n.b.: This document is the "raw" or "uncut" report of the environmental noise measurements within Abuja metropolis completed in 2007. The "cut" format has been reviewed and published in the *Environmental Technology and Science Journal (ETSJ)* **outlet here at the Federal University of Technology, Minna, in the year 2008 (volume 3 number 1, pages 18 to 28). The "raw" report was duly forwarded to the Abuja Environmental Protection Board (AEPB) with the expectation that this agency will enforce regulations regarding excessive noise levels at open-space markets and other places where adults, and children especially, are daily exposed to higher-than-normal noise levels over long spells. The thinking back then in 2007 was this endeavour was appropriate within a Nigeria-centric context whence local resources from a local university study group are deployed to determine the character of a vexing and problematic issue that the general population is blissfully ignorant of, and then proffer low-cost solutions to solving this problem, especially one of the nature of public-health concern. A copy of the "raw" report was also forwarded to the late Senator Idris Awaisu Kuta, the then senator representing the federal zone where the Federal University of Technology, Minna, is located in the hope that he would help force through federal legislations for public-health awareness and mitigation.**

ENVIRONMENTAL NOISE MEASUREMENTS WITHIN ABUJA METROPOLIS

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1.0 EXECUTIVE SUMMARY

This study was designed to determine the maximum ambient noise levels at strategic locations within Abuja metropolis, and thence proposing appropriate mitigating factors where it is discovered that the noise level exceeds the internationally-recognised threshold of 70dB. Measurements were carried out at the designated premises following the standard and uniform procedures of data collection. The original research work was planned for a period of twenty days, thus covering twenty different sites. For accuracy, it would have been appropriate to re-occupy each of those twenty sites a second time thus resulting in about forty days of data collection exercise. This was, however, brought to two days due to the high cost of leasing the equipment per day and associated logistics. Nonetheless, the result of this research shows alarmingly high ambient environmental noise values at all the stations occupied; the values measured at the electric milling section of the Wuse Market and at the security booth area of the A.E.P.B. office complex point to an obvious environmental emergency. This scientific study, hopefully, has helped put into the public consciousness the often-neglected menace of long-term exposure to noise levels that the general population has too often taken for granted; in this regards, then, appropriate recommendations have been proposed.

2.0 INTRODUCTION

2.1 Background to Study

All over the world, natural occurrence and human activities have created pollution in different forms. In recent times, there have been increasing levels of awareness on noise pollution; this may be due to the fact that noise (especially in urban areas) has been increasing rapidly. Noise pollution has now been recognised as a serious threat to the quality of life enjoyed by the citizens; also, noise pollution is also of great concern in the industries because it affects the productivity of the workers. It has been argued that because noise produces no dramatic ill effects, the Nigerian public has been largely uninterested in its mitigation. This may help explain why not much research into environmental noise pollution has been carried out within Nigeria cities. No doubt, armed with these facts, the Federal Government entrusted the Federal Environmental Protection Agency (FEPA) with the responsibility of formulating laws that would regulate and control the level and impact of noise in the country. This study will serve as a principal reference material on the level of noise in some selected areas of Abuja, Nigeria's seat of government.

2.2 Noise as Environmental Pollution

Noise pollution (or environmental noise in technical lingo) is displeasing human or machine-created sound that disrupts the environment. The dominant form of noise pollution is from transportation sources, principally motor vehicles.

2.2.1 Sources of Noise: The overarching source of most noise worldwide is generated by transportation systems, principally motor vehicle noise, but also including air craft noise and rail noise. Poor urban planning may also give rise to noise pollution, since juxtaposition of industrial

to residential land uses, for example, often results in adverse consequences for the residential acoustics environment. Besides transportation noise, other prominent sources are office equipment, factory machinery, appliances, power tools, lighting, human and audio entertainment systems. Furthermore, with the popularity of digital audio player devices, individuals in a noisy area might increase the volume in other to draw out ambient noise sounds. Construction equipment also produces noise pollution.

2.2.2 Effects of Noise Pollution: Everyday noise pollution affects not only the health of millions of people, but also their well-being. Many people are exposed to dangerous levels of noise without even realizing whether it be from loud music, a motorcycle, airplane, lawnmowers, or even driving on the highway with your window open. Transportation vehicles, especially airplanes and airports produce the most amount of noise in our environment. Scientists have recently found that continuing exposure to noise with a volume more than 70decibels (70dB) can lead to permanent hearing damage. Excessive noise levels can also lead to the increase of heart rate, blood pressure, and blood cholesterol. It also has potential to harm the respiratory and digestive systems. Constant noise can lead to stress disorder which could further develop into cancers or high blood pressure. Sleep deprivation usually occurs for people at a decibel of 45 or higher, and at 85 decibels hearing damage occurs. People of all ages who already experience health problems are at very high risk. Scientists have also found that the following list of things produce a sound higher than 70dBA.

- Air raid sirens (140 decibels).
- Airplane taking off and thunder (120 decibels)
- Garbage truck (100 decibels)
- City traffic and truck driver (90 decibels)
- Alarm clock and hair dryer (80 decibel)

Each day, a huge majority of people are exposed to large amounts of noise. Even if we are sitting outside our homes or taking the dog for a walk, we are subjected to loud noises which damage our health whether it is the passing of a garbage truck or the sound of a car horn. Many young people listen to their ear stereos very loud on their way to school or work. If awareness and precautions are not taken to stop noise pollution, there will be a future epidemic of hearing loss. Noise pollution is a serious problem that must be taken seriously. It is not just loud or sudden noise provokes a stress response; chronic low-level noise also negatively influences the brain and behavior. Whether from the road or in the office, low-intensity noise has a subtle yet insidious effect on our health and well-being. Noise at home or school can affect children's ability to learn compared to kids from quitter neighborhoods. Children living near airports or busy highways tend to have lower reading scores and develop language skills more slowly. Psychiatric hospitalizations are higher in noisy communities. Bad moods, lack of concentration, fatigue, and poor work performance can result from continual exposure to unpleasant noise.

2.3 Concept of Decibels

Human ear is capable of hearing a very wide range of sound pressures. The softest sound a normal human ear can detect has a pressure variation of 0.00002 Pascal (Pa); this is referred to as the threshold of hearing. On the other hand, the sound is painfully loud at levels around 20 Pascal (Pa). Thus, the human ear detects sound pressures over a range of 0.00002 Pa to 20 Pa. However, in general acoustics studies, to work with such a broad range of sound pressures an especially logarithmic scale called *Decibel* is employed in noise measuring instruments. The decibels or dB scale compresses very wide range of sound pressure into manageable range, and it gives a much better approximation to human perception. The *Decibel* is named after Alexander Graham Bell, who took great personal interest in the problems of deaf people and formulated a logarithmic scale based it.

2.3.1 Sound Pressure Level

Sound pressure is the amount of air pressure fluctuation a noise source creates. We "hear" or perceive sound pressure as loudness. However, sound pressure converted to the decibel scale is known as *sound pressure level* (SPL). The decibel scale uses hearing the threshold of 0.00002Pa as reference level.

2.3.2 Zero Decibel

Zero decibel does not mean no "noise", it means a sound level where sound pressure is equal to that of the reference level. It is the pressure level where all other levels are compared on the dB scale.

2.4 Weighting Networks

Whenever a measurement level is being obtained, the level is a relative quantity fixed only when a reference condition is established. Different sound level will be obtained from any measurement of the sound if different weighting filters are employed. These weighting networks attempt to alter the measured signal in a similar fashion as the human hearing mechanism. As such, sound level meter has four separate weighting networks that electrically alter the frequency characteristics of the source prior to its display at the meter output; the actual recording at these conditions is a weighted sound pressure level commonly called sound level. The four available weighting networks are as follows:

(i) A-weighting
(ii) B-weighting
(iii) C-weighting
(iv) Flat-weighting

The A-weighting network is the most commonly used for industries and environmental studies because it deletes the low frequency sound energy and has been found to correlate well with human response. Studies have shown that the rate of hearing loss tends to follow the A-scale in that one can tolerate higher level of low-frequency noise for a longer period of time without hearing impairment (Abumere et al, 1999; Ebeniro and Abumere, 1999). An A-weighting filter is built into the noise measuring instrument to correspond to the particularity of human hearing. The noise pressure level measured is designated as dBA; "A" stands for A-weighting network.

2.5 Location of Study Area

2.5.1 Introduction: Abuja was chosen as the location of this study. The areas occupied for this study are within the central spread of Abuja metropolis and these are areas suspected to be susceptible to high ambient environmental noise.

2.5.2 Areas Occupied for Investigation

1. Jabi Motor Park
2. Kado Village Market
3. Utako Market
4. Wuse Market (electric milling machine section)
5. Wuse Market (foodstuff section)
6. Abuja Environmental Protection Board Office
7. Wuse Park
8. Banex Plaza
9. Area 1 Shopping Complex
10. Area 11, NTA Junction
11. FCDA Junction
12. Zone 3 Neighbourhood Shopping Centre

2.6 Objectives of Research Work

The objectives of this project work include the following, viz;

i. Determination of maximum ambient noise levels at strategic locations within Abuja metropolis.
ii. Proposing appropriate mitigating factors where it is discovered that the noise level exceeds the internationally-recognised threshold of 70dB.

2.7 Scope and Limitation of Study

This study was originally designed to cover all the vulnerable areas (e.g. schools, hospitals, offices, etc.) within Abuja city and its outlying neighbourhoods that are constantly at threat of high noise levels. However, due to certain principal constraints, the study was limited to just collection of data from twelve major stations.

3.0 Research Methodology

3.1 Introduction

The research was carried out in selected sites following a uniform procedure of data collection. The operator on each site held the noise level meter in position for a period of 2-3 minutes and the first reading was recorded by the recorder. The second and third readings were also taken

for the same time interval simultaneously. Besides the operator holding the equipment with his hand, a tripod was also provided on which the equipment can be placed as the readings are taken. The equipment also came with a microphone cap (cover), which is put to use in cases of wind disturbance in other to minimize any form of interference or error when taking readings. Upon taking the reading, the distance of the equipment to the major sources of noise was also measured and recorded in meters. The operator also note down other sources of noise in the site in question. Finally, there was an interview session with occupants of the site in question in regards to how long they have to stay under the influence of such noise level and how it affects them.

3.2 Research Work Plan

The original research work was planned for a period of twenty days, thus covering twenty different sites. For accuracy, it would have been appropriate to re-occupy each of those twenty sites a second time thus resulting in about forty days of data collection exercise. This was, however, brought to two days due to the high cost of leasing the equipment per day and associated logistics. The research was designed with an analogue noise meter in mind, and this would have required occupying any designated station for at least 30 minutes. However, the research team leased a digital noise level meter and it was no longer necessary to occupy a particular station for 30 minutes; instead stations were occupied for 2 to 3 minutes with the attendant savings in time.

