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EVALUATION OF NOISE LEVELS OF CORN MILLS IN ABLEKUMA NORTH SUB-METRO, ACCRA.

BY

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CERTIFICATION

I hereby declare that this submission is my own work towards the Msc. And that, to the best of my knowledge, it contains no materials previously published by another person nor materials which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Noise pollution generated from industrial and transport activities in Ghana have received considerable attention from regulators and policy makers. However, rising noise levels in light industries like corn mills have received little attention. A major occupational hazard for workers in corn mills is the noise during the operation of the machines. In this study, evaluation of noise levels was determined by measuring the noise produced by corn mills using sound level meter in Ablekuma North Sub-Metro, Accra. Forty different corn mills were sampled from five electoral areas in the sub-metro, which wereOdorkor North, Odorkor South, Darkuman East, Darkuman West and Kwashieman-Awoshie. The corn mills included imported and locally made ones, new and old teeth of grinding plates were also used for the study. Noise levels were measured 20m and 50m away from source. Questionnaires' were administered to ascertain the age group of people who go to the mills for service, how long the workers have been working there and the ages of the machines. Questionnaires were also administered to know the medical history of the workers and how long the workers have been exposed to the noise.The results showed that corn mills in Ablekuma North sub-metro produced noise levels above the EPA Ghana standard of 85dB. The imported and locally made corn mills produced noise levels ranging from 90db to 106dB. The results also showed that the noise levels of new and old grinding plates of corn mills ranged from 98db to 103db. The study revealed that inhabitants living 20m and 50m away from corn mills are exposed to noise levels above the EPA Ghana permissible noise level of 60dB for area with some commercial and light industry. 200 out of 250 residents and those who go to mill for service and even the workers felt irritated by the noise produced by the numerous corn mills. The reasons given by some of the residents who felt irritated by the noise included disturbance of sleep especially in the afternoon. 25 out of 40 workers complained of hearing impairment and frequent headache. 30 out of 40 operators were found speaker louder when talking to someone

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List of Abbreviation and Acronyms

WHO	World Health Organization
ILO	International Labour Organization
OSHA	Occupational safety and Health Administration
EPA	Environmental Protection Agency
TTS	Temporary Threshold Shift
PTS	Permanent Threshold Shift
AMA	Accra Metropolitan Assembly
dB	Decibel
ISLM	Integrated Sound level meter
SLM	Sound Level Meter
ISO	International Standards Organization
ICM	Imported Corn Mills
LMCM	Locally Made Corn Mill
CI	Confidence Interval

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CHAPTER ONE

INTRODUCTION

1.1 Background

Noise is a disturbing uncomfortable wave which has negative effects on health. It has become a very important “stress factor” in the environment of human beings as a result of technological and industrial progress.Noise pollution has become problematic, yet an unnoticed form of pollution in most developing countries including Ghana (Essandoh*et al.*, 2011). Due to industrialization and urbanization, noise pollution has gained attention as an environmental hazard rated third to air and water pollution (Khilman, 2004; Singh and Daver, 2004).

Davis and Masten (2004) stated three reasons as to why widespread recognition of noise pollution problem has not materialized in a similar fashion as have air and water pollution problems. These reasons are summarized in the definition and perception of noise as a subjective experience, short decay time and difficulty to associate cause with effect when it comes to health impacts.

Several organizations such as World Health Organization, International Labour Organization (ILO) and Occupational Safety and Health Administration (OSHA) have setup new standards for noise and take appropriate actions against their sources. As a result of continuous hard work, standards for noise pollution level in various work places during various times were developed.

Table 1. Some noise standards developed by WHO, ILO and OSHA organization

Area Code	Category of Area/Zone	Limits of L_{eq} dB(A)	
		Day Time	Night Time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence Zone	50	40

Note. L_{eq}: **The equivalent continuous sound level**

Source: www.slideshare.net/mechportal/noise-pollution-in-petroeum-industry-drmandira.

Apart from the discomfort and irritation, noise pollution can cause harm depending on its intensity, duration and frequency. In contrast to many other environmental problems, noise pollution continues to grow and is accompanied by an increasing number of complaints from people exposed to the noise. The need for studies regarding urban noise pollution and its consequences on the environment has motivated various research works on the problem in several countries (Ugwuanyi*et al.*, 2004; Zeid*et al.*, 2000; Zheng, 1996).

Increasingly, noise pollution has become a major problem facing many residents in the national capital. The situation which has assumed alarming proportion in recent times is attributed by worried residents, to the growing numbers of social services centres such as churches and drinking spots and small scale industries like corn mills and saw mills operation.In Ghana, most of our productive human activities are associated with noise generation.

Braj and Jain (1995) reported that commercial areas have the highest noise levels followed by industrial and residential areas. It has been generally accepted that noise pollution particularly road traffic noise issues is widespread in rapidly expanding cities, such as those in southeastern Nigeria (Onuu, 1992) where insufficient control is exercised and cities are poorly planned. Excessive noise beyond certain level of intensity and duration adversely affects human health (EPA, 2011).

Traffic is the dominating source of noise (Skanberg and Ohrstrom, 2002) and is the major source of nuisance and annoyance as cited in social surveys (Panadya, 2003).

Stansfeld and Crombie, (2011) and Kempen*et al*, (2006) reported that there is an association among environmental noise exposure and hypertension and ischemic heart disease. Exposure to acute noise influences the body's compensatory mechanics to stress (Maschke*et al.*, 2000; Babisch, 2002) causes increased blood pressure and vasoconstriction (Berglund *et al.*, 2000), contributes to heart attack, learning disabilities and tinnitus (Moszynski, 2011). The adverse effects of noise on hearing may be classified into three categories namely; temporary threshold shift (TTS), Permanent threshold shift (PTS) and a Caustic trauma. Evidence has accumulated that noise is a risk factor in sleep disturbance, cardiovascular dysfunction, speech interference and mental health distortion including hearing impairment and balance disorder (Ylikoski, 1988; Satterfield, 2001). In some occupational groups, high noise levels can result in intolerable reactions and negatively impact on job satisfaction and performance (Burns and Robinson, 1980). In addition, noise interferes with verbal communications leading to errors and failures to respond to warning signals (Bahadovi*et al*, 1993).

In order to formulate legislation to regulate noise level in the country, it is necessary to evaluate the level of noise of the sources like corn mills located within residential areas; whether the noise generated is hazardous to the health of workers and the people around. It is against this background that the relevance of the study cannot be underestimated.

1.2 **Problem statement**

Although the 2011 statistics on reported cases of noise pollution by residents at the Metro Public Health Department of the Accra Metropolitan Assembly (AMA) was not ready, officials of the department conceded that noise related nuisance dominated complaints for last two years. Whiles noise pollution remains unabated in many areas, the increasing number of small industries like corn mills operation within residents seem to be aggravating the situation making any effort at the fight against excessive noise a difficult one for both the AMA and EPA.

There are for instance, about 40 corn mills in the Ablekuma North Sub-Metro alone and it seems the AMA and EPA have over-looked the exposure of noise level by the numerous corn mills and its effects on the workers and those who go to the corn mills for service. Obviously, many residents are ignorant of the noise level of corn mills in their area.

This therefore provoked a study on evaluation of the noise level of corn mills in Ablekuma North Sub-Metro.

1.3 **Objective of study**

To determine the noise level of corn mills for protective measures

The specific objectives were to:

- investigate noise level of corn mills within their precinct of operation
- investigate noise level 20m away from the place of operation
- investigate noise level 50m away from the place of operation
- determine whether the noise level of corn mills is a potential human hazard
- compare the noise levels of imported and locally made corn mills
- determine which type of corn mill's teeth produces more noise

1.4 Justification of study

Before AMA and EPA can formulate policies to regulate the operations of corn mills in Accra, there is the need to evaluate the noise level of corn mills in order to ascertain whether the noise exposedto the workers and those who go to the corn mills for service is beyond the permissible level. This study would make workers and those who go to the mill for service aware of the hazard they are expose to; in order to adopt protective measures.

1.5 Scope of study

The area selected for the study is Ablekuma North Sub-Metro, Accra. The research involved the measurement of noise levels of forty corn mills selected at random in the sub-metro.

CHAPTER TWO

LITERATURE REVIEW

2.1 DEFINITION OF NOISE

Environmental noise has been defined as an unwanted or harmful outdoor sound created by human activities. This includes noise emitted by means of transport and from sites of industrial activities (Defra, F. N. 2003; Anomoharan and Iserhein, 2004). Ebeniro and Abumere (1999) view environmental noise as an unwanted signal which in most cases is sound.Noise according to EPA Ghana, (2011) is defined as "unwanted or offensive sound that unreasonably intrudes into our daily activities. In the context of seismic prospecting, Dobrin and Savit (1988) defined noise as "spurious seismic signals from ground motion not associated with reflection."

