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Noise Level Assessment in Selected Nigerian Plank Industries: Bodija, Olorunsogo and Olunde in Ibadan, Oyo State, Nigeria

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Abstract:- The nature of work that is commonly done in sawmills, together with the quantity of woods being worked on generate a lot of noise to the working environments. Noise is hazardous to human health as it can cause increased blood pressure, sleep deprivation and other physiological as well as psychological effects on the workers. The aim of this study was to assess the noise exposure level of sawmill workers to evaluate their safety at work. Three sawmills, all located in Ibadan, Oyo State, South-Western Nigeria were selected for study. Noise level measurements for planning, circular and drilling machines used in the three sawmills were determined using a precision sound pressure tester measurement. The fraction of exposure, and daily personal exposure levels for each of the machines were obtained. Also, questionnaires were administered to obtain subjective responses from the workers on their demographic data, their knowledge about sawmill noise and impact, as well as perception of noise on the workers. SPSS version 20 was used for data entry and analysis.

Bodija, Olorunsogo and Olunde sawmills were selected for study in the region. 94.0dB was obtained on the LCD display of the noise level meter after calibration. Maximum values (100.3dB, 986Db, …, 3.46dB) and minimum values (91.5dB, 96.6dB, …, 81.1dB) were obtained for each of the three sawmills under study. The readings: 5.57, 24.88 and 1.57 were obtained as the fraction of exposure for the circular, planning and drilling machines respectively. Daily personal exposure levels for an 8 hours operation time for the machines were 98dB(A) for the circular machine, 104dB(A) for the planning machine and 92dB(A)for the drilling machine. All these values were found to be greater than the maximum permissible limits specified by OSHA and WHO. From the questionnaires administered, it was discovered that 78.7% of workers have their performance reduced by the noise exposure while 74.5% complain of headaches when the machines are in operation and 51.1% have symptoms of NIHL. Noise exposure for workers in the sawmill is higher than the permissible noise limit and therefore is hazardous to the health of both the workers therein and the people living around the environment. This negatively affects the performance and productivity of the workers as well as the comfortability of nearby residents.

Keywords:- *Health, Noise exposure, Noise level, Noise measurement, Sawmill, Sound, Woods.*

I. INTRODUCTION

Whether it is a small office, a factory, or a classroom, noise is a major issue of every workplace. According to Ugwoha (2016), World Health Organization identified noise as the third most harmful form of pollution. Noise reduces the productivity of most work systems and as a result has become a major concern for most managers to recognize it and find a lasting solution to reducing or eliminating it totally. Noise in simple terms can be defined as any unwanted, unpleasant sound. (Niels, 1999; Jhanwar, 2016). Therefore, noise becomes a form of pollution when it is capable of causing mental and physical injury to its perceiver (Jhanwar, 2016). Noise is one of the commonest occupational health hazards (Ugbebor and Yorkor (2015). Loss of hearing is a major health concern in industrial and manufacturing firms. Excessive noise has the ability to cause annoyance, nuisance, sleep deprivation, decreased school performance, stress, increased blood pressure and other physical, physiological and psychological effects (Toronto Public Health, 2000). Research has even proven that exposure to excessive, loud noise often results in damage of the DNA and neurotransmitter in certain areas of the brain (Frenzilli et. al., 2017). According to NASEM (2010), excessive noise, causing hearing loss was first reported as far back as 1713 before the era of Industrial revolution by Bernado Ramazzini among millers and copper – smiths. Ever since, policies and regulations have been put in place to control hazards associated with noise pollution. Alone in America, about 30 million workers are battling with harmful noise of different kinds in their working places (OSHA, 2013). Noise results from construction sites, industrial machines, equipment, facilities, indoor machines, trains, vehicles, market places, musical instruments, airplanes and airports, *etc.* The hospitals too are not left out. For instance, John Hopkins University (2005) reported that rise as a result of purposeful absence of acoustical ceiling tiles from patients' areas which absorb sound but which may likely harbour infectious organisms, noise levels in hospitals internationally have grown continuously for decades, causing more discomforts for patients and increasing risk of medical errors by staff. The findings of Avnish and Mayank (2010) revealed that of 14 different locations investigated for noise level in Moradabad city, noise recorded in the selected were found to be above the prescribed standard noise level. Due to the nature of work usually done at sawmills (cutting and sawing with the associated machineries) and the quantity of logs of wood that pass through on a daily basis, sawmill environ is particularly hazardous from noise exposure stand point (Niels, 1999). As reported in the research findings of Fernandez and Quintana