3.3 Field Equipment

3.3.1 Sound Level Meter: A sound noise level meter is an instrument designed to react to noise much like the human ear. The measurements taken by a sound level meter are compared to the accepted standards to identify whether the noise level could have a detrimental effect on the people located near the noise source. They are commonly used in noise pollution studies for the quantification of almost any noise, but especially for industrial, environmental, aircraft noise, and noise ordinance enforcement. This project work employed the Extech Digital Sound Noise Meter Type 2 Model 407736 instrument for the measurement and data collection. The sound level meter features high and low measuring ranges for maximum hold, allowing highest sound level during a measurement to be hold; in the Max Hold mode the meter takes continuous measurements and only updates the LCD (liquid crystal display) when a higher reading than the previous one is detected. It is also has a built-in calibration check of 94dB and an analogue AC/DC outputs for connection to an analyzer or recorder. Extech 407736 meets ANSI (American Nation Standard Institute) and IEC (International Electrotechnical Commission) 651 Type 2 standards. The model can measure from 35dB to 130dB (A or C), with a dynamic range of 55dB and measurement bandwidth of 31.5Hz to 8000Hz. The operating temperature and humidity are 32^{o}F to 104^{o}F (0 to 40^{o}C) and 10 to 90% (relative humidity) respectively. It also includes “A and C” weighting network which is the necessary international standard for sound level meters performance. Nevertheless, the meter provides a built-in calibration check. The calibration screw adjustment is located on the front panel under the function switch. The characteristics of the Extech 407736 Sound Level Meter also include the following: it comes complete with hard vinyl case and 9V battery, it utilizes 0.49” (12.3mm) condenser microphone, it consists of 0.5” 3-1/2-

digit LCD display, it meets ANSI and IEC 651 Type 2 standards, and it has analog AC/DC conditioned outputs 10mV/dB.

3.3.2 Meter Operation: The meter was turned on by moving the range button to either the Lo or Hi mode for measuring noise level. Measurement mode was selected via the Response Switch; selection of Fast (125msec response) or Slow (1 second response) was determined by their applications and standards related to it. The microphone was usually pointed toward the primary source of noise to be measured and the readings were viewed directly on the meter's LCD screen. Sometimes, when an indication of OVER was displayed, this means that the measurement was out of range. Other measurement ranges were selected by pressing the RESET button.

3.4 Data Collection Procedures

3.4.1 Description of Data Collection Sequences

3.4.1.1 Station 1: Jabi Motor Park is one of the locations suspected to be susceptible to high ambient noise within Abuja metropolis. It is located in the Utako district of the metropolis. The station was occupied by the research team on August 15, 2007. On arrival at the park, different sources of ambient noise were observed and, the major source of noise was noticed at the northwestern section of the park. All of these pieces of information were recorded in the data log sheet. Moreover, a specified time interval for steady-continuous noise measurement was taken and recorded. Initialization time and pause time of the noise level meter were also entered in the data log sheet. Measurements in decibels A (dBA) were tabulated and the average in noise pressure level over the specified time interval was calculated and recorded, see Table 1.

The logarithm sum (lgs) of the noise level measurements shown in Table 1 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(95.00/10)} + 10^{(90.60/10)} + 10^{(93.60/10)}\} dBA \\ &= 10 \log \{10^{9.50} + 10^{9.06} + 10^{9.36}\} dBA \\ &= 10 \log \{3162277660 + 1148153622 + 2290867653\} dBA \\ &= 10 \log \{6601298935\} dBA \\ &= 10\,(9.82) dBA \\ &= 98.2 dBA \\ &= 98.2 dBA \end{aligned} \quad (1)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.1 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.1.

Table 1: Data log sheet for Jabi Park

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…….**JABI MOTOR PARK**…… DATE…**15TH AUGUST 2007**…….....

TIME OF DAY...**11:45A.M**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER…….**SUNDAY JOSEPH ALABI** ……

TIME OF INITIATION OF INSTRUMENT…**11:50A.M**…

PAUSE TIME…..**11:59A.M**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **AUDIO AMPLIFIER (LOUDSPEAKER) FROM MUSIC SHOP**

DISTANCE FROM NOISE SOURCE…**2.80 METRES** ……

OTHER SOURCE(S) OF NOISE…**HONKING FROM VEHICLES AND HUMAN ACTIVITIES**

Time (am)	Measurements in dBA
11:55	95.00 dBA
11:57	90.60 dBA
11:59	93.60 dBA

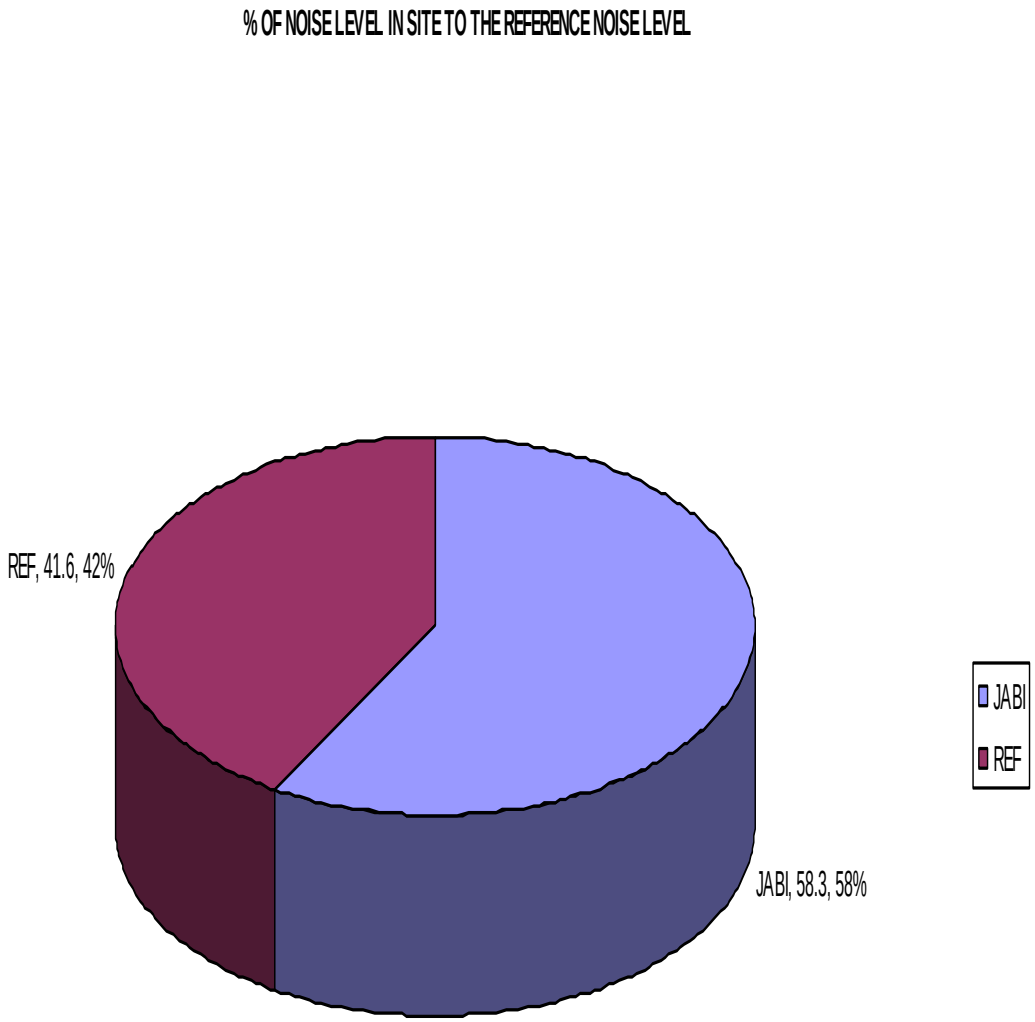

Fig.1: Pie chart representation of the fractional relation of the noise level value at Jabi Motor Park vis-à-vis the internationally recommended ceiling.

3.4.1.2 Station 2: The Kado Village Market was occupied after the Jabi Motor Park; because of the slight drizzle, the usual hustle and bustle a typical market place was subdued. Nonetheless, noise from vehicular traffic could not be totally ignored. The distance of the major source of noise from the point of measurement was 3.40 meters. Table 2 shows the noise data log sheet for Station 2 (i.e. the Kado Village Market).

The logarithm sum (lgs) of the noise level measurements shown in Table 2 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(89.4/10)} + 10^{(78.3/10)} + 10^{(80.6/10)}\} dBA \\ &= 10 \log \{10^{8.94} + 10^{7.83} + 10^{8.06}\} dBA \\ &= 10 \log \{870963590 + 67608297.54 + 114815362.10\} dBA \\ &= 10 \log \{1053387250\} dBA \\ &= 10\,(9.02) dBA \\ &= 90.2 dBA \end{aligned} \quad (2)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.2 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.2.

Table 2: Data log sheet for Kado Village Market

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…….**KADO VILLAGE MARKET**…… DATE…**15TH AUGUST 2007**…….....

TIME OF DAY...**12:15P.M**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER…….**ISAH IDRIS SULE** ……..

TIME OF INITIATION OF INSTRUMENT…**12:20P.M**…

PAUSE TIME…..**12:24P.M**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **VEHICULAR TRAFFIC**

DISTANCE FROM NOISE SOURCE…**3.40 METRES** ……

OTHER SOURCE(S) OF NOISE… **HUMAN ACTIVITIES**

Time (pm)	Measurements in dBA
12 : 20	89.40
12 : 22	76.30
12 : 24	80.60

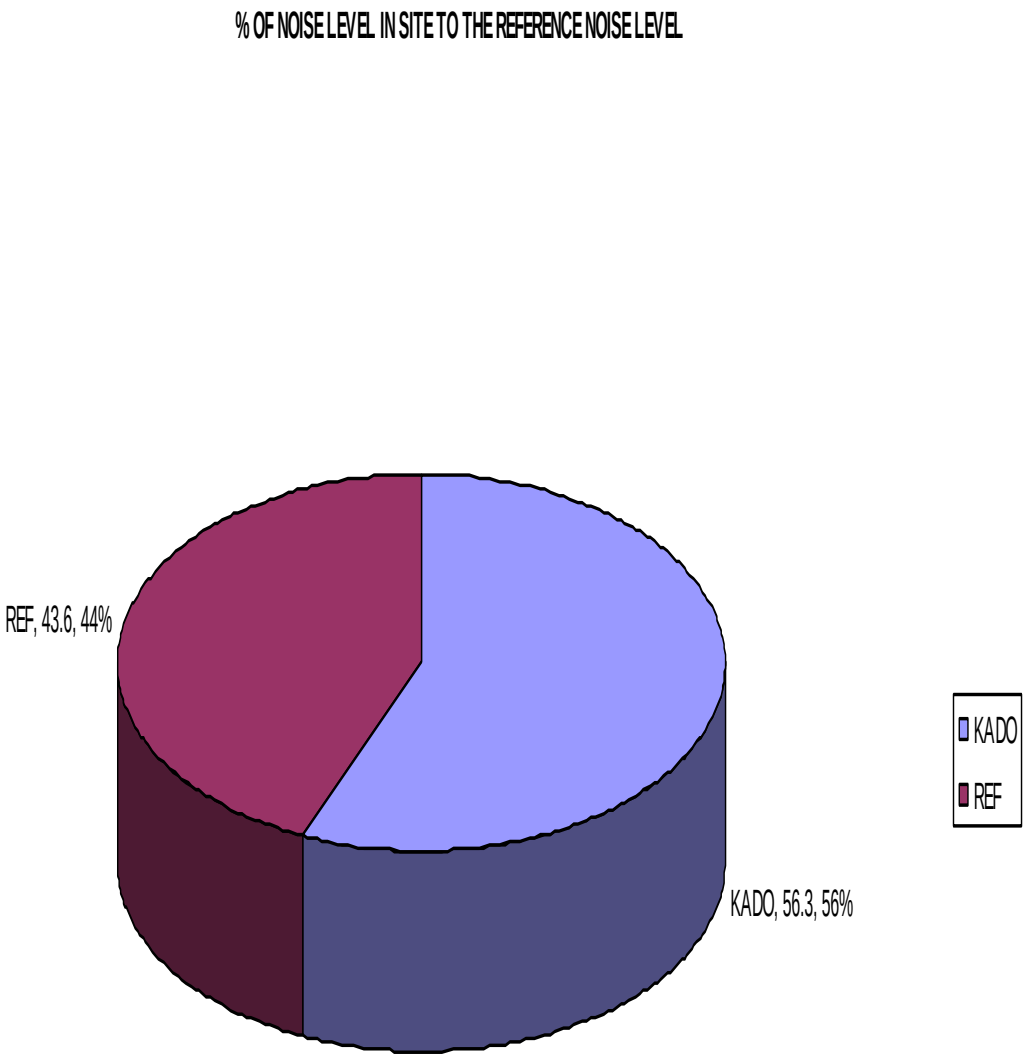

Fig.2: Pie chart representation of the fractional relation of the noise level value at Kado Village Market vis-à-vis the internationally recommended ceiling.

