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To cite this article: A. B. Sholanke *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1054** 012026

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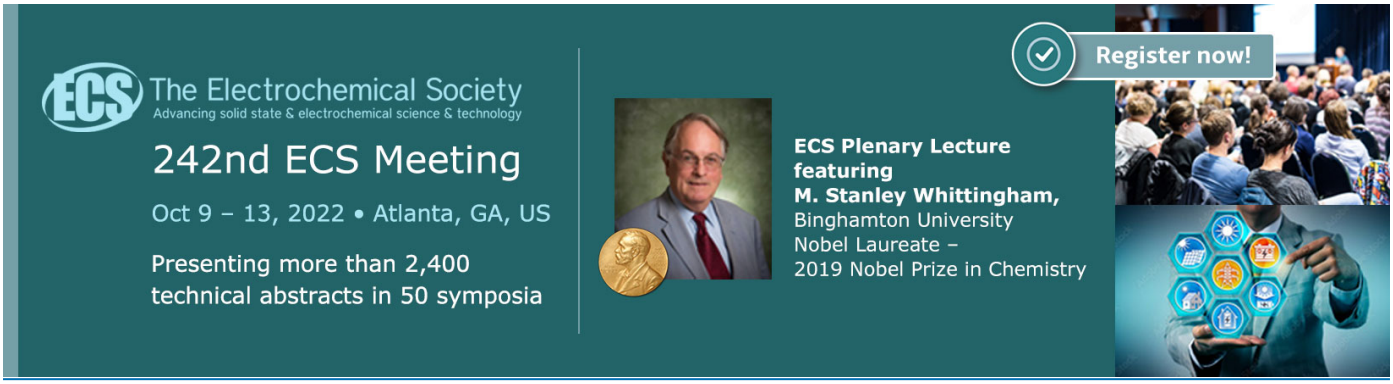

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IOP Conf. Series: Earth and Environmental Science 1054 (2022) 012026 doi:10.1088/1755-1315/1054/1/012026

Users' Perception of Comfort Experienced in Academic Buildings of Selected Universities in Ogun State, Nigeria

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Abstract. In architectural design, the level of comfort experienced in the spaces created serve as one of the units of measurement in assessing a complete design. In a country tropical climate such as Nigeria, indoor environmental conditions are primarily influenced by many factors, including lighting, ventilation, indoor air quality, sound quality and building materials employed. This study investigated users' comfort satisfaction level in relation to environmental design consideration factors in academic buildings of selected universities in Ota, Ogun State, Nigeria, with a view to identify areas for improvement towards making contributions that will help to improve users' satisfaction in the development of academic environments. The study adopted a quantitative research method that used a structured questionnaire to collect data from 291 respondents, out of which 271 are students and 19 are lecturers. The users' sample size was drawn from the Department of Architecture students and lecturers of two selected universities in the study area. The data were analyzed with the aid of Statistical Product and Service Solutions software and presented descriptively with the aid of tables. The results showed that majority of the respondents in the selected universities attested to the adequacy of the four environmental design consideration factors investigated, with the factors recording various levels of adequacies. In few areas were the factors were inadequate, the foremost reason was the inadequacy of the indoor air quality, followed by that of lighting before ventilation. Also, daylighting in classrooms and ventilation in offices was found to be inadequate in one of the universities, while the inadequacy of ventilation in offices in the other university was significantly high. The study recommended that building industry designers should pay more attended to means of achieving adequate indoor air quality, lighting and ventilation in academic buildings, without compromising achieving adequacy of sound quality found to be generally satisfactory. The study has implications for policy formulation, designs and researches that strive towards meeting users' comfort satisfaction level in the development of academic environments.

Keywords: User' Comfort, Academic Buildings, Lighting, Ventilation, Indoor Air Quality, Sound Quality, Environmental Design Consideration Factors, Nigeria.

1. Introduction

Over the centuries, man has frequently pushed to create a suitable environment. This is shown in the building styles adopted around the planet, from ancient buildings to modern structures. A comfortable interior environment usually contributes to assisting occupants to improve on their level of activity in buildings [19]. An important requirement when designing a structure is how suitable its interior spaces are in meeting users' comfort levels. A research by [4] links users' behavior to building's performance, as the variables had a mutual impact on one another.

School represents an important building typology, not only because of their level of resource consumption, but also due to their role as a potential reference in the education of young people. In schools, light has been consistently highlighted as a crucial factor in the performance of school buildings, for two main reasons: visual comfort relates to student performance [12]; and thermal comfort is a significant consideration that is ranked as one of the topmost important performance factors [5].

