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Assessments and Control of Anthropogenic Noise Pollution in Students' Residential Areas in Ogbomoso

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Abstract

Increased rate of noise-associated risk factors such as speech interference and reduction in productivity, necessitated that control and regulation measures be put in place, to contain anthropogenic noise pollution in the students' hostels. Therefore, this study assessed the various anthropogenic sources of noise pollution in students' hostels and developed a Sound Level Monitor and Control (SLMC) device. 1250 undergraduate students across 5 students' residential zones were sampled for demographics and investigations were conducted into respondents' perceived medical history, identification of noise sources, and evaluation of hearing loss. Effects of noise levels were evaluated using 100 respondents' rooms per zone following standard procedures, considering Sound-System-Only (SSO), Generators-Only (GO), and combination of Sound-System-and-Generator (SSG), loud-conversations, etc., as sources of noise. However, a noise control device incorporated with a circuit breaker was developed. The respondents were 51.2% male and 48.8% female, with 58% in the age range 18 – 27 years. The medical history showed that 1.2 and 6.4% had a hearing problem in short and long times, respectively, while 43.6% affirmed that SSO was a major noise pollution causal factor. SSO, GO, loud conversations, traffic, and grinding machines were identified as the prominent sources of anthropogenic induced noise. The minimum average SL result gave a value of 62.8400dB for both ventilated and unventilated rooms, which is 14% above 55dB threshold value recommended by the National Environmental Standards and Regulations Enforcement Agency. The developed SLMC device gave notification at the SL above 55dB for 15 seconds before disconnecting the sound system if not regulated.

Keywords: Anthropogenic; Pollution; Noise; Exposure; Microcontroller.

Introduction

Noise is an unwanted sound considered unpleasant, extremely louder than threshold limit, or highly disruptive to hearing. It is when noise becomes unusually loud and uncontrolled that it diminishes the quality of air and adversely affects the environment, public health, and welfare (Goswami *et al.*, 2018; Hakeem, 2014). Thus, the unacceptability of noise due to the stated conditions makes it generally regarded as one of the prominent environmental pollutants with a very high probability of causing adverse effects. It results from vibrations through media such as air, water, and human activities among others. The term anthropogenic is regarded as man-made, therefore means that anthropogenic noise pollution is an undesired sound generated mainly due to human activities.

Pollution is the introduction of contaminants into the natural environment which in turn causes adverse effects, instability, disorder, harm, or discomfort to the ecosystem i.e., physical systems or living organisms. According to Ibekwe *et al.*, (2016), noise pollution is practically defined as the propagation of noise with varying degrees of impacts on the wellbeing and activities of man or animals, most harmful. Over the years, it has been reported to pose a major environmental threat mainly resulting from robust transport systems, industrial development, and urbanization (WHO, 2011). The most common sources of anthropogenic noise pollution in urban areas include; inter-alia appliances, neighbourhood electrical appliances, TV and music systems, public address systems, railway, and air/road and vehicular traffic activities, commercial motorcycle operation, pressure horns, mixer grinder, pressure cooker, vacuum cleaners, washing machine and dryer, cooler, air conditioners, defense equipment and launching of satellites, social events, religious worship institutions, machinery, construction/industrial activities and power generating sets as well as miscellaneous sources such as automobile repair shops, market places, schools, colleges, bus stands, and railway stations, etc. (Oviasogie and Ikudayisi, 2019; Hakeem, 2014; Akinyemi and Usikalu 2013).

