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ESTIMATION OF NOISE POLLUTION PARAMETERS AND THEIR HEALTH EFFECTS ON BUILDING OCCUPANTS IN LAGOS STATE, NIGERIA

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Abstract

Noise pollution in our environments has been discovered by researchers in recent times to contribute adversely to health conditions, social challenges and occupational efficiencies of its victims. This study considered measuring noise pollution parameters within a particular locality based on the positions of the people from their respective sound sources. The parameters measured in this study are sound pressure level (S_{PL}*), sound intensity level (I), power emitted (*P_{AV}*), dose of noise (D), and noise pollution level (NPL). The devices employed for noise level measurements are dosimeters and sound level meters. A total of 15 locations within Lagos state environs where noise impacts are mostly felt by citizens were considered. The results obtained revealed that the closer the hearer to the sound sources the higher the sound pressure levels and sound intensities. Locations with the highest sound pressure levels are event centers, markets, and religious centers with average sound levels 85.9dB, 84.7dB, and 83.1dB respectively. Event centers recorded the highest noise pollution level and dose of noise while schools recorded the least. Considering the hearing thresholds according to International Standard Organization, the hearers with the highest sound pressures and intensities are likely to suffer over a long period of time from health conditions such as headache, muscle tension, anxiety, insomnia, fatigue, resentment, distraction, hearing impairment, interference with communication, drug consumption, interference with relaxation, and temporary threshold shift. It is however imperative to provide continuous awareness on different ways of curbing noise pollution and its effects in our environments.*

Keywords: Noise pollution, health effects, sound pressure, sound intensity, dose of noise

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1.0 Introduction

Noise is known to be an undesirable sound while sound is created by vibrating objects and arrives at the listener's ears as waves in the air or other media[1]. at the point when an object vibrates[2], it causes slight changes in air pressure[3]. This air pressure changes travel as waves through the air produce sound. This noise is viewed as upsetting, boisterous or problematic to hearing[4]. Noise is undefined from sound, as both are vibrations through a medium, for example, air or water. the distinction between sound and noise relies on the listener and the conditions attached. music can be pleasurable sound to one individual and an irritating noise to another. In one or the other case, it very well may be perilous to an individual's hearing if the sound is noisy and on the off chance that they are uncovered long and regularly enough.

Noise pollution, undesirable or over the top Sound that can seriosly affect human wellbeing[5], natural life[6], and ecological quality[7]. Noisepollution is generally produced inside numerous modern offices[8] and some different working environments[9], yet it likewise comes from parkway, railroad[10], and plane traffic and from open air development exercises.

Sound waves are vibrations of air molecules conveyed from a noise source to the ear. Sound is normally depicted regarding the loudness (amplitude) and the pitch (frequency) of the wave. Loudness (likewise called Sound Pressure Level, or SPL) is estimated in logarithmic units called decibels (dB). The typical human ear can identify Sounds that range between 0 dB (Hearing Threshold) and around 140 dB, with sounds somewhere in the range of 120dB and 140 dB causing torment. The encompassing SPL in a library is around 35 dB, while that inside a moving transport or metro train is approximately 85 dB; Building construction[11], [12], [13] exercises can produce SPLs as high as 105 dB at the source. SPLs decline with distance from the source.

Figure 1: Construction work noise situation

The rate at which sound energy[14] is communicated, called sound intensity, is relative to the square of the SPL. As a result of the logarithmic idea of the decibel scale, an expansion of 10 dB speaks to a 10-crease increment in Sound Intensity, an increment of 20 dB speaks to a 100-overlay Increase in Intensity, a 30-dB increment speaks to a 1,000-overlap increment in Intensity, etc. At the point when Sound intensity is multiplied, then again, the SPL increments by just 3 dB For instance, in the event that a construction[15] drill causes a Noise Level of around 90 dB, at that point two indistinguishable Drills working next to each other will cause a Noise Level

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of 93 dB. Then again, when two sounds that contrast by in excess of 15 dB in SPL are joined, the more fragile sound is hidden by the stronger sound. For instance, if a 70-dB drill is working close to a 85-dB Dozer at a Construction Site[16], [17], [18], the joined SPL of those two sources will be estimated as 85 dB; the less exceptional Sound from the blower won't be recognizable. Recurrence of a Sound Wave is communicated in Cycles every Second (cps), yet Hertz (Hz) is all the more usually utilized (1 cps = 1 Hz). The Human Eardrum is an extremely delicate organ with an enormous powerful reach, having the option to identify Sounds at Frequencies as low as 20 Hz up to around 20,000 Hz. The Pitch of a Human Voice in typical discussion happens at Frequencies between 250 Hz and 2,000 Hz.

