Contributions of roof covering material to Acoustic and Thermal Effect on Learning Activities in Institution Buildings in Nigeria

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Abstract: **The material that makes up the institution buildings for learning activities must meet the required standard for temperature and sound level, else, learning process and the end-users will be affected. Meanwhile, aluminium material that has gained incessant usage as roof covering material for institution buildings in Nigeria is known to be poor insulator of sound and heat. This study, therefore, investigates the contribution of roof covering materials to the acoustic and thermal effect on learning activities in institution buildings with a view to improve the learning environment and health of the end-users in Nigeria. The buildings studied are the lecture halls, library, and student hostel. Using the Krejcie and Morgan (1970) table, a total of 384 sample sizes drawn with the questionnaire were administered, and the number returned and filled was analysed using chi-square and regression analysis. The findings show the disadvantage of aluminium roof covering that includes sound interference during learning activities, diverted attention among students and reduced teaching ability of the teacher or instructors mostly in both the lecture hall and the library. In addition, the material's poor heat insulation nature causes increased sweating and headache. Therefore, recommendations that can sustain the available material best fit the available cost were made based on the study research findings.**

*Keywords***: Acoustic, Institution building, Nigeria, Roofing sheet, Thermal effect.**

I. INTRODUCTION

The standard temperature for learning infrastructures is between 25-27 degrees Celsius (Miller, 2011); when this level is passed in the indoor environment, it causes excessive sweating, confusion, annoyance, increased body temperature, sunburn, and other cardiovascular adverse effects (Gascho, 2006) to users. Also, the standard noise level is between 30-45dB, depending on the characteristics and function. When sounds are above the normal level, they can result in hearing impairment, hypertension, annoyance, ischemic heart disease annoyance, and sleep disturbances, among others. In learning environments, studies show that learning activities are affected due to user interference in sound, increasing user fatigue, and difficulty recognizing speech sources that lead to frustration in students (Bradley and Sato, 2008). Generally, several building components have acoustics and thermal properties depending on the type of materials or finishes used for the components. The component of a building that has an acoustic and thermal influence on its interior includes floors, walls, eaves, windows, doors, ceilings, and roofs. For instance, windows have many types, and each has different acoustic and thermal properties. The main determinant of thermal and acoustic properties is the materials used for building construction and finishes (Stewart, 2015).

This study investigates the effect of the roof covering material used for the learning environment in the Federal Higher Education Institutions in Nigeria. There are two mains seasons in Nigeria: the rainy and dry seasons (NIMET, 2010). The roofing materials used by institutions behave differently during these seasons. In most of South-West Nigeria, zinc roofing sheets were commonly used in the early centuries due to their affordability, durability, availability, history, and technical know-how (Arenibafo, 2017), but the use of aluminium roofing sheets took over in the nineteenth century due to its attractive aesthetic nature and cost consideration (Amusan, 2016). Other common materials include tiles, asbestos, and asphalt shingles (Arenibafo, 2017). Since aluminium is a metal and responds through contraction to heat and is poor in sound insulation (Nosko and Kováčik, 2017), its use in university buildings will affect the learning process (Woolner, 2010). Therefore, this study aims to investigate the effect of this aluminium roof material on the acoustic and thermal condition of the learning facilities of the Federal University in the south-west Nigeria to improve the academic output and health status of users.

II. LITERATURE REVIEW

Tertiary institution-building infrastructures profoundly impact teaching and studying outcomes (Zannin, 2009). Building infrastructure affects trainer recruitment, retention, commitment, and effort, while the trainee is affected in health, behaviour, engagement, learning, and achievements (Zannin, 2009). The major importance of infrastructures in universities includes supporting users' behaviour, increasing learning results, increasing users' motivation, increasing attendance, and completion of academic cycles, and helping to protect users against weather conditions and environmental hazards.