3.4.1.3 Station 3: From the Kado Village Market, the research team proceeded to the Utako Market. Utako Market is a business area which is located near residential and offices. The market is usually open by 8:00am and closes at 6:00pm every day of the week. The major source of noise in Utako Market is from electrical generators; almost all the shops in the market use their 650VA-plus rated standby generators to supply electricity for more than six (6) hours every day due to unstable power supply in the area. Other sources of noise were music stores, saloons, entertainment outlets, and sundry human activities. The distance of the meter from the source was 3.00m. Table 3 shows the noise data log sheet for Station 3 (i.e. the Utako Market).

The logarithm sum (lgs) of the noise level measurements shown in Table 3 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(85.0/10)} + 10^{(89.0/10)} + 10^{(84.0/10)}\} dBA \\ &= 10 \log \{10^{8.5} + 10^{8.9} + 10^{8.4}\} dBA \\ &= 10 \log \{1361744644\} dBA \\ &= 10\,(9.13) dBA \\ &= 91.3 dBA \end{aligned} \quad (3)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.3 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.3.

Table 3: Data log sheet for Utako Market

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…….**UTAKO MARKET**…… DATE…**15TH AUGUST 2007**…….....

TIME OF DAY...**12:40P.M**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **SANTALI MOHAMMED** ……..

TIME OF INITIATION OF INSTRUMENT…**12:45P.M**…

PAUSE TIME…..**12:49P.M**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **STANDBY GENERATORS**

DISTANCE FROM NOISE SOURCE…**3.00 METRES** ……

OTHER SOURCE(S) OF NOISE… **MUSIC STORES, SALOONS, ENTERTAINMENT OUTLETS HUMAN ACTIVITIES**

Time (pm)	Measurements in dBA
12 : 45	85.00
12 : 47	89.00
12 : 49	84.00

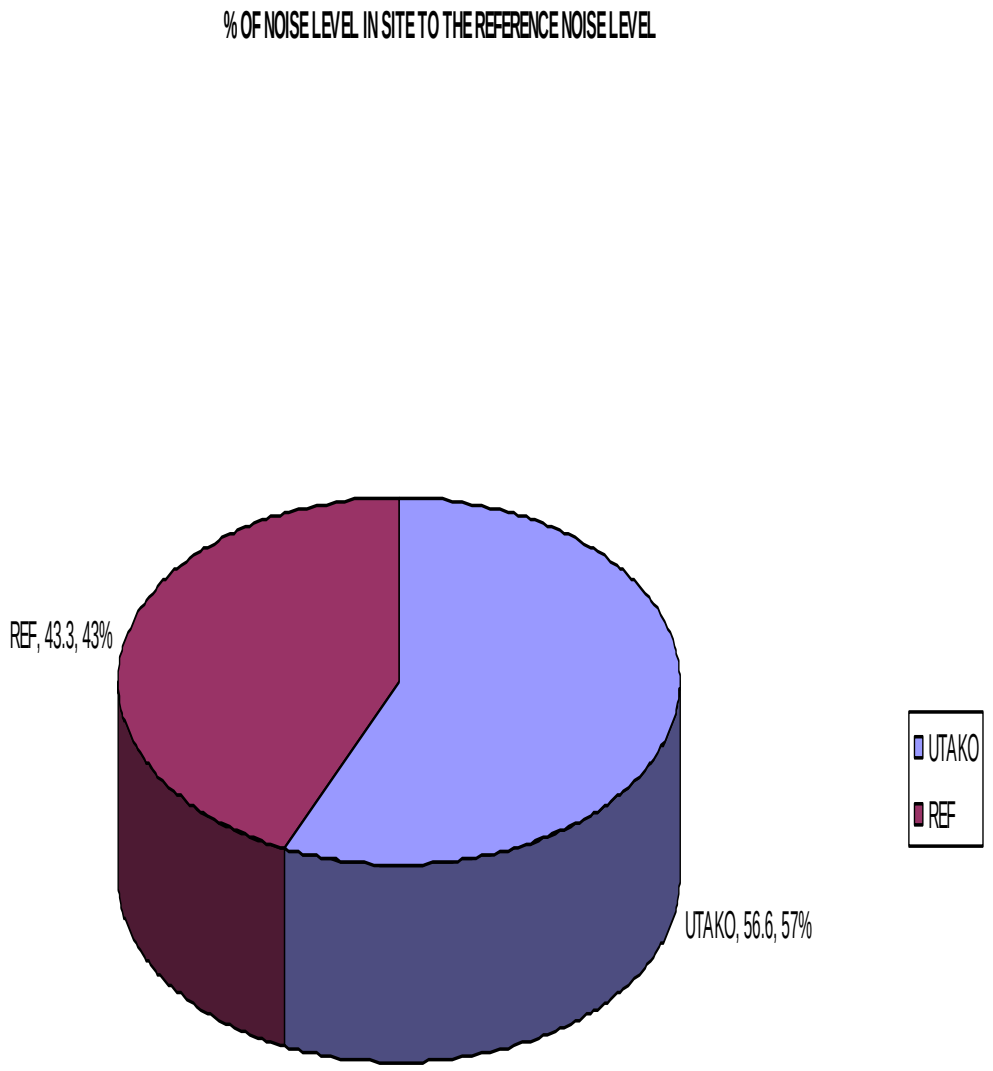

Fig.3: Pie chart representation of the fractional relation of the noise level value at Utako Village Market vis-à-vis the internationally recommended ceiling.

3.4.1.4 Station 4: The electric milling machine section of the Wuse Market was occupied circa 1.15pm after the drive down from Utako Market. The distance of the noise level meter from the electric milling machines was 2m when reading was initiated and terminated. Apart from the milling machines, secondary sources of noise were the shoppers involved in constant haggling and heckling (incidentally the shoppers had to raise their voices in order to overcome the overpowering sound emanating from the electric milling machines, thus increasing the background noise). Table 4 shows the noise data log sheet for Station 4 (i.e. the electric milling machine section of the Wuse Market).

The logarithm sum (lgs) of the noise level measurements shown in Table 4 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(95.0/10)} + 10^{(100.0/10)} + 10^{(100.2/10)}\} dBA \\ &= 10 \log \{10^{9.5} + 10^{10.0} + 10^{10.02}\} dBA \\ &= 10 \log \{23635563140\} dBA \\ &= 10\,(10.37) dBA \\ &= 103.7 dBA \end{aligned} \quad (4)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.4 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.4.

Table 4: Data log sheet for Wuse Market (electric milling machine section)

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…….**WUSE MARKET**…… DATE…**15TH AUGUST 2007**…….....

TIME OF DAY...**1:05P.M**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **MUHAMMAD AWWAL JIBRIL SHAFA** ……

TIME OF INITIATION OF INSTRUMENT…**1:15P.M**…

PAUSE TIME…..**1:19P.M**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **ELECTRIC-MILLING MACHINES**

DISTANCE FROM NOISE SOURCE…**2.00 METRES** ……

OTHER SOURCE(S) OF NOISE… **HUMAN ACTIVITIES (PEDDLERS OF WARES)**

Time (pm)	Measurements in dBA
1:15	97.00
1:17	100.00
1:19	100.20

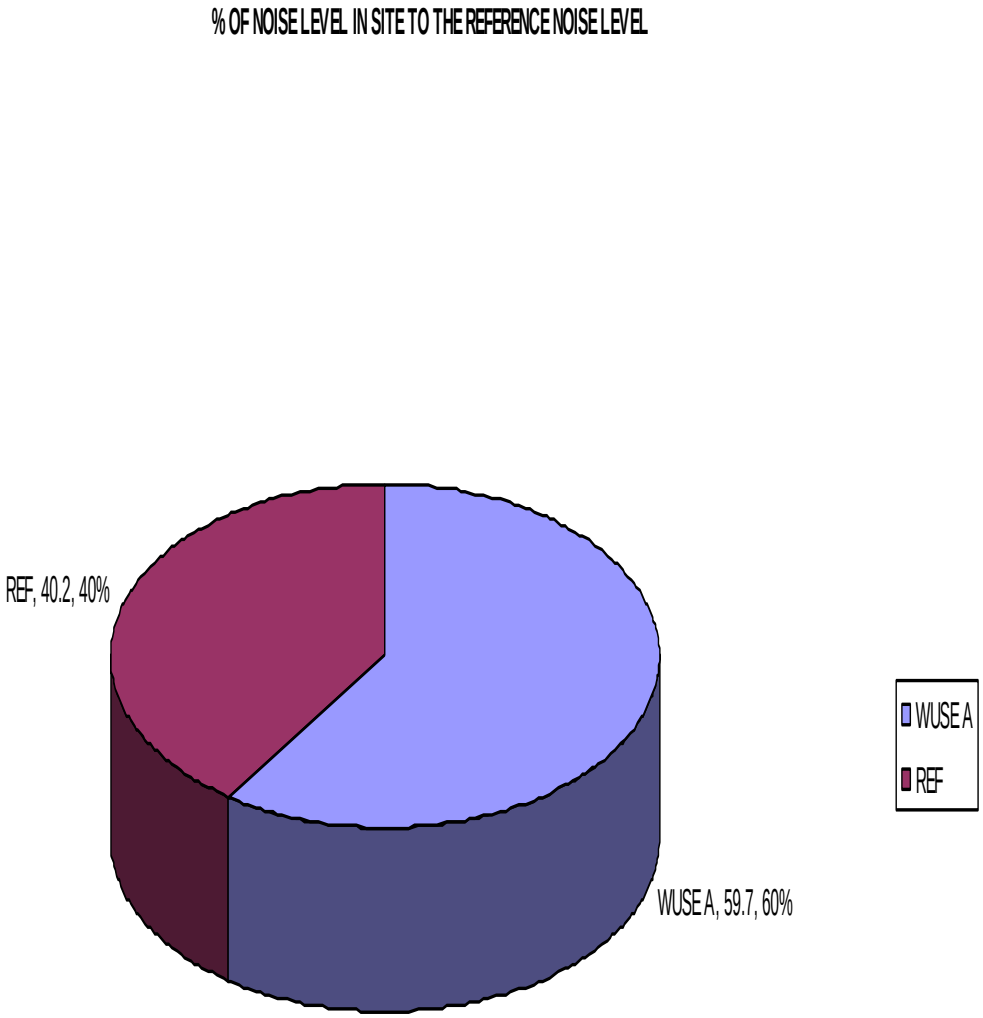

Fig.4: Pie chart representation of the fractional relation of the noise level value at Wuse Market (electric milling machine section) vis-à-vis the internationally recommended ceiling.