(2008), professional deafness or permanent deafness could result if noise is not properly controlled within working environments, especially the construction sector. Agbana *et. al*., (2016) reported that the findings World Health showed that poor occupational health leads to reduction in the workers' productivity, with net effect of economic loss of up to 10–20% of the gross national product of any country. In essence, series of detailed research work have been carried out in different parts of the world with respect to noise pollution as a form of occupational hazard in sawmills, industries, factories and others (Niels, 1999; Sharma *et. al*., 2007; Chauhan *et. al*., 2010; Vaishali *et. al.*, 2011; Agbalagba *et. al.*, 2013). However, little has been heard noise level assessment in working environments in Nigeria, especially the ones that identify with noise continually. Therefore, this research was aimed at assessing noise-exposure level of sawmill workers to know if they are within safety limit. The objectives of this study thus include;

- Measuring the noise level exposure of the workers from sawmill machines.
- Identifying which workers are exposed to noise dangerous to hearing and determining in which of the machines is noise most prominent.
- Analysing and comparing the collected data with acceptable standard(s).

II. THE METHOD OF RESEARCH

The study was carried out in selected sawmills located in Ibadan city, southwest Nigeria. A total of three sawmills were located and visited within Ibadan as the foci points for this research and based on accessibility as at the time of the research only three (3) machines were examined.

A. Equipment and Materials Used During Assessment

The assessment involved digital measurement of noise generated by sawmill machines. Table 1 shows the list of equipment and materials employ during assessment.

S/N	Name	Features
1	Sound Level Meter	Measuring range 30~130Dba Accuracy + or – 1.5. Frequency response 31.5H_z ~8 KHz Resolution 0.1dB Working Temperature and Humidity 0~40^{O}C, 10~80% Storage Temperature and Humidity 10~60^{0}C, 0~90%RH Power source 3*1.5v AAA Batteries Weight 84.08g (excluding battery)
2	Tape Rule	Calibrated to take readings
3	Questionnaire	Specifically designed to capture and collect certain data and information respectively.
4	Microphone	
5	Screw driver	
6	Potentiometer	

Table 1. Equipment and Materials

B. Procedure for Calibrating Noise Level Meter

- The microphone head was carefully plugged at 1½ inch hole of the standard sound source (94dB@1kHz),
- The power switch was then switched on of standard sound source(94dB@1kHz),
- A straight screwdriver was used to adjust potentiometer located in the opening hole within the machine stick until the LCD display 94.0dB

C. Procedure Used for Measurement of Noise Level

- The battery cover was opened and 3 AAA size batteries of 1.5v were put inside it.
- The battery cover was then closed.
- The power button is pressed to the meter and the screen of the LCD panel instantly display the value of current environmental noise but the value changes according to the magnitude of environmental noise.
- The machine was then switched off so as to take the background noise level of sawmill.
- The background noise was taken and the value was recorded.
- Minimum sound level values were measured by entering the "MIN" measuring mode and the minimum sound level is locked and "HOLD" button was pressed in order to retain the measuring data.
- Maximum sound level values were measured by entering the "MAX" measuring mode and the maximum sound level is locked and "HOLD" button was again pressed.
- The meter was turned off at the end of the activities, although the meter has the ability to automatically turn off by itself if not used within an interval of 10 minutes.

D. Sawmill Noise Measurement

For each of the three sawmills under study, measurements of noise-level were made using a Precision Sound Pressure Tester Level Meter Decibel Noise Measurement. Measuring instrument was placed 3 meters above the ground in accordance with NSW (2000) noise measurement procedure. For personal noise exposure of the operators, sound level meter was used and it was done by placing the microphone of SLM 0.1-0.3 meters to the entrance external canal of the ear receiving the higher value of the equivalent continuous sound pressure level. Six set of readings were obtained for maximum and minimum noise level generated by each machine when in operation. The readings in each of the selected location were arranged in the format as shown in the Table 2.

