

Appraisal of the Use of Green Building Design Strategies in Students' Hostels of Selected Universities in Nigeria

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Abstract: Green building design strategies are practices that make use of environmentally friendly materials and technologies in the design, construction and operational lifecycle of a building. This study evaluated the extent to which green building design strategies were employed in the development of students' hostels in select universities in Nigeria, with a view to identify areas for enhancement. A simple random sampling technique was adopted in selecting three universities where two hostels (male and female) were purposively selected from each of the universities. Data was gathered by the aid of a structured observation guide from a total of six hostels. The results were content analysed and presented using charts and plates. The findings show that water recycling and reuse strategies were not used in any of the hostels. But plumbing strategies used to achieve water conservation were found to be adequate. To achieve indoor environmental quality, courtyards, overhangs and shading devices were moderately used. Low heat emitting paints was also found to be highly used. The study recommended the use of appropriate water recycling and reuse measures found to be lacking in the hostels and enhancement to other areas found to require improvements. The study promotes the implementation of appropriate green building design strategies in the development of students' hostels in Nigeria.

Keywords: Green Building Design Strategies, Students' Hostels, Water Conservation, Indoor Air Quality, Universities, Nigeria.

1. INTRODUCTION

The natural environment is greatly affected by the growth and development of cities with activities such as, manufacturing, design, construction, and operation of buildings which we live and work in. These activities have resulted in the depletion of many natural resources (Eghbali and Didari, 2018). According to Nikyema and Blouin (2020), the global environmental issues such as deforestation, land loss, resource depletion, population, rising pollution, desertification, drought, flooding, alkalization and salinization, acute water scarcity, and rapid urbanization with insufficient infrastructure, among others, have compelled professionals from all disciplines to rise to find solutions to these challenges. The use of green building design strategies (GBDS) is one of the popular means of addressing several of these issues.

Green building design strategies are measures for improving performance of buildings and their sites through the use of energy, water and materials in such a way that minimizes their negative effects on human health and the environment, over the course of a building's lifecycle (Eghbali and Didari, 2018). Both developed and developing countries have acknowledged the value of sustainable or green buildings and this innovation is now popular globally (Nikyema and Blouin, 2020).

Onuoha, Kamarudin, Aliagha, Okeahialam, Atilola and Atamamen (2017) noted that Nigeria is in the process of drawing and developing its policy system for green buildings. In the last few years, the Nigerian government and practitioners in the built environment have begun developing the policy for green buildings. The first step to implementing the policy was in 2014 when the Green Building Council of Nigeria (GBCN) registered with the World Green Building Council (WGBC) on a probationary membership level. GBCN is currently working on a policy structure for green buildings. Presently, the Green Building Council of South Africa's (GBCSA) rating mechanism, the Green Star, is what is being utilized to certify green structures in Nigeria. Green Star SA-Nigeria is the name of the certification. Management, indoor environmental quality, energy, transportation, water, materials, land use and ecology, emissions, and innovations are all part of the Green Star SA evaluation methodology (Atanda and Olukoya, 2019).

According to Oluwunmi, Oladayo, Role and Afolabi (2019), Nigeria's educational institutions are yet to tap fully into the use of green building design strategies which can enhance the quality of students' hostels in universities in the country. It is on this note that this study investigated the extent to which green building strategies were employed in the development of students' hostels in selected universities in Nigeria, with a view to identify areas for enhancement, towards promoting the use of green building strategies in the development of educational facilities.

The investigation is limited to two green building design strategies which are: water conservation (WC) and indoor environment quality (IEQ), towards addressing the challenges associated with poor water supply, water scarcity and poor indoor environment. The justification for this study is hinged on making contributions towards achieving sustainable development goal (SDG) 11, which centers around the development of sustainable cities. Moreover, no research was found that identified the extent to which green building design strategies were used in the development of students' hostels in the study area. Hence, the need for the study to fill this gap.