Exact estimation and logical portrayal of Sound Levels contrast from most abstract human insights and suppositions about sound. Abstract human reactions to noise rely upon both Pitch and Loudness. Individuals with ordinary Hearing by and large see High-Frequency Sounds to be stronger than Low-Frequency Sounds of a similar Amplitude. Thus, electronic sound-level meters used to gauge Noise Levels consider the varieties of Loudness with Pitch. Recurrence channels in the Meters serve to coordinate Meter Readings[19] with the affectability of the Human Ear and the overall commotion of different sounds. The purported A-weighted channel[20], for instance, is normally utilized for estimating encompassing network noise. SPL estimations made with this channel are communicated as A-weighted decibels, or dBA. The vast majority see and depict a 6-to 10-dBA increment in a SPL perusing to be a multiplying of "Loudness" Another framework, the C-weighted (dBC) scale, is now and again utilized for sway Noise Levels, for example, gunfire, and will in general be more precise than dBA for the apparent Loudness of Sounds with low recurrence segments.

Noise Levels by and large shift with time[21], so Noise estimation information are accounted for as Time-Averaged esteems to communicate in general Noise Levels. There are a few different ways to do this. For instance, the consequences of a bunch of repeated Sound-Level estimations might be accounted for as L80 = 65 dBA, implying that the levels were equivalent to or higher than 65 dBA for 80% of the time. Another unit, called equal sound levels (Leq), can be utilized to communicate a normal SPL over any time of interest, for example, a seven-hour workday. (Leq is a Logarithmic Average as opposed to an Arithmetic Average, so uproarious occasions win in the general outcome.) A unit called Day-Night Sound Level (DNL) represents the way that individuals are more touchy to Noise during the evening, so a 10-dBA punishment is added to SPL esteems that are estimated between 10 PM and 7 AM. DNL estimations are helpful for portraying by and large network openness to Noise, for example, the one from airplane[22], [23]. Noise is in excess of a simple aggravation.

At specific levels and terms of exposure, it can make actual harm the eardrum[24], [25] and the delicate Hair Cells of the Inner Ear and result in transitory or lasting Hearing Loss, known as Noise-Induced Hearing Loss. Hearing misfortune doesn't typically happen at SPLs under 80 dBA (eight-hour openness levels are best kept under 85 dBA), yet the vast majority consistently presented to in excess of 105 dBA will have perpetual hearing misfortune somewhat. Notwithstanding causing hearing misfortune, inordinate Noise exposure can raise Blood Pressure and Pulse Rates[26], [27], cause Irritability, Anxiety[28], [29], and cerebral depletion, and meddle with rest, entertainment, and individual correspondence. Kids living in territories[30], [31] with elevated levels of Noise Pollution may experience the ill effects[32], [33] of pressure and different

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issues, for example, weaknesses in memory and ability to focus. Noise pollution control is subsequently significant in the working environment[34], [35] and in the network. Roland Barthes recognizes physiological Noise, which is only heard, and mental noise, which is effectively tuned in to. Physiological noise is felt subliminally as the vibrations of the noise (sound) waves actually cooperate with the body while mental noise is seen as our cognizant mindfulness moves its thoughtfulness regarding that Noise. Luigi Russolo, one of the principal authors of noise music, composed the article The Art of Noises. He contended that any sort of noise could be utilized as music, as crowds become more acquainted with noises brought about by mechanical[36], [37] headways; Noise has become so unmistakable that unadulterated sound does not exist anymore. Henry Cowell asserted that innovative progressions[38] have decreased undesirable noises from machines, however have not overseen so far to totally dispose of them. Felix Urban sees Noise because of social conditions[39]. In his relative examination on sound and noise in urban areas, he brings up that noise guidelines are just a single pointer of what is considered as unsafe. It is the manner by which individuals live and act (acoustically) that decides the way how sounds are seen.

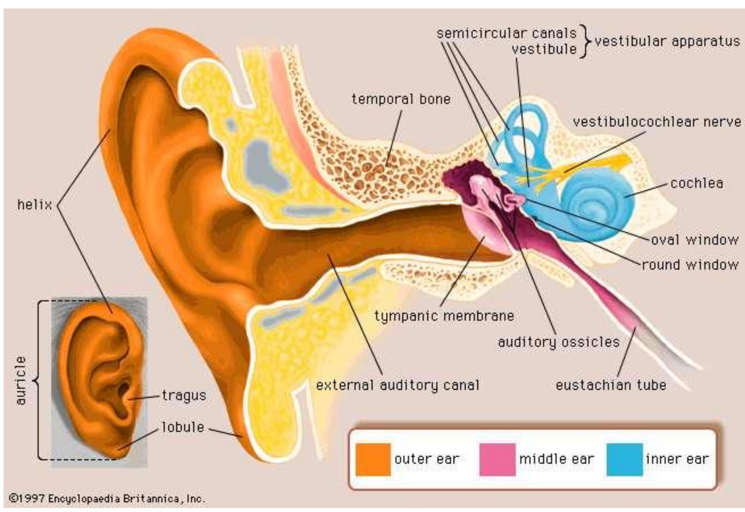

Figure 2: Ear parts affected by noise

2.0 Theoretical Background

2.1 Noise Regulation and Mitigation

Noise Control laws and laws instituted at the nearby, local, and public levels can be successful in relieving the unfavorable impacts of Noise Pollution. Natural and modern Noise is managed in the United States under the Occupational Safety and Health Act of 1970 and the Noise Control Act of 1972[40], [41], [42]. Under these demonstrations, the Occupational Safety and Health

Administration set up mechanical Noise measures as far as possible on the power of Sound openness and on the time length for which that force might be permitted.