S/N	A_{MAX}	A_{MIN}	B_{MAX}	B_{MIN}	C_{MAX}	C_{MIN}
1						
2						
3						
4						
5						
6						

Table 2. Noise Level Measurement

E. Use of Questionnaire

Social survey such as administration of questionnaire was used to obtain subjective responses of sawmill workers in

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order to validate physically measured noise exposure. A structured questionnaire was designed to capture demographic data and feedback from workers on their perception and sensitivity towards noise exposure at workplace. The questionnaire was divided into three sections. Section 1: demographic data, Section 2: knowledge of sawmill workers about noise and section 3: noise perception and impact of noise on workers.

F. Data Entry and Analysis

Data entry and analysis were done using SPSS Version 20. Descriptive statistics were computed and t-test was conducted to determine if the mean noise level between certain variables had statistically significant difference. P-value less than 0.05 were considered statistically significant and P-value more than 0.05 were considered insignificant. Daily personal noise exposure was calculated with average exposure period of 5 hours. Daily personal noise exposure of operators at Bodija were computed using period of 5 hours exposure.

G. Definition of Terms, Symbols and Abbreviation

dB: Decibel- unit of sound level on a scale of logarithm.

dB(A): A-weighted decibel-

MIN: Minimum sound level reading.

MAX: Maximum sound level reading.

L_{eq}: Equivalent continuous level reading.

LAeq,8h Equivalent sound levels for 8h duration

NIHL: Noise-induced hearing loss.

FEPA: Federal environmental protection agency.

USA: United States of America.

EPA: Environmental Protection Agency

WHO: World Health Organization.

NIOSH: National institute of occupational safety and health.

OSHA: Occupational safety and health administration.

HSE: Health and safety executive

OELs: Occupational exposure limits

Lc: Criterion level: It is a recommended noise level p for a complete 8h work shift.

Exchange rate: This is the amount by which the permitted sound level may increase if the exposure time is halved.

Fig 1:- A respondent filling the questionnaire

III. ANALYSIS OF RESEARCH RESULTS

Visited plank industries include: Olorunsogo Omowumi sawmill, Bodija sawmill and Olunde sawmill. The machines assessed for noise levels include: The circular machine, planning machine and drilling machine. These are as shown in Tables 3 and 4 respectively with their local government areas and specifications. Having visited these selected sawmills and taking necessary readings from them, results obtained are as shown in Tables 5 – 13.

S/N	Location	Local Government Area, LGA
1	Olorunsogo sawmill	Ibadan North-East LG
2	Bodija sawmill	Ibadan North LG
3	Olunde sawmill	Oluyole LG

Table 3. Monitored Location

Name	Model no	Work table	Power H.P/R.P.M
Circular machine	WT-118	22”/26”	3/1440
Planning machine	V-421	48”/60”	1.5/1440
Drilling machine	BPSL-40		1.5

Table 4. Specifications of the Machines Under Study

B. Noise level measurement at Olorunsogo

The background noise level taken and recorded was found to be 76.1 dB. Tables 5-7 show the minimum and maximum noise level measurements taken when the machines were in operation.

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SPL	Range	Minimum	Maximum	Mean	Std. deviation
L_{min}	5.2	88.8	94.0	91.5	2.4
L_{max}	1.8	99.0	100.8	100.3	0.7

Table 5. Sound Pressure Level of Circular Machine

SPL	Range	Minimum	Maximum	Mean	St. deviation
L_{min}	8.4	92.4	100.8	96.6	3.7
L_{max}	11.9	90.1	102.0	98.6	4.2

Table 6. Sound Pressure Level of Planning Machine

SPL	Range	Minimum	Maximum	Mean	St. deviation
L_{min}	5.2	83.2	88.4	85.7	1.9
L_{max}	12.9	85.4	98.3	90.7	5.7

Table 7. Sound Pressure Level of Drilling Machine

C. Noise Level Measurement at Olunde

The background noise level taken and recorded was found to be 72.5 dB and the Tables 8-10 show the minimum and maximum noise level measurement when the machines were in operation.

SPL	Range	Minimum	Maximum	Mean	St. deviation
L_{min}	5	91.5	96.5	93.3	1.9
L_{max}	2.5	99.6	102.0	101.0	1.0

Table 8. Sound Pressure Level of Circular Machine

Table 9. Sound Pressure Level of Planning Machine

SPL	Range	Minimum	Maximum	Mean	St. deviation
L_{min}	2.3	96.7	99.0	97.8	1.0
L_{max}	5.3	101.0	106.3	103.4	1.8

SPL	Range	Minimum	Maximum	Mean	St. deviation
L_{min}	5.0	83.5	88.5	86.4	1.9
L_{max}	11.9	87.2	99.1	92.6	4.7

Table 10. Sound Pressure Level of Drilling Machine

D. Noise Level Measurement at Bodija

The background noise level measurement was found to be 78.3dB and the readings in Tables 11 -13 show the minimum and maximum noise level generated by their machines when in operation.