2. LITERATURE REVIEW

Housing is one of the most important elements influencing students' overall academic achievement in universities (Ajayi, Nwosu and Ajani, 2015). Studies have shown that housing has a lot to contribute to the learning and socializing processes of students, in which when jeopardized can be detrimental to academic performance (Yunus, 2018; Owolabi, 2015; Philip, Ileanwa and El-Hussain, 2018). Housing in the context of this study is the students' hostels. They are essential components of universities which complements living and learning, thereby contributing to the growth and development of academic pursuit of students.

The inadequacy of hostels on-campus has led students to source for housing in places far from the academic environment which contributes greatly to low academic performance in Nigeria (Yunus, 2018; Owolabi, 2015; Philip et al., 2018). The conditions of hostel spaces are also of paramount importance. Some of which include: the right number of persons per space; adequate spacing of hostels, availability of recreational spaces; provision of functional internet services; availability of uninterrupted power supply; indoor air quality; availability of water; well-maintained landscaped environment; amongst others (Patricia and Yusuf, 2013).

It has however been established that indoor environmental quality is of preeminent importance in universities since students spend an average of 8–12 hours per day in their hostels. The hostels should therefore be well designed, constructed and maintained to establish quality and productive indoor environment that will help attract qualified student, thereby helping to promote the universities objectives (Valiyappurakkal, 2021). The Indoor Environmental Quality (IEQ) of students' hostels has to do with indoor air quality, thermal comfort, indoor light quality, acoustics comfort and noise (Ezeokoli, Omenyi, Bert-Okonkwo and Iheama, 2020). However, thermal comfort is of paramount importance due to the fact that studies have shown that an average of 80% of human time is spent indoor (Huo, Ann, Darko and Wu, 2019).

Also, life and livelihoods rely on water. Water is crucial to all developmental efforts, making it a hot topic of debate on a global scale. With the increasing number of students enrolling in universities each year, as well as the large number of old students and staff on ground (all needing water), there is a need for the provision of alternative water supply source in students hostels in order to meet the massive water demand.

Due to the importance of having adequate water supply in hostels, some studies were found to have been conducted in this regard. Mishra, Shruthi and Rao (2020) noted that the students' hostel is a major development where a lot of water is used on a daily base. According to Zaki, Gandu, Adah and Ibrahim, (2020) one of the utility challenges faced by students in their hostels is water scarcity. From their study, 78% of the respondents were dissatisfied with water supply in their hostels. Sobowale and Adeyemo, (2020) noted in their study that the current water supply infrastructure cannot support the ever-

growing population of universities. They recommended that universities should invest in water supply infrastructure which will help alleviate the approaching water crisis. They also suggested the installation of water conservation equipment as a short-term approach to regulate water consumption.

In addition, Philip, Ileanwa and El-Hussain (2018) investigated the post-occupancy evaluation of students' hostel facilities. Ayedun, Utom, Oluwunmi, Omonijo, and Akinjare (2021) did an assessment of supporting facilities in hostels, while Ode, Stanley, Dadu, Abah and Sani (2020) examined the electric load consumption profile of students' hostels. However, it is observed that there is dearth of studies on appraisal of green building design strategy in students' hostels. This gap in literature needs to be filled knowing that the world is driving towards sustainability in all areas of human endeavor, as it is in the sustainable development goal. The need to appraise what is existing in order to design adequately for the future of sustainability is of paramount importance. This need is what gave birth to the focus of this study which is to appraise the extent of use of green building design strategies in the design of students' hostels in selected universities in Nigeria. The appraisal was conducted in two areas which are the focus of the study that is water conservation and indoor environmental quality.

3. METHODOLOGY

The study adopted a qualitative research approach. A structured observation guide was used to collect data on the extent of use of GBDS in the selected students' hostels used for the study. Nigeria has three categories of universities namely: federal, state and private. Simple random sampling was used to select one university from each category. The universities selected are: Ahmadu Bello University (federal), Ambrose Alli University (state) and Covenant University (private).

Again, using simple random sampling, a male and a female hostel were selected from each university for the study. Aliko Dangote (male) and Queen Amina (female) were selected in ABU. Igbinedion male and Igbinedion female were selected from Ambrose Alli University. In Covenant University, Daniel Hall (male) and Mary Hall (female) were selected.