World Health Organization (WHO, 2011) stressed that noise pollution has associated risk factors due to exposure to its high levels for which the repercussion may be too severe to bear, such that, they could lead to speech interference, reduction in productivity, high blood pressure, (Potgieter, *et al.*, 2018; Zijlema, *et al.*, 2016), hearing defects, health disorders, sleep interference, cardiovascular effects, loss of concentration and absenteeism (Oguntunde, *et al.*, 2019; Hossain, *et al.*, 2013), tinnitus, temporary/permanent threshold shifts, sleep/reading disturbance, uncoordinated thinking as well as fatigue, sometimes permanent loss of memory or psychiatric disorder (Ajayeoba, *et al.* 2021; Farooqi, *et al.*, 2017). Like every other place where noise is being experienced, students' residential areas are not exempted since they are an integral part of the microenvironment because, asides that the lecture sessions are mainly held in the school premises which is an avenue for cognitive, creative, and social development of students, students hostels are also places where students retire after the school activities to rest and to have an overview of what had been taught as well as to groom for personal and self-development. It is reported that students' residential areas are encouraged to be kept in serene conditions for physical, easy assimilation, and intellectual development, including control of excess environmental noise (Godson et al., 2009). The measuring unit of noise levels are in decibels (dB) and thus, one decibel is the threshold of hearing such that as being reported, approximately 60 dB is the level of normal talking (Usikalu and Kolawole, 2018 Elmenhorst, *et al.*, 2014). According to Berglund, *et al.*, (2000) world health organization, WHO stated that the permissible noise level in school environments should not exceed 35 dB, which students' hostels are assumed to share since they also embrace learning, reading, and group discussion activities after the usual day lectures, and despite that, students' hostels are close to the main campus. Therefore, exposure for more than six hours a day to sound more than 85 dB is potentially hazardous to health (Parida, *et al.*, 2010; Godson, *et al.*, 2009). It is reported that, in developing nations such as Nigeria, many students do not have access to conducive, good, and quality hostels due to anthropogenic activities in such environments, and these have posed great challenges to researchers.

The direct proportionality of the fast-growing population of the world and that of noise pollution has called for a concerted effort by academics, researchers, government, and indeed all stakeholders in the business of maintaining good and adequate living of the populace, to containing the increased rate and spread of noise pollution because of the accompanying adverse effects. Thus, several studies had previously been conducted on different types of groups towards assessing and evaluating the impacts of noise levels and their implications; such as sawmill workers, occupants of industrial hubs, wheat processing workers, secondary school students, occupants of municipals, textile company workers, neighborhood residents, etc. (Forida, *et al.*, 2020; Ajayeoba, *et al.*, 2021; Farooq, *et al.*, 2019; Akinyemi, *et al.*, 2019; Ibrahim, *et al.*, 2014; Godson, *et al.*, 2009; Ibekwe, *et al.*, 2016), Although some of these studies reported detrimental effects of noise pollution on various groups, yet, many did not proffer adequate means of controlling the hazardous effects, asides that, there is a paucity of information on the study area considered in this study. Therefore, this study aimed at conducting investigations into the effect of anthropogenic noise pollution in students' residential areas in Ogbomoso and subsequently proffered appropriate control measures to contain the spread.

Materials and Methods

This study was carried out in Ogbomoso (located on latitude and longitude of 8.1227° N and 4.2436° E respectively) metropolitan city of southwestern Nigeria, which hosted the Ladoke Akintola University of Technology. A descriptive survey approach was adopted for data collection using a questionnaire well-structured into 5 sections. 1250 undergraduate students across the study area were sampled for demographic information using the questionnaire and investigations were conducted into different hostel activities. These were in the forms of perceived medical history about the respondents, identification of noise sources by the respondents, and evaluation of hearing loss. Noise level data were collected in each room, at 15 minutes intervals (according to Orola and David, 2019) between 4 pm and 12 am (which was observed to be the peak of the noise period in the hostels) daily using Extech 407732 Sound Level Meter (SLM) through a period of 12 weeks during an academic session (harmattan and rainy seasons inclusive). The SLM measures from 35 to 130dB with an accuracy of plus or minus 1.5dB and was pre-set to 'A' Weighting and fast response, (as recommended by Concha-Barrientos et. al. (2004), Sawant and Bhave (2014), and Hassan et. al. (2018)), to take note of the fast-changing nature of noise levels.

One hundred (100) samples (respondents' rooms) were considered in each of the five areas where students' hostels were located: Under-G Area (Zone 1), Adenike Area (Zone 2), Yoaco Area (Zone 3), Stadium Area (Zone 4), and General Area (Zone 5). The preferred music was played using the sound system at a preferred volume by each of the respondents in their respective rooms and the sound measurements were taken. The SLM readings when: the doors/windows closed and when doors/windows were opened, were taken and recorded. This process was followed for rooms with the Sound System Only (SSO), Generators Only (GO), and those with the combination of Sound System and Generator (SSG). Also, readings were taken at hostels close to the following: a busy road, grinding machine, and viewing centers. All the readings were taken in triplicates and the averages were taken as the true values. However, a noise control device with a circuit breaker incorporated was developed for use in students' hostels and indeed other places where noise level needs to be controlled and regulated. The device employed the use of Arduino microcontroller board, sound sensor as well as jumper wires connected in line with implementation codes.