SPL	Range	Minimum	Maximum	Mean	St. deviation
L_{min}	5.2	90.0	95.2	92.0	1.8
L_{max}	5.3	100.0	105.3	102.7	2.1

Table 11. Sound Pressure Level of Circular Machine

SPL	Range	Minimum	Maximum	Mean	St deviation
L_{min}	3.7	99.8	103.5	101.9	1.3
L_{max}	6.6	109.1	115.7	119	2.6

Table 12. Sound Pressure Level of Planning Machine

SPL	Range	Minimum	Maximum	Mean	St. deviation
L_{min}	12.0	83.5	95.5	87.1	4.4
L_{max}	12.8	87.2	100.0	93.46	5.5

Table 13. Sound Pressure Level of Drilling Machine

Table 14. T-Test Result of the Maximum Noise Level Generated by Circular Machines Between Bodija and Olunde Sawmill.

Variable	N	Mean	SD	df	t	p value	Remark
Bodija	6	102.7	2.1	5	2.6	0.04	S
Olunde	6	101.0	1.0				

Tables 14. - 22 Present the results of the conducted t-test

S- Significant. P<0.05

This shows that there is significant difference in the noise generated by circular machine between Bodija and Olunde sawmill.

Variable	N	Mean	SD	df	t	p value	Remark
Bodija	6	102.7	2.1	5	3.0	0.03	S
Olorunsogo	6	100.3	0.6				

S- Significant. P<0.05

This shows that there is significant difference in the noise generated by circular machine between Bodija and Olorunsogo sawmill.

Variable	N	Mean	SD	df	t	p value	Remark
Olunde	6	101.0	1.0	5	2.1	0.0	NS
Olorunsogo	6	100.3	0.7				

Table 16. T-Test Result of the Maximum Noise Level Generated by Circular Machines Between Olunde and Olorunsogo Sawmill.

NS-Not significant. P>0.05

This shows that there is no significant difference in the noise generated by circular machine between Olunde and Olorunsogo sawmill. Although there is different in their mean but the difference is not statistically significant.

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Variable	N	Mean	SD	df	t	p value	Remark
Bodija	6	111.9	2.6	5	6.9	0.00	S
Olunde	6	103.4	1.8				

Table 17. T-Test Result of the Maximum Noise Level Generated by Planning Machines Between Bodija and Olunde Sawmill.

S- Significant. P<0.05

Variable	N	Mean	SD	df	t	p value	Remark
Bodija	6	111.9	2.6	5	6.7	0.00	NS
Olorunsogo	6	98.6	4.2				

Table 18. T-Test Result of the Maximum Noise Level Generated by Planning Machines Between Bodija and Olorunsogo Sawmill.

S- Significant. P<0.05

Variable	N	Mean	SD	df	t	p value	Remark
Olunde	6	103.4	1.8	5	2.6	0.04	S
Olorunsogo	6	98.6	4.2				

Table 19. T-Test Result of the Maximum Noise Level Generated by Planning Machines Between Olunde and Olorunsogo Sawmill.

S- Significant. P<0.05

Variable	N	Mean	SD	df	t	p value	Remark
Bodija	6	93.5	5.5	5	0.8	0.5	NS
Olunde	6	92.6	4.7				

Table 20. T-Test Result of the Maximum Noise Level Generated by Drilling Machines Between Bodija and Olunde Sawmill.

NS- No significant. P>0.05

Variable	N	Mean	SD	df	t	p value	Remark
Bodija	6	93.5	5.5	5	1.4	0.2	NS
Olorunsogo	6	90.7	5.7				

Table 21. T-Test Result of the Maximum Noise Level Generated by Drilling Machines Between Bodija and Olunde Sawmill.

NS- No significant. P>0.05

Variable	N	Mean	SD	df	t	p value	Remark
Olunde	6	92.6	4.7	5	0.7	0.5	NS
Olorunsogo	6	90.7	5.7				

Table 22. T-Test Result of the Maximum Noise Level Generated by Drilling Machines Between Olunde and Olorunsogo Sawmill.