3.4.1.5 Station 5: When the survey at the electric milling section of Wuse Market was complete, a spot around the middle of the foodstuff section suspected to have a very high noise level was chosen for the next round of survey. Measurement of noise level was initiated at about 1:32pm and terminated at about 1:36pm. Table 5 shows the noise data log sheet for Station 5 (i.e. the foodstuff section of Wuse Market).

The logarithm sum (lgs) of the noise level measurements shown in Table 5 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(87.0/10)} + 10^{(90.0/10)} + 10^{(87.0/10)}\} dBA \\ &= 10 \log \{10^{8.7} + 10^{9.0} + 10^{8.7}\} dBA \\ &= 10 \log \{2002374467\} dBA \\ &= 10\,(9.30) dBA \\ &= 93.0 dBA \end{aligned} \quad (5)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.5 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.5.

Table 5: Data log sheet for Wuse Market (foodstuff section)

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…….**WUSE MARKET**…… DATE…**15TH AUGUST 2007**…….....

TIME OF DAY...**1:30P.M**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **SEFA NOAH IKYAATOR** …….

TIME OF INITIATION OF INSTRUMENT…**1:32P.M**…

PAUSE TIME…..**1:36P.M**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **RETAILERS AND SHOPPERS HECKLING AND HAGGLING**

DISTANCE FROM NOISE SOURCE…**1.40 METRES** ……

OTHER SOURCE(S) OF NOISE… **LOUD BACKGROUND DIN FROM ELECTRIC MILLING MACHINES**

Time (pm)	Measurements in dBA
1:32	87.00
1:34	90.00
1:36	87.00

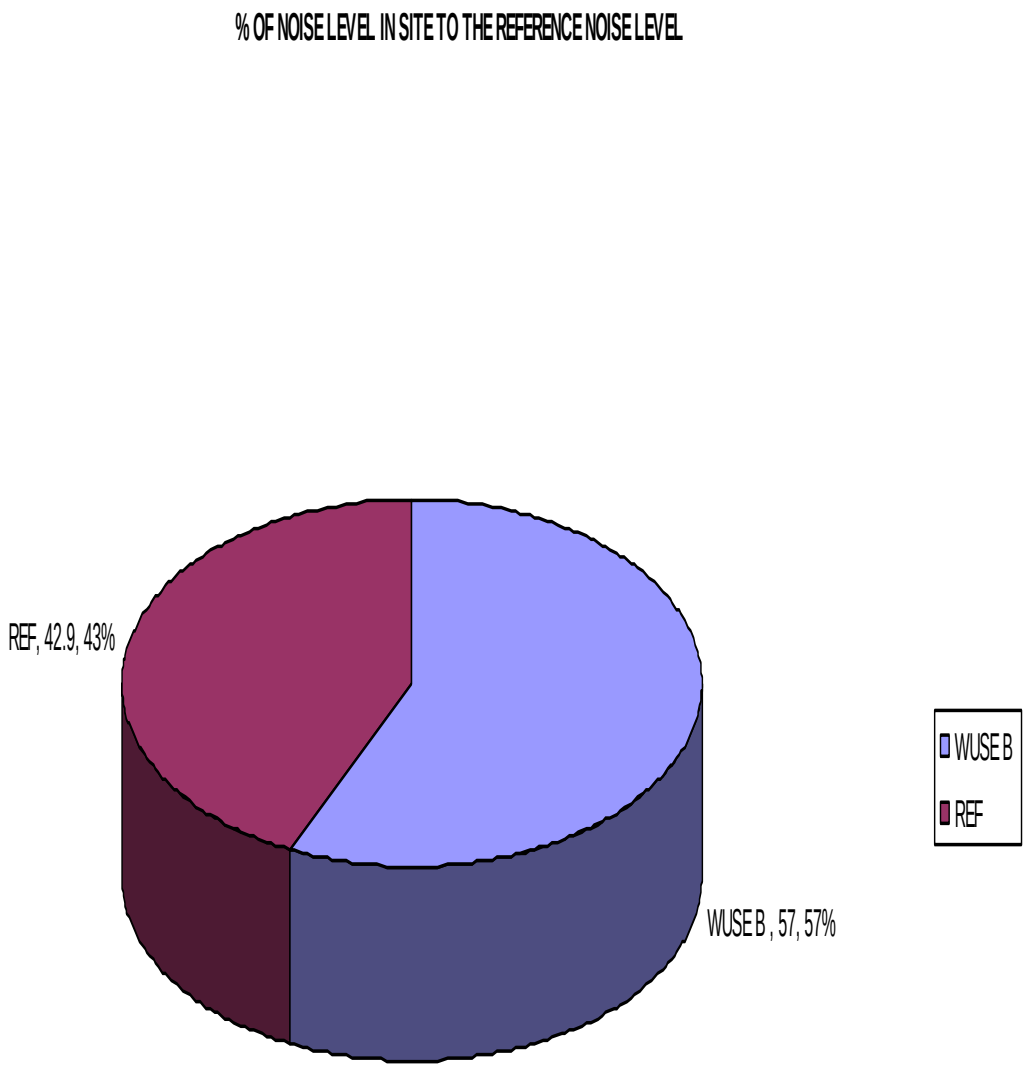

Fig.5: Pie chart representation of the fractional relation of the noise level value at Wuse Market (foodstuff section) vis-à-vis the internationally recommended ceiling.

3.4.1.6 Station 6: The office complex of the Abuja Environmental Protection Board (AEPB), specifically the generator house, was occupied at about 1:50pm. The generator house attracted the greatest interest because the security booth (always manned) is located just a couple of metres away from the generator house. Also, the non-sound-proofed generator house is always occupied by an operator on a seemingly round the clock basis. Table 6 shows the noise data log sheet for Station 6 (i.e. AEPB office complex).

The logarithm sum (lgs) of the noise level measurements shown in Table 6 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(99/10)} + 10^{(97/10)} + 10^{(95/10)}\} dBA \\ &= 10 \log \{10^{9.9} + 10^{9.7} + 10^{9.5}\} dBA \\ &= 10 \log \{16117432340\} dBA \\ &= 10\,(10.2) dBA \\ &= 102.0 dBA \end{aligned} \quad (6)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.6 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.6.

Table 6: Data log sheet for AEPB Office Complex

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION **ABUJA ENVIRONMENTAL PROTECTION BOARD** DATE…**15TH AUGUST 2007**

TIME OF DAY...**1:50P.M**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **SHADRACH SHEPHERD JIYA** …….

TIME OF INITIATION OF INSTRUMENT…**2:02P.M**…

PAUSE TIME…..**2:06P.M**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **DIESEL GENERATOR**……

DISTANCE FROM NOISE SOURCE…**2.80 METRES (GENERATOR HOUSE); 10.00 METRES (SECURITY BOOTH)**……

OTHER SOURCE(S) OF NOISE……..

Time (pm)	Measurements in dBA
2:02	99.00 (2.8m)
2:04	97.00 (10.0m)
2:06	95.00 (10.0m)

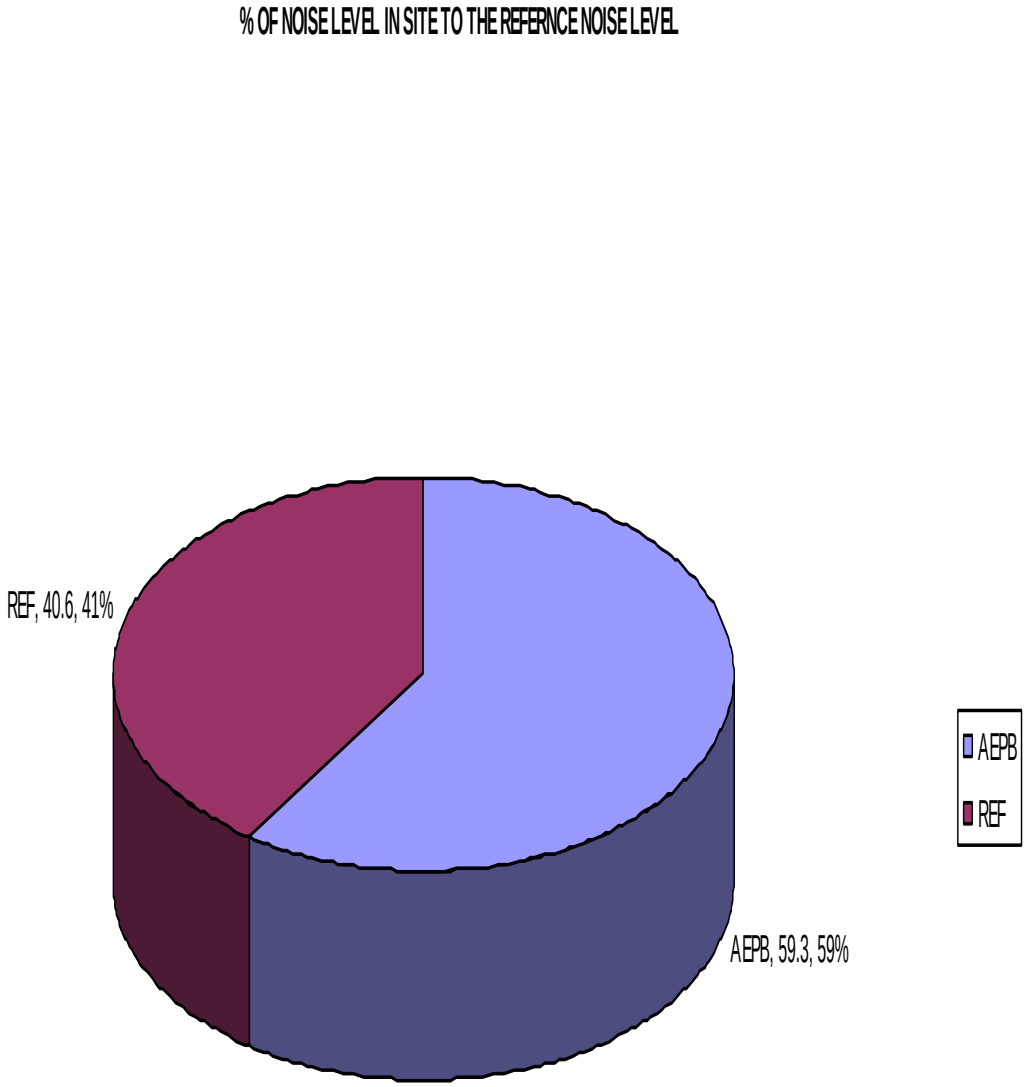

Fig.6: Pie chart representation of the fractional relation of the noise level value at AEPB Office Complex vis-à-vis the internationally recommended ceiling.