Sound level data collection and analysis

The equivalent continuous sound level (L_{eq}) was measured directly by the SLM as digital numerical, showed values that stabilized after about 30s (Ajayeoba, *et al.*, 2021). The SLM was designed to be hand-held such that the microphone attached to the SLM faced the catchment of the sound source and simultaneously very close to the respondent since the effect of noise level on the respondents is one of the major objectives of this study. The average noise pollution levels were then calculated using Equation 1 (Ajayeoba, *et al.*, 2021) and compared permissible noise exposure time per day in Table 1. Data collected were presented on an excel spreadsheet in preparation for analyses. Descriptive statistics in the forms of mean, standard deviation, frequency distribution, and percentage were used to evaluate the demographic information of the respondents, and subsequently, analysis of variance, ANOVA was conducted on the gathered data to determine statistical differences in the various noise levels assessed.

$$L_{np} = L_{eq} + 2.565\sigma \qquad 1$$

where L_{np} is the noise pollution level, σ is the standard deviation of the sound levels collected

Table 1: Permissible noise exposure time per day

S/N	Noise Level dB (A)	Duration per day (Hour)	S/N	Noise Level dB (A)	Duration per day (Hour)
1	83	21.1	14	96	3.5
2	84	18.4	15	97	3.0
3	85	16.0	16	98	2.6
4	86	13.9	17	99	2.3
5	87	12.1	18	100	2.0
6	88	10.6	19	101	1.7
7	89	9.2	20	102	1.5
8	90	8.0	21	103	1.3
9	91	7.0	22	104	1.1
10	92	6.1	23	105	1.0
11	93	5.3	24	106	0.9
12	94	4.6	25	107	0.8
13	95	4.0	26	108	0.7

Source: Ajayeoba et. al., 2021

Development of noise control device

The noise level monitor unit was built around a microcontroller, PIC16F88, and programmed to process the sound/ noise level obtained. The design has four stages as shown in Figure 1and each noise level monitor unit with a microphone has the primary transducer for detecting sound. The output of the microphone is amplified by a non-inverting amplifier with a high gain. The amplified output, being analog, is digitized by the microcontroller and used to drive the Liquid Crystal Display (LCD) stage that shows a graphical output of the noise level obtained.

Microphone stage

An electrostatic capacitor-based microphone also known as electret microphone (of Maximum Voltage (V_{mic}) of 3V and Maximum Current (I_{mic}) of 1.8mA) stage shown in Figure 2 were employed in this design. To protect the microphone, a limiting resistor, R_1, was used to ensure that voltage across and current through the microphone are not more than those specified by the manufacturer. Thus, R_1 was calculated using Equation 2

$$R_1 = \frac{V^+ - V_{mic}}{I_{mic}} \tag{2}$$

Where $V^+ = 9V$.

However, C_1 (coupling capacitor) was then used to couple the microphone stage to the preamplifier stage. C_1 was selected as $C_1 = 0.01\mu F = 10nF$, to have a low reactance at the lowest signal frequency, therefore, giving a good performance over the frequency in use (sound frequency).

Sound amplification stage

This signal was amplified by using LM 358 and for sufficient amplification, operational amplifiers were used with a gain of 200 due to the weakness in the sound detected by the microphone stage in Figure 3. The audio output is received through pin 3. The LM 358 is a dual operational amplifier consisting of two independent high gains, internally frequency compensated operational amplifiers that are designed specifically to operate from a single power supply over a wide voltage range. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V and VCC is at least 1.5 V more positive than the input common-mode voltage. The low supply current drain is independent of the magnitude of the supply voltage. This analog output is fed to the analog input of the PIC16F88 microcontroller.

Analogue to digital conversion

Since interaction with a digital world is quite common for microcontrollers, PIC16F88 which has a 10-bit resolution, four-channel built-in Analog to Digital Conversion (ADC) was used. The whole procedure takes place in analog to digital, A/D converter module which has the following features:

i. The converter generates a 10-bit binary result using the method of successive approximation and stores the conversion results into the ADC registers (ADRESL and ADRESH).
ii. There are 4 channels of analog input.
iii. The A/D converter allows the conversion of an analog input signal to a 10-bit binary representation of that signal.
iv. By selecting voltage references Vref- and Vref+, the minimal resolution or quality of conversion may be adjusted to suit various needs.

