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A Survey Of The Noise Generated By Timber Market Machines And Its Health Implications On The Workers And Their Environment, In Calabar, Cross River State.

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ABSTRACT

This research work focuses on The Survey Of The Noise Generated By Timber Market Machines And Its Health Implications On The Workers And Their Environment In Calabar Metropolis, Cross River State. Acoustical and physical measurements were made using a sound level meter and a real time frequency analyzer. Social survey and attitudinal response characteristic of the industrial workers to the industrial noise were determined by means of interviews and questionnaires. The results showed that A-weighted sound levels produced by the woodworking machines with the meter at 1m away from the machines were 100.1 dBA, 99.2 dBA, 100.4 dBA, 100.5 dBA and 90 dBA for Band saw, Table saw, Plainer, Spindle/Curving machines and Drilling machines respectively. Generally the subjective results in the industry shows that 305 out of 505 respondents, representing over 60 percent, are exposed to the noise for 9 hours and above per day. 380 out of 530, representing 72 percent of the respondents are exposed for 6 days and above per week while 66 percent of them, that is, a total of 355 out of 535 respondents, have been exposed to the noise for more than ten years. Looking at the hourly, daily and yearly exposure results mentioned above and considering the noise levels in the markets which far exceeds the industrial Occupation Safety and Health Act (OSHA) permissible noise level of 90 dBA for an exposure time of 8 hours and 5 days a week, it can be concluded that workers who fall within these exposure time period in this high noise level generating industry have hearing impairments.

Keywords: Timber market machines, Noise levels, Acoustical and physical measurements, Interviews and questionnaires, Permissible noise level, Exposure time, Hearing impairment.

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1. INTRODUCTION

Sound can be defined as a vibration that propagates in form of an audible mechanical wave of pressure and displacement, through a medium such as air or water. Sometimes, sound refers to only those vibrations with frequencies that are within the audio range of humans and some domestic animals. Such sound waves are generated by sound sources such as the vibrating diaphragm of a stereo speaker, barks from domestic animals and spoken communications with family and friends.

Noise, on the other hand, is defined as unpredictable sound, particularly loud ones, which disturb people or make it difficult for them to hear 'wanted' sound. In industries generally, noise is one of the most undesired and unavoidable by-products of modern mechanical operations and a prolonged exposure to it of 85dB (which is the threshold for dangerous levels of noise, according to the Academy of Pediatrics and the National Campaign for Hearing and Health) and above, can lead to hearing impairments, hypertension, ischemic heart diseases, annoyance, and sleep disturbance.

There are many health and environmental consequences of elevated sound levels. Some of these problems are hearing impairment, hypertension, ischemic heart disease, annoyance, sleep disturbance, wild life disturbance and a possible change in ecosystem. These problems directly affect Timber Market workers who make use of Wood Machines in processing timber products.

Some Timber Market workers in Nigeria have been diagnosed with some noise related ailments like heart diseases, hearing impairment, insomnia, etc. Because of this, many of them have lost their lives prematurely. There is also a general low level of concentration on individuals living around timber markets. Hence, the justification of the study for proper recommendation and ameliorating these problems.

The study examines the levels of sound produced by the Wood Machines in Akim Timber Market in Calabar metropolis. Comparing the findings with the level of sound acceptable for human and his environment, the risk factors were ascertained and the workers as well as the manufacturers of the machines were properly advised.

The machines surveyed and their location code are: Band saw (AKM1), Table saw (AKM2), Plainer (AKM3), Spindle/Curving machine (AKM4) and Drilling machine (AKM5). These are the machines commonly used in timber markets.

2. MATERIALS, METHODS AND STUDY AREA

2.1 Materials

This research work was carried out with the following materials:

2.1.1 Digital sound level meter

The digital sound level meter (SLM) used was that of Mastech, model MS6700. This model provides 30dB - 130dB capability with an accuracy of ± 1.5 dB in six CPU controlled and automatically selected ranges. It has a frequency range between 31.5 Hz and 8.5 KHz.