However, building elements such as windows, doors, ceiling, eaves, floor finishes, and roof materials contribute greatly to academic activities. The materials used for these building elements determine the level of noise and thermal comfort that is incurred in such spaces (Menon 2010). All elements of the roof, such as external cladding of tiles or metal sheeting, foil sparking, airspace above the ceiling, insulation, and ceiling material, play a role in limiting some elements of weather from being incurred in the building, such as unwanted sound from precipitation and heat from increasing temperature (Stewart, 2015). However, the most important single item is the roof covering material. Building environments go a long way to determine the student's reaction to learning (Gilavand, 2016). To investigate the best sound and thermal comfort needed in those spaces, the properties of the materials that protect them must be checked.

Tertiary institutional building infrastructures profoundly impact teaching and studying outcomes (Zannin, 2009). Several factors determine the impacts that the building of tertiary institutions provides its users, including the removal of unwanted sound, protection from animals, easy audibility due to its enclosure, and thermal comfort for wind control. Quietness and thermal comfort are the most important factors in learning. A quiet environment is an environment free from background noise such as rain noise, thunder sound, car horns, while an environment is said to be thermally comfortable when excessive and constant heat is not incurred in the infrastructure; this can be caused by poor ventilation, use of thermal conducting materials which helps transmit heat from external environment to the internal, overcrowding of building users, and poor building orientation.

The lack of quietness and thermal comfort in educational facilities will negatively influence user performance. Infrastructures that are constantly exposed to unwanted sound and thermal comfort expose users to some bad features such as speech interference, lack of concentration, annoyance, increased sweating, confusion, irritation, and increased body temperature. Studies have shown that noise and heat are the major disturbances in the learning process. For instance, when there is rain during a lecture hour, the lecture tends to be completely disrupted because the noise generated from the roofs distorts communication. This is common in the rainy seasons, and during hot weather, you see people in these facilities using their books as fans due to the presence of heat. For this to be controlled, it must be studied.

The noise of raindrops falling on an aluminium roof is incomparably greater than the noise caused by raindrops falling on other roofing covering materials (Woolner, 2010). Therefore, it is disturbing for people and the activities inside the building. The noise caused by the raindrops falling on the aluminium roof surface spreads throughout the metal construction and finds its way into the room. Furthermore, noise activities are particularly problematic in closed aluminium constructions, where sounds amplify significantly. This is because of metal sheets' poor sound absorption capability of metal sheets, which causes echo in a room.

Acoustic became a part of science in the early 19th century through the intervention of Wallace Sabine to investigate the human behaviour within the Fog lecture hall located inside the museum to rescue the hall from terrible echo and make it comfortable for the lecture. Due to the many research works achieved; the standard level of sound (dBA) required for learning building infrastructures has been evaluated (Table 1). As shown in table 1 below, the standard level of sound for lecture hall is 35dBA while that of libraries and hostels are 30dBA respectively.

Table 1: The standard noise level in selected spaces

Building Spaces	**Standard Noise Level (dBA)**
Lecture Halls	35
School libraries	30
School Hostels	30

Source: **ANSI** (2010)

The learning environment provided by a school should be understood as resulting from a complex and dynamic relationship between the various physical elements and the attitudes and actions of the different users who make up the school community. Therefore, although a narrow focus may aid in the identification of problems in the physical setting, any attempt to improve the environment and facilitate better learning will require a wider perspective (Higgins, 2005). Studies and research have shown that noise directly negatively affects student learning, particularly reading development. According to Larsen and Blair (2008), what interferes the most in a classroom is the signal-to-noise ratio (SNR). The more positive it is, the better the listening situation offered to the students will be. The closer it is to zero or negative, the worse it will be for the students to understand the teacher's speech, which means that the elucidation of this relationship is important. A noisy classroom influences students' attention, memory, and motivation, and the teacher's health status by raising voices beyond the limit. Vitásková, Jehličková, Šebková, and Keprdová, (2014) discovered that the teacher belongs to a group that uses the voice professionally and that needs to have special care, including the attainment of educational programs focusing on the prevention of vocal problems (Russel et al., 2007). Akinbode et al. (2014) posits that constant raising of voice or forceful increase in voice by teachers can lead to voice disorders, reducing speech intelligibility and becoming aesthetically unacceptable, bringing social and economic harm. Therefore, it is crucial to address background noise in classrooms so that both students and teachers may learn and work in a healthy environment.