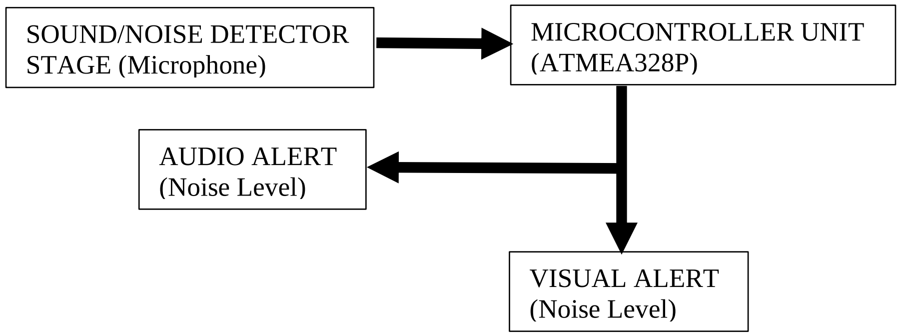


Figure 1: Design stages of the developed device

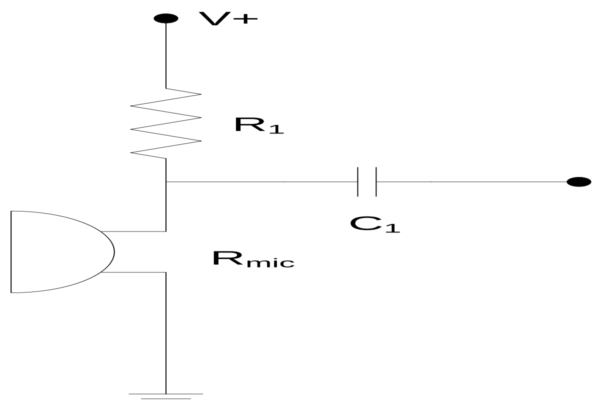


Figure 2: Microphone stage

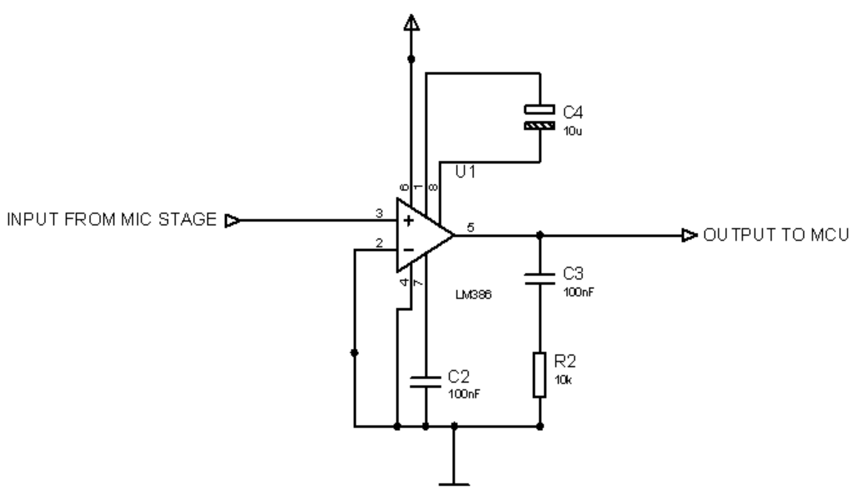


Figure 3: Microphone amplifier stage

A/D acquisition requirements

For the ADC to meet its specified accuracy, it is necessary to provide a certain time delay between selecting specific analog input and the measurement itself. Thus, in this work, 20µs time delay was used to enable the ADC maximal conversion accuracy.

The microcontroller specifications

In this study the following various factors were considered in the choice of the microcontroller to be used:

i. The number of digital inputs, analog inputs the system concerned requires, a factor that helps to determine the minimum number of inputs and outputs (I/O) that the chosen microcontroller must have and the extent of need of an internal analog to digital converter module.

ii. The size of program memory storage required

iii. The magnitude of clock frequency; a factor that determines the execution rate of tasks by the microcontroller

iv. The number of interrupts and timer circuits required.

In this study the data obtained varied depending on the noise level obtained, thus, the choice of PIC16F88 (a low-pin count microcontroller with an ADC) is quite acceptable for this research.