Noise pollution is excessive, displeasing human, animal or machine-created environmental noise that disrupts the activities or balance of human or animal life (http://en.wikipedia.org/wiki/noise). By definition, noise is "sound without value" or "any noise that is undesired by recipient (http://www.preservearticles.com/201101072790/noise-pollution-article.html). In this study, noise is a sound that is incoherent and irregular and produces an unpleasant sensation that is unwanted or that interferes with the ability to hear (EPA 2011).The word noise is derived from the latin word "nausea", meaning a feeling of sickness at the stomach with an urge to vomit.

2.2 **MEASUREMENT OF NOISE**

The most common measurement of environmental noise is the decibel (dB) level. According to Stumpf(1980), the dB is thus expressed as

$$\text{Sound Intensity Level} = 10 \log \frac{\text{Intensity Measured (I)}}{\text{Reference Intensity } (I_0)}.$$

OR

$$dB = 10 \log \frac{(I)}{(I_0)}.$$

Noise is measured by a sound level meter; which is an instrument which responds to sound in approximately the same way as the human ear and which givesreproducible measurements of sound level. The integrating sound level meter (ISLM), and the noise dosimeter are also used to measure noise. 20 db is whisper, 40 db the noise in a quiet office, 60 db is normal conversation, 80 db is the level at which sound becomes physically painful(Mato and Mufuruki, 1999).

The equivalent continous equal energy level (L_{eq}) is appliedto fluctuating noise level. The $L_{eq}$is defined as the constant noise level that expends the same amount of energy as the fluctuating level over the same time period (Davis and Masten, 2004).

Table 2 provides some instrument selection guidelines. Measuring noise levels and worker's noise exposure is the most important part of a workplace hearing conservation and noise control programme. It helps identify work locations where there are noise problems, employees who may be affected, and where additional noise measurements need to be made.

Table 2.Guidelines for Instrument Selection

Type of Measurement	Appropriate Instruments (in order of preference)	Result	Comments
Personal noise exposure	1) Dosimeter	Dose or equivalent sound level	Most accurate for personal noiseexposures
	2) ISLM*	Equivalent sound level	If the worker is mobile, it may be difficult to determine a personal exposure, unless work can be easily divided into defined activities.
	3) SLM**	dB(A)	If noise levels vary considerably, it is difficult to determine average exposure. Only useful when work can be easily divided into defined activities and noise levels are relatively stable all the time.
Noise levels generated by a particular source	1) SLM**	dB(A)	Measurementshould be taken 1 to 3 metres from source (not directly at the source).

	2) ISLM**	Equivalent sound level dB(A)	Particularly useful ifnoise is highly variable; it can measure equivalent sound level over a short period of time (1 minute).
Noisesurvey	1) SLM	dB(A)	To produce noise map of an area; take measurements on a grid pattern.
	2) ISLM	Equivalent sound level dB(A)	For highly variable noise.
Impulse noise	1) Impulse SLM	Peak pressure dB(A)	To measure the peak of each impulse.
* SLM stands for Sound Level Meter ** ISLM stands for Integrating Sound Level Meter			

Source: http://www.ccohs.ca/oshanswers/phys_agents/noise measurement.htm

The SLM consists of a microphone, electronic circuits and a readout display. The microphone detects the small air pressure variations associated with sound and changes them into electrical signals. These signals are then processed by the electronic circuitry of the instrument. The readout displays the sound level in decibels. The SLM takes the sound pressure level at one instant in a particular location.

2.3 Permissible noise levels

The Accra Metropolis has been zoned into categories of seven with specified levels of noise allowed for each area. According to Ghana EPA (2011) the permissible noise level (dBA) for people living in residential areas is rated A; that is areas with low or infrequent transportation disturbances, (55 dBA) during the day and 48 dBA at night. Similarly, areas rated B1 which comprise educational and health facilities are also expected to have noise dBA of 55 during the day and 50 at night.

Areas rated B2 which is a commercial or light industry are allowed a noise dBA of 60 during the day and 55 at night while that of C1, which comprise areas with some light industry, places of entertainment or public assembly, and places of worship are allowed only 65 dBA during the day and 60dB at night.

Predominantly commercial areas are required to have noise levels of 75dB during the day and 65dB at night and light industrial areas required to have noise level 70dB during the day and 60dBat night.

Finally, heavy industrial areas are also required to have noise levels of not more than 70 dBA during the day and the same at night.

2.4SOURCES OF NOISE

Noise pollution like other pollutant is also a byproduct of industrialization and urbanization; it is now recognized as a major problem for the quality of life in urban areas.

The increase in population and in the number of vehicles has led to an increase in noise pollution, but noise pollution has been considered less than other contaminants in the environmental problems (Mansouri*et al.*, 2006).Noise generation from natural sources like lightening, blowing air and flowing water, is a common phenomenon in our life. But the two main anthropogenic (man-made) sources which are mainly responsible for noise pollution are as follows.

- Industrial Sources: Noise is generated by various industrial processes like grinding, cutting, welding, pressing and blasting. Similarly noise is produced by machinery or equipment used for various industrial operations. The major noise producing equipments include gas turbine, rotary compressor, centrifugal pump, fermentation tank, mills etc.
- Non-industrial Sources: It consists of noise generated from domestic activities, loudspeaker, construction and traffic. Use of loudspeaker during various religious or non-religious, public or private functions is a common practice. It considerably increases level of noise. During construction activities, use of various machinery and equipment also increase noise levels in the surrounding environment. Noise is a big problem to the people residing near highways or railway tracks.

Table 3.Some Typical sound levels in dB of various noise sources

Sr.No.	Sources	Noise levels (dB)
1	Rusting of leaves due to gentle wind	20
2	Normal Conversation	50-60
3	Average Office noise	55
4	Small Shop	60
5	Printing Press	80
6	Heavy traffic	80
7	Large Factory	90
8	Train whistle	90
9	Boiler Factory	110
10	Firecrackers	110
11	Aeroplane noise (at a distance of 3 meters)	130

Source; envis.maharashtra.gov.ind

2.4.1 **Industrial Sources**

The industrial sources include noise from various industries and big machines working at a very high speed and high noise intensity(http://www.legalserviceindia.com/article/noip.htp). Noise is generated by various industrial processes like grinding, cutting, welding, pressing and blasting. Industrial machinery and processes are composed of various noise sources such as rators, stators, gears, fans, vibrating panels, turbulent fluid flow, impact processes, electrical machines and internal combustion engines. The mechanisms of noise generation depend on the particular noisy operations and equipment including crushing, riveting, blasting (quarries and mines), and shake-out (foundries). Noise is therefore a common occupational hazard in a large number of workplaces such as the iron and steel industry, foundries, saw and corn mills, textile mills, airports and aircraft maintenance shops, crushing mills, among many others. In many countries, noise-induced hearing loss is one of the most prevalent occupational diseases (gerges@mbox1.ufsc.br). Most of these workers are in the production and manufacturing industries (see Table 4). Studies in Germany and other industrialized countries have showed that the proportion of these exposed to daily average noise levels above 85dB(A) can generally be taken as 12% to 15% of all employed person; that is 4 to 5 million persons in Germany (Pfeiffer 1992). After many years of exposure to noise, there are numerous cases of occupationally related hearing damage recognized as the occupational diseases "noise-related hearing impairment" according to the Occupational Disease Ordinance.

Table 4. Workers exposed to daily L_{Aeq} exceeding 85dB(A). (EPA, 1981)

Agriculture	323000
Mining	40000
Construction	513000
Manufacturing and Utilities	5124000
Transportation	1934000
Military	976000
Total	**9270000**

Source, Gerges, 1992

The sound pressure level generated depends on the type of the noise source, distance from the source to the receiver and the nature of the working environment (gerges@mbox1.ufsc.br). For a given machine, the sound pressure level depends on the part of the total mechanical or electrical energy that is transformed into acoustical energy. Sound fields in the workplace are usually complex, due to the participation of many sources: propagation through air (air-borne noise), propagation through solids (structure-borne noise), and diffraction at the machinery boundaries, reflection from the floor, wall, ceiling and machinery surface andabsorption on the surfaces (Gerges 1992).

2.4.2. **Non Industrial Source**- Most leading noise sources fall into the following categories: roads traffic, aircraft, railroads, construction, industry, noise in buildings, and consumer products (www.legalserviceindia.com/articles/noip.htm).