Very high levels of sound pressure may burst the eardrum, causing immediate damage to the middle ear structure and permanently and instantly damaging hair cells in the inner ear. Long-term exposure to high sound levels may destroy the inner ear's hair cells, resulting in cochlear hearing loss (salvi et al., 2017). In studies in which the level of exposure to sound was known, a clear relationship was observed between the increasing incidence of hearing loss and the increasing level of exposure to sound (Chen et al., 2017). Sudden changes in acoustic surroundings may activate several physiological systems leading to such changes as an increase in blood pressure and circulatory effects (Borg 2008). For instance, Reybrouck (2019) and Münzel, et al (2019) recently found that workers exposed to sound levels exceeding 80dBA had increased blood pressure. Some other studies show an effect on levels of noradrenaline and adrenaline (Ising and Kruppa, 2004).

Speech communication interference is of special interest in school settings, as daily activities in the classroom are based on communication and concentration. Emanuel (2008) reports that students spend about 45% of the school day engaged in listening activities. Talk is used to organize classroom settings, initiate, and facilitate learning situations and constitute the framework for classroom organization and management (McSporran, 2004). Noise and libraries are mutually exclusive. Library spaces require attention. Dealing with noise is the most fundamental way of checking this measure. In any library, regardless of its location, a quiet environment is required both within and outside the environment to provide a measure of reading comprehension. There is a need to study the effects of noise in library users to know the impacts and effects on the users. However, in a noisy library, the readers tend to leave the library for a classroom or use it for other purposes other than reading, especially when there is external noise. So, designers should consider sound control to ensure that users are comfortable within the design.

The various impacts of noise in students' hostels include auditory and non-auditory effects, which cause fatigue, prolonged noise leading to deafness, psychological changes, mental disturbances, irritation, and restlessness in the room users. (Stansfield, 2005). Studies have shown that high temperature harms memory ability (Pilman, 2009). According to Psych Central, high humidity levels, usually accompanied by hot weather, reduced concentration scores while increasing sleepiness. A heatwave with high humidity can sometimes cause us to feel like we are lacking energy, decrease memory ability, and even lose focus.

III. RESEARCH METHODOLOGY

The study was carried out at the Federal University of Technology, Akure in Ondo State, Nigeria. The institution is selected due to its popularity, accessibility, and size. Akure, the state capital of the Ondo state, is a Nigerian city located in the southern part of Nigeria (Plate 1-3). It is a more developed city in Nigeria. The town is an important junction linking the Nigerian towns of Ikare, Ilesha, Ilawe, Ila, and Ado. The climate is hot and humid, influenced by rain-bearing southwest monsoon winds from the ocean and dry northwest winds from the Sahara Desert. The rainy season lasts from April to October, about 1524 mm per year. Temperatures vary from 28 °C to 31 °C, with a mean annual relative humidity of about 80% (NIMET, 2010).

Akure is the largest state in Ondo state, with 484,798 from the 2006 population census. It is the centre of trade for a farming region where cocoa, yams, cassava, corn, and tobacco are grown. The city hosts many Federal schools at the three levels of academic knowledge in Nigeria: primary, secondary, and tertiary institutions. The Federal University of Technology, Akure (FUTA) used for this study was founded in 1981 under a drive by the government of Nigeria to create universities that specialized in producing graduates with practical and theoretical knowledge of technologies. The school is ranked 11th best university and second-best university of technology in Nigeria. Considering the major routine that a student needs to succeed academically, FUTA is one of the few universities qualified for that due to well-planned learning environments (plate 4).