2.1.2 Real time audio spectrum analyzer

The frequency analyzer used was Real Time Audio Spectrum Analyzer, version 3.3. It is a collection of real-time software-based instruments for testing and evaluating audio systems using a PC with basic sound input/output capability. The instruments found in TrueRTA include a low distortion signal generator, a digital level meter, a crest factor meter, a dual trace oscilloscope and a high-resolution real time analyzer.

2.2.3 Twenty-eight item self-study questionnaire

Six hundred and fifty (650) copies of a self-study questionnaire containing twenty-eight items, in form of questions that covers ill-effects of noise, personal and demographic effects, and the general attitude to noise and its control, was used.

2.2 Method

2.2.1 Objective Measurement

The noise level resulting from the operation of each of the available wood working machine was measured at a place at which the respondents reside and are regularly engaged in remunerative activities. Also measurements were made very close to the machine itself as it concerns the operators.

The following procedures were strictly adhered to:

a. The weighting network of the sound level meter was set in the ''A'' position and the dynamic characteristic of the meter set to ''slow'' response.

b. The sound level meter was set to its best operation and such a position was maintained throughout the period of measurement.

c. All measurements were made with the microphone of the sound level meter at a height of 1.2 to 1.5 meters above the floor and, in a congested area as the case may be, 3.0 to 3.5 meters from any vertical reflecting surface.

d. The axis of maximum sensitivity of the microphone was directed towards the noise source(s).

e. Care was taken to avoid influence on the result, from extraneous signals, not under consideration, such as wind on the microphone and electrical interference.

f. On each day that noise measurements were taken, a reference sound source (accurate within plus or minus 5dB) was used both before and after measurements. This was to check the performance of the sound level meter.

2.2.2 Subjective Measurement

Noise quantification is very difficult due to the subjective contents involved. Annoyance, for example, as an effect of noise is extremely difficult to quantify, since the decibel level that can cause annoyance to one person may not have the same effect on another person within the same environment or community.

In this research work, emphasis was on the whole residents or community, rather than on individuals or small groups.

The assessment questionnaire was sub-divided into three major sections; A, B and C. Questions 1 to 4 in section A provides information on easy sorting. Question 5 to 13 in section B was the demographic information section. In this section, respondents answered questions about age, marital status, sex, area of residence/location, number of years of residence in that area, and educational qualification, if any. Section C contains questions 15 to 28 which was based on general feeling on the effect of woodworking noise such as communication disruption, annoyance rating, likeness rating, who should control noise, and others like sleeplessness, headache, hearing loss, fatigue, and adaptation, as the case may be.

2.3 The study area

This research was carried out in one of the two Timber markets in Calabar metropolis: the Akim timber market.

Calabar metropolis is located in Cross River State, Nigeria. It lies between latitude 4^0 21′ North and longitude 8^0 55′ East in the globe while Akim Timber Market lies between latitude 4^0 57′ 44.62′′ North and 8^0 20′ 2.15′′ East in the globe.

3. RESULTS AND DISCUSSION

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3.1 Results of the objective measurements with sound level meter and the frequency analyzer

The tables below show the results of the objective measurements in Akim Timber Market. Table 1 shows the machines/the machine locations, the number of samples, background noise, average number of the samples examined and the power source. It can be seen from the table that all the machines examined were eternally powered. That is to say that there is no external noise introduced through a stand-by alternating current generator. The Band saw (AKM1) produced the highest average sound of 99.5 dBA with the sound level meter at a distance of 1m away from the machine when the machine is not loaded, while the drilling machine (AKM5) produced the least average sound of 82.5 dBA at the same condition. The relationship between the working condition and the sound pressure level produced by the machines is shown on Table 2. When loaded, Spindle/Curving machine (AKM4) produced the highest average sound pressure level of 100.5 dBA while Drilling machine (AKM5) produced the least average sound pressure level of 90.0 dBA.