1. **Road TrafficNoise**

In the city, the main sources of traffic noiseare the motors and exhaust system of smaller trucks, buses, and motorcycles. Theebe (2004) reported that, in a rising market, the impacts of traffic noise on house prices reached a maximum of 12% with an average of about 5%. This has led researchers in many countries to investgate and characterize traffic noise pollution problems (Sommerhoff*et al*., 2004; Panadya, 2003; Bhadram, 2003).

2. **Air Craft Noise**

Now-a-days , the problem of low flying military aircraft has added a new dimension to community annoyance, as the nation seeks to improve its nap-of the- earth aircraft operations over national parks, wilderness areas , and other areas previously unaffected by aircraft noise has claimed national attention over recent year (www.legalserviceindia.com/articles/noip.htm).

3.**Noise from railroads**

Thenoise from locomotive engines, horns and whistles, and switching and shunting operation in rail yards can impact neighboring communities and railroad workers. For example, rail car retarders can produce a high frequency, high noise level that can reach peak levels of 120 dB at a distance of 100 feet, which translates to levels as high as 138, or 140 dB at the railroad worker's ear (Panadya, 2003).

4. **Construction Noise**

The noise from the construction of highways, city streets, and buildings is a major contributor to the urban scene. Construction noisesources include pneumatic hammers, air compressors, bulldozers, loaders, dump trucks (and their back-up signals), and pavement breakers (Bhadram, 2003).

5. Noiseinbuilding:-

Apartment dwellers are often annoyed bynoise in their homes, especially when the building is not well designed and constructed. In this case, internal buildingnoise from plumbing, boilers, generators, air conditioners, and fans, can be audible and annoying. Improperly insulated walls and ceilings can reveal the sound ofamplified music, voices, footfalls and noisy activities from neighboring units. Externalnoise from emergency vehicles, traffic, refuse collection, and other city noises can be a problem for urban dwellers, especially when windows are open or insufficiently glazed (www.legalserviceindia.com/articles/noip.htm).

6. **Noise from Consumer products**

Certain household equipment, such as vacuum cleaners and some kitchen appliances have been and continue to be noisemakers, although their contribution to the dailynoise dose is usually not very large (www.legalserviceindia.com/articles/noip.htm).

2.5TYPES OF NOISE

All noiseis not created equal - nor is it perceived in the same way. There are many different types of noise, and depending on the circumstances and upon the person; some noises are far more annoying than others.Certain noise characteristics can greatly increase the annoyance factor and the health impacts associated with noise. These factors include:

- the presence of tones (tonal noise)
- the presence of low frequency noise
- fluctuating, intermittent or periodic sounds; and
- Impulsive sounds.

2.5.1 Tonal Noise

Tones are noises with a narrow sound frequency composition (e.g., the whine of an electrical motor). Annoying tones can be created in numerous ways: machinery with rotating parts such as motors, gearboxes, fans and pumps often create tones. An imbalance or repeated impacts may cause vibration that, when transmitted through surfaces into the air, can be heard as tones. Pulsating flows of liquids or gases can also create tones, which may be caused by combustion processes or flow restrictions (Leventhall, 2003)

Tones can be identified subjectively by listening. Regulations, however, often require an objective measurement of tonal content as well. In such cases, frequency analysis, where a noise signal is electronically separated into various frequency bands (e.g., octave bands or third-octave bands) may be employed. The tonal audibility or annoyance factor is then calculated by comparing the tone level to the level of the surrounding spectral components ((Leventhall, 2003).

Measuring tonal noise using 1/3-octave band frequency analysis

Germany - DIN 45680 methods (Leventhall, 2003)

In Germany, there is an assumption that the great majority of low frequency noise problems from industrial sources are tonal. For tonal frequencies, the allowable noise limit is less than the non-tonal noises. If the level in a particular third-octave band is 5 dB or more above the level in the two neighboring bands, the noise is described as tonal. This is similar to a standard for tonality set by the ISO (1987).

The test for the presence of tonal components consists of two parts.

1) The sound pressure level of any one of the slow-response, A-weighted, 1/3-octave bands between 20 and 16 000 Hz is 10 dBA or more than the sound pressure level of at least one of the adjacent bands within two 1/3-octave bandwidths. In addition, there must be a minimum of a 5 dBA drop from the band containing the tone within two bandwidths on the opposite side.

Penalties for tonal noise

In some jurisdictions, when noise has an obvious tonal content, a penalty or correction may be used to account for the additional annoyance. (ISO, 1987) The penalty for tones varies between 0 dB (no penalty) and 6 dB. (Bruel and Kjaer, 2000) This penalty is added to the measured dB level before the measured dB level is compared to the legal allowable noise limit.

For example, if the noise from a compressor is measured as 40 dBA, but it is determined that the noise has tonal components, a penalty of 6 dBA would result in a level of 46 dBA. If the noise standard is 45 dBA, the noise from the compressor would be out of compliance.

2.5.2 **Low Frequency Noise**

A large proportion of low-frequency components in noise may increase considerably the adverse effects on health.Low frequency noisecan disturb rest and sleep even at low sound levels.Low frequency noise does not have a consistent definition, but it is commonly defined as noise that has a frequency between 20 and 100 - 150 Hz. Noise at levels below 20 Hz is referred to as infrasound (Bruel and Kjaer, 2000). Depending on the actual conditions, many types of noise can be regarded as low frequency noise:

- Low frequency noise and infrasound are produced by machinery, both rotational and reciprocating, and all forms of transport and turbulence. Typical sources include pumps, compressors, diesel engines, aircraft and fans.
- Combustion turbines are capable of producing high levels of low frequency noise. This noise is generated by the exhaust gas.
- The firing rate of many diesel engines is usually below 100 Hz, so road traffic noise can be regarded as low frequency. Similar considerations can be made for engines or compressors in industries or co-production plants.
- Burners can emit broadband low frequency flame roar.
- Structure borne noise, originating in vibration, is also of low frequency, as is neighbor noise heard through a wall, since the wall blocks higher frequencies more than lower ones.
- Low frequency noise can be noise or vibration from traffic or from industries, totally or partly transmitted through the ground as vibration and reradiated from the floor or the walls in the dwelling (Bruel and Kjaer, 2000).

Low frequency noise creates a large potential for community annoyance. It is most often experienced inside of homes and buildings where resonance amplifies the sound. It is a general observation that indoor noise is perceived as more "low-frequency-like" than the same noise heard out of doors. (Poulsen*et al*, 2002).

Also, low frequency noise can be a factor at much greater distances than audible noise sources. A case study in Northern Carolina near a wind turbine documented low frequency noise problems at residences located more than 1/2 mile from the turbine (SERI, 1995).

Health Effects of Low Frequency Noise

It is well established that the annoyance due to a given noise source is perceived very differently from person to person (SERI, 1995). For many humans, their ears are not very sensitive to low levels of low frequency sound. At low frequencies, however, noise may not be perceived as sound but rather is "felt" as a vibration or pressure sensation. For those who are sensitive to low frequency sound the effects can be dramatic. Complainants often describe the noise as:

- Humming
- Rumbling
- Constant and unpleasant
- Pressure in ears
- Affects whole body
- Sounds like large, idling engine
- Coming from far away

Vasudevan and Gordon(1977) conducted field measurements and laboratory studies of people who complained of low frequency noise in their homes, and concluded the following:

- The problems arose in quiet rural or suburban environments
- The noise was often close to inaudibility and heard by a minority of people
- The noise was typically audible indoors and not outdoors
- The noise was more audible at night than day
- The noise had a throbbing and rumble characteristic
- The complainants had normal hearing

In an epidemiological survey of sufferers from low frequency noise, the following health effects were documented. Comparisons were made between a test group of people who lived with low frequency noise in their homes, and a control group of individuals not regularly exposed to Low frequency noise (Mirowska and Mroz. 2000) .

Measuring and Regulating Low Frequency Noise

When prominent low-frequency noise components are present, noise measurements based on A-weighting are inappropriate. A-weighting has the effect of reducing measured levels of low and very high frequencies, but has less filtering effect on most mid-range sound frequencies where speech and communication are important.

- **Fluctuating, Intermittent and Periodic Noise**

Fluctuating noises may be far more annoying than predicted by average sound levels (Leventhall, 2003).Oil and gas pumpjacks can create fluctuating or intermittent noises.

Pumpjacks may operate and automatically shut off for specific periods of time. When improperly maintained, pump jacks can develop rubbing noises or squeaking noises.

When there is a cyclical rubbing or squeaking, when machinery operates in cycles, when single vehicles pass by, the noise level increases and decreases rapidly. These sorts of regular or periodic variations of sound pressure levels with time have been found to increase the annoying aspects of the noise. Research suggests that variations at about 4 per second are most disturbing (Berglund *et al*., 2000). Noises with very rapid onsets could also be more disturbing than indicated by average sound pressure levels (e.g., dBA).