Plate 1: Map of Nigeria

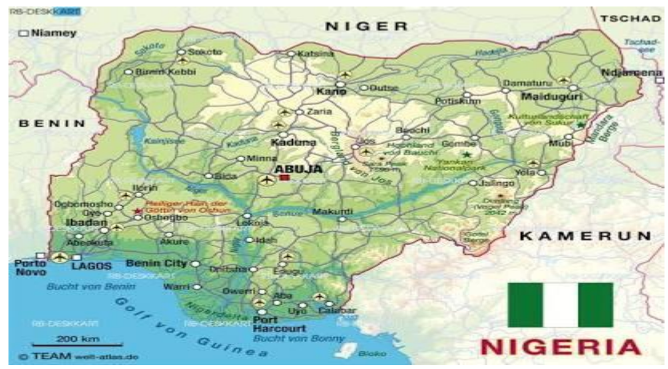
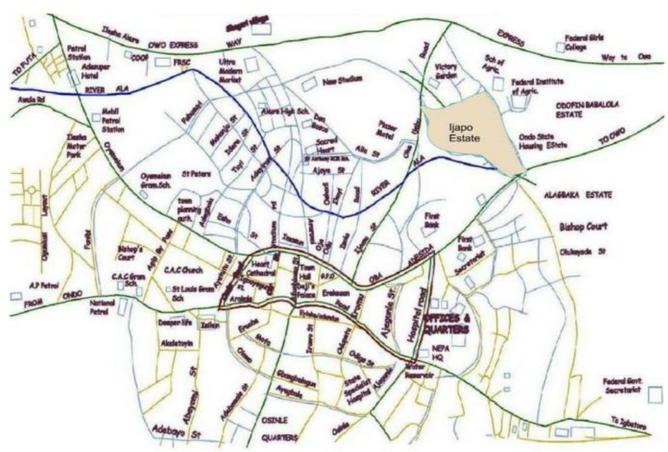