2.2 Environmental and Workplace Noise

Noise is perhaps the most well-known work related wellbeing perils. In substantial mechanical and assembling conditions[43], just as different circumstances, for example, ranches, cafeterias, or bars. Lasting Hearing Loss is the principle wellbeing concern. Irritation, stress and impedance with discourse correspondence are the primary worries in uproarious workplaces[44], [45], [46], schools and PC rooms. To forestall unfriendly results of Noise exposure, noise levels ought to be decreased to worthy levels. The best strategy for Noise decrease is to utilize designing adjustments to the noise source itself, or to the working environment climate. Where innovation [47] can't enough control the issue, individual hearing insurance can be utilized. Individual assurance, nonetheless, ought to be considered as an interval measure while different methods for diminishing work environment noise are being investigated and actualized. As an initial phase in managing noise, work environments need to distinguish territories or activities where exorbitant exposure to Noise happens. Natural noise is the collection of all Noise present in a predefined climate. The chief wellsprings of natural Noise are surface engine vehicles, airplane, trains and modern sources[48]. These noise sources uncover a large number of individuals to Noise pollution that makes irritation, yet in addition critical wellbeing results, for example, raised frequency of hearing misfortune and cardiovascular disease [49] Urban Noise is for the most part not of a force that causes hearing misfortune but rather it intrudes on rest, upsets correspondence and meddles with other human activities[50]. There are varieties of relief techniques and controls accessible to decrease sound levels including source power decrease, land-use arranging procedures, Noise hindrances and sound confuses, season of day use regimens, vehicle operational controls and building acoustics configuration measures.

2.3 Sound Pressure and Sound Pressure Level

Sound Pressure is the measure of Air Pressure variance a Noise source makes. We perceive sound pressure as Loudness. In the event that a drum is hit softly, the surface moves just an extremely short distance and creates frail weight changes and a weak Sound[51]. In the event that the drum is hit more enthusiastically, its surface moves farther from its rest position. Thus, the Pressure increment is more prominent. To the audience, the Sound is stronger. Sound weight additionally relies upon the climate wherein the source is found and the audience's separation from the source. The sound delivered by the drum is stronger two meters from the drum on the off chance that it is in a little washroom, than if it is struck in a football field. For the most part, the farther one moves from the drum, the calmer it sounds. Additionally if there are hard surfaces that can mirror the sound (e.g., dividers in a room), the sound will feel stronger than if you heard a similar sound, from a similar distance, in a vast area. Sound Pressure is generally communicated in units called Pascal (Pa). A solid, youngster can hear Sound Pressures as low as 0.00002 Pa[52]. A typical discussion creates a Sound Pressure of 0.02 Pa. A Gasoline-Powered Lawn Mower produces around 1 Pa. The Sound is agonizingly noisy at levels around 20 Pa. Along these lines the basic sounds we hear have Sound Pressure over a wide reach (0.00002 Pa - 20 Pa). It is hard to work with the wide scope of regular sounds pressures (0.00002 Pa - 20 Pa)[53]. To defeat this trouble we use decibel (dB, or 10th (deci) of a Bel)). The decibel or dB

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scale is more advantageous on the grounds that it packs the size of numbers into a reasonable reach. Sound weight changed over to the decibel scale is called sound weight level. The zero of the decibel scale (0 dB) is the sound weight of 0.00002 Pa. This implies that 0.00002 Pa is the reference sound strain to which any remaining sound weights are thought about on the dB scale.

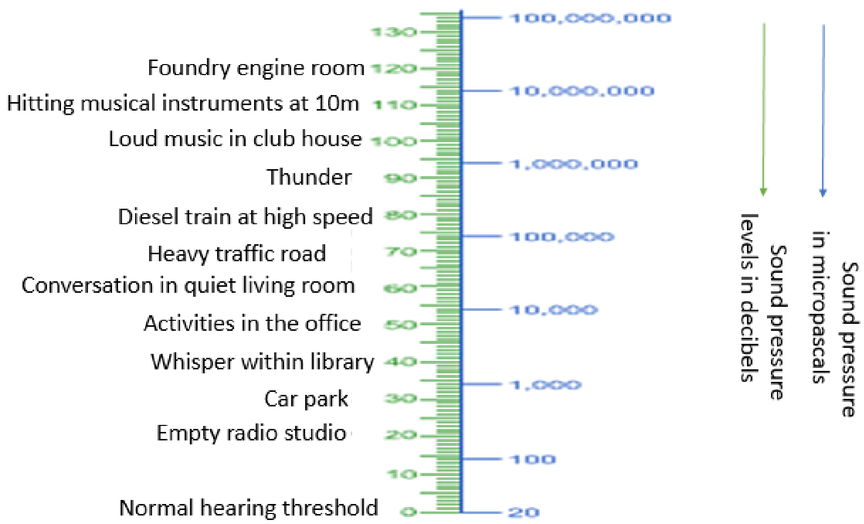

Figure 3: Sound pressure and levels from literature[53]

2.4 Sound Power

The Sound Power is the Sound Energy transferred per second from the Noise Source to the Air. A Noise Source, such as a compressor or drum, has a given, constant sound power that does not change if the Source is placed in a different environment.Power is expressed in units called watts (W). An average whisper generates a sound power of 0.0000001 watts (0.1 microwatt (µW)), a truck horn 0.1 W, and a turbo jet engine 100,000 W[53]. Like Sound Pressure, Sound Power (in W) is usually expressed as Sound Power levels in dB. Figure 4 relates Sound Power in watts to Sound Power level in decibels. Note that while the Sound Power goes from one trillionth of a watt to one hundred thousand watts, the equivalent sound power levels range from 0 to 170 dB[53].