Similarly, Table 3 shows the relationship between the sound pressure levels the working condition of the machines and the distances of the meter away from the machine. It can be seen from the table that the Spindle/Curving machine produced the highest average sound level at the working condition, of 87.5 dBA and 56.5 dBA, with the meter at distances of 10m and 25m respectively, away from the machines.

The frequency analysis of the sounds measured, using the Real Time Frequency Analyzer, shows that the machines have fairly flat spectra, from which one can say that, the acoustical energy from their noise spectra are Gaussian.

TABLE 1:

Machines, number of samples, background noise, noise range and power source in Akim timber market

S/N	Location code	Total number of samples surveyed	Background Noise level (dBA)	Noise range (dBA)	Average noise level of the samples measured (dBA) (A-weighted)	Power source
1	AKM1	7	45.5	96-99	99.5	External
2	AKM2	8	44.0	84-88	86.0	External
3	AKM3	7	43.0	94-98	97.0	External
4	AKM4	10	45.0	94-98	96.5	External
5	AKM5	5	43.5	75-86	82.5	External

3.2 Results of the subjective assessment of workers with questionnaire

It is necessary to mention that questionnaires were distributed to workers who operate the machines at the designated locations in the timber markets as well as the business men and women who are directly influenced by the noise from the machines.

TABLE 3

Relationship between sound pressure level, the working condition and the distance of the meter away from the machine in Akim timber market

Location code	Working condition	One meter (1m) away, (dBA) (Average background noise=44.2dBA)	Ten meters (10m)away, (dBA) (Average background noise=46.3dBA)	Twenty five meters (25m) away, (dBA) (Average background noise=48.0dBA)
AKM1	No load	99.5	84.4	51.8
	Loaded	100.1	87.9	54.7
AKM2	No load	86.0	71.3	45.0
	Loaded	99.2	87.0	54.0
AKM3	No load	97.0	80.0	49.0
	Loaded	100.4	86.9	52.7
AKM4	No load	96.5	80.5	49.5
	Loaded	100.5	87.5	56.5
AKM5	No load	82.5	68.4	40.4
	Loaded	90.0	78.0	45.0

TABLE 2:

Relationship between sound pressure level and the working condition of the machines in Akim timber market

Location code	Average sound level when there is no load (dBA)	Average sound level when loaded (dBA)
AKM1	99.5	100.1
AKM2	86.0	99.2
AKM3	97.0	100.4
AKM4	96.5	100.5
AKM5	82.5	90.0

This questionnaire was designed to have five degrees of response as summarized below:

i. Very High (VH) = 5 points
ii. High (H) = 4 points
iii. Moderate (M) = 3 points
iv. Low (L) = 2 points
v. Very Low (VL) = 1 point

These questionnaires were distributed to respondents from ages 20 years to 55 years and above. These are people who could read, write and work, who do businesses around the timber markets. A total of six hundred and fifty (650) copies were distributed and the valid responses received were six hundred and thirty (630), representing 97 percent.

Tables 4, 5 and 6 show the hourly, the daily and the yearly exposure of respondents to the timber market noise. Table 4 shows that 305 out of 505 respondents, representing over 60 percent, are exposed to the noise for 9 hours and above per day, while Table 5 shows that 380 out of 530, representing 72 percent of the respondents are exposed for 6 days and above per week. 66 percent of them, that is, a total of 355 out of 535 respondents, have been exposed to the noise for more than ten years, as can be seen from Table 6.

From clustered column chart of Fig. 1, it can be seen that headache and irritation of the ear, represented by 140 and 160 respectively, out of a total of 515 respondents are the most common effects of noise as expressed by the respondents. Fig. 2 is a line graph that shows the respondents' reaction to the timber market noise pollution control. A total of 590 respondents out of 597, representing 99 percent, were of the opinion that timber market machines noise should be controlled.