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However, a research by [22] revealed how different building materials used to finish floors and walls affect the comfort level of users. This indicates that selection of building and finishing materials in academic environments is equally an important factor to consider in the development of school buildings whose environment are capable of enhancing students' performance.

It is against this backdrop that this study investigated users' comfort satisfaction level in relation to environmental design consideration factors in academic buildings of selected universities in Ota, Ogun State, Nigeria, with a view to identify areas for improvement towards making contributions that will help to improve users' satisfaction in the development of academic environments. Five cardinal questions shaped the research as follows: (i) How much time do users' spend in their academic buildings? (ii) How adequate are the windows in the academic buildings for achieving natural ventilation and lighting? (iii) What are the environmental design consideration factors responsible for the users enjoying or not enjoying working in the buildings (iv) To what extent do users perceive the adequacy of lighting, ventilation, indoor air quality and sound quality in the academic buildings? (v) What material was mainly used to construct the academic buildings?

The study area is Ota, a town in Ogun State, Nigeria. Ota is a town with a high concentration of industrial estates and a major industrial hub in Ogun State. The scope of the study was limited to two universities in Ota namely, Covenant University and Bell University of Technology both of which are private institutions. The scope was further limited to the responses of Department of Architecture students and lectures of the universities in order to streamline the data collection to a manageable level, as well as provide a specific focus for the study. For the same reason, the scope of the areas of the academic buildings investigated was limited to classrooms and lecturers' offices. The design variables investigated were streamlined to environmental design consideration factors considered to significantly affect users' comfort satisfaction level. They include, artificial and daylighting, ventilation, indoor air quality and sound quality. The findings of the study have implications towards the improvement of users' comfort, satisfaction and performance in the development of future academic environments. The study is also a useful reference material for stakeholders in the building industry, policy makers and the research community to consult on issues relating to the enhancement of environmental design consideration factors in buildings, as well as to build upon. The study was conducted between November 2019 and February 2020.

2. Literature Review

2.1. Indoor Environmental Quality

In the construction of buildings, we tend to overlook that the result of a project rests on its indoor environmental quality. Healthy and comfortable users of buildings are happier and more productive. As a result, many of today's sustainable building designs take the issue of indoor environmental quality that includes comfort into consideration. Indoor environmental quality refers to the level of health and wellbeing of its users [2]. Indoor environmental is vital, as the indoor air quality inside some buildings could be more polluted than that of their exterior.

A building's indoor quality is determined by several factors such as: level of acoustics, indoor air quality, visual comfort and thermal comfort. Indoor air quality is a combined balance of the air temperature, level of humidity, water and light. Requirements of indoor air quality provide certain lists of the maximum contaminant levels for spaces to be able to maintain the required level of indoor air quality, which will eventually contribute to reducing the possibility of adverse health effects on building occupants. Indoor air quality is sometimes determined based on the concentration of pollutants in indoor environments also expressed as the concentration of carbon dioxide. Academic building indoor quality assessments have been carried out in several studies and some of the results indicate poorly ventilated classrooms and poor indoor air quality issues [11].

2.2. Thermal Comfort

Thermal comfort in architecture is explained as the state of wellbeing of users of a building and their state of mind, which translate to their satisfaction in a particular environment. Buildings contribute to

thermal discomfort and if not addressed while selecting building materials for the construction and applying them in the design stage, the challenge of thermal discomfort could be too expensive to handle later. Windows act as a medium for heat transfer, as glass absorbs and traps the heat inside a room. Radiation between a wall structure and a ceiling also affects the internal temperature and subsequently the thermal comfort of the occupants in a building. A study showed that materials that reflect, rather than absorb radiation and more readily release the absorbed quantity as thermal radiation, will result in a lower temperature within a structure [9].

2.3. Echo in Buildings

Echoes are often created when sound waves hit an obstacle and bounce back. It is observed that the smoother the obstacle the sound wave hits, the clearer and louder the echo that is produced because the sound wave retains its intensity when it hits a smooth surface than when it hits a rough one. In order to hear a loud, clear echo, the hearer must also be far enough away from the surface the sound wave is bouncing off, so the sound wave has space to reverberate. This phenomenon is usually experienced in buildings with large empty spaces and voids.

In conventional buildings, materials that have a flat surface will be able to produce echo, e.g. bricks, glass, concrete and steel. But a hard material like concrete makes it difficult for sound wave to pass through its surface. As the wave is unable to pass through the surface, it bounces back as an echo. In natural environments, materials that have smooth surfaces produce a lot of echoes, e.g. Lake Bottom, cave walls lined with limestone that have been smoothened by the sea, or a cave interior that has been smoothened by flowing groundwater. It is important to note that the geometry, form and size of a space are all contributing factors to the echo level experienced by users. In large spaces, sounds can be reflected directly, whereas in smaller spaces, another sound follows the first sound which is perceived differently as an echo.