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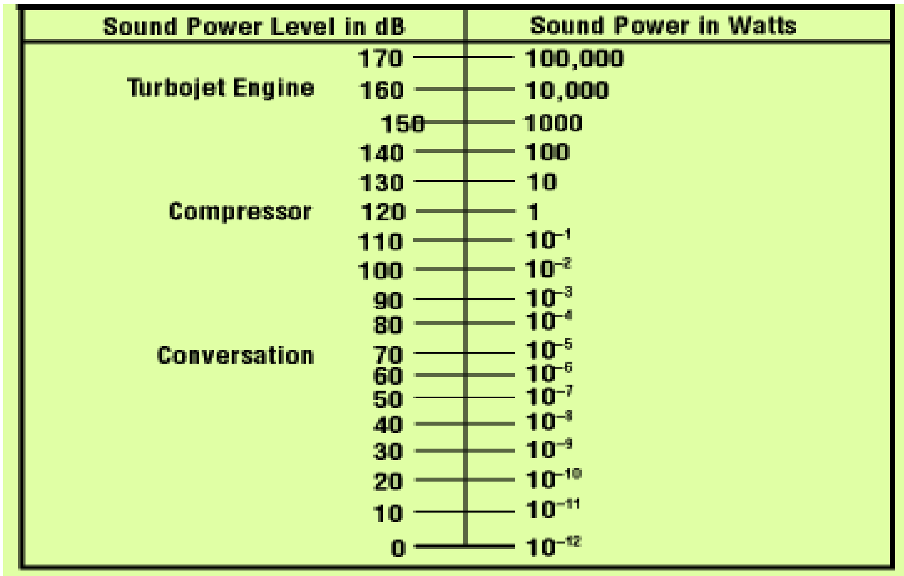

Figure 4: Sound powers and levels from literatures

3.0 Materials and Methods

Noise levels were measured in respective locations using a well calibrated sound level meter (SLM) with resolution and accuracy of 0.1dB and 1.6dB,respectively. Other materials are noise dosimeter, protective case, SLM Battery Life / Charged, Wind Shield, Tripod, Outdoor Weather Equipment, Outdoor battery pack, Memory Cards for SLM, Camera, Paper / Record Sheet / Pen, and Personal Protective Equipment. The measurements on environmental noise were conducted close to the point of reception of the noise. For traffic moise, measurements were done close to the location of the residents, rather than close to the road.These methods were adopted to have a clear view of the sound source and so that the propagation of the sound to the microphone is not shielded or blocked by structures that would reduce the incident sound pressure levels.

A position 2 m from the frontagewas adopted as recommended by some standards (ISO, 1978; ASTM, 1992).When considering indoor exposures, measurementsat different points were done to describe the average sound pressure level in the room. To obtain the most accurate data using this method, the SLM was held out at arm's length along with the microphone towards the source of the noise.One of the precautions that was taken into consideration during measurements was to avoid background moises as much as possible while ensuring the least amount of reflective surface from your body is exposed to the meter.

The receptor height formed the benchmark where every noise reading was conducted. For receptors at the ground level,measurement was also done at the ground level (1.3–1.4m above the ground).Measurements of noise intensities were taken at various places, areas or sources such as: Event center, Market, Religious centers, Excavation work noise, Industrial noise, Traffic noise, Aircraft noise, Pepper grinding machine, Power generator, Loudspeaker, Drilling machine, School, Building construction, Noise from leisure activities, Domestic noise in Lagos and its neighborhoods. The instrument has resolution and accuracy of 0.1dB and 1.5 dB respectively. Other features embedded in the sound level meter are fast/slow response, maximum hold

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function,and AC/DC output. All source noises affected by peripheral noises were measured at points closest to the source and the results were extrapolated back to the sensitive receiver/boundary. Once noise levels were obtained, the noise level at the affected premises were inferred to the desired measuring location using the relevant metrics.

$$S_{PL}(dB) = 20\log\{\frac{S_P}{S_{PR}}\} \qquad (1)$$

The sound pressure level (S_{PL}) in decibels is given in Equation (1) where S_P is the sound wave pressure, S_{PR} is the reference pressure ($2*10^{-5}Pa$) – the lowest noise that a healthy young person can hear.

$$S_{PL(T)}(dB) = 10\log\{\sum_{i-1}^{n} 10^{\frac{S_{PL(i)}}{10}}\} \qquad (2)$$

The overall value of all the sound pressure levels is obtained using Equation (2).