It has been suggested that a penalty of 3 dB may adequately deal with the annoyance caused by fluctuating noise (Broner and Levanthall, 1983).

2.5.3 **Impulsive Noise**

Impulsive noise is brief and abrupt, and its startling effect causes greater annoyance than would be expected from a simple measurement of sound pressure level (Breul and Kjaer, 2000).Impulsive sounds, such as gun shots, hammer blows, explosions of fireworks or other blasts, are sounds that significantly exceed the background sound pressure level for a very short duration. Examples of impulsive noise in the oil and gas industry could include venting and flaring, pipe-on-pipe impacts due to unloading pipe at a well site, and pile driving.

Typically each impulse lasts less than one second. Measurements with a sound meter set to 'Fast' response do not accurately represent impulsive sounds. To cope with this, a third time constant called I (for impulse) has been developed. The time constant of I is 35 milliseconds, which is sufficiently short to permit detection and display of transient (rapidly changing) noise in a way resembling the human perception of sound.

In Alberta, Canada, measurements of the A-weighted impulse response setting sound level measurement and the A-weighted slow-response setting sound level are taken. If the difference is 10 dBA or less, the impulsive sound is not deemed significant (AEUB, 1999).

The maximum penalty for impulsiveness varies from country to country, and both subjective (based on the type of source, using a list enumerating noise sources such as hammering, explosives, etc.) and objective methods are used to determine the penalty.

In Colorado and Denmark, a 5 dB penalty is added for impulsive noise, while in France a penalty of 3, 5 or 10 dB is assessed, depending on the duration of the impulsive noise (Bruel and Kjaer, 2000).

2.6 **EFFECTSOF NOISE**

Noise has become a very important “stress factor” in the environment of man. It has many effects on exposed population. It can have a number of undesirable effects depending upon its intensity, frequency, duration and time of the day when it occurs. The various effects of noise pollution on human beings are classified as auditory effects (directly affecting ear & hearing ability) and non-auditory effects (affecting other physiological process). Similarly, noise can show various detrimental effects on other living organisms like plants and animals ((http:en.wikipedia.org/wiki/health effect from noise).

Auditory Effects

The most acute and immediate effect of noise pollution is impairing of hearing which may cause auditory fatigue and may even finally lead to deafness.

- Auditory fatigue occurs when exposed to noise levels of 90 dB or above. In metro cities, most of the shopkeepers, cobblers, fruit sellers complain tinnitus in ear.

- Deafness occurs when exposed to loud noise. The workers working in the noisy workplace environment may suffer from Noise Induced Hearing Loss (NIHL). Hearing loss may be temporary or permanent. Prolonged exposure to high noise levels leads to permanent deafness (http:en.wikipedia.org/wiki/health effect from noise).

Non-auditory Effects -

- Non-auditory effects are also alarming, because of the fact that they also cause severe diseases. It includes interference with speech communication, annoyance leading to ill-temper, mental disturbance and violent behavior. It also causes loss of working efficiency due to physiological disorder. Physiological disorders associated with noise include increase heart rate, increase in blood pressure, and change in skin temperature and blood circulation, Cardio-vascular diseases, and change in levels of hormones. In females, the chances of miscarriage and congenital birth defects are more in noisy environment (http:en.wikipedia.org/wiki/health effect from noise).

2.6.1 Hearing loss

The mechanism of hearing loss arises from trauma to stereo cilia of the cochlea, the principal fluid filled structure of the inner ear. The pinna, combined with the middle ear amplifies sound pressure levels by a factor of twenty, so that extremely high sound pressure levels arrive in the cochlea, even from moderate atmospheric sound stimuli.Exposure to high levels of noise have differing effects within a given population, and the involvement of reactive oxygen species suggests possible avenues to treat or prevent damage to hearing and related cellular structures (http:en.wikipedia.org/wiki/health effect from noise).

The elevated sound levels cause trauma to cochlear structure in the inner ear, which gives rise to irreversible hearing loss.A very loud sound in a particular frequency range can damage the cochlea's hair cells that respond to that range thereby reducing the ear's ability to hear those frequencies in the future. However, loud noise in *any* frequency range has deleterious effects across the entire range of human hearing. The outer ear (visible portion of the human ear) combined with themiddle ear amplifiessound levels by a factor of 20 when sound reaches the inner ear(http:en.wikipedia.org/wiki/health effect from noise).

Hearing loss is somewhat inevitable with age. Though older males exposed to significant occupational noise demonstrate significantly reduced hearing sensitivity than their non-exposed peers, differences in hearing sensitivity decrease with time and the two groups are indistinguishable by age 79. Women exposed to occupational noise do not differ from their peers in hearing sensitivity, though they do hear well than their non-exposed male counterparts. Due to loud music and a generally noisy environment, young people in the United States have a rate of impaired hearing 2.5 times greater than their parents and grandparents, with an estimated 50 million individuals with impaired hearing estimated in 2050 (http:en.wikipedia.org/wiki/health effect from noise).

2.6.2Cardiovascular effects

Noise has been associated with important cardiovascular health problems. In 1999, the World Health Organization concluded that the available evidence suggested a weak association between long-term noise exposure above 67-70 dB(A) and hypertension. More recent studies have suggested that noise levels of 50 dB(A) at night may also increase the risk of myocardial infarction by chronically elevating cortical production (http:en.wikipedia.org/wiki/health effect from noise).

Fairly typical roadway noise levels are sufficient to constrict arterial blood flow and lead to elevated blood pressure; in this case, it appears that a certain fraction of the population is more susceptible to vasoconstriction. This may result because annoyance from the sound causes elevated adrenaline levels trigger a narrowing of the blood vessels (vasoconstriction), or independently through medical stress reactions. Other effects of high noise levels are increased frequency of headaches, fatigue, stomach ulcers and vertigo.

2.6.3 Stress

Research commissioned by Rockwool, a UK insulation manufacturer, revealed that in the UK one third (33%) of victims of domestic disturbances claim loud parties have left them unable to sleep or made them stressed in the last two years. Almost one in ten (9%) of those affected by domestic disturbances claim it has left them continually disturbed and stressed. Over 1.8

million people claim noisy neighbors have made their life a misery and they cannot enjoy their own homes. The impact of noise on health is potentially a significant problem across the UK given over 17.5 million Britons (38%) have been disturbed by the inhabitants of neighboring properties in the last two years. For almost one in ten (7%) Britons this is a regular occurrence (http:en.wikipedia.org/wiki/health effect from noise).

2.6.4 Annoyance

Because some stressful effects depend on qualities of the sound other than its absolute decibel value, the annoyance associated with sound may need to be considered with regard to health effects. For example, noise from airports is typically perceived as more disturbing than noise from traffic of equal volume.Annoyance effects of noise are minimally affected by demographics, but fear of the noise source and sensitivity to noise both strongly affect the 'annoyance' of a noise. Even sound levels as low as 40 dB(A) (about as loud as a refrigerator or library can generate noise complaintsand the lower threshold for noise producing sleep disturbance is 45 dB(A) or lower (http:en.wikipedia.org/wiki/health effect from noise).

Other factors that affect the 'annoyance level' of sound include beliefs about noise prevention and the importance of the noise source, and annoyance at the cause (i.e. non-noise related factors) of the noise. For instance, in an office setting, audible telephone conversations and discussions between co-workers were considered to be irritating, depending upon the contents of the conversations. Many of the interpretations of the level of annoyance and the relationship between noise levels and resulting health symptoms could be influenced by the quality of interpersonal relationships at the workplace, as well as the stress level generated by the work itself. Evidence regarding the impact of long-term noise versus recent changes in ongoing noise is equivocal on its impact on annoyance(http:en.wikipedia.org/wiki/health effect from noise).

When young children are exposed to speech interference levels of noise on a regular basis (the actual volume of which varies depending on distance and loudness of the speaker), they may develop speech or reading difficulties, because auditory processing functions are compromised. Children continue to develop their speech perception abilities until they reach their teenage years. Evidence has shown that when children learn in noisier classrooms, they have a more difficult time understanding speech than those who learn in quieter settings.In a study conducted by Cornell University in 1993, children exposed to noise in learning environments experienced trouble with word discrimination as well as various cognitive developmental delays.In particular the writing learning impairment known as dysgraphia is commonly associated with environmental stressors in the classroom.The effect of high noise levels on small children has been known to cause physical health damages as well. Children from noisy residences often possess a heart rate that is significantly higher (by 2 beats/min on average) than in children from quieter residences.