To appraise the extent of use of GBDS in the selected hostels, water conservation and indoor environmental quality were investigated as earlier mentioned. For water conservation, the following variables served as strategies for the appraisal:

- (i) Are provisions made for rainwater harvesting and reuse?
- (ii) Are the toilet fixtures low flush water cisterns?
- (iii) Are the showers low flow showers?
- (iv) Are there other provisions for water reuse and recycling?
- (v) Are the plumbing systems functioning properly?

The IEQ appraisal variables are:

- (i) Were large windows used?
- (ii) Were low emitting paints used?
- (iii) Were overhangs or shading devices used?
- (iv) Were courtyard and/or atrium used?
- (v) Were proper orientation and daylighting used?

The extent of use of the variables were rated using a three-scale of "Not used", "Moderately used" and "Highly used".

The data were content analyzed and the results presented in text with the aid of figures.

4. RESULTS AND DISCUSSIONS

The results in this section show the extent of use of water conservation and indoor environmental quality in the hostels investigated using various strategies for the appraisal and are presented as follows:

4.1 Water Conservation

4.1.1 Extent of Use of Rainwater Harvesting and Reuse

The findings on the extent of use of rainwater harvesting and reuse strategy is shown in figure 1.

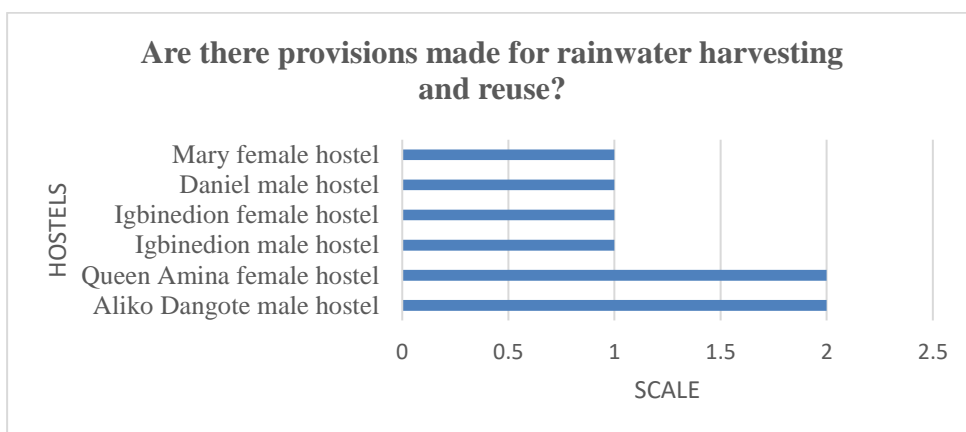


Fig. 1: Extent of Use of Rainwater Harvesting and Reuse

The results displayed in figure 1 indicate that rainwater harvesting and reuse strategy were not used in four of the hostels, but were moderately employed in just two, that is, Aliko Dangote and Queen Amina hostels. This implies that majority of the hostels did not make provision for any strategy that can harvest rainwater and reuse. This is considered poor, considering the high stress level of water usually associated with most developing nations.

4.1.2 Extent of Use of Low Flush Water Cisterns

The result on the extent of use of low flush water cisterns is presented with figure 2.