Finally, Table 7 shows that 290 and 255 respondents out of a total of 630 rated noise Very High and High respectively while Table 8 shows the correlation between the objective and the subjective responses for the noise levels. The objective responses measured with the sound level meter represents the x-variants and the

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subjective responses are represented by the corresponding scale value as y - variants. The correlation coefficient between objective and subjective measures was calculated to be 0.65.

TABLE 6

Yearly exposure of respondents to timber market noise respondents in Akim timber market

Location code	Exposure time (Years)						Total
	1-5	6-10	11-15	16-20	21-25	26-30	
AKM1	10	35	40	50	5	4	144
AKM2	20	30	30	35	4	3	122
AKM3	10	25	10	40	6	4	95
AKM4	5	25	30	50	3	2	115
AKM5	5	15	10	25	2	2	59
Total	50	130	120	200	20	15	535

TABLE 4

Hourly exposure of respondents to timber market noise respondents in Akim timber market

Location code	Exposure time (Hours)				Total
	3-5	6-8	9-12	Above 12	
AKM1	15	35	75	0	125
AKM2	12	38	65	0	115
AKM3	8	25	60	0	93
AKM4	10	15	55	0	80
AKM5	5	37	50	0	92
Total	50	150	305	0	505

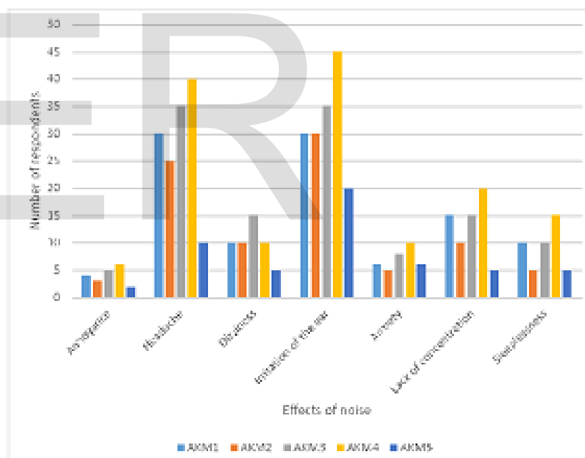

FIG. 1: Respondents' reaction on the effects of noise

TABLE 5

Daily exposure of respondents to timber market noise respondents in Akim timber market

Location code	Exposure time (Days)						Total
	2	3	4	5	6	7	
AKM1	0	0	0	40	70	15	125
AKM2	0	0	0	45	65	20	130
AKM3	0	0	0	30	80	15	125
AKM4	0	0	0	15	50	10	75
AKM5	0	0	0	20	50	5	75
Total	0	0	0	150	315	65	530

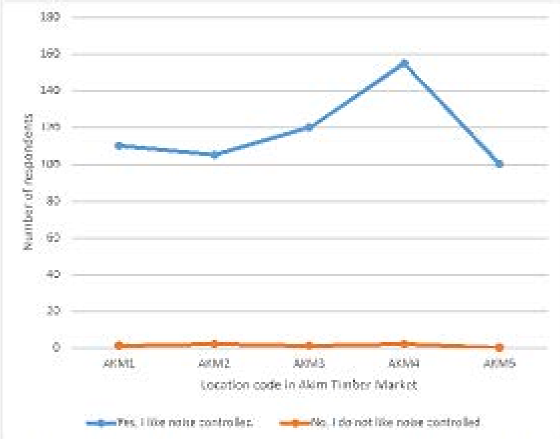

FIG. 2: Respondents' reaction to timber market noise pollution control

TABLE 7

Summary of respondents' timber market noise rating in Akim timber market

Location code	Noise rating					Response per location (n)	Weighting rating (nx)	Average value per location (nx/n)=y
	Very high (5)	High (4)	Moderate (3)	Low (2)	Very low (1)			
KM1	60	55	20	0	0	135	580	4.30
KM2	50	45	15	0	0	110	475	4.32
KM3	65	55	10	0	0	130	575	4.42
KM4	70	60	20	0	0	150	650	4.33
KM5	45	40	20	0	0	105	445	4.24
Total						**630**	**2,725**	**21.61**