2.4. Tropical Building Design Principles

Tropical zones are defined as areas with land and water located between the Tropic of Cancer and the Tropic of Capricorn. They are occupying almost forty per cent of the earth surface, and home to half of the planet's population [18]. External shading devices are used to control solar radiation allowed into a building, which could foster thermal comfort and the quality of daylighting in the tropics. The shape of a shading device usually influences the interior thermal experience. To improve the thermal comfort for naturally ventilated buildings, façade shading devices are needed, most especially in humid regions.

2.5. Wall Design Principles for Tropical Climates

Thermal comfort is vital as it stabilizes indoor environment [7]. Materials with high thermal mass are considered effective against transfer of heat. Such materials include: cement block, concrete, brick and several other solid masonry materials. They are often considered due to their abilities to absorb heat from solar radiation at a slower rate than lightweight materials.

Four tropical design factors for wall are: material, thickness, solar shade and solar reflection [18]. [20] stipulated that in choosing building materials, the economy, suitability for the climate and durability are very important considerations. Building materials like brick and other solid masonry materials are considered to have high thermal mass. Although ineffective against rapid heat transfer, high thermal mass materials are superior, due to the fact that they absorb heat at a slower rate than light materials. It has been observed that clay which is most suitable for manufacturing bricks with high strength, is not widely used in most places in Nigeria, and where they are used, they do not have uniform quality [15].

In the case of selecting glass in for buildings in the tropics, three factors to consider are: visible transmission, solar heat gain coefficient and the U-value. Visible transmission is the amount of sunlight that is passed through the glass, while the solar heat gain coefficient is the fraction solar heat that can be transmitted through the glass. The U-value is the conduction, convection and radiation of heat through

the glass [17]. Argon is usually used due to its reduced cost and efficiency. Krypton is used for thin special glasses, while xenon is not usually used due to its high cost [17].

To improve energy efficiency, low emissive panels are recommended. The glass possesses an inner side that is coated with metallic oxide layer. The coating prevents the transfer of heat between the panels, that is, from a glass of considerably high degree of temperature to a glass of lower temperature. In places with hot climates, the low emissive coating has to be applied to the inner side of the outermost panel. Low emissive glass reduces the heat gain in the interior and considered as the most suitable for energy efficient windows in hot climates [17].

2.6. Design Strategy for Openings in Tropics

Shelter is the most significant human requirement after food [16]. In olden days' buildings, windows were positioned to facilitate free movement of air. Opening windows was seen to reduce humidity and heat experienced, whereas increases temperature through solar radiation penetration. Walls and windows that face east and west are the most crucial to shade, as solar heating is most intense in these orientations. To reduce unwanted morning and afternoon solar heat gain, minimizing or protecting the extent of walls and windows facing the east or west is required [18]. Ceiling fans have been noted to make people feel cool. However, their location and orientation need to be properly considered when planning in tropical regions for them to be effective. This was uncovered in a case study that investigated the level of comfort in a female hall of residence in Bells University, Ota, Nigeria [10].

2.7. Lighting

Indoor comfort is influenced by a variety of environmental, architectural, and human factors. With a different weighting factor, each parameter adds to the indoor atmosphere in its own way. Humans, on the other hand, perceive their surroundings through interactions and integrations of various sensory stimuli [21]. In academic buildings, adequate daylighting has been found to have a substantial impact on students and staff concentration ability, whereas inadequate daylighting causes discomfort and lowers learning ability [14]. To this end, adequate daylighting is also a key factor to consider in the design and planning of educational environment towards enhancing users' comfort, concentration and learning ability, especially in tropical regions of a developing nation like Nigeria where power supply is not reliable.

3. Methodology

This section is dedicated to presenting the approach adopted in conducting the study. The selection of the samples, data collection instruments and methods of analyzing and presenting the data. The research centers around finding ways of enhancing users' comfort satisfaction level in university environments. Thus, Ogun State was preferable as the study area, because the state has the highest number of universities in Nigeria. To further give the study a specific focus and keep the sample size within a manageable level that could be accommodated within the budget set aside for the study, the choice of the target respondents was limited to students and lecturers of the Department of Architecture. By the virtue of their training that centers on designing of sustainable buildings and environment, the lecturers and students of the department are assumed to be knowledgeable to provide reliable data on issues pertaining to the designing and development of educational environments that are suitable for meeting users' comfort satisfaction level.

