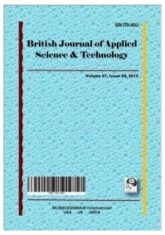

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Evaluation of Noise Levels in Oil Mill Market and Its Environs, Port Harcourt, Nigeria

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Authors' contributions

This study was conducted through collaboration among all authors. Author JNN carried field monitoring, data collection and literature searches. Author BY performed statistical analysis of data and wrote the first draft manuscript while author JNU designed the study framework and supervised the work. All authors read, reviewed and approved the final manuscript.

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ABSTRACT

Noise in market places can be a matter of public concern to traders and other close residents. Exposure to excessive noise has the ability to cause both physiological and psychological effects in humans. A systematic noise survey was conducted at different locations within Oil Mill Market and Eleme Junction in Port Harcourt, Rivers State, Nigeria. Modelling of noise levels within the market area is presented. A cumulative noise level of 108.6dB (A) was obtained along East-West Road between Oil mill market and Eleme junction; Eleme junction showed cumulative noise level of 105.4dB (A); also, Elelenwo by Oil-Mill market showed noise level of 103.8dB (A); while, Oil-Mill Market showed cumulative noise level of 108.2dB (A). Computed mean noise value is 109±3dB (A), computed Leq index is 123.6±2.3dB (A), while computed noise pollution level is 117.1dB (A). Findings showed that use of grinding machines and generators within the market accounted for 27% of noise within the market; mobile sellers contributed 26%; while vehicular movement along the East-West highway and Eleme junction constituted 19% of the noise produced in the area. High noise pollution prevails within the market environment withpotentialhealth effects on traders and the public. State and/or Local Governments should carry out awareness campaigns among traders on the effects of noise on their health. Noise control by-laws or regulations should be enforced so as to regulate the activities of mobile advertisers or sellers.

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Keywords: Noise level; oil mill market; noise pollution levels; cumulative noise; noise mapping.

1. INTRODUCTION

Noise is one of the most common environmental pollutions often associated with anthropogenic activities [1] such as industrial, commercial, institutional and recreational activities. Noise pollution constitutes environmental hazards and poses a threat to public health and the environment. Noise pollution is rated among the most hazardous form of pollutions in many metropolitan cities of the world after air and water pollution [2]. Noise has been broadly categorized into residential, commercial and industrial type and regulated according to WHO and NESREA [3,4]. Residential noise also known as domestic noise is generated at homes, commercial noise from business environments such as shops and market places, while industrial noise are generated within industrial environment through the use of equipment and machineries [5].

Commercial activities including buying and selling are important aspects of human endeavors and play central roles in the economic and social advancement of the people. However, commercial activities in market places in developing countries are associated with a lot of health and environmental issues including noise pollution. Noise in market places can be a matter of public health concern especially for merchants engaged in commercial activities within market places and residents.Noise emanating from market places is considered as commercial noise and capable of affecting the general public. Prolonged exposure to excessive noise has the ability to cause adverse health effects (physiological, psychological and hearing loss)in humans [6]. Health effects associated with noise pollution can be classified into auditory (physiological) and non-auditory (psychological/ sociological) effects [1,7]. Auditory or physiological noise effects include hearing impairment and other effects such as noise induced hearing loss and presbycusis [8]. Research has shown that people exposed to noise level above 90 decibels are at risk of hearing loss [9]. Non-auditory or psychological/sociological effects of noise include cardiovascular disorder, hypertension, release of adrenaline, mental health, interference with speech communication, sleep disturbance, interference with learning process and annoyance [1,7,8,10]. Individual's responses or reactions to noise are influenced by the susceptibility levels of the individual to sound level, frequency, duration of exposure and previous experience [7].