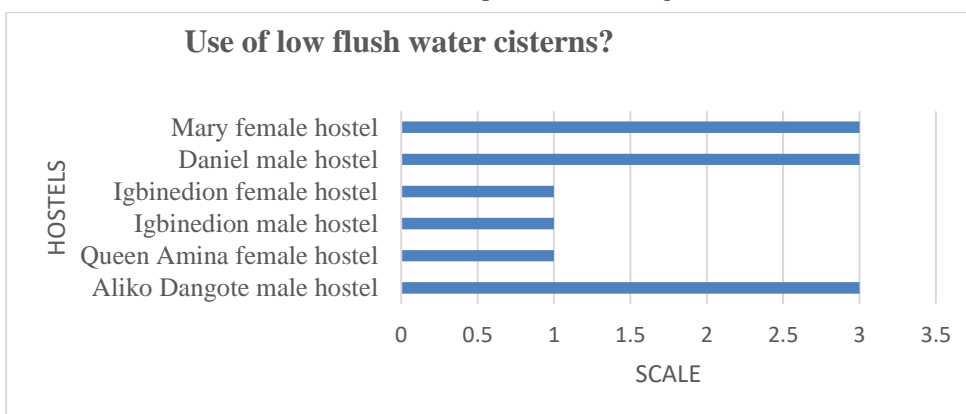


Fig. 2: The Extent of Use of Low Flush Water Cisterns

Figure 2 shows that the use of low flush water cisterns is high in three of the hostels, namely: Mary Hall, Daniel Hall and Aliko Dangote Hostel. This indicates that generally, low flush water cisterns are averagely used in the hostels.

4.1.3 Extent of Use of Low Flow Showers

The result for the extent of use of low flow showers is indicated in figure 3.

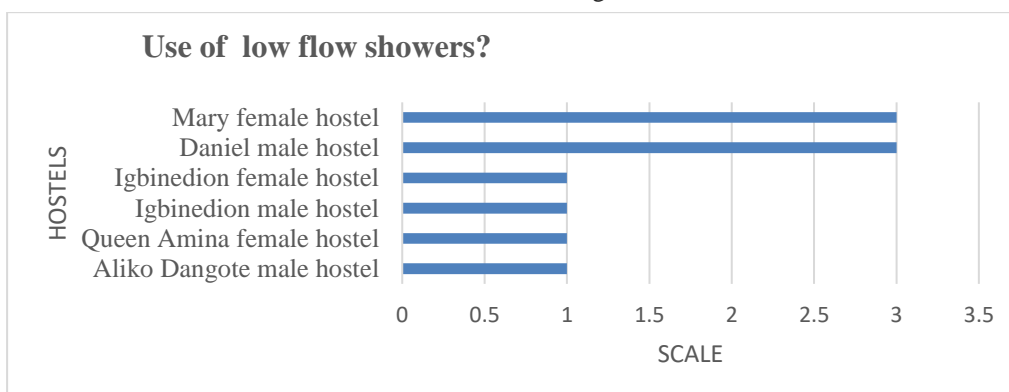


Fig. 3: Extent of Use of Low Flow Showers

Figure 3 shows that just two of the hostels (Mary Hall and Daniel Hall) recorded a high use of low flow showers. Majority of the hostels recorded low use. This implies that water is not being conserved in most of the hostels through the use of low flow showers.

4.1.4 Other Provisions for Water Reuse or Recycling

In figure 4, the results show if there was any provision made for water reuse or recycling.

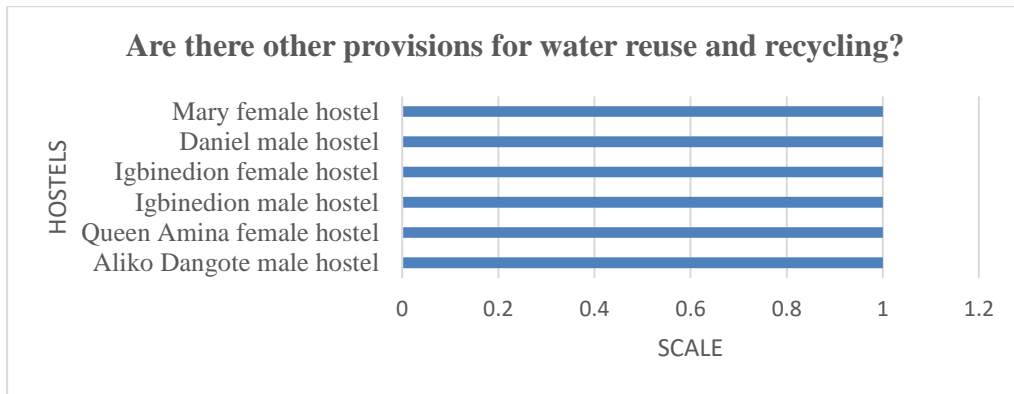


Fig. 4: Other Provisions for Water Reuse or Recycling

Figure 4 shows that none of the hostels were found to have any provision made for water reuse or recycling. This implies that once water is used or wasted in the hostels, it can no longer be available for reuse, which falls short of the idea of water conservation in buildings.