To select the universities used for the study, only universities accredited by the Architects Registration Council of Nigeria (ARCON) to offer Architecture as a course and offer the course at both undergraduate and post graduate levels were considered. Four universities were found to offer Architecture at undergraduate level in Ogun State and they are: Crescent University, Abeokuta; Bells University of Technology, Ota; Olabisi Onabanjo University, Ago-iwoye; and Covenant University, Ota. The sample size of the study was however limited to two (50%) of the universities namely, Bells University of Technology and Covenant University, both of which are private universities situated in Ota. This is because they are the only two universities that offer Architecture at both undergraduate and

postgraduate level among the four found in the state [13]. Both universities are at close proximity to one another which facilitated the easy collection of data within a short period. Both universities are also among the first set of private universities established in the country. Covenant University was established in 2002, while the Bells University of Technology was founded in 2004 [13].

To select the sample size of the respondents in both universities, first year students were not considered, because they are new students who are yet to spend enough time in the university that will enable them provide reliable answers to the survey. To arrive at the sample size of the respondents for each of the university, 50% of the population of the students and 50% of the population of the lecturers were used. Table 3. 1 shows the sample size of respondents and how it was derived.

Table 3.1. Sample Size of Respondents

SN	University	Students		Lecturers	
		Population	Sample Size (50% of Population)	Population	Sample Size (50% of Population)
1.	Bells University of Technology, Ota	280	140	24	12
2.	Covenant University, Ota	357	179	21	11
	Total	**637**	**319**	**45**	**23**

Source: Architecture Department of the Bells University of Technology and Covenant University; Authors' Design

Table 3.1 indicates that the combined sample size of students for the study is 319, whereas that of lecturers is 23. Thus, the sample size for the study is 342. The sample sizes of students and lecturers in Bells University of Technology are 140 and 12 respectively, while that of Covenant University are 179 and 11 respectively. Based on the sample sizes adopted for the study, a total of 342 survey instruments were shared to students and lecturers across both institutions in the manner shown in Table 3.1. The simple random sampling technique without replacement was used to distribute the survey instruments to respondents who willingly volunteered to provide data for the study in each of the institutions. The survey instruments were shared to the respondents in their academic areas.

The data collection instrument used for the study is a structured questionnaire due to the large figure arrived at. The survey instrument was divided into two sections. The first section contained a brief introduction of the purpose for which the data was requested and information pertaining to the personal characteristics of the respondents that were considered relevant for achieving the aim and objectives of the study. The second section contained information designed to collect data relevant for addressing the five research questions formulated for the study. The data include the perception of the respondents on: how much time they spend in the academic buildings; adequate of windows in the buildings for achieving daylighting and natural ventilation; environmental design consideration factors responsible for them enjoying or not enjoying working in the buildings; the extent to which they perceive the adequacy of lighting, ventilation, indoor air and sound quality in the buildings; and the material mainly used to construct the academic buildings. To analyze the data, the Statistical Product and Service Solutions software was use. The data was presented descriptively with the aid of tables for clarity. The data was collected between the first week of December 2019 and last week of January 2020.

4. Results and Discussion

This section is dedicated to presenting the findings and discussing the result of the study. As stated earlier, a total of 342 questionnaires were distributed across the two selected universities used for the study, out of which 291 (85%) of the questionnaire was retrieved, found useful and analyzed. The results obtained in each of the university are presented and discussed in the following sections.

4.1. Response Rate

A total of 152 questionnaires was distributed in the Bells University of Technology. 140 of the questionnaires was shared among the students, while 12 was shared to lecturers in conformity with the

sample size. A total of 129 of the questionnaires was retrieved, found useful and analysed to record a response rate of 84.87%. 120 out of the questionnaires was retrieved from students, while 9 was retrieved from lecturers. A response rate of approximately 85% is considered high and appropriate for generalization of the results as a true representation of the study population. A further analysis of the data indicated that majority (74%) of the respondents are undergraduate students.

In Covenant University, a total of 190 questionnaires was distributed out of which 179 was shared among the students, while 11 was shared to lecturers. A total of 162 of the questionnaires was retrieved, found useful and analysed to record a response rate of 85.26%. 152 out of the questionnaires was retrieved from students, while 10 was retrieved from lecturers. Again a response rate of approximately 85% recorded is considered high and suitable for generalization of the findings as a true representation of the study population. In addition, the data indicated that majority (78%) of the respondents are also undergraduate students.

4.2. Time Spent in Academic Buildings

The data on the time the respondents spent in their academic buildings are displayed in Table 4.1.