Implementation and testing

After carrying out all the paper design and analysis, the design was implemented, constructed, and tested to ensure its working ability. The construction of this device was carried out in three different stages as the paperwork was transformed into finished hardware:

i. The implementation of the whole project on a solder-less experiment board – The implementation of this device was carried out on the breadboard. The power supply was first derived from a bench power supply in an electronics laboratory. To confirm the workability of the circuits before the power supply stage was soldered. The implementation of the project on the breadboard was successful and it met the desired design aims with each stage performing as designed.

ii. The soldering of the circuits on printed circuit boards – The various circuits and stages of this device were soldered in tandem to meet the desired workability of the device. The microcontroller stage was first soldered before the audio alert stages were done. The soldering of the project was carried out on a printed circuit board shown in Figure 4.

iii. The coupling of the entire device to the casing – This device was coupled in a plastic adaptable box for ease of demonstration.

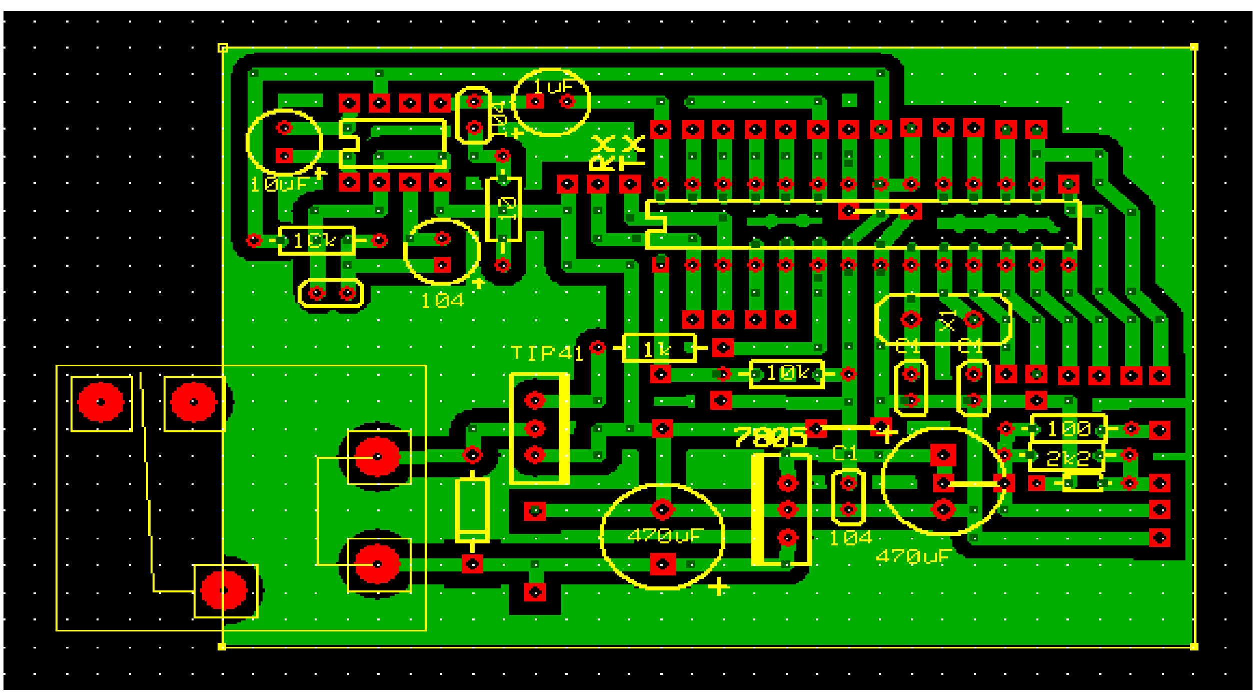


Figure 4: PCB artwork for the design of the noise level monitoring system

Testing

Stage-by-stage testing was conducted according to the block representation in Figure 4 on the breadboard, before the soldering of the circuit commenced on the printed circuit board.

Results and Discussion

The sources of noise included noise from the sound system, generators, loud conversations in viewing centers, traffic, and grinding machines as indicated by respondents and through physical observation by this study. The household equipment including kitchen utensils was considered potential sources of noise, and these consequently resulted in high levels of noise pollution which travels wide and are unsuitable for healthy living.