Furthermore, studies have shown that neighborhood noise (consisting of noise from neighboring apartments, as well as noise within one's own apartment or home) can cause significant irritation and noise stress within people, due to the great deal of time people spend within their residences. This can result in an increased risk of depression and psychological disorders, migraines, and even emotional stress.

In the workplace, noise pollution is generally a problem once the noise level is greater than 55 dB(A). Selected studies show that approximately 35 to 40% of workers in office settings find noise levels from 55 to 60 dB(A) to be extremely irritating.In fact, the noise standard in Germany for mentally stressful tasks is set at 55 dB (A).However, if the noise is source is continuous, the threshold level for tolerable noise levels amongst office workers actually becomes lower than 55 dB (A).

One important effect of noise is to make a person's speech less easy to hear. The human brain automatically compensates the production of speech for background noise in a process called the Lombard effect in which it becomes louder with more distinct syllables. But this cannot fully remove the problems of communication intelligibility made in noise.

Other Effects of Noise -

- Birds that rely on hearing to locate prey are seriously disadvantaged by anthropogenic noise.
- Birds in a city need to call longer and louder than their country counterparts.
- Noise disturbs feeding and breeding patterns of some animals and has been identified as a contributing factor of the extinction of some species.
- Aircraft noise and sonic booms have been implicated as a cause of lowered reproduction in a variety of animals.
- Military sonar has been responsible for the deaths of possibly thousands of dolphins and whales.
- In dairy cows, excessive noise reduces feed consumption, milk yield, and rate of milk release.
- Intense noise can affect growth of chickens and egg production. Noise has also been showing to have a detrimental effect on the growth of some plants too.

CHAPTER THREE

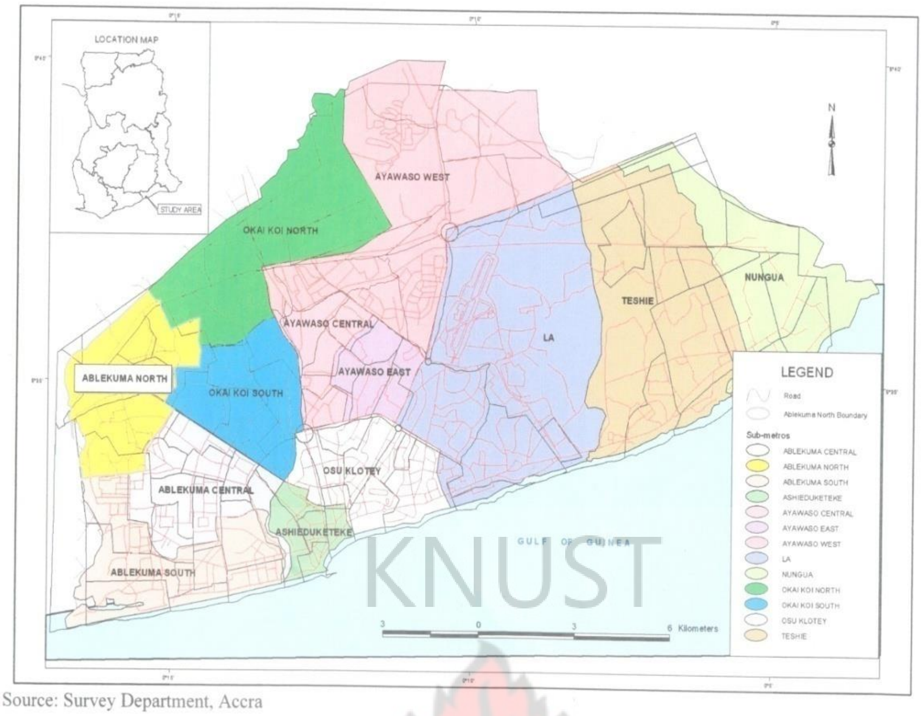
MATERIALS AND METHODS

3.1 Study Area

The Ablekuma North Sub-Metro is unique for its strategic position in the Accra Metropolitan Assembly. It is the entry point when entering Accra from the Central and Eastern Regions of Ghana. The Sub-Metro shares boundary with the Ga West District on the Western part of the Metropolis. It also shares boundary with Okaikoi North and South Sub-Metros and Ablekuma Central Sub-Metro.

The Sub-Metro has five main electoral areas namely;Odorkor North, Odorkor South, Darkuman East, Darkuman West and Kwashieman-Awoshie. The Sub-Metro is characterized by religious and commercial activities. The topography is lowlying with a relatively high water table. The soil type is clayey and rocky rendering it impermeable.

Figure ACCRA METROPOLITAN ASSEMBLY SHOWING ABLEKUMA NORTH SUB-METRO



Source: Survey Department, Accra

Figure 1 is a map of Accra Metropolitan Assembly showing Ablekuma North Sub-Metro

Figure 2 is a map of Ablekuma North Sub-Metro showing the five electoral areas

3.1.1. Climate

The Sub-Metropolis lies in the West semi equatorial climate with a double maxima rainfall recording an average annual rainfall of between 125cm and 200cm. The major rainy season is from May to June and the minor from September to October. The highest temperatures, averaging 30^{o}C are recorded between March and April with the lowest average temperature of 26^{o}C recorded in August.

3.1.2. Population

The Ablekuma North Sub-Metro has a population of 140,063 (Ghana Statistical Service National Population and Housing Census, 2000). The population density of the Sub-Metro is 227 persons per square kilometre. The current population growth rate is estimated at 2.1% per annum with 69,388 male and 70,676 females. With regard to gender split, the sex ratio for the Sub-Metro stands at 97.1 males to 100 females.

3.2. Experimental Apparatus

Noise measurements were made at the selected corn mill sites using a sound level meter (SLM; Model ST-85A) as shown below (Plate 1). The desired response of the SLM was set at slow. The experimental apparatus was calibrated to the EPA Ghana standard.

Plate 1.Shows the Noise Measuring Instrument (Sound level meter)

The Noise Measuring Instrument had the following specifications;

- Measuring level range is 40-130
- Frequency weighing is A
- Time weighing is slow
- Operation temperature is $0^{o}C$ -$40^{o}C$
- Weight is 135g

3.3. Sample Size Selection

A total of 40 corn mills were selected for the study from within the Ablekuma Sub Metro. Out of these 40 corn mills, 20 had their corm mill machines fitted with new grinding plates and 20 had their corm mills fitted with old grinding plates. The grinding plates of corn mills is considered to be new when it has been sharpened in the last two days but after the third day, it wasconsidered old. Therefore, noise levels were measured on the day the teeth of the grinding plates were sharpened and after three days of operation.

Out of the 20 new corm mills, 10 were imported and 10 were locally made. Measurements of noise levels of corn mills were taken at 20 and 50 metres away from the corn mill sites.

The corn mill industries selected for the study coveredall the five electoral areas within the Ablekuma North Sub-Metro. The sample size selected for the study was based on the number of corn mills within the Ablekuma North Sub-Metro. The effect of the noise produced by the mills on human was not quantified.

3.4. Measurement of Noise

In measuring the noise produced by the corn mills, the noise measuring instrument was held in the hand with the microphone pointing to the noise source. A-weighted instantaneous sound pressure level (L_{A1}) measurement was recorded. Measurements were done in the morning between 7.00am and 8.00am, afternoon between 12.00noonand 1.00pm and evening between 4.30pm to 5.30pm. Measurements were done in triplicates and the mean noise level calculated. All measurements were done in accordance with the time specifications of the Ghana EPA (GEPA Act 490, 1994).

Within the month, each of the selected corn mills site was visited in the first week of the month, on the third week and within the last week for noise measurements to be made. Monthly average noise level was calculated. Measurements were done over a period of six months from October 2011 to March 2012. Plate 2, 3 and 4 depict the measurement of noise levels of corn mill within the precinct of operation.

Plate 2. depicts the measurement of noise levels within the precinct of operation

Plate 3. Questionnaires being conducted from the worker

Plate 4. depicts measurement of noise levels in different industry

Structured questionnaires were also administered to obtain the following information

1. Persons (Customers) who visited the corn mills sites daily to access service.
2. The age of the corn mill operators,
3. How long the operators have been working at the corm mill site
4. Age of the corn mill machines
5. Medical history of the corn mill operators
6. Handy workers or laborers on the corn mill floor and hence length of noise exposure.

Data Analysis:

Data on measured noise levels were treated as continuous data and presented as table and graphs (Box plots and Histogram with fit). Data were analyzed using Minitab version 14 statistical software. T-test was also carried out to compare the average noise levels of the imported and locally made corn mills and the new and old teeth of corn mills. Statistical significance was determined using an alpha value of 0.05 to compare to the p-value.