3.4.1.7 Station 7: The Wuse Motor Park was occupied at about 10:10am on the morning of the second day of survey; at that time of day, noise from vehicular traffic was predominant. Table 7 shows the noise data log sheet for Station 7 (i.e. Wuse Motor Park).

The logarithm sum (lgs) of the noise level measurements shown in Table 7 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(89.0/10)} + 10^{(86.2/10)} + 10^{(89.3/10)}\} dBA \\ &= 10 \log \{10^{8.9} + 10^{8.62} + 10^{8.93}\} dBA \\ &= 10 \log \{2062335656\} dBA \\ &= 10\,(9.31) dBA \\ &= 93.1 dBA \end{aligned} \quad (7)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.7 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.7.

Table 7: Data log sheet for Wuse Motor Park

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…….**WUSE MOTOR PARK**…… DATE…**16TH AUGUST 2007**…….....

TIME OF DAY...**10:10AM**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER…….**SAMSON SHOLADEMI** ……

TIME OF INITIATION OF INSTRUMENT…**10:20AM**…

PAUSE TIME…..**10:24AM**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **VEHICULAR TRAFFIC**……

DISTANCE FROM NOISE SOURCE…**1.00 METRES** ……

OTHER SOURCE(S) OF NOISE…**COMMUTERS, DRIVERS, AND CONDUCTORS HECKLING**……..

Time (am)	Measurements in dBA
10:20	89.00
10:22	86.20
10:24	89.30

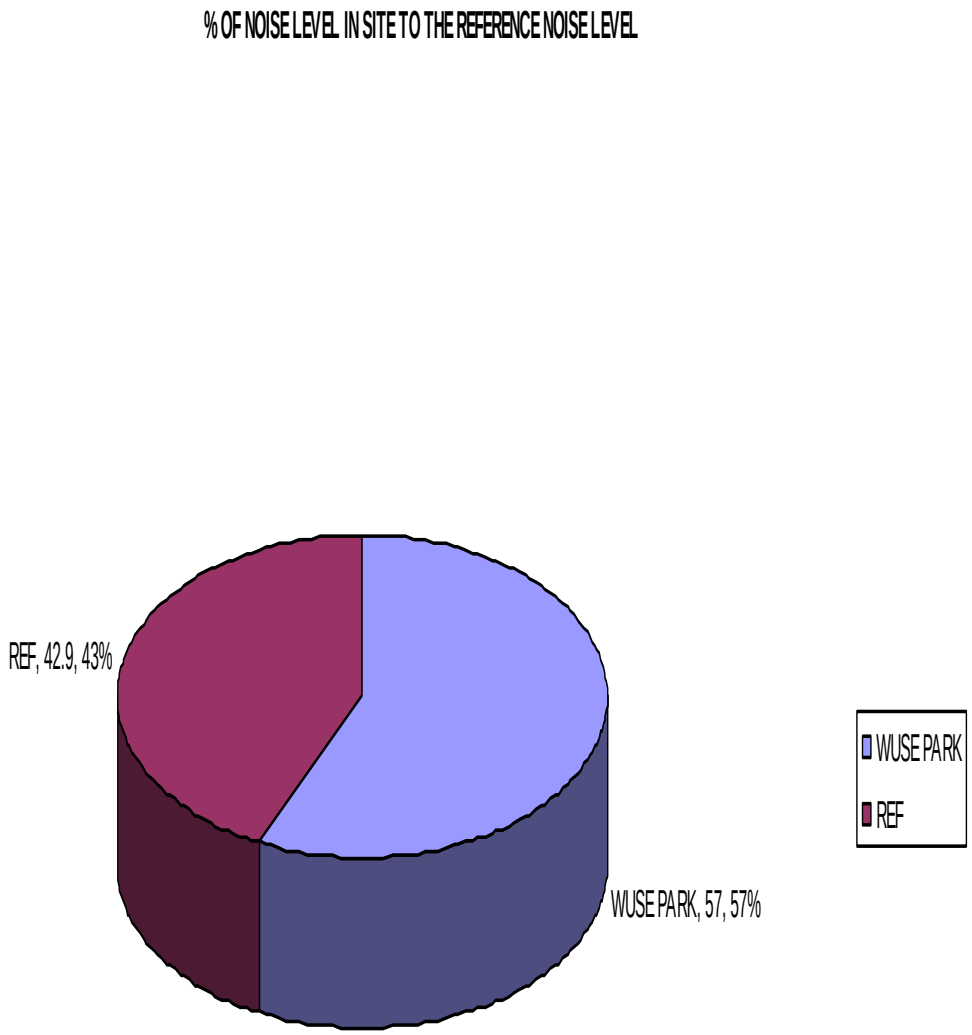

Fig.7: Pie chart representation of the fractional relation of the noise level value at Wuse Motor Park vis-à-vis the internationally recommended ceiling.

3.4.1.8 Station 8: The popular Banex Plaza was occupied after the research team was done collecting data at the Wuse Motor Park. Table 8 shows the noise data log sheet for Station 8 (i.e. Banex Plaza).

The logarithm sum (lgs) of the noise level measurements shown in Table 8was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(88.3/10)} + 10^{(87.9/10)} + 10^{(83.9/10)}\} dBA \\ &= 10 \log \{10^{8.83} + 10^{8.79} + 10^{8.39}\} dBA \\ &= 10 \log \{1538148869\} dBA \\ &= 10\,(9.19) dBA \\ &= 91.9 dBA \end{aligned} \quad (8)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.8 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.8.

Table 8: Data log sheet for Banex Plaza

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…….**BANEX PLAZA** …… DATE…**16TH AUGUST 2007**……..

TIME OF DAY...**11:00AM**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **SULEIMAN E. ABUBAKAR** ……..

TIME OF INITIATION OF INSTRUMENT…**11:08AM**…

PAUSE TIME…..**11:12AM**…

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **ELECTRIC POWER GENERATORS**……

DISTANCE FROM NOISE SOURCE…**4.00 METRES** ……

OTHER SOURCE(S) OF NOISE…**TRAFFIC NOISE, LOUD DIN FROM MUSIC STORE**……..

Time (am)	Measurements in dBA
11:08	88.30
11:10	87.90
11:12	83.90

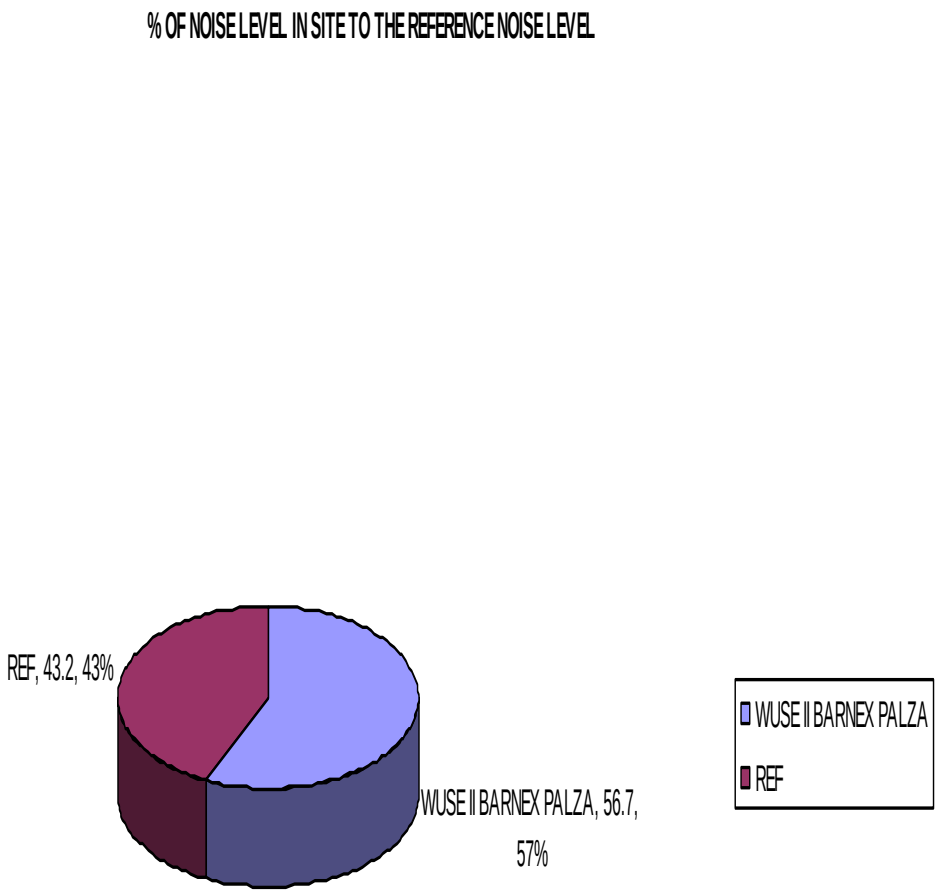

Fig.8: Pie chart representation of the fractional relation of the noise level value at Banex Plaza vis-à-vis the internationally recommended ceiling.

3.4.1.9 Station 9: The Area 1 Shopping Complex was occupied at about 11:40am, and Table 9 shows the noise data log sheet for this station.

The logarithm sum (lgs) of the noise level measurements shown in Table 9 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(80.4/10)} + 10^{(81.3/10)} + 10^{(80.4/10)}\} dBA \\ &= 10 \log \{10^{8.04} + 10^{8.13} + 10^{8.04}\} dBA \\ &= 10 \log \{354191927.5\} dBA \\ &= 10\,(8.54) dBA \\ &= 85.4 dBA \end{aligned} \quad (9)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.9 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.9.

Table 9: Data log sheet for Area 1 Shopping Complex

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…**AREA 1 SHOPPING COMPLEX**…. …… DATE…**16TH AUGUST 2007**…….....

TIME OF DAY....**11:40AM**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **MUSA GARBA KUTA**…….

TIME OF INITIATION OF INSTRUMENT…**11:48AM**…

PAUSE TIME….**11:52AM**….

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **ELECTRIC POWER GENERATORS**……

DISTANCE FROM NOISE SOURCE…**2.80 METRES** ……

OTHER SOURCE(S) OF NOISE……..