In Table 2 the results of demographic information of the respondents as obtained from the questionnaires show that 51.2% of the respondents were male, 48.8% were female and 58% of the students were within the age range of 18 – 27 years. 35.2% of the respondents are housed at Zone 1, compared to zone 5 which is the farthest. The figures recorded for both Zone 1 and Zone 2 are due to their proximity to the University campus. The respondents of this study cut across the faculties on campus with students from the faculty of engineering having the highest percentage of 18.8%, and faculty of Agriculture with the least percentage of 11.6%.

The medical history of the respondents also revealed that 6% of the students had a hearing problem since their childhood while 87.6% never had a hearing problem. Though the research revealed that there was no loss of hearing and no student was using a hearing aid, yet 1.2, and 6.4% had a hearing problem in a short time and long time, respectively. It therefore becomes highly imperative that the population studied see cautions and embrace the use of noise control devices.

It was as well revealed in Table 2 that 72% of the students prefer to increase the volume of their sound systems above the middle volume point when listening to music, while only 28% prefer below the middle volume of their sound systems. 15% of them hear a kind of echo for some time after being exposed to noise in their ears, this shows a kind of hearing problem. Meanwhile, a larger percentage 72% feel some kind of discomforts when exposed to noise pollution while 28% feel no discomforts and 53% of the respondent had good hearing abilities and 46% had fairly poor hearing abilities while the remaining 0.4% had completely poor hearing abilities. This shows that a larger percent has good hearing abilities but still feels some kind of discomfort when exposed to noise pollution due to their preferences for increasing the volume of their sound systems to the highest when listening to music.

Sources of noise pollution

The sources of noise were identified through visual, auditory observation of the researcher, and evaluation of questionnaires administered which allowed students to point out the main sources of noise pollutions. Results in Table 3 revealed that 43.6% of the respondents affirmed that sound system was a major noise pollution causal factor in students' hostels, whereas it is the second to loud conversions according to Orola and David, (2019). These results could imply that respondents were exposed more to noise pollution from sound systems and generators relative to those from other sources. It could further be said that some students are more committed to living large and flexing in their various hostels, reasons for the high percentages recorded for sound systems and generators since the two are complementary gadgets probably because of the epileptic nature of power supply in the study areas.

Further investigation, revealed that though the grinding machine, traffic, and loud conversations are also sources of noise pollution but their percentages compared to that of the sound system and generator are very low. This is suggested to be as a result of the probability of having generators or sound systems in every hostel visited than a grinding machine which only occurs at some particular locations.

Table 2: Respondents' bio-data and hearing evaluation record

S/N			Parameters	Frequency	Percentage
1	Demographic of Respondent	i	Gender		
			Male	640	51.2
			Female	610	48.8
		ii	Age		
			< 18	355	28.4
			18 – 27	725	58.0
			28 – 37	170	13.6
		iii	Students Hostel Area		
			Zone 1	440	35.2
			Zone 2	270	21.6
			Zone 3	200	16.0
			Zone 4	215	17.2
			Zone 5	125	10.0
		iv	Faculty		
			Engineering	235	18.8
			Pure and Applied Sciences	220	17.6
			Environmental Sciences	160	12.8
			Management Sciences	175	14
			Clinical Sciences	150	12
			Medical Sciences	145	11.6
			Agriculture Sciences	165	13.2
2	Evaluation of the hearing ability of the respondent	i	Hearing problem		
			As a child	75	6.0
			As an adult	45	3.6
			Both	35	2.8
			None	1095	87.6
		ii	Period of hearing problem	0	
			Short time	15	1.2
			Long time	80	6.4
			None	1155	92.4
		iii	How will you rate your hearing ability?	0	
			Good	665	53.2
			Fair	580	46.4
			Poor	5	0.4
		iv	Do you feel discomfort after listening to a piece of very loud music?		
			Yes	895	71.6
			No	355	28.4
		v	Do you feel a sound echoing in your ear after long exposure to noise?		
			Yes	190	15.2
			No	1060	84.8
		vi	Do you increase the volume of your Sound system to the highest?		
			Yes	900	72.0
			No	350	28.0

The effects of noise generated from grinding machines and traffic are dependent on the closeness to the sources and loud conversation mostly on football season (as it was gathered that football activities like commentaries among viewers were the major contributory factor to the loud conversation). It was also observed from Table 3 that 82% of the students did not read in the hostels because of distractions which are noise, while half of the 20% of the students that were used to reading in the hostel, read when the hostel is noiseless, mostly late into the night. Asides from the results obtained from questionnaire analysis, personal interaction with the respondents revealed that many of them agreed to the fact that noise pollutions were being created in their hostels and seriously need to be controlled.