CHAPTER FOUR

RESULTS

Average noise levels produced by the imported corn mills ranged between 90dB and 99dB; with industry I corn mill producing the highest noise level of 99dB. In contrast, the locally made corn mills noise levels ranged from 95dB to 106dB; with industry C corn mill producing the highest noise.

The total average noise level produced by both the imported (94.2dB) and locally (101.1dB) made corn mills were all above the GEPA standard of 85dB (Table 5a). Comparing the average noise levels produced by both the imported (94.2dB) and locally (101.1dB) made corn mills, the locally made corn mills produced statistically significantly (p=0.000) higher levels of noise than the imported corn mills (Table 5b).

Table 4. Average noise levels from ten imported and locally made corn mills operating in the Ablekuma North Constituency over a six month period

INDUSTRY	**Types**		**EPA noise in dB(A) threshold Limit**
	Imported dB(A)	Locally made dB(A)	
A	92	101	85
B	96	102	85
C	94	106	85
D	90	100	85
E	97	104	85
F	94	98	85
G	93	95	85
H	95	104	85
I	99	100	85
J	92	101	85
Total Average Noise	**94.2**	**101.1**	**85**

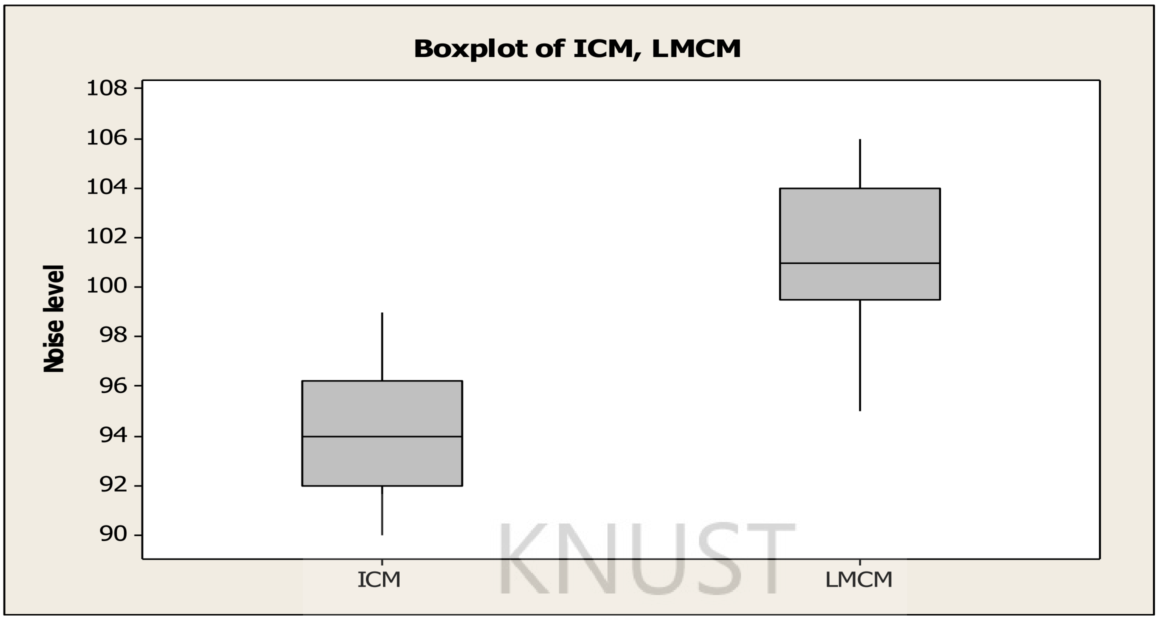


Figure 3: Box plot of imported corn mills and locally made corn mills

Average noise levels from the imported corn mills at 20m and 50m away from the corn mill sites were 82dB and 74.7dB, respectively while that from the locally made corn mills at the 20m and 50m away from the source were 85.8dB and 79.9dB, respectively. All these average noise levels were above the EPA permissible noise level for an area with some commercial or light industrial activity.

Table 5. Average of noise levels from ten imported and ten locally made corn mills recorded at 20m and 50m away from the corn mills operating in the Ablekuma North Constituency over a six month period

Factory	Imported Corn mill		Locally made corn mill		EPA permissible noise level in dB(A) for areas with some commercial or light industry
	20m	50m	20m	50m	60
A	83	74	86	79	60
B	84	76	85	80	60
C	81	73	85	81	60
D	82	72	86	80	60
E	82	75	88	81	60
F	83	75	86	78	60
G	80	73	84	79	60
H	84	76	87	80	60
I	81	75	85	80	60
J	80	78	86	81	60
Total Average Noise	**82**	**74.7**	**85.8**	**79.9**	**60**

Average noise levels produced by the corn mill with New teeth ranged from 98dB to 103dB; with industry C, M, R and S corn mills producing the highest noise level of 103dB whereas the noise level produced by corn mill with Old teeth ranged from 88dB to 95dB; with industry C and S corn mills producing the highest noise level of 95dB. Averagely, noise levels from both corn mills with new and old teeth were 100.95dB and 91.25dB respectively. Comparing the average noise level of the new (100.95dB) and the old (91.25dB) teeth of corn mills, corn mills with new teeth produced statistically (p=0.000) significant higher noise levels than that with old teeth (Table 6b).

Table 6. Average of noise levels from new and old teeth of corn mills operating in the Ablekuma North Constituency over a six month period

Industry	Types of Corn Mills Teeth		EPA noise Threshold Limit
	New, dB(A)	Old, dB(A)	85
A	102	93	85
B	101	94	85
C	103	95	85
D	98	93	85
E	100	91	85
F	99	90	85
G	100	91	85
H	98	89	85
I	102	91	85
J	101	90	85
K	99	89	85

L	102	92	85
M	103	93	85
N	100	89	85
O	102	90	85
P	101	89	85
Q	102	89	85
R	103	94	85
S	103	95	85
T	100	88	85
Total Average Noise Level	**100.95**	**91.25**	**85**

From the questionnaire survey, it was found that 35 out of 40 corn mill industries have motor with capacity of 15Hp whilst the rest have a motor capacity of 10Hp. Ten (10) out of 40 industries that were visited had two machines but at the time of the studyonly one machine was operating. 32 out of 40 corn mill machines are less than 5 years. 20 out of 40 workers have being at the job for ten years and above and the rest have been working for 5 to 10 years and 25 out of 40 workers complained of hearing defeat and frequent headache. Most of the workers were found shouting when talking to someone.

CHAPTER FIVE

DISCUSSION

5.1. Noise levels produced by imported and locally made corn mills

The study has shown that noise levels produced by imported and locally made corn mills in the Ablekuma North Sub-metro were above that recommended by the Ghana EPA (GEPA Act 490, 1994). Thus persons/customers who patronize these corn mills for service, the corn mill operators and laborers' at the site were exposed to noise levels well above the threshold limit of 85dBA. Although, the noise levels produced by the imported and locally made corn mills were far above the EPA threshold limit; the study shown that the locally made corn mill produced noise more than the imported corn mills. Boateng and Amedofu. (2004) reported that locally made corn mills make more noise than the imported corn mills, although both corn mill machines producednoise levels far above the EPA standard of 85dB.

The box plot in figure 3 exhibits the medians of noise levels produced by both the imported corn mills and the locally manufactured corn mills. From the median for the locally manufactured corn mills there lies an uneven distribution (large) compared to the median of the imported corn mill. This clearly stipulates that the locally manufactured corn mills make more noise than the imported corn mills.

From the table of descriptive statistics, interval for the upper quartile values for the mean of the imported corn mills and the locally manufactured corn mills was determined to be 96.25dB and 104.0dB, respectively and with means 90.00dB and 101.10dB, respectively. This clearly indicated that 75% of the noise level produced by the imported corn mills and locally made corn mills is equal to 96.25dB or less and 104.0dB or less respectively.

Comparing the mean values for both the imported corn mills and the locally manufactured corn mills with the EPA standard of 85dB, the study undoubtedly observed that both corn mills make noise above the EPA standard(85dB) nonetheless, the study shown that locally made corn mills make more noise than the imported corn mills.

The t- test carried out in table 5b gave a p-value of 0.000 which is less than the α-value of 0.05. Since the p-value is less than the α-value of 0.05, it means that there is a significant difference between the noise levels produced by both the imported and locally made corn mills.

The locally made corn mills produced more noise than the foreign made due to the following reasons.