NS- No significant. P>0.05

E. Worker's Noise Level Exposure.

The daily noise exposure of the operators at Bodija for the planning machine, circular machine and drilling machine are respectively 104dB (A), 98dB (A) and 92dB (A) for a period of 8hrs per day. These exceed the maximum permissible exposure limit of 90dB (A) for 8hrs recommended by Federal Environmental Protection Agency (FEPA, 1991). This means that workers in this industry and those in the vicinity have possibility of developing chronic health problem.

F. Calculation of Fraction of Exposure, F

Fraction of exposure can be regarded as a dose of sound energy received, expressed as fraction of the dose received from exposure to 85 dB (A) for 8 hours. Values of 'F' less than 1 represent an acceptable dose, while values more than 1 represent the number of times that the acceptable dose has been exceeded. Fractional exposure, F is given by this expression:

$$F = T/8\ 10^{(LAehq-90)/10}$$

Daily Personal Noise Exposure Level, L_{Aeq} is given by:

$$LAeq = 10 \log_{10} F + 90$$

L_{Aeq} =A weighted equivalent continuous sound level.

F = Fractional exposure

Note: all machines are operating for an average of 5 hrs

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G. Operator at Planning Machine

The measurement of the planning machine noise level at Bodija was found to be 106dB (A). that's LAeq=106dB. Thus, $F = 5/8\ 10^{(106-90)/10}$

$$F = 24.88$$

$L_{Aeq,8h} = 10 \log 10\ 24.88 + 90$

$L_{Aeq,}8h=103.96dB(A)$

$L_{Aeq,}8h104dB(A)$

Daily Personal Exposure Level, $L_{Aeq,}8h$ of operator at crosscut is 104dB(A)

H. Operator at Circular Machine.

The measurements of the circular machine noise level at Bodija indicate 99.5dB (A)

$L_{Aeq=}99.5dB(A)$

Thus

F =5.57

$L_{Aeq,}8h=97.55$

$L_{Aeq,}8h \cong 98dB(A)$

Daily Personal Exposure Level, $L_{Aeq,}8h$ of operator at circular machine is 98dB(A)

I. Operator at drilling Machine

The measurement of the circular machine noise level at Bodija indicate 94dB (A)

$L_{Aeq=}94dB(A)$

Thus

F =1.57

$L_{Aeq,}8h=10\log1.57+90$

$L_{Aeq,}8h=92dB(A)$

Daily Personal Exposure Level, $L_{Aeq,}8h$ of operator for drilling machine is 92dB(A)

It is very clear from the calculations above that the operator's exposure to noise in relation to all the machines are greater than the maximum permissible limit specified by OSHA. Fig. 2 compares noise level exposure of operators at planning, circular and drilling machine with maximum permissible limit specify by WHO and OSHA.

Fig 2:- Sawmillers operating the circular machine at one of the plank industries

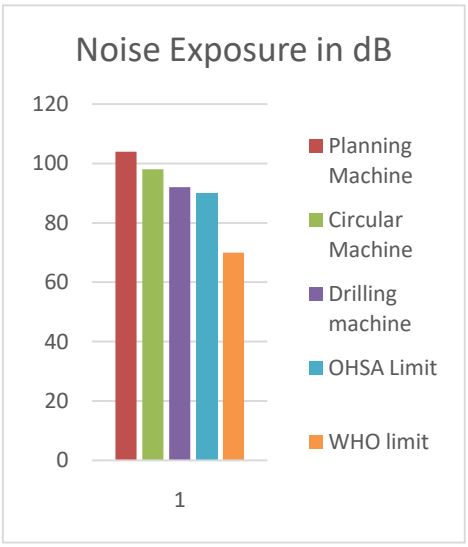

Fig 3:- Comparison of the obtained noise-levels with OSHA and WHO limits.