Table 3: Students' Response to noise pollution

S/N			Sources of Noise Pollution	Frequency	Percentage
		i	Sound System		
			Not often	245	19.6
			Often	460	36.8
			Very often	545	43.6
		ii	Generator		
			Not often	335	26.8
			Often	460	36.8
			Very often	455	36.4
1	Sources of Noise Pollution	iii	Loud conversation		
			Not often	465	37.2
			Often	625	50.0
			Very often	160	12.8
		iv	Traffic		
			Not often	1225	98.0
			Often	15	1.2
			Very often	10	.8
		v	Grinding machine		
			Not often	1220	97.6
			Often	30	2.4
			Very often	0	0
		i	Does noise in your hostel disturb your sleep?		
			Yes	1130	90.4
			No	120	9.6
		ii	Your level of assimilation under noise while in the hostel?		
			Good	85	6.8
	Hostel Noise Pollution		Fair	485	38.8
			Poor	680	54.4
2		iii	Where do you love to read?		
			Hostel	225	18.0
			Lecture rooms	65	5.2
			Library	410	32.8
			Others	550	44.0
		iv	Do you enjoy reading while music is on?		
			Yes	400	32.0
			No	850	68.0
		v	Do you read in a noisy place?		
			Yes	435	34.8
			No	815	65.2

Sound level meter analysis results

The results in Table 4 revealed that there were significant differences in the L_{eq} results recorded for the different zones and sources. It was also observed that the average L_{eq} of the sound system is highest in Zone 1; 93.5400 and 95.4000dB for ventilated (when the windows or/and doors were opened) room and unventilated (when the windows or/and doors were closed) room, respectively. In all the sources considered, the use of generating set with the sound system gave the highest sound level of 102.5500 dB in ventilated rooms (zone 1) while the least sound level of 62.8400dB (zone 2) was experienced during a loud conversation. This is apparent, as the sound system and generator individually generated a high sound level. For CSSG as a source of noise, the L_{eq} in all the zones are significantly different from one another while in other sources of noise, the L_{eq} are not significantly different in some zones as shown in Table 4. This shows that the L_{eq}depends on the source of noise and also on the zones. Table 4 further showed that students from Zone 1 with an average sound level of 93.54dB when the room is closed and 95.40dB, when the rooms were ventilated and were Unventilated, respectively, produced the highest noise pollution in terms of sound systems. The Average Lnp results shown in Table 5 revealed that loud conversations in/around the hostels gave the lowest noise pollution

Table 4: Average sound level results of each zone

Sources/Area		Average Sound level (L_{eq}) (dB)				
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Sound system	Ventilated room	93.54±1.67[a]	90.05±1.56[d]	91.37±1.61[c]	91.20±1.65[c]	92.43±1.59[b]
	Unventilated room	95.40±1.77[a]	91.76±1.74[d]	92.82±1.66[c]	92.64±1.69[c]	93.74±1.62[b]
Generator	Ventilated room	87.06±1.36[c]	89.45±1.52[a]	88.58±1.39[b]	88.54±1.35[b]	86.61±1.58[c]
	Unventilated room	85.30±2.19[c]	86.20±1.65[b]	84.70±1.84[d]	85.67±2.01 [c]	88.88±1.87[a]
Sound system and Generator	Ventilated room	102.55±1.38[a]	101.69±1.63[b]	100.64±1.34[c]	99.76±1.46[d]	99.65±1.44[d]
	Unventilated room	100.21±1.59[a]	99.09±1.04[b]	97.66±1.22[e]	98.13±1.11[d]	98.34±1.34[c]
Traffic		83.74±1.71[c]	84.10±1.77[b]	84.44±1.65[a]	82.78±1.74[d]	83.78±1.69[c]
Loud conversation in/around hostel		64.36±1.67[a]	62.84±1.28[d]	63.34±1.51[c]	63.68±1.23[b]	63.78±1.12[b]
Grinding machine		68.46±1.67[b]	68.30±1.53[b]	68.70±2.65[a]	68.46±1.63[b]	68.10±1.66[b]