Table 4.1. Time Spend in Academic Buildings

SN	University	Time Spend in Academic Buildings			
		Below 2 hours	2-4 hours	5-7 hours	Above 8 hours
1.	The Bells University of Technology, Ota	22%	28%	32%	18%
2.	Covenant University, Ota	10%	36%	32%	22%

The result in Table 4.1 revealed that in the Bells University, majority (32%) of the respondents spend 5-7 hours in their academic buildings. While, some (28%) spend 2-4 hours and 22% spend less than 2 hours. Few (18%) of the respondents spend above 8 hours. However, in Covenant University, majority (36%) of the respondents spend 2-4 hours in their academic buildings, whereas, some (32%) spend 5-7 hours and (22%) spend above 8 hours. Just a few (10%) of them spend below 2 hours.

4.3. Adequacy of Windows in Academic Buildings

The data analysis on the adequacy of windows in the academic buildings for achieving daylighting and natural ventilation revealed that majority (78%) of the respondents in the Bells University of Technology are of the opinion that the windows in their academic buildings are adequate, while few (22%) of them believe that they are not adequate. None of the respondents were uncertain of their opinion. Likewise, in Covenant University, majority (82%) of the respondents are of the opinion that the windows are adequate, whereas just few (18%) perceive that they are not adequate. Again, none of the respondents in the university indicated that they are uncertain of their opinion on the adequacy of the windows in meeting their daylighting and natural ventilation needs.

4.4. Environmental Design Consideration Factors Responsible for Enjoying Working in Academic Buildings

To discover if the reasons why he respondents enjoy working in their academic buildings is related to the environmental design consideration factors responsible for achieving user comfort satisfaction, which are lighting, ventilation, sound and indoor air quality, the result obtained in the Bells University of Technology indicated that majority (74%) of the respondents are of the opinion that the adequacy of the variables was responsible for them enjoying to work in the academic buildings. Whereas few (26%) of them think otherwise. None of the respondents are uncertain of their opinion.

Similarly, in Covenant University, majority (62%) of the respondents agree that the adequacy of the variables is a contributing factor to them enjoying to work in their academic buildings. However, some (38%) of them are of the opinion that they do not enjoy working in them due to the inadequacy of the variables. Again, none of the respondents indicated that they are uncertain of their opinion.

4.5. Environmental Design Consideration Factors Responsible for Not Enjoying Working in Academic Buildings

To discover if the reasons why the respondents do not enjoy working in their academic buildings is related to the environmental design consideration factors responsible for achieving user comfort satisfaction, they were asked if poor ventilation, lighting, indoor air quality, sound quality or none of the four variables was responsible. The findings obtained are shown in Table 4.2.

Table 4.2. Environmental Design Consideration Factors Responsible for Not Enjoying Working in Academic Buildings

SN	University	Poor ventilation (%)	Poor Lighting (%)	Poor Indoor Air Quality (%)	Poor Sound Quality (%)	None of the Options Apply (%)
1.	The Bells University of Technology, Ota	8	16	24	0	52
2.	Covenant University, Ota	16	30	40	0	14

The data in table 4.2 indicated that in the Bells University of Technology, majority (52%) of the respondents specified that none of the options provided are applicable to them. This means that most of the respondents are satisfied with the design variables responsible for discomfort in their academic buildings. But out of the four variables that were considered as the possible reasons why the respondents might not enjoy working in their academic buildings, poor indoor air quality ranked the highest with 24% of the respondents agreeing to it as the major cause of their discomfort in the academic buildings. This is followed by poor lighting with 16% and poor ventilation with just 8%. None of the respondents are of the opinion that poor sound quality is the reason why they do not enjoy working in the buildings.

In Covenant University however, majority of the respondents believe that they do not enjoy working in their academic buildings as a result of the inadequacy of the environmental design consideration factors. Out of the four variables investigated, again, poor indoor air quality ranked the highest with 40% of the respondents agreeing that it is the main reason for their discomfort in the academic buildings. This is followed again by poor lighting with 30% and poor ventilation with 16%. Once again, none of the respondents felt that poor sound quality is a contributing factor for them not to enjoying working in the buildings.

4.6. Level of Agreement with Adequacy of Environmental Design Consideration Factors for Achieving Users' Comfort Satisfaction in Academic Buildings

4.6.1. The Bells University of Technology, Ota

The respondents were asked twelve questions relating to their comfort satisfaction level within their academic buildings with regards to the adequacy of lighting, ventilation, sound and indoor air quality. The findings of the investigation are shown in Table 4.3.