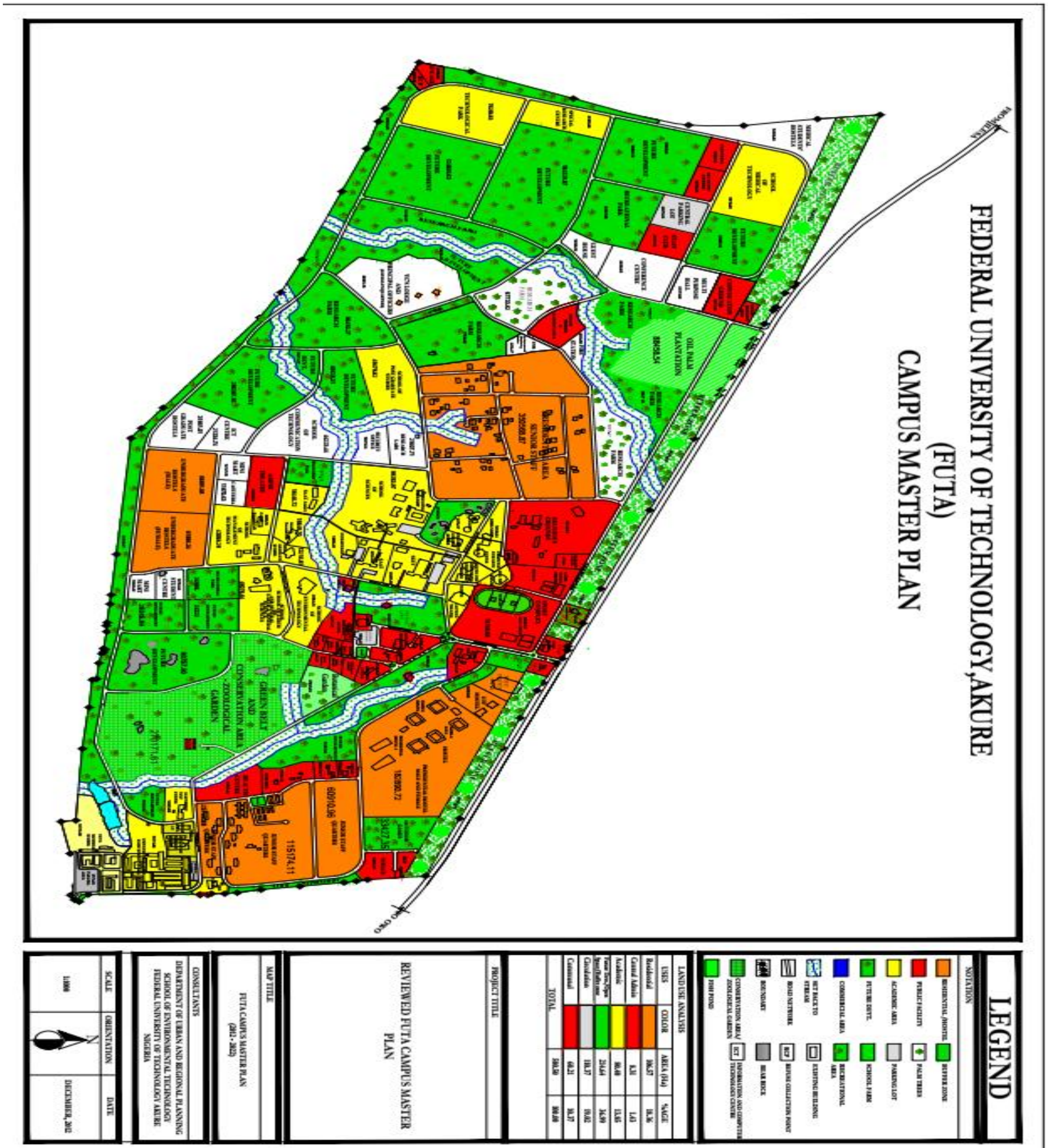
Plate 2: Map of Ondo state, Nigeria

Plate 3: Akure street map, Ondo state



Source: Google Maps

Plate 4: FUTA Master plan



The targeted population were students at the Federal University of Technology, Akure, and the lecture halls, hostels, and library studied. A total of 384 questionnaires were administered to the buildings under study users using Krejcie and Morgan (1970) table, which shows the universal minimum returned sample size scale for continuous and categorized data.

All 288 questionnaires returned were used for the analysis. The questionnaire consists of 51 variables in question format, succinctly coined in a short and simple form, avoiding ambiguities. The data collected from the respondents were subjected to both descriptive and inferential statistics. Descriptive statistics were used to show the frequency and percentile distribution of the study results. Furthermore, chi-square and regression analysis were the inferential statistics used to demonstrate whether there is a significant relationship between the identified challenges and the choice of roof covering materials used for the buildings under study. Additionally, the process of articulating this research information was provided based on secondary forms of information derived from existing literature such as books, publications, magazines, journals, and past thesis reports.

IV. RESULTS AND FINDINGS

Level of heat control

Table 2 shows the frequency distribution of the roof cover used in FUTA. About 66% of the lecture halls building was covered with aluminium sheets, 58% of the hostel was asbestos. Also, the library is covered with an aluminium roof sheet. The findings show that most of the lecture halls, hostels, and libraries covered with aluminium sheets were built within the last two decades, and those with other roof covering materials were the building the school started with. Nevertheless, some of the old buildings the school started with have also been renovated over time and re-roofed with aluminium roof covering.

Table 2: Roof Covering Materials

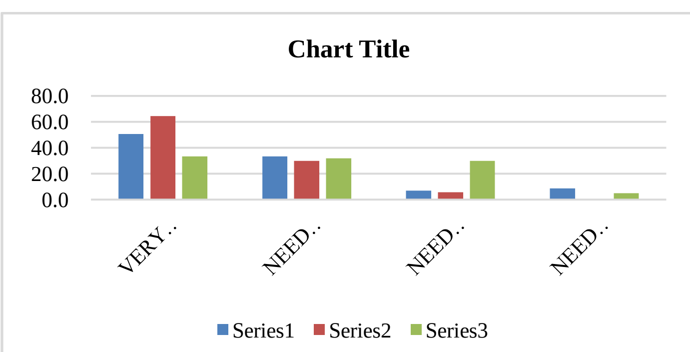
Roof Type	Lecture halls		Hostel		Library	
	Freq.	%	Freq.	%	Freq.	%
Aluminium sheet	192	65.6	110	37.7	280	100
Asbestos	82	28.6	165	57.9	8	0
Clay Tiles	11	3.7	13	4.5	0	0
Asphalt shingle	3	2.4	0	0	0	0