$$I = \frac{P_{AV}}{4\pi r^2} \qquad (3)$$

The sound power P_{AV} emitted by the source is given in Equation (3) and dependent on sound intensity and distance of source to hearer.

$$I_L(dB) = 10\log\{\frac{I}{I_0}\} \qquad (4)$$

Sound intensity level are determined by Equation (4), where I_0 is the threshold of hearing and the reference power is ($1*10^{-12}W$)

$$\%D_N = \{\frac{t_1}{T_1} + \frac{t_2}{T_2} + \frac{t_3}{T_3}.........\}*100\% \qquad (5)$$

If an individual is exposed to various levels of noise for different time intervals during the day, the total exposure or dose (*D*) of noise is obtained from the relation given in Equation 5 where *t* is the real time of exposure and *T* is the permissible time of exposure at any level.

$$NPL = S_{50} + S_{10} - S_{90} + \frac{(S_{10} - S_{90})^2}{60} \qquad (6)$$

The noise pollution level is obtained using Equation (6), where S_{50} represents dB level exceeded 50% of time. The standard adopted for this study from ISO and ASTM is given in Table 1 where the permissible exposure hours and their respective sound level in decibels were highlighted.

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Table 1: Standards on Permissible exposure hours and sound level[54],[55], [56]

Exposure (Hours)	Sound level (dB)
256	65
128	70
64	75
32	80
16	85
8	90
4	95
2	100
1	105
0.5	110

4.0 Results and Discussion

Table 2: Average Soud Pressure Levelsand Average Sound Intensity Levels

S/N	Locations	Sound Pressure (Pa)	Sound pressure level		Sound Intensity (W)	Sound Intensity level	Emitted Power (watts)	Distance from sound to hearer (m)
1	Event center	0.395	85.91134		0.084	106.2325	26.38938	5
2	Market	0.344	84.71057		0.076	105.7978	95.50442	10
3	Religious centers	0.287	83.13704		0.0497	103.9533	140.5234	15
4	Excavation work noise	0.263	82.37852		0.0186	99.68483	93.4938	20
5	Industrial noise	0.219	80.78828		0.0095	96.76694	74.61283	25
6	Traffic noise	0.197	79.86872		0.0076	95.79784	85.95398	30
7	Aircraft noise	0.176	78.88965		0.0057	94.54845	87.74468	35
8	Pepper grinding machine	0.146	77.26646		0.0049	93.89166	98.52035	40

9	Power generator	0.112	74.96376		0.0034	92.30449	86.51946	45
10	Loudspeaker	0.096	73.62482		0.0021	90.21189	65.97345	50
11	Drilling machine	0.074	71.36403		0.00087	86.38489	33.07155	55
12	School	0.045	67.04365		0.00065	85.11883	29.40531	60
13	Building construction	0.0352	64.91025		0.00049	83.89166	26.01553	65
14	Noise from leisure activities	0.0245	61.76272		0.00021	80.21189	12.9308	70
15	Domestic noise	0.0187	59.41623		0.00017	79.29419	12.01659	75

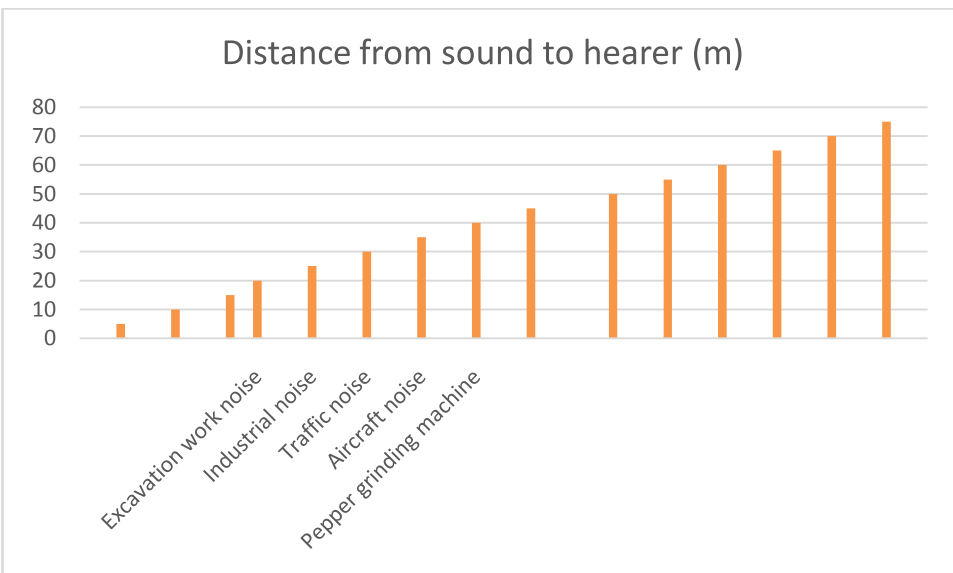

Figure 5: Sound locations against their respective hearer distances

Figure 5 shows the sound locations considered in this study with the respective distances of hearers to the sound sources. The hearers were found to be closest to the sound sources at the event centers (5m), market (10m) and religious centers (15m) and farthest at domestic noise (75m), leisure activities (70m), and building constructions (65m).Literature has proven that distances of hearers to sound sources is a critical parameter that affects sound pressure and intensity in the long run.