4.3. Level of Agreement with Adequacy of Environment Design Consideration Factors of the Bells University of Technology Academic Buildings

SN	Questions	Percentage of Respondents' Level of Agreement				
		Strongly Agree (%)	Agree (%)	Not Certain (%)	Disagree (%)	Strongly Disagree (%)
1.	Lighting in classrooms is adequate	36	22	26	16	0
2.	The indoor air quality in classrooms is suitable for learning	26	30	24	20	0

3.	Ventilation in classrooms is adequate	34	28	24	14	0
4.	There are echo in the classrooms in academic buildings	22	36	22	20	0
5.	Daylighting in classrooms is adequate	44	38	14	4	0
6.	Artificial lighting in classrooms is adequate	28	50	16	6	0
7.	Lighting in offices is adequate	33	48	20	0	0
8.	The indoor air quality in offices is suitable for learning	33	53	7	0	7
9.	Ventilation in offices is adequate	67	13	20	0	0
10.	There are echo in the offices in academic buildings	7	67	20	0	6
11.	Daylighting in offices is adequate	7	40	20	33	0
12.	Artificial lighting in offices is adequate	13	40	33	7	7

The data in Table 4.3 revealed that majority of the respondents considered ventilation, sound and indoor air quality, as well as artificial and daylighting in their classrooms, as been adequate. Out of the variables investigated, daylighting ranked topmost with 82% of the respondents agreeing that it is adequate. This is followed by artificial lighting with 78%. However, when asked about the adequacy of the overall lighting, which is a combination of both artificial and daylighting, a lower percentage (58%) agreed that it is adequate. Sound quality measured by echo and indoor air quality both recorded 56% each, to indicate that they recorded the least percentage behind ventilation that recorded 62%. Though the findings indicated that majority of the respondents consider all the user comfort variables adequate, a significant percentage of them were not certain of their opinion.

Similarly, the data showed that most of the lecturers also attested to the adequacy of all the environmental design consideration factors in their offices, with indoor air quality recording the highest percentage with 87%. This is followed by overall lighting and ventilation with 80% each. Daylighting with 47% adequacy score was the least. However, a significant percentage of the lecturers (33%), are of the opinion that natural ventilation is not adequate.

4.6.2. Covenant University, Ota

The respondents were also asked twelve questions relating to their comfort level within their academic buildings pertaining to the adequacy of lighting, ventilation, sound and indoor air quality. The results obtained are shown in Table 4.4.

4.4. Level of Agreement with Adequacy of Environment Design Consideration Factors of Covenant University Academic Buildings

SN	Questions	Percentage of Respondents' Level of Agreement				
		Strongly Agree (%)	Agree (%)	Not Certain (%)	Disagree (%)	Strongly Disagree (%)
1.	Lighting in classrooms is adequate	32	14	28	26	0
2.	The indoor air quality in classrooms is suitable for learning	22	24	18	32	4
3.	Ventilation in classrooms is adequate	26	16	22	36	0
4.	There are echo in the classrooms in academic buildings	22	32	26	18	2

5.	Daylighting in classrooms is adequate	22	8	22	48	2
6.	Artificial lighting in classrooms is adequate	26	44	14	14	2
7.	Lighting in offices is adequate	20	47	27	6	0
8.	The indoor air quality in offices is suitable for learning	20	27	40	13	0
9.	Ventilation in offices is adequate	20	13	27	33	7
10.	There are echo in the offices in academic buildings	7	33	27	27	6
11.	Daylighting in offices is adequate	7	40	20	33	0
12.	Artificial lighting in offices is adequate	13	40	33	7	7

The results tabulated in Table 4.4 showed that while majority of the respondents considered ventilation (42%), artificial lighting (70%), sound quality (54%) and indoor air quality (46%) as adequate in the classrooms, most (48%) of them indicated that the daylighting is not adequate. Although, majority of the respondents rated the adequacy of the daylighting low, most of them agreed that the overall lighting which is the combination of artificial and daylighting, is adequate. Out of the factors investigated, artificial lighting ranked topmost with 70% of the respondents agreeing that they are adequate. This is followed by sound quality with 54%. However, when asked about the adequacy of the overall lighting, a lower percentage (58%) agreed that it is adequate.

In general, though majority of the respondents agreed that the variables investigated with regards to the classrooms are to a large extent adequate, the percentages recorded are significantly lower than what was recorded in the Bells University of Technology. The percentage of the respondents that believe that the variables are not adequate are higher than the percentage recorded in the Bells University of Technology. But like what was found in the Bells University of Technology, a significant percentage of the respondents were not certain of their opinion. In addition, a significant percentage of the respondents believe that the variables are not adequate. Generally, this result signifies that users' comfort satisfaction level of classrooms in Covenant University academic buildings is lower than what obtains in the Bells University of Technology.