Furthermore, the internal ceiling finish was considered for the lecture rooms, the hostel, and the library understudy, as shown in Table 3. For lecture halls, 57.7% use suspended ceiling, 20.8% PVC, 13.0% asbestos slate, and 8.5% concrete slab. For the hostel, 76.5% is asbestos, and 9.6% is PVC. A suspended ceiling was used for the reading areas in the library and PVC for the attached offices in the library. In addition, the condition of the ceiling in the building was examined and the result is as shown in figure 1. The figure shows that about 51% of the ceiling in the lecturer hall is in good condition; while 33%, 7%, and 8.7% require minor repair, major repair, and total replacement respectively. The library was recently expanded due to the increase in the number of students it needs to accommodate. So, every necessary renovation was done along with the expansion. For hostels, 33.4% are in good condition, while 31.8%, 29.8% and 4.6% need a minor repair, a major repair and total replacement respectively.

Table 3: Ceiling types

Ceiling Types	Lecture halls		Hostel		Library	
	Freq.	%	Freq.	%	Freq.	%
Asbestos	38	13	225	76.5	92	32.4
Pvc	64	20.8	27	9.6	65	22.4
Suspended ceiling	179	57.7	26	9.3	124	42.8
Concrete slab	7	8.5	10	4.6	7	2.4

Figure 1: Condition of ceiling types



4.1 Challenges of roofing materials

The noise implications of the choice of roof covering material used for hostels, lecture halls, and the library on end users were further investigated. Table 4 below shows the frequency distribution and classification of the impact of unwanted and disturbing sounds emanating from the roof cover finish during the dry season (through a contraction) and the rainy season (being a poor acoustic material). From the findings in the table, speech interference diverts readers' attention and reduction in teaching ability with mean scores 4.53, 4.45 and 4.44, respectively, were ranked among the first three consequences of the roofing sheet material, while the least ranked are sleep disturbances, dizziness, and increased blood pressure with mean scores of 3.91, 3.67, and 3.48, respectively.

Table 4: Noise Impacts on Learning

Noise impacts	SAG	AG	NS	DAG	SDAG	M.I. S	RANK
Cause speech interference	184	81	22	1	0	4.53	1
Divert attention of reader	158	110	19	1	0	4.45	2
Reduce teaching ability	170	101	11	5	2	4.44	3
Decrease learning ability	137	144	7	0	0	4.43	4
Cause audible discomfort	160	106	20	2	0	4.42	5
Lead to user's lack of concentration.	132	140	13	3	0	4.34	6
Reduce relaxation	89	167	24	6	2	4.13	7
Cause hearing loss	137	107	22	12	10	4.11	8
Increase playful act	89	170	17	10	2	4.08	9
Can cause annoyance and frustration	89	131	57	11	0	3.97	10
Suffering from sleep disturbances	88	126	61	11	2	3.91	11
Cause dizziness in users	93	96	52	16	31	3.67	12
Increase blood pressure	65	70	101	48	4	3.48	13

Furthermore, the relationship between the material used and the first three ranked effects was investigated using the chi-square as shown in table 5. From Table 5, the results show that there is a significant relationship between the three highest-ranked noise impact (speech interference, diverted attention and reduced teaching ability) and the roof covering used for the lecture hall (Chi-square = 71.585, p-value = 0.0001; 25.031, p-value = 0.003; 90.540, p-value = 0.0001), and the library(Chi-square = 23.983, p-value = 0.004; 64.484, p-value = 0.0001; 37.957, p-value = 0.0001). Since the p-value < α = 0.05 for lecture halls and the library, the null hypothesis (H_0) was rejected.

Regression analysis was also performed to measure how well the model fits the actual data. The R-squared result shows that 83.4%, 62.3% and 72.3% of the variance found in the response variable (type of roof covering) can be explained by the predictor variables, which shows that the model is good for predictions.