Several studies have been carried out to assess and investigate noise levels in industrial areas [5,11,12,13], road traffic [14,5] and construction areas [6,16], but little has been done to assess noise levels in market places. The present study aimed to evaluate noise levels in the Oil Mill Market and Environs in Port Harcourt, Rivers State, Nigeria; and its potential impacts on public health. Also there is no sufficient information on noise pollution in market places in metropolitan city of Port Harcourt. It is based on this fact that this study was carried out on the popular Oil Mill market in Port Harcourt city order to evaluate and assess noise levels within the market area and its environ. Study of noise levels in Abuja cosmopolitan in Nigeria has been carried out [10]; the study indicated that market place is the noisiest area in Abuja cosmopolitan and classified noise levels obtained in market places in Abuja as unsatisfactory.

2. MATERIALS AND METHODS

2.1 Study Area

The Oil Mill market is a mid-week market located at Rumuchorlu Community in Obio/Akpor local government area of Rivers State (Fig. 1). It is within longitude E7° 03' 47.388'' and latitude $N4^0$ 51' 17.976''. The weekly market, held every Wednesday, attracts merchants from different parts of Rivers State and beyond [17]**.** The chaotic traffic jam the market causes every Wednesday constitute nuisance to free flow of traffic along the Aba/Port-Harcourt Road. The location of the market has also put the lives of merchants at risk of noise pollution. On Market days, human traffic produces noise nuisance along the flyover end of the popular Eleme Road where most of the merchants display their goods [17].

2.2 Data Collection

Field measurement of noise levels at different locations around Oil Mill market and Eleme Junction was conducted on the 3rd, 7th, 10th and 11th of August 2016. A systematic monitoring of noise levels was carried out at each location within the market area. Monitoring was carried out at pre-determined locations within and outside the market and its environs using Smart

Sensor (Model AR854) and TES (Model 1352H) sound pressure level meters which give instant, real time readings according to regulatory noise measurement standards. The instruments were set on the A-weighting scale and fast response. Measurement of sound pressure levels was carried out at 15 minutes intervals in an eight (8) hour working day. The instruments were placed3 to 10 meters above ground level in accordance with ISO 9613 noise measurement procedure [18]. Four sets of sound pressure readings were taken at each location and a total of 112 data sets were obtained for the study. A method of visual traffic count of vehicular movements around the market area was used. Two directions of traffic flow were considered in the traffic count exercise to cover the entire intersect of the Oil mill market and Eleme junction (Fig. 1). The number of vehicles passing per hour was recorded; this was done for 8 hours each day. Volume of vehicles q was calculated using the expression (Equation 1):

$$q = \frac{N_t}{t} \quad (1)$$

Where q is the volume of vehicles per hour; N_t is the number of vehicles passing at time t; and t is the period in hour. Mean volume of vehicles was calculated by dividing total number of vehicles counted by total number of hours (Equation 2).

$$q_{mean} = \frac{\sum_{t=1}^{n} N_t}{\sum_{i=1}^{n} t_i} \quad (2)$$

Noise average (Lavg), equivalent continuous noise level (Leq), noise pollution levels (Lnp) and noise exceedance factors (NEF) were statistical noise descriptors used to analyze and evaluate noise pollution levels within the market. Noise pollution levels were computed using equation in [19]; while noise exceedance factors were computed using equation in [20]. Measured noise levels within the market area and its environs were compared with Federal Ministry of Environment (FMEnv) stipulated permissible limit as contained in FEPA [21]. While, computed noise averages, Equivalent continuous equal noise level (Leq) and Noise pollution levels (Lnp) were compared with World Health Organization (WHO) and National Environmental Standards and Regulatory Enforcement Agency (NESREA) standards. Noise mapping model was done using ArcGIS 10.2 software. The software integrated the spatial noise data from different sampling points within the market and analyzed them as input variables for graphical presentation to produce noise curves or contours. In the noise mapping, inverse distance weighted interpolation was adopted which is the basis for the spatial analysis and interpolation.

2.3 Regulatory Framework

2.3.1 National regulatory documents

Noise regulation in Nigeria is covered in National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35. The main objective of the provisions of this Regulation is to ensure tranquility of the human environment or surrounding and their psychological well-being by regulating noise levels [4]. Permissible noise exposure limits in Nigeria is shown in Table 1.