Time (am)	Measurements in dBA
11:48	80.40
11:50	81.30
11:52	80.40

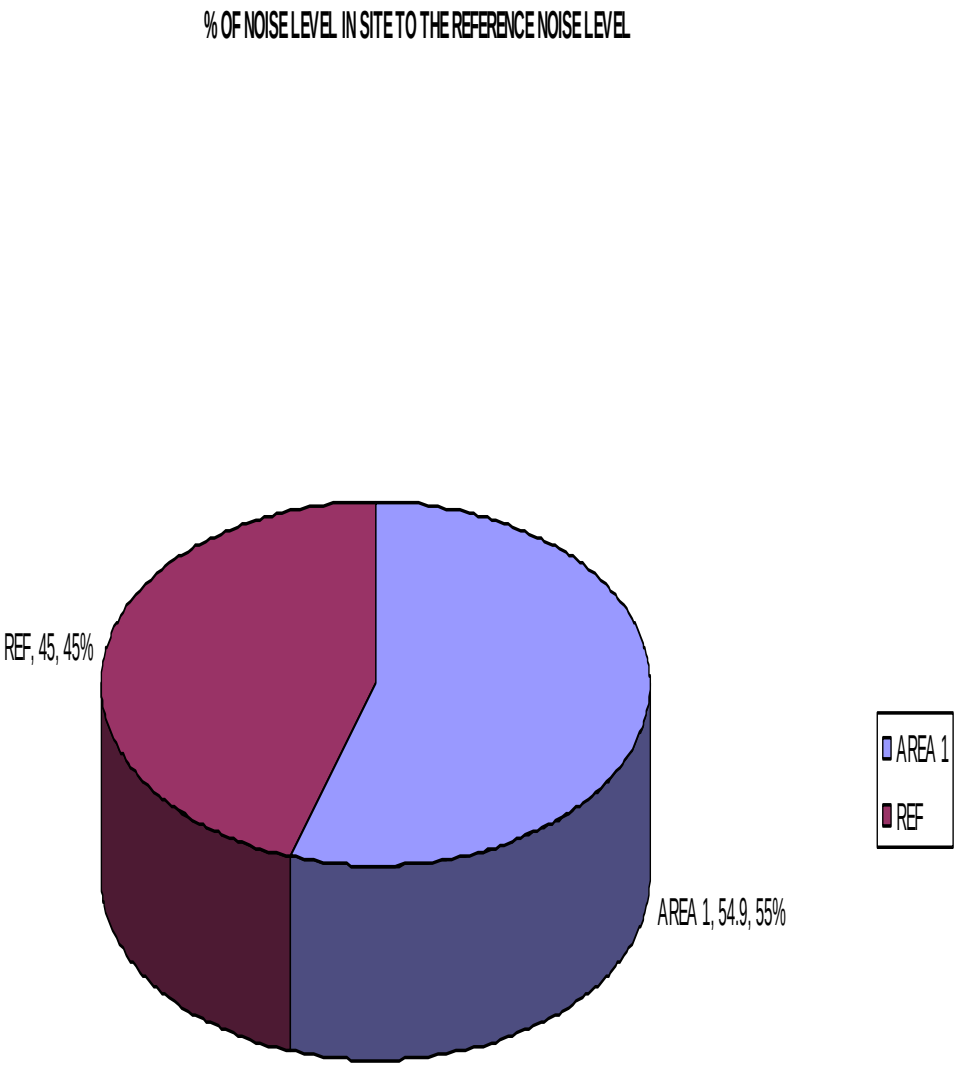

Fig.9: Pie chart representation of the fractional relation of the noise level value at Area1 Shopping Complex vis-à-vis the internationally recommended ceiling.

3.4.1.10 Station 10: The tenth station occupied in the course of the research was the NTA Junction at the Area 11 precinct of the Abuja metropolis. The distance from the major source of noise was 3.4m. Table 10 shows the noise data log sheet for Station 10 (i.e. the NTA Junction).

The logarithm sum (lgs) of the noise level measurements shown in Table 10 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(75.4/10)} + 10^{(76.4/10)} + 10^{(80.5/10)}\} dBA \\ &= 10 \log \{10^{7.54} + 10^{7.64} + 10^{8.05}\} dBA \\ &= 10 \log \{190527113.7\} dBA \\ &= 10\,(8.27) dBA \\ &= 82.7 dBA \end{aligned} \qquad (10)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.10 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.10.

Table 10: Data log sheet for NTA Junction (Area 11)

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION… **NTA JUNCTION** …. …… DATE…**16TH AUGUST 2007**…….....

TIME OF DAY....**12:00 NOON**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **VIMCY PAULINUS UGWU** …….

TIME OF INITIATION OF INSTRUMENT…**12:10PM**…

PAUSE TIME…**12:14 PM**.….

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…… **VEHICULAR TRAFFIC**……

DISTANCE FROM NOISE SOURCE…**3.40 METRES** ……

OTHER SOURCE(S) OF NOISE…**MISCELLANEOUS (HUMAN, etc)**…

Time (pm)	Measurements in dBA
12:10	75.40
12:12	76.40
12:14	80.50

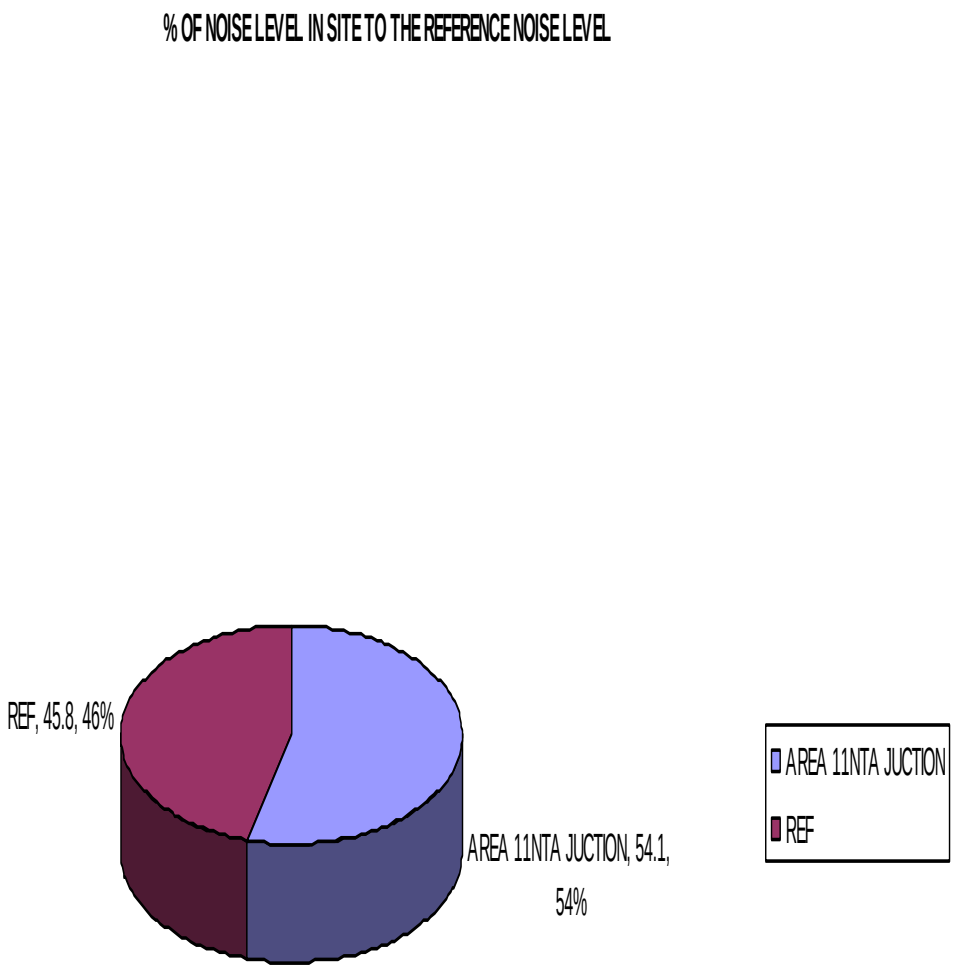

Fig.10: Pie chart representation of the fractional relation of the noise level value at NTA Junction (Area 11) vis-à-vis the internationally recommended ceiling.

3.4.1.11 Station 11: Table 11 shows the noise data log sheet for Station 11 [i.e. the Federal Capital Development Authority (FCDA) Junction].

The logarithm sum (lgs) of the noise level measurements shown in Table 11 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(88.7/10)} + 10^{(80.1/10)} + 10^{(83.6/10)}\} dBA \\ &= 10 \log \{10^{8.86} + 10^{8.01} + 10^{8.36}\} dBA \\ &= 10 \log \{1072726306\} dBA \\ &= 10\,(9.03) dBA \\ &= 90.3 dBA \end{aligned} \quad (11)$$

Abumere *et al.* (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.11 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.11.

Table 11: Data log sheet for FCDA Junction

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…**FCDA JUNCTION** …. …… DATE…**16TH AUGUST 2007**…….....

TIME OF DAY....**1:15PM**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER……. **ELIJAH HARUNA YISSA**…….

TIME OF INITIATION OF INSTRUMENT…**1:24PM**…

PAUSE TIME…**1:28PM**.….

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE… **VEHICULAR TRAFFIC** … ……

DISTANCE FROM NOISE SOURCE…**1.80 METRES** ……

OTHER SOURCE(S) OF NOISE……..

Time (pm)	Measurements in dBA
1:24	88.70
1:26	80.10
1:28	83.60

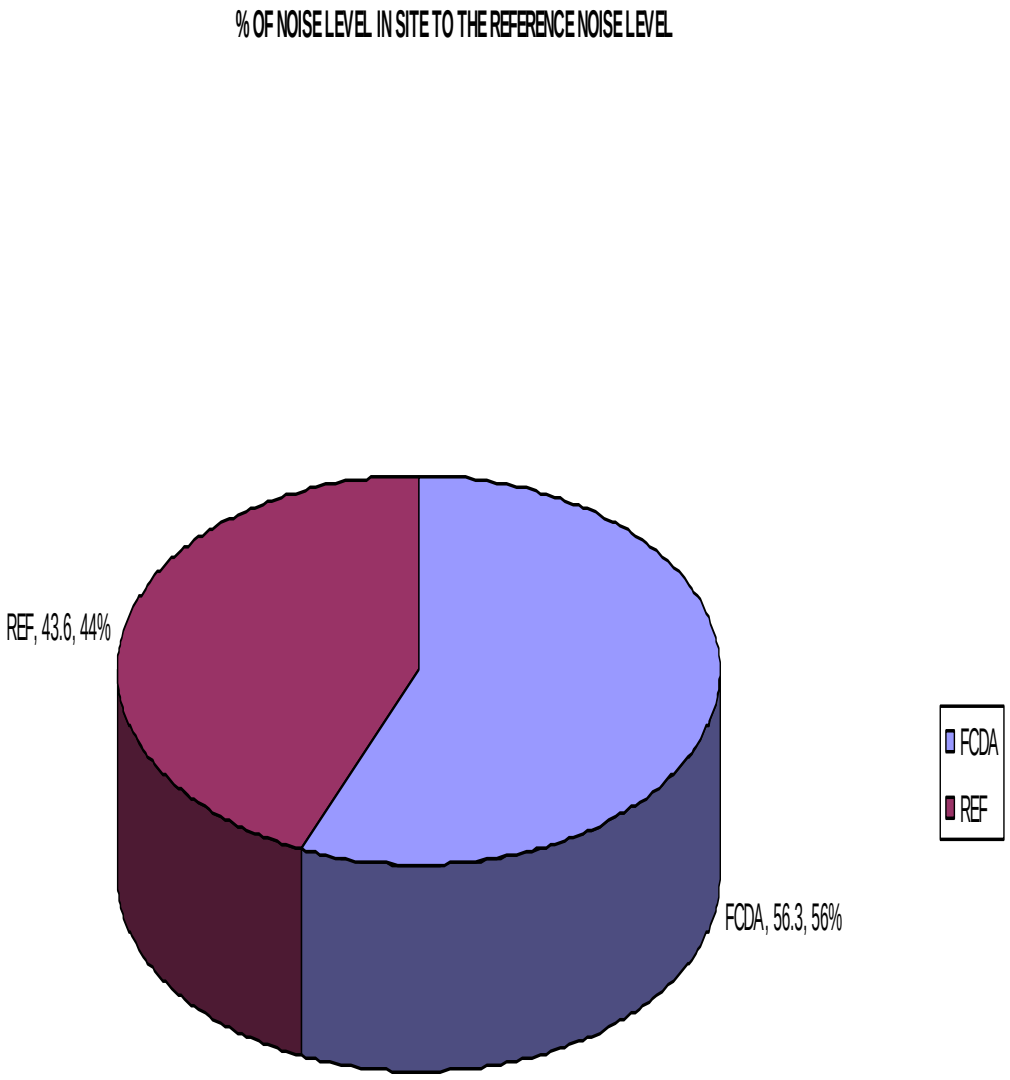

Fig.11: Pie chart representation of the fractional relation of the noise level value at FCDA Junction vis-à-vis the internationally recommended ceiling.