Table 5: Noise impacts through roof used

	Lecture halls		Library		Hostel	
	λ^2	P value	λ^2	P value	λ^2	P value
Speech interference	71.585[a]	0.0001	23.983[a]	0.004	9.736[a]	0.136
Diverted attention of the reader.	25.031	0.003	64.484	0.0001	21.080	0.002
Reduce teaching ability	90.540	0.0001	37.957	0.0001	12.836	0.118
R-square	0.834		0.623		0.723	

Similarly, the heat impact of the choice of roof covering material used for hostels, lecture halls, and the library on end users was also investigated. Table 6 below shows the frequency distribution and classification of the impact of heat emanating from the roof cover finish in both seasons. From the findings in the table, the reduction in teaching ability, increased sweat and headache with mean scores of 4.48, 4.47, and 4.46, respectively, were ranked among the first three consequences of the roofing sheet material. The least ranked are cool pale, clammy skin, increased blood pressure, and dark-coloured urine with mean scores of 3.27, 3.22, and 3.10, respectively.

Table 6: Heat Impacts on Learning

	Strongly agree	Agree	Not sure	Disagree	strongly disagree	MIS	RANK
Reduce teaching ability	170	112	11	7	0	4.48	1
Increase sweating	151	142	3	4	0	4.47	2
Cause headache	131	127	39	3	0	4.46	3

Lead to user's lack of concentration	132	134	34	0	0	4.33	4
Divert attention of reader	137	127	23	13	0	4.29	5
Reduce relaxation	109	143	48	0	0	4.20	6
Cause dizziness in users	113	119	63	5	0	4.13	7
Can cause annoyance and frustration	110	135	31	24	0	4.10	8
Loss of consciousness	127	58	74	31	0	3.97	9
Cause heat edema	102	76	116	6	0	3.91	10
Affect academic progress	97	132	32	19	20	3.89	11
Cause muscle cramps	80	105	90	25	0	3.80	12
Causes fatigue	81	97	96	22	4	3.76	13
Cause confusion	87	84	71	53	5	3.65	14
Cause rapid pulse	33	82	162	23	0	3.42	15
Cause cool pale clammy skin	30	55	181	34	0	3.27	16
Increase blood pressure	39	60	130	71	0	3.22	17
Cause dark coloured urine	6	40	233	21	0	3.10	18

Furthermore, the relationship between the first three rated effects was tested against the hostel buildings, the lecture hall, and the library as shown in table 7. The chi-square analysis shows that calculated value is 147.627[a], 65.641, 72.356 (p-value = 0.0001). Since the p-value < α = 0.05, the null hypothesis (H_0) is rejected, thus showing that there is a significant relationship (H_1) between the type of roof material used in the hostel and the impact (reduce teaching ability). That is, the type of roof material used in the university hostel may determine if there is a reduction in teaching ability in lecture halls, library and hostel or not. Furthermore, in table 7, the regression analysis shows the R-squared result at 86.8%, 69.4%, and 87.1% of the variance, respectively. This shows that the model is good for predictions.

Table 7: Heat impacts through roof used

	Lecture halls		Library		Hostel	
	λ^2	P value	λ^2	P value	λ^2	P value
Reduced teaching ability	173.864[a]	0.0001	65.641[a]	0.0001	73.965[a]	0.0001
Increases sweating	48.333	0.0001	28.189	0.001	42.920	0.0001
Headache	23.251	0.006	48.578	0.0001	11.344	0.078
R-square	0.868		0.694		0.871	