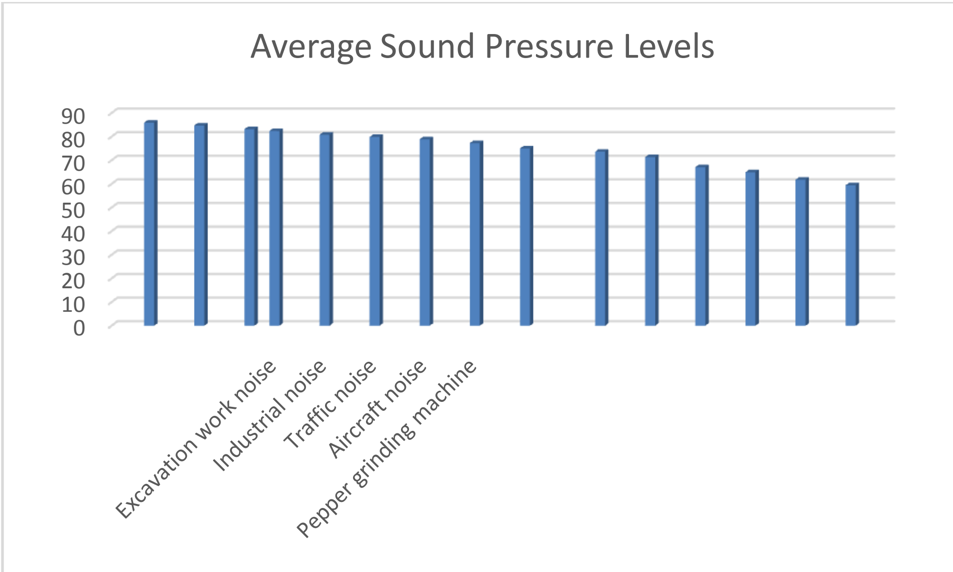

Figure 6: Sound locations against their respective sound pressure levels

Figure 6 depicts the sound locations considered in this study with the respective sound pressure levels.The sound pressure levels were computed using Equation (1). The closer the hearer to the sound sources the higher the sound pressure levels. Locations with the highest sound pressure levels are event centers, markets, and religious centers with average sound levels 85.9dB, 84.7dB, and 83.1dB respectively. Locations with the lowest sound pressure levels are domestic noise centers, leisure activities, building construction centers with average sound levels 59.4dB, 61.8dB, and 64.9dB respectively. Considering the hearing thresholds according to standards, the hearers with the highest sound pressures are likely to suffer from health conditions such as Headache, muscle tension, anxiety, insomnia, fatigue, resentment, distraction, hearing impairment, interference with communication, drug consumption, interference with relaxation, and temporary threshold shift.

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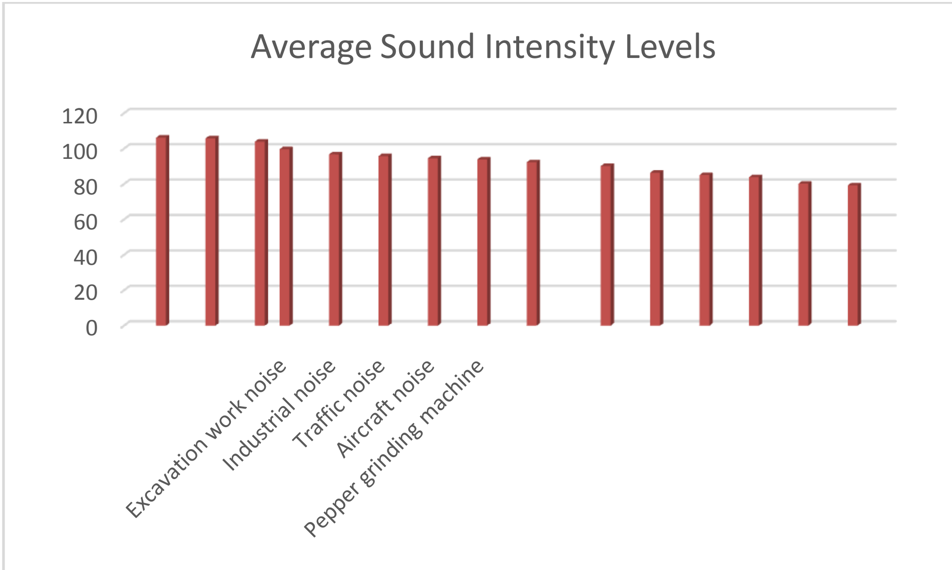

Figure 7: Sound locations against their respective sound intensity levels

Figure 7 represents the sound locations considered in this study with the respective sound intensity levels. The sound intensity levels were computed using Equation (3) and (4). The trend of the sound intensity levels is similar to that of sound pressure levels. Locations with the highest sound intensity levels are event centers, markets, and religious centers with average sound levels 106.2dB, 105.8dB, and 104.0dB respectively. Locations with the lowest sound intensity levels are domestic noise centers, leisure activities, building construction centers with average sound levels 79.3dB, 80.2dB, and 83.9dB respectively. The sound intensities obtained in this study are far beyond the normal intensity levels as obtained from standards and as such health conditions such asHeadache, muscle tension, anxiety, insomnia, fatigue, resentment, distraction, hearing impairment, interference with communication, drug consumption, interference with relaxation, and temporary threshold shift.