4.1.5 Extent of Use of Adequate Plumbing System

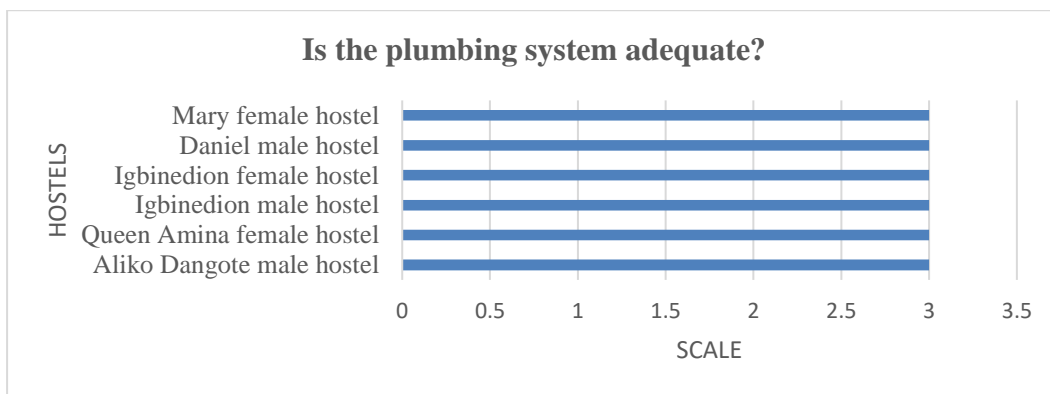


Fig. 5: Extent of Use of Adequate Plumbing System

The plumbing system employed in all the hostels were found to be working as expected and considered adequate. There is free flow movement of all the water fixtures. There is a need for free flow of water in plumbing fixtures in order to preserve water. Where there are damages and blockages in plumbing systems, there are bound to be water wastages.

4.2 Indoor Environmental Quality

4.2.1 Extent of Use of Large Windows

The extent of use of large windows in the rooms in each of the hostels are as shown in figure 6.

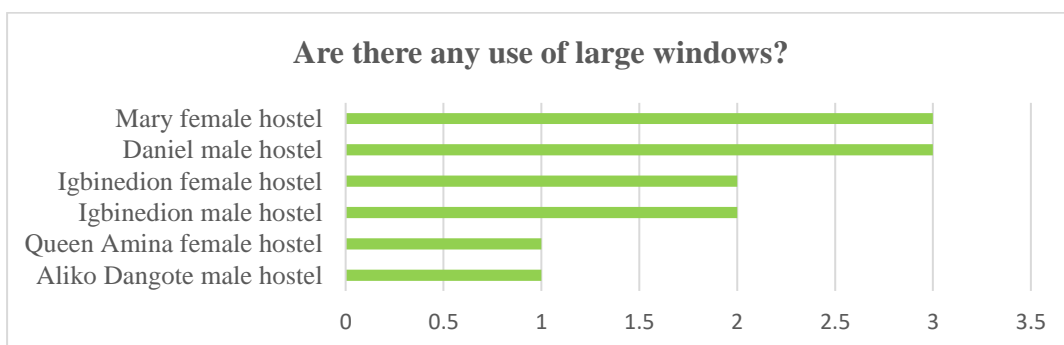


Fig. 6: Extent of Use of Large Windows

The result shown in figure 6 indicates that two of the hostels (Mary Hall and Daniel Hall) recorded a high use of large windows. Another two of the hostels (Igbinedion male and Igbinedion female Hostels) recorded moderate use of large windows. Whereas, the last two hostels (Queen Amina and Aliko Dangote Hostels) did not make use of large windows. This indicates that majority of the hostel rooms have desirable window sizes which are capable of enhancing the ventilation of the rooms and improving users comfort level in them.

4.2.2 Extent of Use of Low Emitting Paints

The extent of use of low emitting paints result is shown in figure 7.