Fig. 1. Map of Eleme junction showing location of oil mill market
Source: http://wikimapia.org/9697092/Oil-Mill-Market

Table 1. Nigeria noise exposure limits

Duration	Permissible exposure limit dB(A)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Source: [21, 22]

2.3.2 WHO noise guidelines

WHO Noise Guidelines prescribe noise levels for the day and night periods are presented in Table 2.

Table 2. WHO noise level guidelines

Receptor	One hour L_{Aeq} (dBA)	
	Daytime 07:00 – 22:00	Nighttime 22:00 – 07:00
Residential; Institutional, Educational	55	45
Industrial; Commercial	70	70

Source: [23]

3. RESULTS AND DISCUSSION

3.1 Results

Results of field measurements on day 1 in comparison with FMEnv limit are shown in Fig. 2. A minimum noise value of 75.1dB (A) was recorded around Elelenwo; while a maximum noise value of 105.1dB (A) was obtained around Oil-Mill Market Point 1 area. Highest noise levels, Lmax were observed for the Oil mill market and Eleme junction and these exceeded FMEnv limit (Fig. 2). The maximum noise level obtained during monitoring exceeded regulatory standard by 17%. Prolong exposure to such noise can lead to hearing impairment among exposed merchants.

Noise levels measured on day 2 in comparison with FMEnv limit are shown in Fig. 3. A minimum noise level of 73.5dB (A) was measured around Market Boundary with Rumukwurushi town; while a maximum level of 102.1dB (A) was recorded along East-West Road between Oil mill market and Eleme junction. Minimum noise levels, Lmin are below FMEnv limit, while maximum noise levels exceeded FMEnv limit at all monitoring points within the market (Fig. 3). The maximum noise level obtained during monitoring exceeded regulatory standard by 14%. This implies that traders exposed for a long period of time can be negatively affected. This level of noise is capable of causing psychiatric disorder in them, thus poses significant risk to business operators in the market. Also, long time exposure can cause annoyance which may leads to more serious psychological problems among the exposed [8].

Results of noise levels monitored on day 3 in comparison with FMEnv limit are presented in Fig. 4. A minimum noise value of 71.1dB (A) was obtained around Elelenwo by Oil-Mill Junction area; while a maximum noise value of 108.3dB (A) was measured around Oil-Mill Market Point 2 area. Minimum noise value recorded at Oil Mill market point 2 was 93.5dB (A) and exceeded FMEnv limit by 3.9%, while maximum noise values recorded at all monitoring points far exceeded the prescribed limit (Fig. 4). The high noise levels recorded around Oil mill market point 2 was caused by clusters of grinding machines in the area. Noise levels of these magnitudes portend serious health implications on those doing business in the market area. These elevated noise levels can potentially trigger psychological symptoms such as headaches, nausea, argumentativeness and changes in mood and anxiety in traders and merchants.

Noise levels recorded on day 4 in comparison with FMEnv limit are shown in Fig. 5. A minimum noise value of 71.0dB(A) was measured around Elelenwo Road by Petro Station; While a maximum noise value of 103.6dB(A) was recorded along East-West Road between Oil mill market and Eleme junction. This value exceeded regulatory limit by 15.1%. Minimum values, Lmin are below FMEnv limit, while maximum values, Lmax exceeded FMEnv limit at all monitoring points within the market (Fig. 5). These noise levels lasting for a long time could pose serious health effects on those doing business in the market. This implies that cases increased blood pressure level, noise induced stress and increased cortisol levels could exist among traders and merchants in the market, but they may not be cognizant of it.