Table 3: Dose of noise and noise pollution level at the event centers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
2	1	100	206%	4151.667
4	2	95		
8	3	90		
2	1	100		
16	3	85		

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Table 3 represents the percentage dose of noise, noise pollution levels obtained based on the recorded real time of exposure, permissible time of exposures as seen in Table 2, and sound levels. The dose of noise was computed using Equation (5) while the noise pollution level was determined using Equation (6). The total exposure value (206%) obtained suggests that the hearers involved are overexposed to noise and as such need to attend hearing conservation programs to minimize such exposure in the future.Furthermore, the noise pollution level (4151.667dB) obtained is quite beyond what is acceptable compared with standard according to [56].

Table 4: Dose of noise and noise pollution level at the religious centers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
8	1	90	141%	3745.41
2	1	100		
4	2	95		
32	4	80		
32	5	80		

Tables 4, 14, and 17 show similar situation compared to Table 3 where total exposure and noise pollution level are much higher than the hearing threshold recommended by international standard organization.The sound hearers at the event centers suffers the most with the highest pollution level while those located at the religious centers suffers the least in this category.Health conditions such hearers can suffer from are Headache, muscle tension, anxiety, insomnia, fatigue, resentment, distraction, hearing impairment, interference with communication, drug consumption, interference with relaxation, temporary threshold shift.

Table 5: Dose of noise and noise pollution level at the market centers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
4	1	95	87.5%	1586.667
32	1	80		
8	2	90		
32	3	80		
4	1	95		

Table 5, 6, 7, 8, 9, 10, 11, 12, 13, and 16 show similar trend in terms of total exposures and noise pollution levels. The parameters recorded in the schools produced the least values in this category, which is an indication that hearers of such sound are not likely to be affected health-

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wise by such noise because the dose of noise and the pollution level are much lower than the stated values in standard.

Table 6: Dose of noise and noise pollution level at the industrial centers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
64	0.5	75	57.8%	245.4167
128	0.5	70		
256	1	65		
8	0.5	90		
4	2	95		

Table 7: Dose of noise and noise pollution level at the traffic areas

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
256	0.058	65		
0.5	0.048	110	39.3%	266.6667
32	1	80		
2	0.5	100		
128	2	70		

Table 8: Dose of noise and noise pollution level at the aircraft areas

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
8	0.58	90	28.4%	245.4167
128	0.48	70		
1	0.024	105		
4	0.643	95		
32	0.75	80		

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Table 9: Dose of noise and noise pollution level for pepper grinding machines

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
32	1.038	80	77.8%	791.6667
8	1.029	90		
2	1.0067	100		
0.5	0.049	110		
128	1.96	70		

Table 10: Dose of noise and noise pollution level for power generators

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
4	1.067	95	43.6%	311.6667
256	1.089	65		
32	1.0054	80		
0.5	0.06	110		
128	1.79	70		

Table 11: Dose of noise and noise pollution level for loudspeakers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
128	2.056	70	61%	266.6667
64	1.078	75		
2	1.0048	100		
8	0.036	90		
16	1.12	85		

Table 12: Dose of noise and noise pollution level for drilling machines

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
32	2.077	80	58%	755.4167
4	1.034	95		
128	1.0026	70		
1	0.075	105		
8	1.39	90		

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Table 13: Dose of noise and noise pollution level at the schools

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
0.5	0.0023	110	12.2%	0
16	1.034	85		
128	0.0057	70		
4	0.21	95		
256	0.0043	65		

Table 14: Dose of noise and noise pollution level at the building construction centers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
0.5	0.0023	110	149%	928.75
2	2.066	100		
8	0.099	90		
4	1.76	95		
128	0.062	70		

Table 15: Dose of noise and noise pollution level at the excavation center

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
0.5	0.0077	110	95.7%	100
256	2.087	65		
32	0.092	80		
2	1.86	100		
64	0.064	75		

Table 16: Dose of noise and noise pollution level at the leisure activities centers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
32	1.0045	80	100%	366.6667
256	2.096	65		
128	0.078	70		
2	1.65	100		
8	1.098	90		

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Table 17: Dose of noise and noise pollution level at the Domestic noise centers

Permissible time of exposure	Real time of Exposure (Hours)	Sound level (dB)	Total exposure (Dose of noise)	Noise Pollution Level (dB)
8	1.0089	90	125.8%	325
256	2.067	65		
0.5	0.034	110		
2	1.98	100		
16	1.056	85		