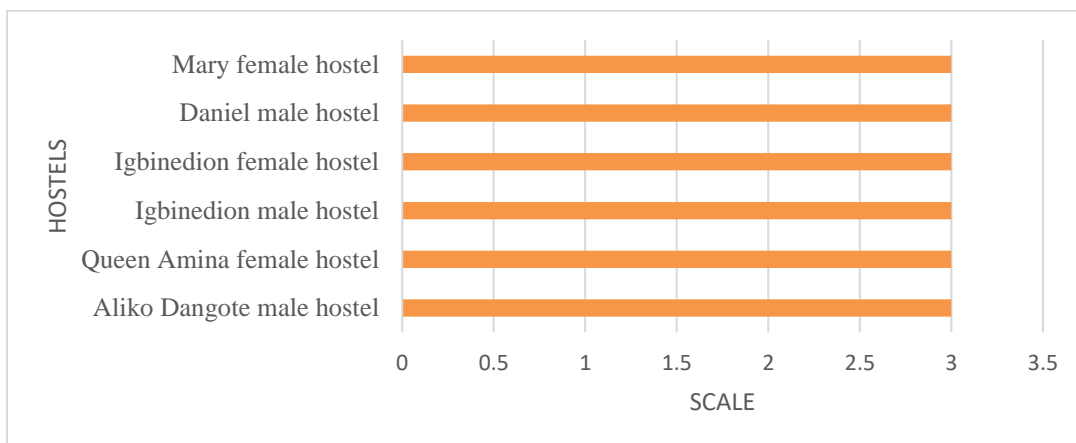


Fig. 7: Extent of Use of Low Emitting Paints

Figure 7 indicates that all the hostels recorded a high use of low emitting paints. These are paints with low emission of volatile chemicals in their composition. The use of low emitting paints will help reduce indoor unpleasant odor thereby enhancing the quality of the indoor environment for users in the hostels.

4.2.3 Extent of Use of Overhangs or Shading Device

The result for the extent of use of overhangs or shading device over openings in the hostels is shown in figure 8.

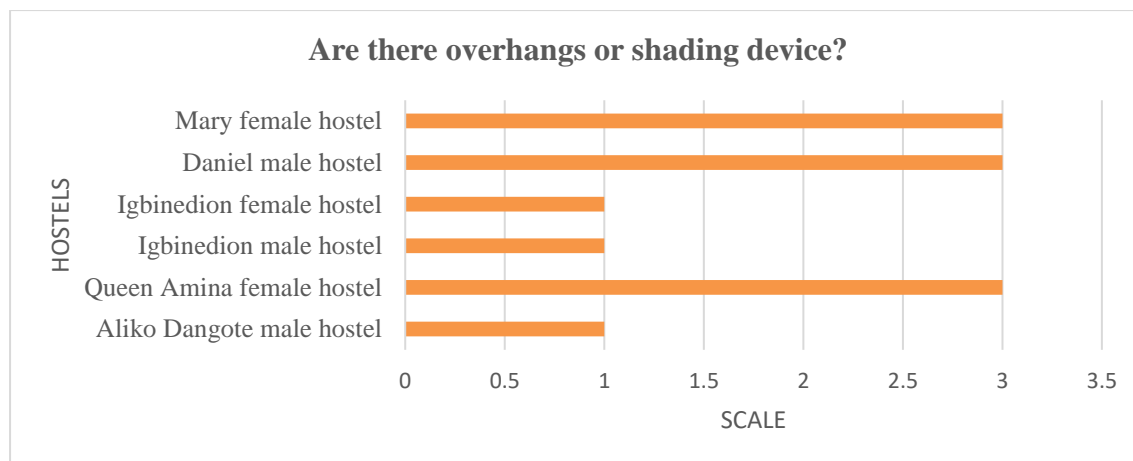


Fig. 8: Extent of Use of Overhangs or Shading Device

The result displayed in figure 8 indicates that three of the hostels (Mary Hall, Daniel Hall and Queen Amina Hostel) recorded a high use of overhangs or shading device. Whereas, the other three hostels (Igbinedion female and male hostels, and Aliko Dangote hostel) did not make use of roof overhangs or shading devices. This implies that only the first set of three hostels that made use of them are most likely to have adequate air flow into them as the roof overhangs and shading devices will help to reduce the amount of sun radiation that may penetrate the buildings, thereby helping to enhance the quality of the indoor environment in the said hostels.

