoption of window opening
Source: Author's Fieldwork (2019)

Window Shading

The energy conservation measure of shading was not efficiently utilized in the postgraduate hostel buildings. Aesthetics was also the utmost priority as observed that, 25% of the windows had internal shading. Also carefully observed from the study is the use of concrete skirting of about 25mm thick were mostly used on the exterior which measured up to 75%.



Source: Author's Fieldwork (2019)

The use of fin overhangs which was observed to have started becoming obsolete in the designs of postgraduate hostel building.

Building orientation

The buildings studied in the course of the study were mostly not adopting the energy conservation measure as the buildings were oriented on site in various directions that can make the building receive more heat energy from the sun in most hours of the day time. The best direction to orientate buildings as established from various studies are the North and South directions.

Thermal mass

This measure was adequately adopted as a means of energy conservation. The brick walls had a 100% level of adoption while ceramic tiles and adobe plaster were incorporated at 50% and 25% respectively.

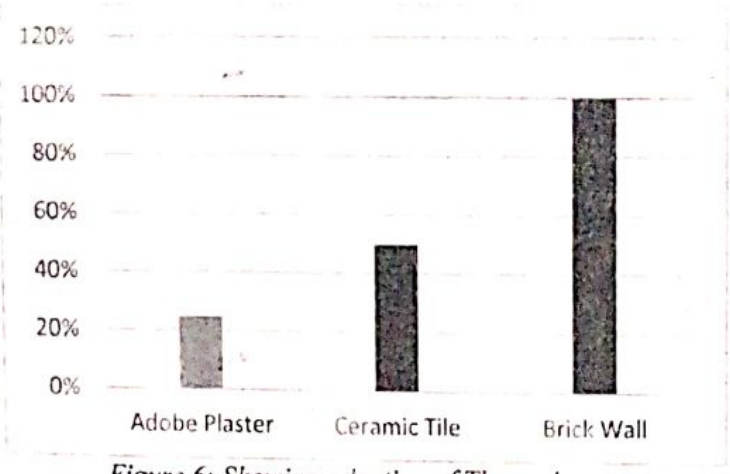


Figure 6: Showing adoption of Thermal mass
Source: Author's Fieldwork (2019)

CONCLUSIONS AND RECOMENDATIONS

The study to assess the energy conservation measures on the postgraduate hostel buildings has shown an average level of adoption of the energy conservation measures in general. This was conspicuously observed in the attempt to achieve the conservation measures through design. Mostly owing to trending technologies in design and maintenance, most postgraduate hostel buildings have shaded away from these measures to majorly focus on aesthetics. A continuation in this manner of shading away from these measures can pose a harmful effect on the coming generation as the population of humans in all human settlement is daily on the increase and also observed to have effects on the productivity of the students

Postgraduate students' hostels which are the temporal living environment for students needs the conservation measures to be also adopted in their design just as it is adopted in other

good living environment for postgraduate students.

The following recommendations will help address the issue. Design plans taken for approvals should incorporate most of the energy conservation measures effectively. Technologies that completely disagrees with these energy conservation measures in hostel settings should be avoided or technically reviewed. A timely check should also follow after it has been adopted as its effects in a case of partial compliance can be detrimental to the health and safety of the students.

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