With regards to the offices, the result is similar to what was recorded in the classroom as most of the lecturers also attested to the adequacy of majority of the variables with the exception of ventilation that was considered inadequate. While 33% of the lecturers agreed that ventilation in their offices is adequate, majority (40%) of them believe it is not adequate. overall lighting ranked topmost with 67% of the lecturers agreeing that it is adequate, followed by daylighting with 53%, sound and indoor air quality with 47% each, before ventilation with 33%.

4.7. Main Material Used to Construct Academic Buildings

The study investigated the main materials used to construct the academic buildings to find out if their known characteristics has any effect on the result. The research findings indicated that the academic buildings of the Bells University of Technology are mainly built with clay bricks. Although, difficult to manipulate for aesthetic reasons, clay bricks are not only durable and eco-friendly, but suitable for achieving favorable cool interior conditions that enhances users' thermal comfort level in tropical environments. This suggests why the study recorded a high proportion of user comfort satisfaction level in the university.

In Covenant University however, the academic buildings were mainly built with sandcrete blocks that are rendered with sand-cement screed and painted. This is the way most buildings are built in the study area where majority of buildings are built with sandcrete blocks that are usually strong, durable and easy to manipulate to achieve aesthetically pleasing structures, unlike clay brick buildings. However, the interior thermal comfort condition level of sandcrete block buildings are usually lower

than that of clay or mud buildings, which suggests why the user thermal comfort satisfaction level obtained in the university was lower than what was obtained in the Bells University of Technology where clay bricks were the chief material used to build most of the academic buildings.

4.8. Discussion

Users' comfort satisfaction level is an important area in research used to identify areas for improvements in the design and development of buildings. With academic environment as a focus, this study investigated the comfort satisfaction level of users' in academic buildings of the Bells University of Technology and Covenant University, using the Department of Architecture students and lecturers as the sample size. The response rate of 85% was recorded and this percentage is considered high enough to allow for the generalization of the results as a true representation of the study population.

Based on the first research question of the study, the result obtained on time spent in academic buildings indicated that most of the respondents in both universities spend between 2-7 hours in their academic buildings on a daily basis. In general, few of the respondents spend below 2 hours or above 8 hours. This is understandable because academic activity hours are usually between 2 to 8 hours per day. The time spent on a regular basis by the respondents in the academic buildings is considered sufficient enough for them to be able to provide reliable answers for achieving the aim of the study. Also, majority of the respondents have been using the academic buildings for over a year which was also an added advantage in this regard. Thus, the data supplied by the respondents that led to the results and deductions of the study are considered to a large extent reliable.

The second research question borders on the adequacy level of the windows in the academic buildings which is usually a major parameter for influencing environmental design considerations to achieve users' comfort satisfactory level in buildings. The findings revealed that most respondents are of the opinion that the windows are adequate in both institutions. This is likely to translate to having sufficient daylighting and natural ventilation, which are the two key factors that contribute to achieving visual and thermal comfort respectively, in learning environments. This suggests why in a bid to find answers to the third research question which was to find out if users enjoy working in their academic buildings as a result of the adequacy of any of the environmental design consideration factors, majority of them attributed their enjoying to working in the buildings to none of the variables.

However, a further analysis of the result obtained on the third research question indicated that the environmental design consideration factors needed for enhancing users' comfort in academic environments are to a large extent considered satisfactory by majority of the respondents in both universities. However, to find out which of the variable is the foremost reason for discomfort, a closer analysis of the results revealed that while the design consideration factors for achieving thermal, visual and indoor air quality comfort are considered satisfactory by majority of the respondents in the Bells University of Technology, the reverse was the case in Covenant University. But in both cases poor indoor air quality ranked as the foremost reason for discomfort, followed by poor lighting before poor ventilation. This finding is similar to that of [11] that found that poor ventilation in classrooms and poor indoor air quality were observed in some academic environments. The importance of adequate natural daylighting in academic environment was emphasised by [14] that identified inadequate daylighting as a cause of discomfort and lowering of learning ability. Nevertheless, in both universities, poor sound quality was not considered as an option for causing discomfort to the point that will make the respondents not to enjoy working in the academic buildings. This indicates that the sound quality in the academic buildings is generally conducive for learning.