4.2.4 Extent of Use of Courtyards and /or Atrium

Figure 9 shows the result for the extent of use of courtyard and /or Atriums.

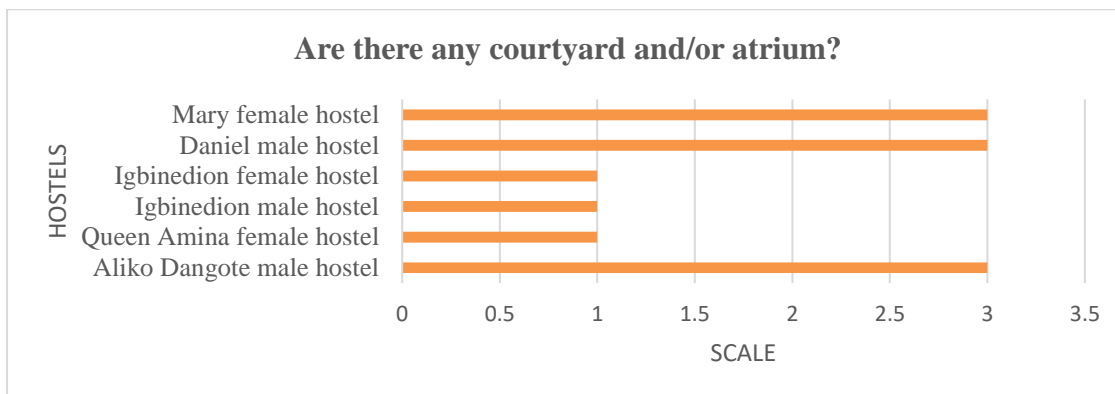


Fig. 9: Extent of Use of Courtyards and/or Atrium

Again, the result presented in figure 9 shows that three of the hostels (Mary Hall, Daniel Hall and Aliko Dangote Hostel) recorded high use of courtyards and/ or atrium. But for the other three hostels (Igbinedion male and female Hostels, and Queen Amin Hostel), courtyards and/or atrium were not employed. This indicates that only the first three set of hostels are most likely to experience adequate ventilation for using this important green building design strategy associated with tropical climates for enhancing adequate ventilation and daylighting.

4.2.5 Extent of Use of Desirable Building Orientation

The result in figure 10 shows the extent of the use of desirable building orientation to achieve adequate ventilation and daylighting.