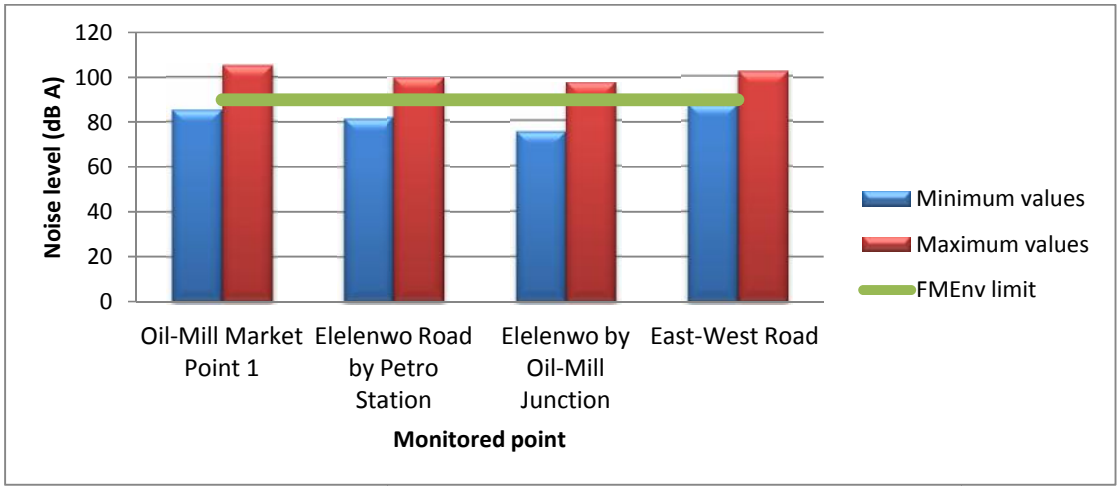

Fig. 2. Minimum and maximum Noise levels on Day 1 in comparison with FMEnv limit

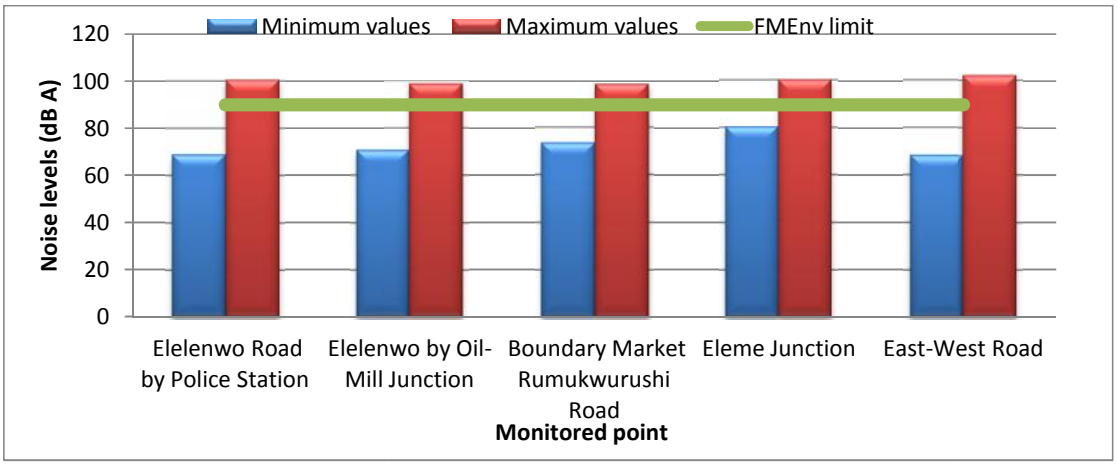

Fig. 3. Minimum and maximum Noise levels on Day 2 in comparison with FMEnv limit

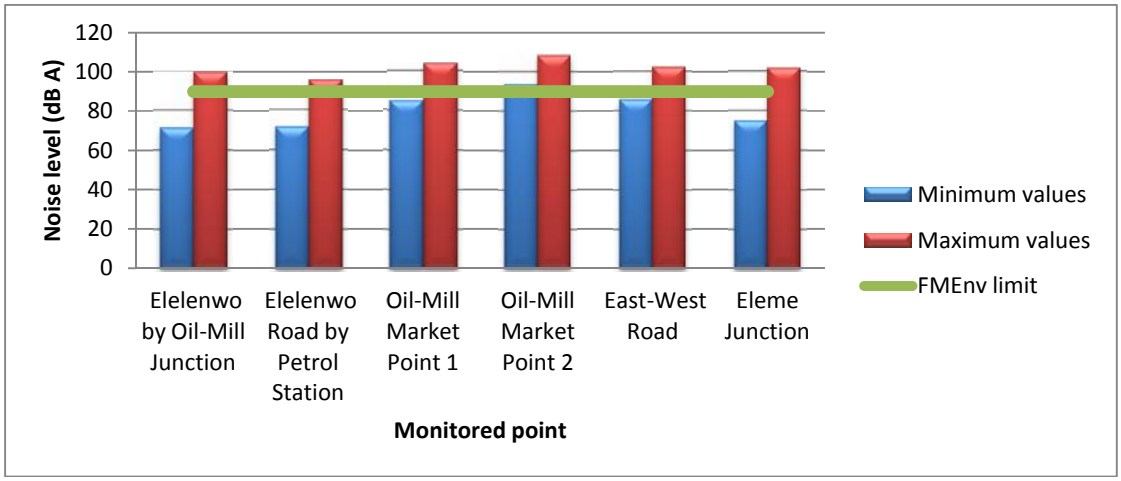

Fig. 4. Minimum and maximum noise levels on day 3 in comparison with FMEnv limit

Cumulative noise levels for all monitoring points in the market in comparison with FMEnv limit are shown in Fig. 6. The cumulative noise levels far exceeded the stipulated limits in all monitoring points within the market area. High noise levels of this magnitude is very hazardous and may pose significant health risks to traders and all those who spent more time doing business in the market area.

Equivalent continuous equal energy level (Leq) and Noise pollution levels (Lnp) showed the degree of noise pollution prevailing in the market area. Computed Average noise level, Lavg, and Equivalent Continuous Equal Energy level, Leq for the market far exceeded both NESREA and WHO permissible exposure limits of 75dB (A) and 70dB(A) respectively for commercial environment as shown in Table 3 and Fig. 7. Total Leq value of 123.6±2.3dB (A) exceeded NESREA limit by 64% and WHO permissible limit by 75.71% and is ranked very high based on standards. Leq value of this magnitude constitutes noise hazard and accordingly, traders doing business should not expend more than 2 hours in the market, however, it is observed that majority of the traders spent up to 12 hours in the market and are not aware of the deleterious effects of noise pollution on their health.