The investigation carried out to determine the answer to the fourth research question indicated that, majority of the respondents believed that the environmental design consideration factors investigated are to a large extent adequate in the Bells University of Technology. This implies that the user comfort satisfaction level of the academic buildings in the university are generally satisfactory. However, in Covenant University a higher percentage of the respondents considered daylighting in classrooms and ventilation in offices inadequate. This conforms with the findings of [11] that indicated that poorly ventilated classrooms are a problem in academic buildings. Nevertheless, most of the

respondents are of the opinion that majority of the variables are to a somewhat extent, adequate. This is because a significant percentage of the respondents are of the opinion that several aspects of the variables are not adequate, while another substantial percentage were not certain of their opinion. This implies that the user comfort satisfaction level of academic buildings in Covenant University is only moderately satisfactory. Though on a general note, the user comfort satisfactory level is academic buildings in the selected universities is considered reasonable.

On the last research question that centres around the key materials used in constructing the academic buildings, the study found that clay bricks were majorly used for the construction of the academic buildings in the Bells University of Technology, while sandcrete blocks were mostly used in Covenant University. This finding is considered a likely contributing factor to why the Bells University of Technology recorded a higher user thermal comfort satisfaction level than Covenant University. It has been observed in the past that the interior of clay or mud buildings are usually cooler and perform better with regards to enhancing user comfort satisfaction level in tropical climates than buildings built with sandcrete block or stone.

5. Conclusion and Recommendations

The study investigated users' comfort satisfaction level in academic buildings of selected universities in Ogun State, Nigeria, in order to identify areas for improvement towards making contributions that will help to improve users' satisfaction in the development of academic environments. Four key environmental design consideration factors for achieving users' comfort satisfaction were focused on. They include: adequate lighting, ventilation, air and sound quality. The selected universities used for the study are, the Bells University of Technology and Covenant University, both of which are private universities. The sample size of users was selected from the Department of Architecture students and lecturers of the universities.

The study found that majority of the respondents attested to the adequacy of most of the environmental design consideration factors in the academic buildings. However, daylighting in classrooms and ventilation in offices were considered inadequate in Covenant University, even though most of the respondents consider the windows in their academic buildings, generally adequate. Furthermore, majority of the respondents did not attribute discomfort in their academic buildings to any of the environmental design consideration factors, which implies that the factors are to a large extent satisfactory. But in situations where discomfort was attributed to one of the variable, the foremost reason for discomfort generally is poor indoor air quality, followed by poor lighting before poor ventilation. Poor sound quality was not considered as an option for causing discomfort in the academic buildings to indicate that the sound quality in the academic area is generally conducive for learning. In general, though majority of the respondents are of the opinion that most of the environmental design consideration factors are adequate, the percentages recorded in the Bells University of technology in most cases, are higher than that of Covenant University. This implies that though the users' comfort satisfaction level in academic buildings is to a reasonable level, generally satisfactory, the satisfaction level recorded is higher in the Bells University of Technology. This further implies that the environmental design consideration factors were better addressed in the design of academic buildings in the Bells University of Technology than in Covenant University.

The contributions to knowledge of the study include: provision of empirical evidence on users' comfort satisfaction level with lighting, ventilation, indoor air and sound quality of academic buildings in the selected universities, which were to a large extent considered adequate; in cases where one of the environmental design consideration variable was recorded as a contributing factor to discomfort, the study identified poor indoor air quality as the foremost reason, followed by poor lighting before poor ventlation; and the identification of inadequate daylighting in classrooms and inadequate ventilation in offices as the two factors that the users believe they are not satisfied with in Covenant University academic buildings.

Though the study was limited to two universities and opinion of students and lecturers of the Department of Architecture of the institutions, its findings and contributions have a wider usefulness

beyond the scope of the study. Based on the findings, the study recommended that relevant building industry designers should pay more attention to achieving adequacy in areas found to slightly fall short of users' comfort satisfaction level such as, indoor air quality, lighting and ventilation in academic environments. This should be done without compromising paying attention to achieving adequate sound quality that was found to be generally satisfactory.

Based on the geographical limitations of the study, similar studies should be conducted in other universities in Ogun State to enable the generalization of the results. Such studies could be extended to other academic institutions in Nigeria and around the globe. Further studies should also be carried out to find out the extent to which building materials and finishes influence users' comfort in academic buildings, towards discovering more areas for further improvement on issues bordering on users' comfort satisfaction in the development of academic environments.

6. Acknowledgements

The authors appreciate Covenant University management for providing the required resources to conduct this research. The authors also express gratitude to those that supplied data that was used to carry out this research in the Bells University of Technology and Covenant University. Additionally, researchers whose works were consulted while establishing the background that laid the foundation for the study and the anonymous reviewers whose review comments contributed to improving the earlier version of this paper, are also appreciated.

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