V. DISCUSSIONS

The result of this study reveals the roof covering material that dominates most of the existing buildings within FUTA to be aluminium roofing sheet. It shows that the buildings for learning process exhibit same interior traits in terms of its advantages and challenges to academic activities. The findings show that speech interference, diverted attention and reduced teaching ability are ranked the most among the challenges exhibited by the buildings for learning process in FUTA. This was found to have a significant relationship with the roof covering material used for the buildings, especially in the lecture halls and the library. The result substantiate the findings of Woolner (2010) who posits that the use of aluminium material will affect learning process. Although, Nosko and Kováčik (2017) has reported the material to be poor in sound insulation, Amusan (2016) posits that the material cost effectiveness that fits into the under financed situation in the Nigeria universities could have encouraged its viral usage. A similar study by Larsen et al (2008) posits that the students' ability to understand teachers' speech will worsen when the signal to noise ratio is negative. The teachers' would want to raise their voices to augment the anomalies, and according to Akinbode and colleagues (2014), this could result to voice disorder, reducing speech intelligibility and socioeconomic harm. So, it can be concluded that the students and teachers using the learning facilities in FUTA are disadvantaged and their health are endangered with the use of the material. Considering the economy of the country, further studies might need to look into a better way of insulating aluminium material or devise an alternative material that will be cost efficient and readily available with uncomplicated technical know-how.

According to Woolner (2010), aluminium roof sheet is not just a poor acoustic materials, but also create a thermal effect being a heat conductor. The level of heat emitted into the interior is, however, regulated using good thermal material for ceiling covering. In FUTA, this study found that half of the university halls have suspended ceilings used for their ceiling finishes and are in good condition. Others require a minor or major renovation. For hostel, the asbestos that is mostly used is, however, in bad condition enquiring minor or major repair. The suspended ceiling is made of wood particles that can help to contain heat to a great extent. This helps to regulate the level of heat rise in the library and lecture hall, thereby reducing the need for passive cooling of the interior. However, lecture halls with damaged ceiling finish due to slack in the hanger holding the ceiling or poor construction work suffer great heat penetration into their interior spaces. Although asbestos material is also a good insulating material, its poor state subjects the interior spaces of the hostels to a high level of internal temperature. Also, the poor heat insulation nature of the material results in increased sweating and headache. Consequently, research shows that aluminium sheets are not a good insulation and soundproofing material. However, heat and sound could be controlled using heat and soundproof ceiling finish materials such as wood or suspended ceiling. Therefore, when the roof covering material that is good in insulation and soundproofing is unavailable, probably due to cost or inaccessibility, an alternative should be sorted using good heat and sound insulation ceiling material. However, poor construction work or lack of maintenance can make the combination of these two materials ineffective.

VI. CONCLUSIONS

This research investigates the level at which roof covering materials contribute to the increase or decrease in the level of noise and heat in the interiors of libraries, classrooms, and lecture halls. This was done to aid decisions about the choice of construction materials for academic buildings considering their acoustics and thermal effect on the learning process. The study results show that aluminium roofing sheet is mostly used as roof coverings due to its cost effectiveness, availability, and easy technical know-how. The study also show that suspended ceiling was majorly used for ceiling finish in the building infrastructures in FUTA. However, the findings show the disadvantage of aluminium roof covering to include sound interference and diverted attention to the students, and reduced teaching ability of the teacher or instructors in both the lecture hall and the library where major learning activities take place. As discovered in this study, the poor thermal performance of aluminium material was complemented with the use of a suspended ceiling finish which is relatively a good heat and sound insulator. Meanwhile, poor construction and lack of maintenance have led to different openings in the roof where the heat contained within the roof sheet and the ceiling finish gain open access to the interior space of the education building infrastructure.

However, this study neither reveal the extent by which the heat and sound penetrate the building interior and the consequence on the physical health of the end-users of the building. Similarly, the extent at which the suspended ceiling covering used helps to reduce the effect of heat and need for passive cooling in the interior was not captured by this study. Therefore, further study is needed to know the extent of effect the aluminium material has on the health and wellbeing of the end-users of the institutional buildings in Nigeria. Nevertheless, based on the findings in this study, this study recommends improvement on maintenance culture in the tertiary institutions so that damages in any part of the building can be fixed in due time. Also, further study can be carried out to discover an alternative roof covering material that are cost-friendly to lessen the disadvantages in the use of aluminium material. On the other hand, an intensified research study can be carried out on how the cost of clay tile material, which has been rated as a better roof covering for learning infrastructures due to its high acoustic and thermal properties, can be made more economically friendly.

Declaration of Conflicts of Interest

This study was solely produced and sponsored by the author. So, there is no conflict of interest.

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