- The grinding plates of the locally made corn mills are thicker than the foreign plates. Due to the thickness of the plates of the locally made corn mill, the steer need to be closed or tightened well to allow proper friction between the two plates and therefore produce more noise.
- Most grinding plates are made of steel or cast iron; but it was found out that most plates of locally made corn mills were made of improper materials or inferior steel as compared to that of the foreign made corn mills.
- The space between the grooves (teeth) of the locally made corn mills is too big compared to that of foreign made corn mill. Because the spaces are big, grains are unable to stick in between the grooves to reduce direct contact of the two plates.

5.2Noise produced by imported and locally made corn mills 20m and 50m away from source

At a distance of 20 metres from the corn mills, both the imported and locally made machines produced an average noise level of 82dB and 85.8dB, respectively and from the 50m range an average noise level of 74.7dB and 79.9dB, respectively. Contrary to the EPA recommended permissible noise level of 60dB for light industrial areas, the corn mills in the study area at 20 and 50metres from the corn mills produced noise levels which were higher and hence a worry for inhabitants within that range.

From the table of descriptive statistics, the upper quartile and lower quartile values (80.75dB and 83.25dB, respectively) for the imported corn mills and (85.00dB and 86.25dB) for the locally made corn mills operating from 20 metres range. This indicates that 25% of the noise level emanating from the imported corn mills operating within a 20 metres range was 80.75dB or less whiles 75% of the noise levels recorded from the imported corn mills operating from the 20m range was 83.25dB or less. Similarly, 25% of the noise levels produced from the locally made corn mills operating from a 20m range was 85.00dB or less whiles 75% of the noise level recorded from the locally made corn mills operating from the same range was 86.25dB or less.

Interestingly, the study shown that the EPA permissible noise levels for areas with some commercial activities and light industries value of 60dB was found below the inclusive interval (85.00dB and 86.25dB) for the locally made corn mills and the interval of (80.75dB and 83.25dB) for the imported corn mills.Hence it was obvious that the locally made corn mills operating from the 20m range produced more noise than the imported corn mill operating from the same range, although both corn mills operating from the 20 metres range produced noise far above EPA permissible noise level for areas with light industries and some commercial activities. Therefore, inhabitant living within the range of 20 metres from corn mills site were exposed to more noise from locally made corn mill than the imported; even though both noise levels were above EPA permissible noise level for areas with some commercial activities and light industries.

The study shown that, upper quartile and lower quartile values (73.00dB and 76.00dB respectively) for the imported corn mills and (79.00dB and 81.00dB) for the locally made corn mills operating from 50 metres range. This indicates that 25% of the noise level emanating from the imported corn mills are operating within a 50metres range was equal to 73.00dB or less whiles 75% of the noise levels recorded from the imported corn mills operating from the 50m range was equal to 76.00dB or less. Similarly, 25% of the noise levels produced from the locally made corn mills operating from a 50m range is equal to 79.00dB or less whiles 75% of the noise level recorded from the locally made corn mills operating from the same range is 81.00dB or less.

Interestingly, the study shown that the EPA permissible noise level for areas with some commercial activities and light industries value of 60dB is found lying below the interval (79.00dB and 81.00dB) for the locally made corn mills and the interval of (73.00dB and 76.00dB) for imported corn mills. Hence, it was obvious that both corn mills operating from within 50 metres range produced noise levels far above EPA permissible noise level for areas with light industries (60dB). Therefore, inhabitants living within the 50 metres range from corn mill sites were exposed to serious hazards.

Noise levels exposing to 20 metres from corn mills site were higher than the noise levels exposed to 50 metres from source due to the following reasons;

- For most sources a doubling of distance results in a 6dBA fall in level.
- Barriers- Walls and trees can reduce the level of noise 50m away from source
- Most of the noise will be reflected and diffracted before reaching 50m away from source and this result to the reduction of noise level from 82dB to 74.7dB of the foreign made corn mills.

5.3Noise produced by New and Old teeth of corn mill

The mean of the noise levels produced by the new grinding plates and the old grinding plateswere100.95dB and 91.25dB respectively with 95% confident intervals (100.18dB, 101.72dB) and (90.21dB, 92.92dB) respectively. This interval indicated that the study was 95% confident that the mean noise produced by corn mills operating with new and old grinding plates within the Ablekuma North Sub-metro will significantly fall between (100.18dB, 101.72dB) and (90.21dB, 92.92dB) respectively. The study observed from this analysis that the mean noise level together with their confident intervals emanating from both new and old grinding plates corn mills falls above the EPA standard (85dB). This is a major sense of concern and must be addressed to avoid any noise damages to the operators and the residents who leave within the catchment area of the corn mills operating within the Ablekuma North Sub-metro.

The median values for the noise levels produced by new and old grinding plates were determined to be 101.00dB and 91.90dB respectively. These values indicated that 50% of noise levels produced by new and old grinding plates are less than or equal to 101.00dB and 90.90dB respectively. Furthermore, the study shown that five out of every ten corn mills operating with new grinding plate would produce noise at the level of 101.00dB or less and similarly, five out every ten corn mills operating with old grinding plate would produce noise at the levels of 91.900dB or less.

The coefficient of skewness for new and old grinding plates was found to be -0.390931 and 0.35415; clearly indicating that the noise level produced from new grinding plate is negatively skewed and that of the old grinding plate is positively skewed. This value means that most corn mills within the Ablekuma North Sub-metro operating with new grinding plate were producing noise levels greater than the mean value of 100.95dB. This is the reverse for the old grinding plate since most of the old teeth corn mills were producing the noise levels below the mean value of 91.25dB, therefore the study shown that the new grinding plate makes more noise than the old. It also confirms that fact that the new grinding plates aremore hazardous than the old grinding plates with reference to the EPA standard of 85dB.

From table 7, the upper quartile values for new and old teeth were observed to be 102.00dB and 93.000dBwhiles lower quartile values for new and old teeth were observed to be 100.00dB and 89.000dB respectively. These values implies that 75% of the noise levels produced from the new and old grinding plates were less than or equal to 102.00dB and 93.00dB respectively. Inotherwords, a little above seven out of every ten corn mills with new teeth would produce noise levels that are less than or equal to 102.00dB and a little above seven out of ten corn mills with old teeth would produce noise levels that are equal to 93.000dB or less. The lower quartile values 100.00dBand 89.00dB were observed for the new and old teeth respectively. These values clearly stipulates that 25% of the noise level produced by new and old teeth would be less or equal to 100.00dB and 89.00dB respectively. However it would be interesting to know that a little above two out of ten corn mills with new and old teeth would produce noise at levels equal to 100.00dB and 89.00dB or less. The upper quartile values for both the new and old grinding plates clearly shown that the new grinding plateof corn mills produced more noise than the old grinding plateof corn mills. However these values are all above the EPA standard (85dB).

The t-test carried out in table 6b gave a p-value of 0.000 which is less than the α-value of 0.000. Since the p-value is less than the α-value chosen, it means that there is a significant difference between the noise produced by the new and old teeth of corn mills.

Although both the new and old teeth of corn mills produced noise levels above the EPA Ghana threshold limit of 85dB, corn mills with new teeth produced more noise than that of old teeth. This is because when the grooves on the plates are sharpened and therefore new; it makes the plate smooth, therefore reducing the length of the grooves on the plate. During the grinding process when grains are lodge in the rotating plate and are sheared by the new grooves on the smooth plate, the grains are unable to stick in between the grooves and so the two plates have direct contact which produced more noise. The old teeth make the grinding plate rough and therefore during shearing, grains get stuck in between the teeth reducing the contact of the two plates.

Perceptions of workers and residents on the noise levels of corn mills

200 out of 250 residents and those who accessed corn mill services and the workers were all irritated by the noise produced from the corn mills in their neighborhood. Reasons given were varied and included sleep disturbance especially during the afternoon, perceived hearing loss and frequent headache. 30 out of 40 workers were found speaking louder than normal. Problem solving and memorization were among the cognitive effects most strongly felt as a result of noise (WHO, 1999). Noise from light industrial activities within residential areas could disturb sleep, speech, information extraction disturbance and annoyance (Goines and Hagler, 2007). Although 150 out of 250 residents said they had adjusted to the noise levels of the corn mills in their area, prolonged exposure to acute noise may cause susceptible individuals in the population to develop permanent health effects (Niemann*et al.,* 2006).

200 out of 250 residents called for the operations of corn mills to be regulated. Generally, control of environmental noise has not been effective due to lack of knowledge about its effect on humans and about dose-response relationships (Essandoh*et al.*, 2011). According to Tsai *et al.* (2009), the lack of strategies to improve noise control is responsible for the unacceptable noise levels of corn mills in the country. The provision of effective and meaningful information on noise in any community would ensure good public education, improved legislation and enforcement of regulations (GoinesandHagler, 2007; Tsai *et al.,* 2009).