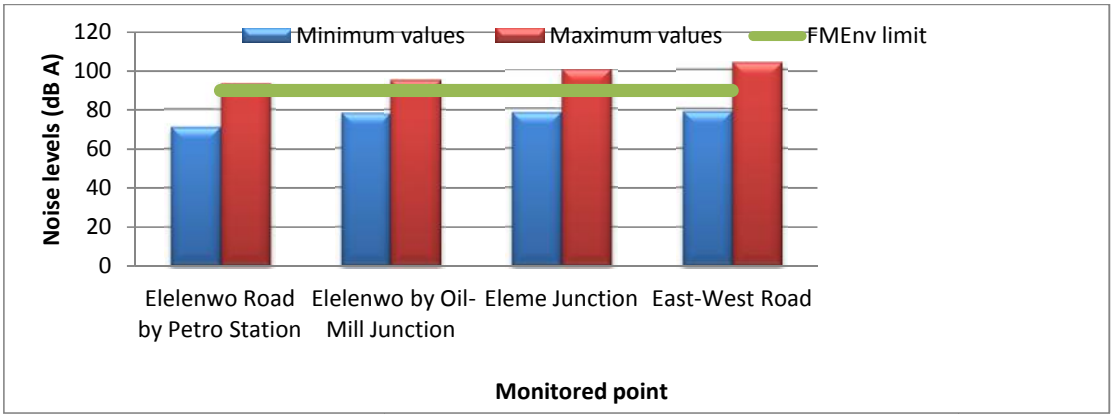

Fig. 5. Minimum and maximum noise levels on day 4 in comparison with FMEnv limit

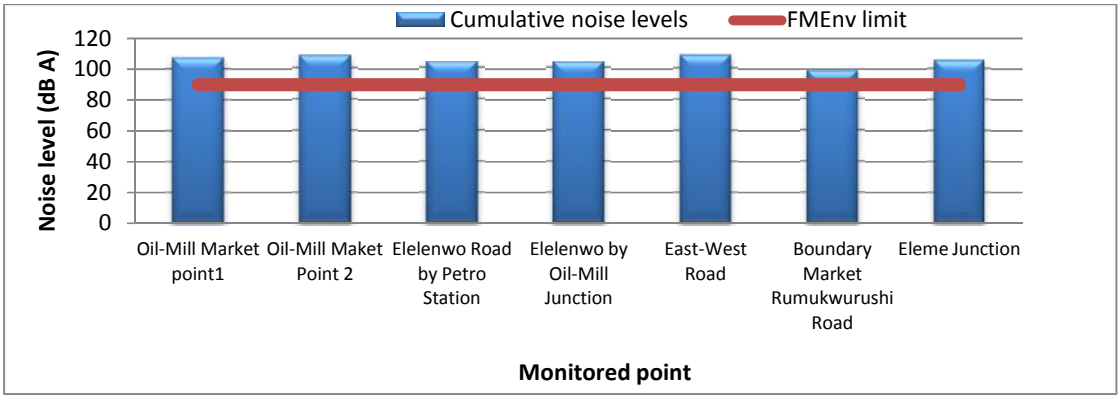

Fig. 6. Cumulative noise levels in comparison with FMEnv limit

Table 3. Computed average noise level, Lavg, Leq and Lnp

	Lavg	Leq	WHO limit	NESREA limit	Lnp	NEF	Noise rating	Impact/Risk ranking
Day 1	101.4	116.9	70	75	122.9	1.67	Very high	Significant
Day 2	100.1	116.2	70	75	116.2	1.66	Very high	Significant
Day 3	102.6	120.3	70	75	120.3	1.72	Very high	Significant
Day 4	98.9	114.8	70	75	114.8	1.64	Very high	Significant
Total	**109±3**	**123.6±2.3**	70	75	**117.1**			