Values with the same superscript within a row are not significantly different ($p<0.05$)

Sound level monitor and control device

The Sound Level Monitor and Control (SLMC) device as shown in Figure 5 was assembled as a box on which the socket and monitor to plug the system and display information regarding the sound level, respectively, were placed. As the SLMC device is switched on, the monitor displays the name of the device as shown in Figure 5a, then it began starting up (Figure 5b), and later displays the $L_{eq}$of the sound system (Figure 5c). Gradually, as the volume of the sound system increases the L_{eq}increases (Figure 5d), and when it goes above 55 dB, the SLMC device gives a buzzing alarm for 15 seconds to allow the student to reduce the volume of the sound system and if nothing is done, the device will be automatically disconnected. Though the Federal Environmental Protection Agency (FEPA) (1991) recommended 90dB for an interval of 8hrs but considering a factor like disturbance avoidance, maybe some students are sleeping or reading and from the fieldwork, it was realized that the likelihood that other students in other rooms will be distracted or affected is low. This is also supported by the Gazette of Nigeria on noise pollution, regulation, and control (NESREA, 2009), which recommended 55 dB for the residential area (during daytime which is from 6 AM to 10 PM). The device developed was evaluated for performance, it was able to control the noise pollution level in a particular room by breaking the circuit of the socket to which a sound system is connected, for power supply. However, any other external sounds added to the L_{eq}, were detected by the device and reflected on the device monitor.

Table 5: Average noise pollution level results of each zone

Sources/Area		Average Noise pollution level (Lnp) (dB)				
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Sound system	Ventilated room	97.81329	94.32329	95.64329	95.47329	96.70329
	Unventilated room	99.94518	96.30518	97.36518	97.18518	98.28518
Generator	Ventilated room	90.5484	92.9384	92.0684	92.0284	90.0984
	Unventilated room	90.64803	91.54803	90.04803	91.01803	94.22803
Sound system and Generator	Ventilated room	106.0897	105.2297	104.1797	103.2997	103.1897
	Unventilated room	104.296	103.176	101.746	102.216	102.426
Traffic		88.44165	88.80165	89.14165	87.48165	88.48165
Loud conversation around hostel		68.6256	67.1056	67.6056	67.9456	68.0456
Grinding machine		72.73329	72.57329	72.97329	72.73329	72.37329

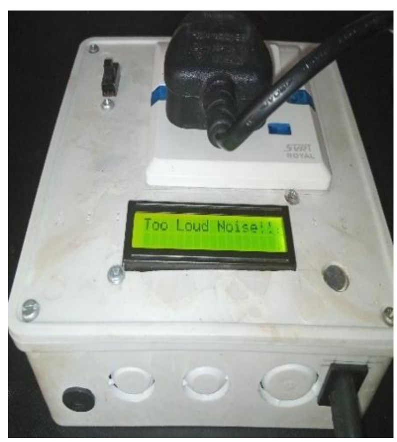
a: SLMC device when switched on

b: SLMC device Starting up

c: SLMC device @ L_{eq} < 55dB

d: SLMC device @ L_{eq} = 55dB

e: SLMC device @ L_{eq} > 55dB



f: SLMC device when buzzing

Figure 5: Sound System Control at different period

Conclusion

Noise sourced from various anthropogenic activities in the hostel environment is mostly due to human involvement in the use of operations of generator and sound systems, traffic, loud conversation, and grinding machines. This research revealed that the effects of excessive or prolonged noise could lead to stress, poor concentration, loss in academic productivity, communication difficulties, sleep disturbance (this can be any of the following: difficulty to fall asleep, or inability to stay asleep/sleep for a long time, or waking up early), fatigue and reduction of cognitive functions. However, if these are not well controlled, it can lead to serious health and psychological issues like distorted hearing, cardiovascular problems, persistent high-pitched ringing in the ears, abnormal loudness perception, emotion, and behavioural change, and abnormal loudness perception, among other hearing problems. Also, of all the sources of noise pollution, sound systems, and generators, when used simultaneously, constituted the larger percentage of noise pollution in the studied areas. The SLMC device was able to control noise pollution when the noise level is above 55dB, in a particular room by giving a warning alarm and later breaking the circuit, thereby switching off the sound system.

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