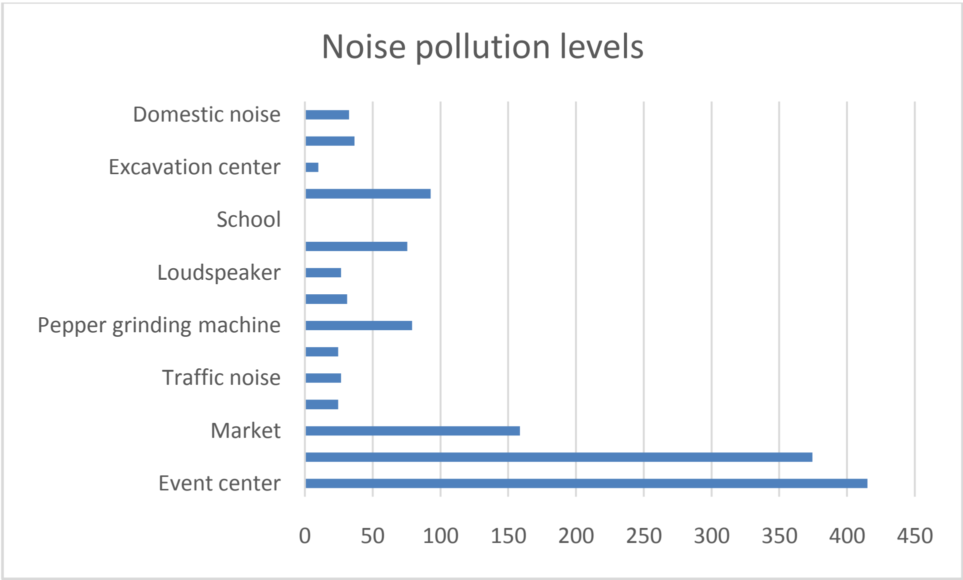

Figure 8: Sound locations against noise pollution levels

Figure 8 denotes the sound locations and their respective noise pollution levels as obtained from the measurements recorded in the study. These results are based on output of Tables 3 to 17. Event center recorded the highest noise pollution level while school recorded the least. Other locations with low noise pollution levels are excavation centers, domestic noise areas, and leisure activity areas. Health conditions such as temporary threshold shift of people located at event centers, religious centers and market centers may deteriorate except adequate precautions are in place.

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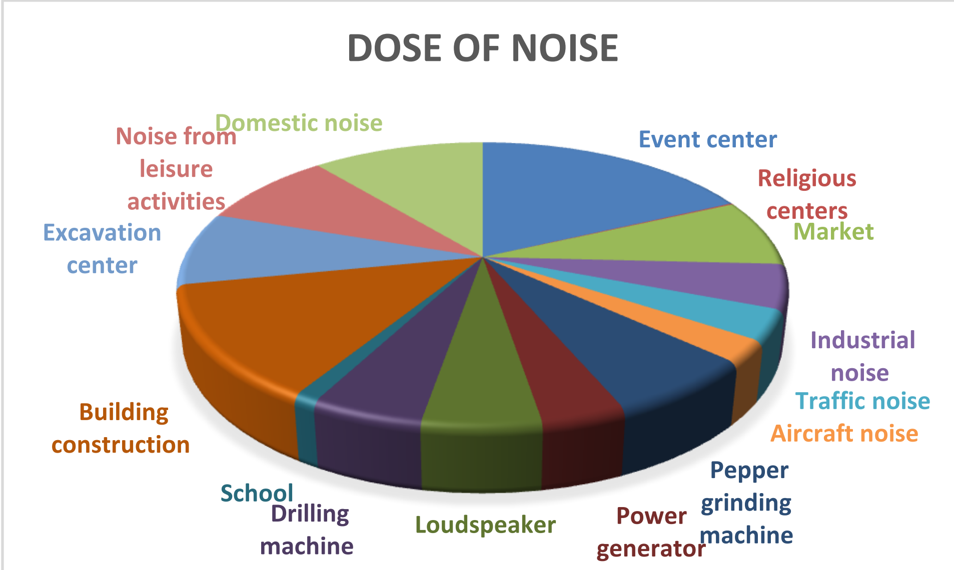

Figure 9: Sound locations against dose of noise

Figure 9 denotes the sound locations and their respective dose of noise as obtained from the measurements recorded in the study. These results are based on output of Tables 3 to 17. Event center recorded the highest dose of noise with 18%, followed by building construction with 13% while school recorded the least with 0%. Other areas with low total exposure are aircraft noise, industrial noise, and power generators. This corroborated a study by [30] where it was established that noise emanating from aircraft and power generators could not have negative impacts on humans.

5.0 Conclusion and Recommendations

The effect of noise pollution in the society was dealt with in this study. Relevant measuring devices like noise dosimeter, sound level meter were adopted for measurements and the average values were obtained thereafter. Noise level parameters obtained at different locations within the same geographical area were compared with standard values. Health conditions associated with unpleasant situations from noise pollution were highlighted. Relevant bodies like World Health Organization should ensure adequate awareness are created regularly to beat this invisible enemy. Government should ensure that measures are taken to provide adequate noise management process. It is therefore pertinent to state that research on noise control should include an evaluation of several methods for source reduction, and for construction standards which will reduce both impact and transmission of noise and noise reverberation. It is also in the right direction to ensure constant awareness and information are available to all and sundry to ensure the effects of noise pollution are minimized significantly.

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