J. Result Relating to The Administered Questionnaire

Out of 50 questionnaires distributed, 47 were returned. The first question of interest in the questionnaire examine the issue of age bracket of the sawmill workers and their average daily working hour. Among many effects of noise pollution is that of accelerated decrease of hearing sensitivity with age or impairment of hearing acuity with age, a process called presbycousis. The Presbycousis process appeared from the age of 30 years onward and becomes noticeable after the age of 40 years. For the three sawmills in this study, the ages of the respondents are as follow: under 25 years is 2.1%, 26-30 years is 14.9%, 31-35 years is 27.7%, 36-40 years is 25.5%, 41-45 years is 17.0%, 46-50 years is 6.4%, 50 years and above is 6.4%. Second area of interest is the years workers have spent on the job in relation to noise exposure. 12.8% of the respondents have served between 0 and 5 years; while 87.2% have served from 6 years and above. 59.6% of the sawmill workers said they work for 5- 8 hours while 19.1% of workers work for 8-12 in a day. This means that majority of the workers may therefore be exposed to high noise levels which may lead to hearing impairment or presbycousis, as stated earlier. The result also shows that 51.1% of respondents have symptoms of NIHL within a short distance to the extent that workers need to shout before been heard while 48.9% does not

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have the symptom. 78.7 % of workers said that noise reduce their working performance which will in turn lead to increase in the loss of man-hour and therefore lead to reduction in the productivity of workers output. In addition to this 74.5% of the respondents complain of having headache when machine is in operation which is also reduces their productivity.

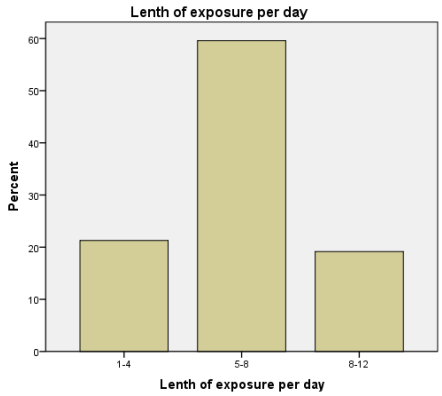

Fig 4:- Chart of length of noise exposure

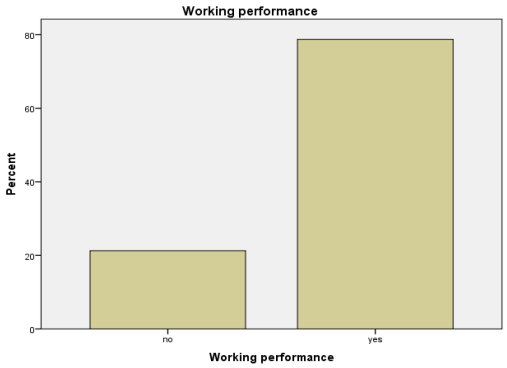

Fig 5:- Chart of worker's working performance when exposing to noise

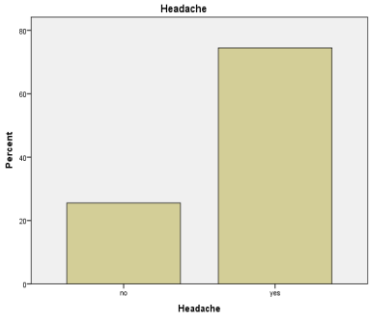

Fig 6:- Chart of respondents having headache and no headache

IV. CONCLUSION

The noise level assessment of selected sawmill industries in the city of Ibadan has been carried out. The following conclusions can be drawn based on the results of the field measurements, data analysis and the conducted social survey:

The field survey and noise data analysis revealed that a high-level noise is being generated at sawmills factories and this may have a negative impact on the health of operators who are working directly to the noise source and those workers on bench. And this may cause hearing impairment on them. The planning machine is the predominant noise source in the field survey follow by circular machine and drilling machine in that order. The noise generated is fund to range from 86dB(A)-112dB(A) for a period of 8 hours and this is above 90dB(A) for a period of 8 hours recommended by Occupation Health and Safety Administration (OSHA). Higher sound levels are allowable if employee exposure is less than 8 hours. Thus, the limit stipulated by OSHA is not strictly adhered to as some workers sometimes even work for more than a period of 8 hours despite the high noise generated in the sawmills.

V. RECOMMENDATIONS

The following recommendations are made in order to address the issue of workers who are fond of exposing themselves to noise greater than 90dB (A):

- Ear protective gadgets should be enforced on sawmill workers by government.
- Reduce noise as much as possible from potential sources.
- By increasing the awareness and training programs for sawmill operators and workers on noise safety.
- Periodic medical checkups should be enforced on sawmill workers especially the operators.
- Sawmill machine owners should be enlightened to have proper routine maintenance of their machines regularly, as lack of this contributes to high noise.
- Regular auditing of plank industries should be conducted to ensure their compliance with Federal Ministry of Environment's guidelines on noise generation and control.

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