3.4.1.12 Station 12: The last station occupied for this data collection exercise was the Zone 3 Neighbourhood Shopping Centre, and Table 12 shows the noise data log sheet for this station.

The logarithm sum (lgs) of the noise level measurements shown in Table 12 was determined as shown below:

$$\begin{aligned} lgs &= 10 \log \{10^{(89.9/10)} + 10^{(89.7/10)} + 10^{(94.7/10)}\} dBA \\ &= 10 \log \{10^{8.99} + 10^{8.97} + 10^{9.47}\} dBA \\ &= 10 \log \{4861700748\} dBA \\ &= 10\,(9.69) dBA \\ &= 96.9 dBA \end{aligned} \qquad (12)$$

Abumere et al (1999) pointed out that the maximum environmental noise exposure limit or ceiling allowed by International Standards is 70dB.Thus, the arithmetic sum of this reference value and the calculated logarithm sum of Eq.12 was determined, and their fractional relationship was also computed in order to produce the pie chart representation of Fig.12.

Table 12: Data log sheet for the Zone 3 Neighbourhood Shopping Centre

DEPARTMENT OF PHYSICS

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOISE LEVEL DATA ACQUISITION LOG

LOCATION…**ZONE 3 NEIGHBOURHOOD SHOPPING CENTRE**. DATE…**16TH AUGUST 2007**…

TIME OF DAY...**2:20PM**……..

EQUIPMENT…..**EXTECH DIGITAL SOUND NOISE METER TYPE 2 MODEL 407736**

OPERATOR…….**HUSSEIN HAMISU ISAH** ……..

RECORDER…….**VICTOR FOLUSHO AROKOYO**…….

TIME OF INITIATION OF INSTRUMENT……**2:32PM**…

PAUSE TIME….**2:36PM**….

TIME INTERVAL….**2 MINUTES**

MAJOR SOURCE OF NOISE…**COMPRESSOR PUMPS FOR CAR WASH SERVICES**… ……

DISTANCE FROM NOISE SOURCE… **2.5 METRES** ……

OTHER SOURCE(S) OF NOISE… **HIGH PRESSURE NOZZLE SPRAYER** ……..

Time (pm)	Measurements in dBA
2:32	89.90
2:34	89.70
2:36	94.70

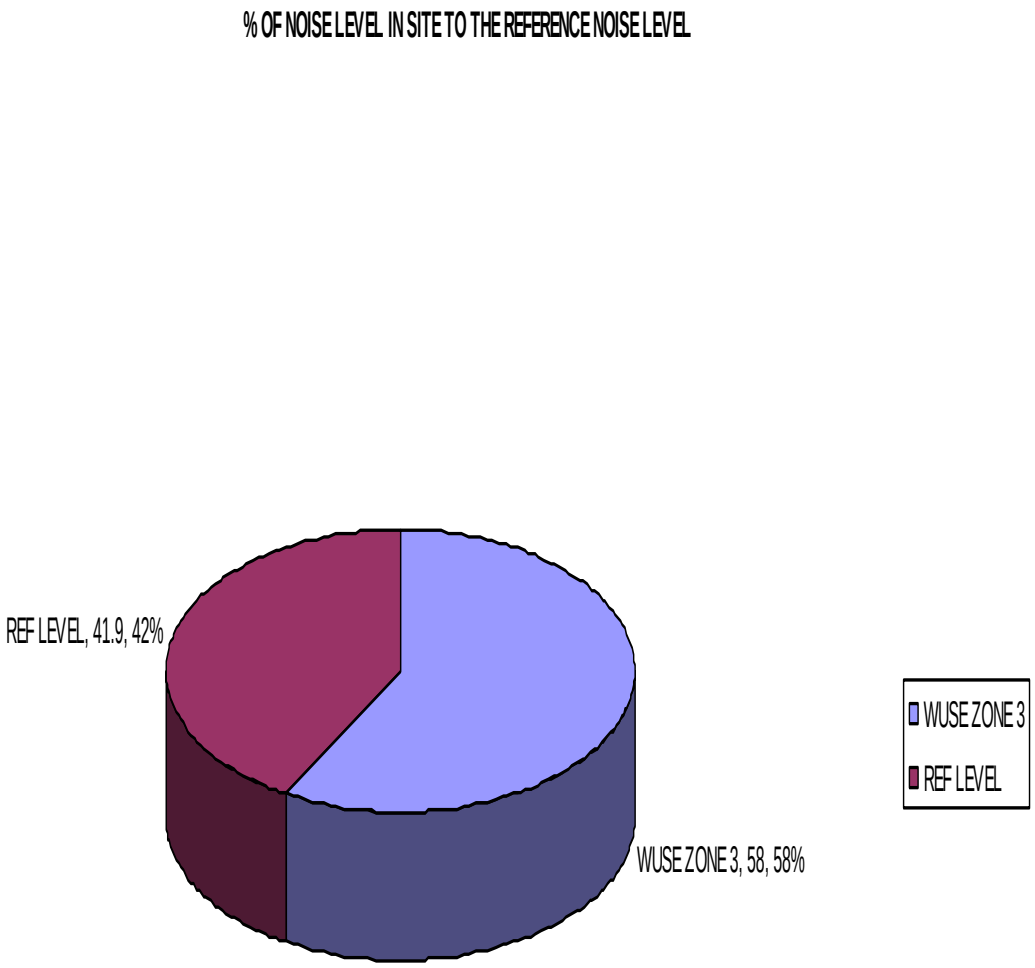

Fig.12: Pie chart representation of the fractional relation of the noise level value at Zone 3 Neighbourhood Shopping Centre vis-à-vis the internationally recommended ceiling.

3.4.2 Bar Chart

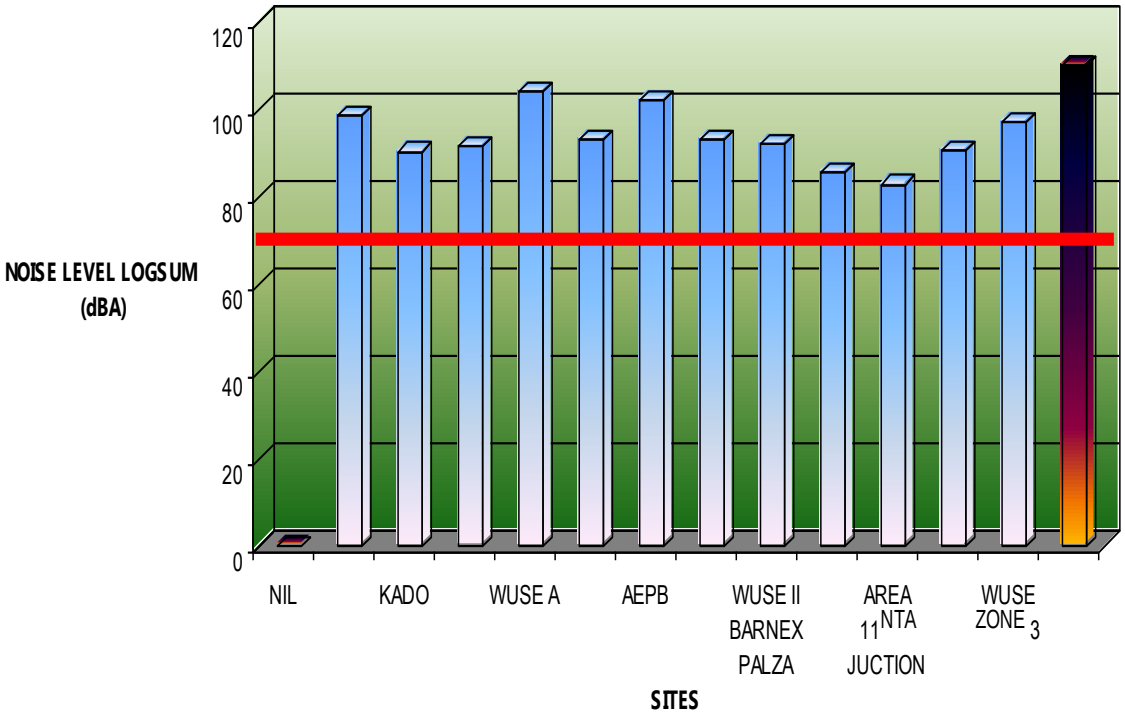

Fig.13: Bar Chart representation of the noise level values at the different stations surveyed.

4.0 Discussion

The two-day exercise on the measurement of environmental noise in Abuja metropolis, which began at the Jabi Motor Park at about noon (at peak activity period) on the first day culminated with measurements at the Zone3 Neighbourhood Shopping Centre around mid-afternoon on the second day. At each of the twelve sites surveyed, pertinent pieces of information were recorded on the data log sheet; such pieces of information include the time of occupation of station, initiation and pause times of the noise meter, operator and recorder of the equipment, major and secondary (if any) sources of noise, and distance of the noise meter from the primary source of noise. Furthermore, at each station, three different readings were tabulated over the equipment exposure time of 4 minutes (at 2-minute interval, that is), see Tables 1-12.

The logarithm sum (rather than the arithmetic sum) over the 4-minute exposure time at the different stations occupied were calculated as shown in Eqs 1-12. As the results show, all of the twelve sites surveyed are characterised by logarithm sums greater than the internationally-recognised threshold (i.e. safe limit) of 70dB. This observation is not particularly surprising because the site selection process was skewed in favour of areas suspected to be susceptible to high ambient environment noise. To put this in perspective, the pie charts of Figs 1-12 have been presented; in each of the figures, it is seen that that the pie segment corresponding to the value of the noise level at the measurement station is always greater than that corresponding to the 70dB threshold.