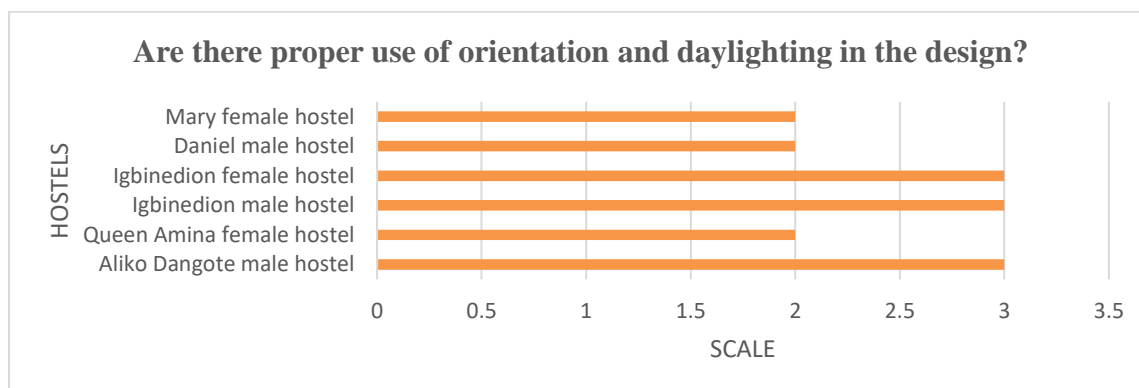


Figure 10: Extent of Use of Desirable Building Orientation

The findings in figure 10 indicate that four of the hostels (Igbinedion male and female Hostels, as well as Queen Amina and Aliko Hostels) were found to have used desirable building orientation strategy for enhancing adequate ventilation and daylighting. Mary Hall and Daniel Hall were found to have moderately employed the building orientation strategy. The result shows that majority of the hostels were orientated to have the longer axis of the buildings facing the North-South direction which is the preferred orientation for achieving good ventilation and daylighting in tropical climates.

4.3 Discussion

To investigate the extent of use of GBDS in six hostel buildings in Nigeria, water conservation and indoor air quality approaches employed in the hostels were used to evaluate the hostels. With regards to water conservation strategies employed, this was found to be low. Only two of out of six of the hostels used moderate strategies for harvesting rainwater. None of the other four hostels had any form of strategy in place to cater for reuse or recycling of water, a situation that usually makes water scarcity issues to bite harder in areas with high water stress levels. This result agrees with the study of Zaki, et al., (2020) that found that students' hostel facilities are having chains of scarcity of water. The consequence is that students tend to suffer more when there is a disruption in the supply of water that leads to water scarcity. This was why

rainwater harvesting has been recommended for use as an alternative source to water supply to guide against the issue of water scarcity in buildings (Mishra et al., 2020), especially in areas where high water stress levels are experienced. This recommendation also supports the recommendation of the study of Sobowale and Adeyemo (2020) that stressed the need to invest in water supply infrastructure to help alleviate water crisis now and in the future.

The result on indoor air quality shows that majority of the hostels made use of desirable building orientation strategy for achieving proper ventilation and adequate daylighting. Three of the hostels made use of courtyards and/ or atriums, three used overhangs or shading device, while all of them made use of low emitting paints. Only two made use of small windows, others made use of either large or moderately sized windows that allows in adequate air for ventilation and daylighting. This result shows that majority of the hostels paid attention to providing sizable windows for achieving good ventilation and adequate daylighting. This agrees with the study of Valiyappurakkal (2021) that emphasized the need to have good indoor air quality towards enhancing users' comfort. The use of shading devices, overhangs, courtyards and atriums should be considered in the design of students' hostels to help enhance their indoor environmental quality towards improving users' comfort level (Yunus, 201; Philip et al., 2018).

5. CONCLUSION

The study was carried out in a bid to appraise the extent to which green building design strategies were employed in the development of students' hostels in select universities in Nigeria with a view to making contributions on how to achieve sustainability in the development of students' hostels. The variables investigated were water conservation and indoor environmental quality. The key findings indicated that for water conservation, rainwater harvesting and reuse were only employed in few of the hostels investigated. Apart from rainwater harvesting methods, no any other method was found to have been provided for harvesting and reuse of water in the hostels. However, water conservation through the use of appropriate plumbing system were found to be adequate.

As for the quality of indoor environment, the findings revealed as follows: large windows were moderately used to enhance good ventilation; low emitting paints were highly used to improve the air quality; and overhangs, shading device, courtyards and atrium were moderately employed to enhance natural cooling of the indoor environment. Building orientation and daylighting were highly utilized to achieve quality indoor environmental in some hostels. Contributions to knowledge of this study includes the provision of empirical evidence on the extent to which green building design strategies of water conservation and indoor environment quality were utilized in the selected students' hostels.

Based on the key findings, the study recommends that apart from rainwater harvesting, more methods of harvesting and reuse of water should be employed in the hostels. This will help complement the present water supply system in the hostels and ease the problem of scarcity that may occur during maintenance periods. High use of overhangs, shading device and courtyard are also advised in students hostels design as a way of enhancing users' comfort.

In conclusion, the study investigation is limited to two out of the various green building design strategies available and the study area restricted to three universities in Nigeria. Further studies can be conducted to investigate other green building design strategies and the scope expanded to other universities and higher institutions, to gain more insight on the subject.

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