TABLE 8

Correlation between objective and subjective responses for Akim Timber Market machines noise

S/N	Location code	Mean value, loaded - state, A-weighted SPL ±0.5dBA (x_i)	Mean value per location (y_i)	x_iy_i	x_i^2	y_i^2	Correlation coefficient (r)
1.	AKM1	100.1	4.30	430.43	10,020.01	18.49	0.65
2.	AKM2	99.2	4.32	428.54	9,840.64	18.66	
3.	AKM3	100.4	4.42	443.77	10,080.16	19.54	
4.	AKM4	100.5	4.33	435.17	10,100.25	18.75	
5.	AKM5	90.0	4.24	381.60	8,100.00	17.98	
	Total	**490.2**	**21.61**	**2,119.51**	**48,141.06**	**93.42**	

4. CONCLUSION

From Table 2, it can be seen that sound levels produced by the woodworking machines are all 90 dBA and above, with the sound level meter at a distance of 1m away from the machines. The values obtained are 100.1 dBA, 99.2 dBA, 100.4 dBA, 100.5 dBA and 90 dBA for Band saw, Table saw, Plainer, Spindle/Curving machines and Drilling machines respectively. From the responses of the respondents, 61 percent of the workers work for over 8 hours with 73 percent working for 6days in a week and 61 percent having worked for over 10 years now. These values exceed the recommendation of the Occupational Safety and Health Act (OSHA) of 1970 which permits noise level of 90 (dBA) for a daily exposure time of 8 hours and 5 days a week. Above 90 (dBA), the Environmental Protection Agency (EPA) warns that shift at 500, 1000 and 2000 Hz begin to appear indicating the onset of hearing impairment. With continued exposure, the severity of the hearing loss increases with the A-weighted level of the noise and with the exposure time of 10 years after which it appears to reach an asymptotic value.

Also, the workers were observed to have violated the following recommendations for Hearing Protection by

OSHA (OSHA Requirements 29 CFR 1910.95 Occupational Noise Exposure):

- Hearing protection must be made available to all employees exposed to 8-hour TWA (Time-Weighted-Average) noise levels of 85 dB or above and must be worn by all employees exposed to a TWA of 90 dB(A) and above.
- Hearing protection must be provided at no cost
- Employees shall be given the opportunity to select hearing protectors from a variety of suitable hearing protectors.

It can therefore be concluded that the workers within these conditions as stated above have hearing impairments and other noise related ailments.

The good correlation coefficient of 0.65 is related to the fact that Cross River State is Civil Service state. This situation has made the respondents react adversely to any increases in the noise levels. They are poorly adapted to the noise from the machines and as such, could easily decipher any slight effect the noise had on them.

Table 3 shows that there is a gradual reduction in the noise levels as the distance from the source is increased. This is in accordance with the well-established inverse distance law which states that sound pressure falls inversely proportional to the distance $1/r$ from the sound source.

85 dB is the threshold for dangerous levels of noise, according to the Academy of Pediatrics and the National Campaign for Hearing and Health. All the sounds levels measured at 10m away from the machines are within this dangerous levels, except that of the drilling machines. At 25m away from the machines, all sound levels measured were below 60 dB. Hence, we recommend that:

- Government should enact suitable legislation stating the acceptable distances for siting of shop and other business outlet from the machine locations in Akim Timber Market, Calabar.
- From this research work, the minimum distance that should be accepted is 25m.
- Workers should strictly adhere to recommendations for Hearing Protection by OSHA (OSHA Requirements 29 CFR 1910.95 Occupational Noise Exposure)
- There should be regular maintenance and servicing of the machines by the workers. Older machines should be put out of use.
- Manufacturers of the woodworking machines should adopt the best machine designs for noise reduction.

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