The primary sources of noise at each of the station are varied and manifold; nonetheless they are the ubiquitous realities of modern urban life that we Nigerians are unfortunately accustomed to living with. Whereas the ambient noise level value at the NTA Junction is a "fractionally" high 82.7dBA. The values of 103.7dB and 102.0dB at the electric milling section of the Wuse Market and the AEPB Office Complex are just intolerable! The distances separating the noise meter from the major sources of noise are not fixed by any rule; however, these distances are generally the mean separations of the sources of noise from the positions that people are most likely to be found for the duration that the disturbances last.

Fig.13 is the bar chart representation of the logarithm sums at the twelve stations viewed with respect to their relationship with one another, and most especially, their relationship to the safe limit of 70dB (seen here as a horizontal bar cutting across each of the vertical bars).

5.0 Conclusion

Noise represents an important public health problem that can lead to hearing loss, sleep disruption, cardiovascular disease, social handicaps, reduced productivity, impaired teaching and learning, absenteeism, increased drug use, and accidents. It can impair the ability to enjoy one's property and leisure time and increases the frequency of antisocial behavior. Noise adversely affects general health and well-being in the same way as does chronic stress. It adversely affects future generations by degrading residential, social, and learning environments with corresponding economic losses. Local control of noise has not been successful in most places.

The Columbia Electronic Encyclopedia pointed out that studies have shown that when subjected to 45 decibels of noise, the average person cannot sleep. At 120 decibels the ear registers pain, but hearing damage begins at a much lower level, about 85 decibels. The duration of the exposure is also important. There is evidence that among youth hearing sensitivity is decreasing year by year because of exposure to noise, including excessively amplified music. Apart from hearing loss, such noise can cause lack of sleep, irritability, heartburn, indigestion, ulcers, high blood pressure, and possibly heart disease. One burst of noise, as from a passing truck, is known

to alter endocrine, neurological, and cardiovascular functions in many individuals; prolonged or frequent exposure to such noise tends to make the physiological disturbances chronic. In addition, noise-induced stress creates severe tension in daily living and contributes to mental illness.

At 93dB the Jabi Motor Park is a very noisy workplace. Those who work daily in the park are at a high risk of permanent hearing loss and other ailments because of the constant exposure to high ambient noise. Assuming most parks are this noisy, frequent public transport users also stand the risk of sleeplessness, irritability, ulcer or even high blood pressure. The area around the Kado Village Market also experiences some disquiet. The major source of noise at this location was identified to be vehicular traffic. The drivers who ply this route inadvertently play significant roles to exacerbate the problem of noise pollution; what with indiscriminate honking and all manners of attention-grabbing mannerisms. This problem is serious in the daylight hours and early evenings but is less significant late into the night and the wee hours of the morning. Any school located close to the Kado Village Market obviously would not provide the right learning environment, especially for young school graders, and this is a factor in intellectual development.

At the Utako Market, the standby generator units and sundry human activities were to blame for the 91.3dB noise level. The generator units that were originally meant for interim measures were observed to be working overtime because of the widespread epileptic power supply problem plaguing the typical Nigerian business establishment. Other than noise pollution, another serious threat to health observed at the Utako Market was the harmful combustion exhaust of these generator units. The electric milling section of the Wuse Market is experiencing what could only be truly called a “noise catastrophic problem”. The milling machine operators are at risk of early onset permanent hearing loss unless proper mitigating measures are taken to minimize this risk; this early onset loss is easily facilitated by exposure to very high ambient noise over a short time.

The foodstuff section of the Wuse Market is modeled like an open-plan office (with low brick partitioning) with tall arching roof overhead; this roofing structure forms a barrier that facilitates reflection of sound thereby emphasising the level of noise in the enclosure. The result is that buyers, sellers, bystanders are not immune from noise pollution. It would seem that noise pollution knows no boundary and spares no one judging by the readings at the Abuja Environmental Protection Board’s office; alas, the Federal Capital’s environmental watchdog suffers from high ambience environmental noise due to the constant drone of the large electricity generator unit at the entrance of the office complex. Without a doubt, the efficiency of staff members at the A.E.P.B. is threatened and the health of the security men whose booth is located just a few metres away from the generating unit are in serious jeopardy. It would be interesting to look out for symptoms of attention-deficiency and irritability amongst staffers of A.E.P.B.

The Wuse Motor Park, like most other motor parks, suffers from unacceptably high ambient noise levels. Large cities are characterized by many shopping malls and plazas, spread around the cities and less of the overcrowded old market structure systems; one of such places in Abuja is the Banex Plaza. The premises of the Banex Plaza suffer from unacceptably high environmental noise level due to the large number of standby generator units that are now a part of the small and medium scale business units. A visit to the shopping plaza or mall, which by tradition ought to be a lively family routine, is now turning into an excursion surrounded by great health anxiety. The Area 1 Shopping Complex, the Area 11/NTA Junction, the FCDA Junction, and the Zone 3 Neighbourhood Shopping Centre are all afflicted by very high environmental noise level not suited to adequate functioning of the human system. The Zone 3 neighbourhood is supposed to be a quiet district because of the presence of schools and private residences but the car wash compressor power pump often shatters the peace of the neighbourhood.

6.0 Recommendation

As a society, our history is filled with failures to recognize the agents that cause disease; once the causes have been recognized, we have responded reluctantly, slowly, and often inadequately. The case with tobacco is an instructive one. It took many years of lobbying by dedicated individuals before legislators and the general public recognized the links between the hazards of tobacco smoke and disease; as a result, laws were finally enacted and behaviors changed accordingly. Despite the evidence about the many medical, social, and economic effects of noise, as a society, we continue to suffer from the same inertia, the same reluctance to change, and the same denial of the obvious that the anti-tobacco lobby faced a couple of decades ago. This inertia and denial are similar to those that delayed appropriate action on lead, mercury, and asbestos. Now we seem unable to make the connection between noise and disease, despite the evidence, and despite the fact, which we all recognize, that our cities are becoming increasingly more polluted with noise. Noise makers and the businesses that support them are as reluctant as smokers to give up their bad habits.

Arising from this research work are the following recommendations:

1. The government has a responsibility to overhaul the power supply system so as to reduce the number of noisy standby electricity generators.
2. There should be a constant environmental awareness by the government to educate the public on the aftermath effects of environmental noise pollution on human health.
3. Environmental education should be added to the school curricular in order to have basic orientation about noise pollution.
4. In Abuja metropolis, where population is fast increasing, noise pollution constitutes a serious health problem. In order to protect the health of the teeming populace, certain measures should be put in place as part of the public health awareness scheme; these could be in form of warning signs against noise pollution, billboards, awareness in encouraging people to plant sound proof trees, etc.
5. Environmental safety monitoring team: The federal government should also establish a monitoring team on environmental noise pollution.

6. Vehicles in bad shape should be declared off-limit on city streets.
7. Construction of underground road networks (tunneling): The federal government should build subways in order that residential areas, schools, hospitals could be shielded from noise generated by vehicles.
8. The government and non-governmental organization should encourage the citizens in using ear muffle at their working place where noise is of great impact i.e. the milling section of the Wuse Market.
9. Enlightenment on the use of silencer for generators or other machines that has exhaust.
10. Discussion of environmental noise pollution issue on the broadcasting stations.
11. Planting of sound proof trees.
12. Conservation centre should be put into consideration like parks, playing-ground within the metropolis.

Lastly, the scope of this study should be expanded for future work and this should be replicated in major urban centres across Nigeria.

Appendix 1: All set to roll. Research team members with the team bus in the background, seen here at the Bosso Campus of the Federal University of Technology, Minna. Team member Samson Sholademi (who is not seen in this shot) and equipment operator Mallam Hussein Hamisu Isah were scheduled to join the posse at Abuja from Kaduna. From left: Idris Sule, Suleiman Abubakar, Vimcy Ugwu, Elijah Haruna, Shadrach Jiya, S.A. Jonah, Mohammed Santali, Sunday Alabi, Victor Arokoyo, Sefa Ikyaator, Musa Kuta, and Muhammad Shafa.

Appendix 2: Project Supervisor, S.A. Jonah, stressing the need to wear earmuff when the risk of exposure to continuous high ambient noise is very high [this is most apt at the electric milling section of the Wuse Market (seen here)]. Research team member Musa Garba Kuta is seen just to the left of the project supervisor.

Appendix 3: Hussein Hamisu Isah, the ubiquitous equipment operator (seen here dispensing advice at the foodstuff section of the Wuse Market). With him is research team member Victor Arokoyo.

Appendix 4: Field strategy session with the project supervisor. Seen here with him are research team members Elijah Haruna, Muhammad Shafa, and Musa Garba Kuta.

Appendix 5: From strategy session to work session: research team members are busy recording noise meter readings.

Appendix 6: Research team members at the premises of the Nigerian Television Authority (NTA) headquarters, Abuja.

Appendix 7: Research team members Samson Solademi, Victor Arokoyo, and Sefa Noah Ikyaator at work. One could just make out the dim outline of Suleiman Abubakar, Shadrach Jiya, and Santali Mohammed in the background.

Appendix 8: Research team member Sunday Alabi is in the middle of this photo.

Appendix 9: The office complex of the Abuja Environmental Protection Board (A.E.P.B.) is shown in this photo. The A.E.P.B. office complex is, unfortunately, plagued by very high incidence of environmental noise originating from the power generating plant mounted a few metres away from the security booth.

Appendix 10: Inside the A.E.P.B. building. The A.E.P.B. contributed immensely to the success of this project; the project supervisor is seen here having a chat with the research team's liaison person (fondly called Sister Mary by members of the research team). Despite the locked windows, this third floor office was not immune from the drone of the generator several metres below and away from the window sill.

Appendix 11: Sister Mary shares a light moment with research team members Samson Sholademi, Victor Arokoyo, and Sefa Noah Ikyaator in her third floor office. The camcorder operator is research team member Isah Idris Sule.

Appendix 12: Sister Mary comes “down to earth” to hear things for herself. Even though the constant drone of the big generator is a fact of everyday office life, the fact it it is being given a scientific appraisal creates a whole new dimension for this invisible pollution menace. The project supervisor is seen here in his rather dorky hat.

Appendix 13: Research team member Vimcy Paulinus Ugwu can just be seen in the foreground in this photo.

Appendix 14: Other than scientific measurements, counsellng was also part of the mission statement of the research team. In this photo, at the popular Banex Plaza, a professional hairdresser shares her views on constant exposure to noise from standby generator units.

Appendix 15: This photo shows another stakeholder who also underwent counseling; he is a mobile phone repairman who is constantly exposed to the noise emanating from standby generator units.

Appendix 16: Typical source of noise; metropolitan vehicular traffic.

Appendix 17: Environmental noise culprit (primary source of noise at the Zone 3 Neighbourhood Shopping Centre); a compressor pump for car wash service.

Appendix 18: Secondary source of noise at the Zone 3 Neighbourhood Shopping Centre; high pressure nozzle sprayer.

Appendix 19: Research team members Sefa Noah Ikyaator, Isah Idris Sule, and Sunday Alabi relax in the team's bus.