CHAPTER SIX

Conclusion and Recommendation

The study showed that corn mills operating in Ablekuma North sub-metro produced noise levels far above EPA Ghana standard of 85dB. This means that noise levels of corn mills in Ablekuma North sub-metro are serious hazard to humans and measures must be taken to prevent any damage to human health. Noise levels of imported and locally made corn mills ranged from90dB to 99dB and 95dB to 106dB respectively.

The study showed that locally made corn mills produced more noise than the imported corn mills. The noise levels generated by new and old teeth of corn mills ranged from 98dB to 103dB and 88dB to 95dB respectively. The study revealed that although both the new and old teeth of corn mills produced noise levels above the EPA standard of 85dB, new teeth of corn mill produced more noise levels than the old teeth of corn mill.The study also showed that inhabitants living 20m and 50m away from corn mills are exposed to noise levels above the EPA Ghana permissible noise level of 60dB for an area with some commercial and light industry.

There is therefore the need for formulation and enforcement of regulations to control the operation of corn mills in the country to avoid any health effects on humansthat are exposed to such hazardous noise levels.

The study provides some recommendations for the operation of corn mills; these recommendations are;

- The steer of the corn mills must not be too tight in order to reduce the noise produced
- Combination of one new and one old teeth of corn mills can reduce the noise levels

- There should be a regular maintenance of the machines
- Workers should be encouraged to wear ear protective instrument like ear muff.

CHAPTER SEVEN

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Appendix

Table 7.Descriptive statistics of all the variables that were used.

Descriptive Statistics: New, Old, ICM, LMCM, ICMF, LMCMF, ICMT, LMCMT

Variable	N	N*	Mean	SE Mean	StDev	CoefVar	Minimum	Q1	Median
New	20	0	100.95	0.366	1.64	1.62	98.00	100.00	101.00
Old	20	0	91.250	0.497	2.221	2.43	88.000	89.00	91.00
ICM	10	0	94.200	0.841	2.658	2.82	90.000	92.00	94.00
LMCM	10	0	101.10	1.00	3.18	3.14	95.00	99.50	101.00
ICMF	10	0	74.700	0.559	1.767	2.37	72.000	73.00	75.00
LMCMF	10	0	79.900	0.314	0.994	1.24	78.000	79.000	80.00
ICMT	10	0	82.000	0.471	1.491	1.82	80.000	80.750	82.00
LMCMT	10	0	85.800	0.359	1.135	1.32	84.000	85.00	86.00

Variable	Q3	Maximum	Skewness
New	102.00	103.00	-0.39
Old	93.000	95.000	0.35
ICM	96.250	99.000	0.31
LMCM	104.00	106.00	-0.40
ICMF	76.000	78.000	0.27
LMCMF	81.000	81.000	-0.61
ICMT	83.250	84.000	0.00
LMCMT	86.250	88.000	0.48

Table 5b. Shows Two-Sample T-Test and CI: ICM, LMCM

Two-sample T for ICM vs. LMCM

	N	Mean	StDevSE	SE Mean
ICM	10	94.200 0.66		0.84
LMCM	10	101.10	3.18	1.0

Difference = mu (ICM) - mu (LMCM)

Estimate for difference: -6.90000

95% CI for difference: (-9.65266, -4.14734)

T-Test of difference = 0 (vs. not =): T-Value = -5.27 P-Value = 0.000 DF = 18

Both use Pooled StDev = 2.9297

Table 6b, Two-Sample T-Test and CI: New, Old

	N	Mean	StDev	SE Mean
New	20	100.95	1.64	0.37
Old	20	91.25	2.22	0.50

Difference = mu (New) - mu (Old)

Estimate for difference: 9.70000

95% lower bound for difference: 8.65963

T-Test of difference = 0 (vs. >): T-Value = 15.72 P-Value = 0.000 DF = 38

Both use Pooled StDev = 1.9514

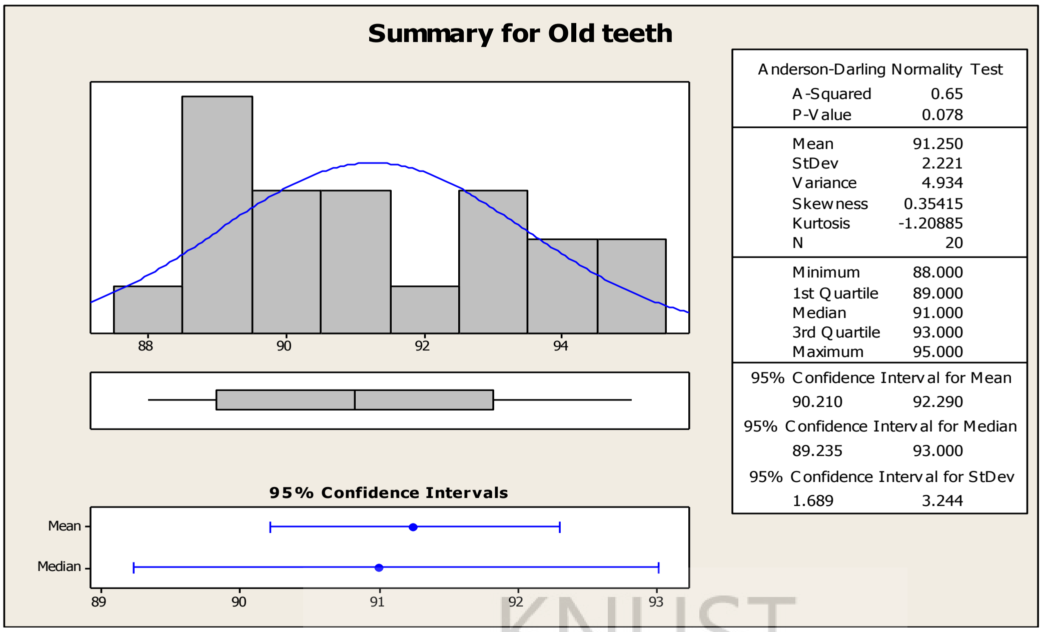

Figure 4a Summary of the old teeth corn mills

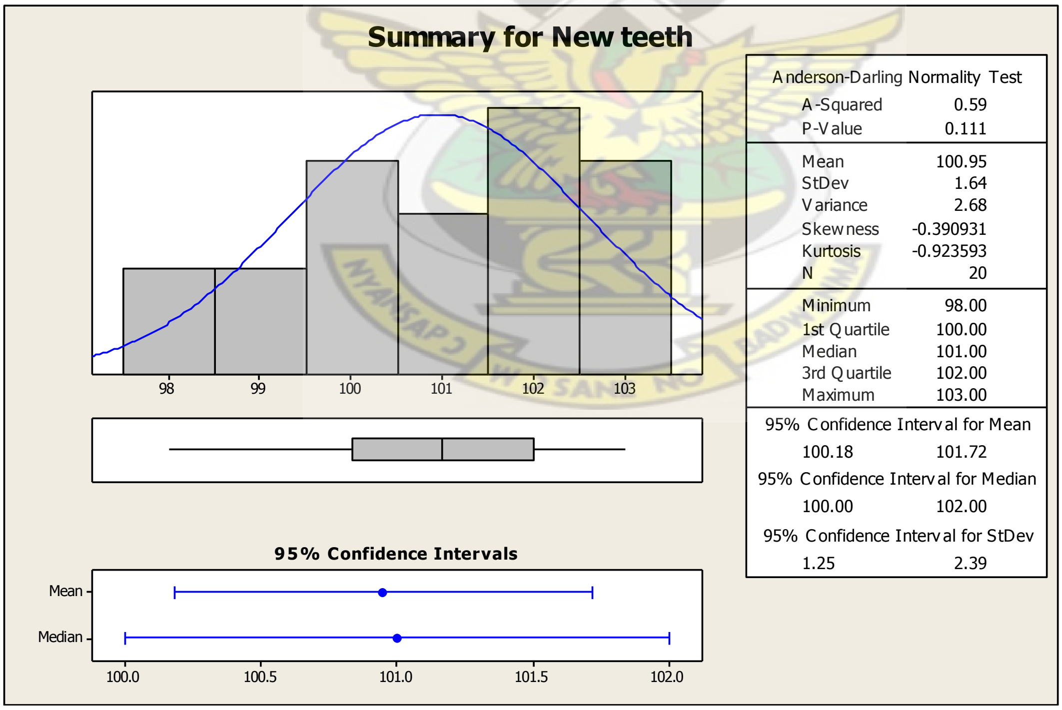

Figure 4b Summary of the new teeth corn mill