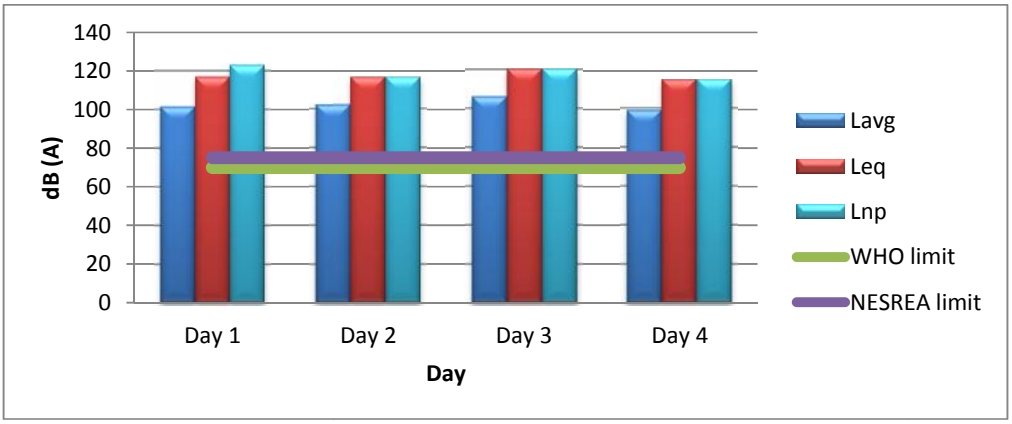

Fig. 7. Computed Lavg, Leq and Lnp in comparison with NESREA/WHO Limit

3.1.1 Sources of noise in the market

Main sources of environmental noise around the market and its environs were identified and rated as presented in Fig. 8. Mobile sellers (music record sellers, herbal medicine sellers and telecom equipment sellers) all used public address system/megaphone to advertise or announce their products produced loud noise and constituted 26% of noise produced in the market; Horns from cars and heavy duty trucks on traffic also produced loud noise and constituted 19%; Similarly, sirens from security vehicles produced loud wailing sounds and constituted 8%; Likewise, the use of grinding machines and generators within the market produced loud noise and constituted major source of noise (27%)in the market. In addition, sellers shouting to draw people's attention to their products produced moderate level of noise and constituted 13% of the commercial noise in the market, while other sources such as people loading commercial vehicles accounted for 7% of the noise monitored in the market area. The current study's findings on sources of environmental noise in the oil mill market corresponded with study by Ibekwe et al. [10], which also attributed sources of noise in Abuja market to very high human activities, heavy-duty trucks and other vehicular movement. This implies that environmental noise in market places in Nigeria is mainly caused by a combination of factors ranging from human activities (such as grinding and use of public address system by mobile sellers) to vehicular traffic. Local by-laws which discourage the use of public address systems within the market can be used to reduce environmental noise within the market. The provision of steady public power supply in the market can reduce the use of electric power generators in the market; the creation of alternative routes can help divert vehicles from the main Eleme junction thus reducing the noise levels in the oil mill market.

3.1.2 Traffic flow count around the market area

Traffic flow around the market area was assessed to determine the contribution of vehicular movement to total noise production in the market place. Total volume of traffic recorded on day 1 was 26776 with a mean value of 3347 and an average speed of 10km per hour. Total volume of traffic flow counted on day 2 was 8192 with a mean value of 1024 and an average speed of 46 km per hour (Fig. 9). Total volume of traffic on day 3 was 24899 with a mean value of 3112 and an average speed of 11 Km per hour. While the total number of vehicle counted on day 4 was 22959 with a mean value of 2870 and an average speed of 20 km per hour. Heavy duty vehicles contributed an average of 37% of total traffic flow in the area. While light vehicles (cars and buses) constituted majority (an average of 63%) of the vehicles counted in the study area. It was observed that vehicular movements in the area are not quite evenly distributed with time; this may be due to the prevalence traffic congestion in the Oil mill market and Eleme junction from morning till evening time. The average speed of vehicles was relatively low between the hours of 11.00 and 13.00 (Fig. 10) causing heavy traffic congestion during this time of the day. It is discovered that percentage of heavy-duty vehicles has great significance influence on noise levels in the study area.

Generally, Figs. 8 to 10 indicated that the Oil Mill market experienced heavy vehicular traffic and contributed 19% to the high noise levels obtained in the market area. The high volume of vehicular traffic around the market area can be explained of location. The market is located around the major Eleme junction and often witness heavy traffic.

3.1.3 Noise mapping

A model showing noise mapping of the Oil Mill Market is presented in Fig. 11. The model showed high noise level within the Oil-Mill Market as indicated by the dark red colour band contour of the map. A cumulative noise level of 108.2dB (A) was obtained indicating that there is high noise pollution within the market area. These noise levels were cause mainly by use of several grinding machines and generating sets within the market. High noise level up to a cumulative value of 108.6dB (A) was also obtained along East-West Road between Oil mill market and Eleme junction as also indicated by dark red colour band contour. This was cause mainly by sirens from security vehicles and sounds from vehicle's horns as well as loud shouts sound from traders along the road. Cumulative noise level around Eleme junction was high, up to 105.4dB (A) as indicated by dark orange colour band contour. This could have been due to manual loading of commercial vehicles, security vehicles and sounds from vehicle's horns. The area around Elelenwo by Oil-Mill Junction also had high cumulative noise level up to 103.8dB (A) as indicated by the light orange colour band contour. This may be due to sirens from security vehicles and sounds from vehicle's horns as well as loud shouts sound from traders along the road. The noise levels decreased towards Market Boundary with Rumukwurushi town as indicated by the light and dark yellow contours on the model.

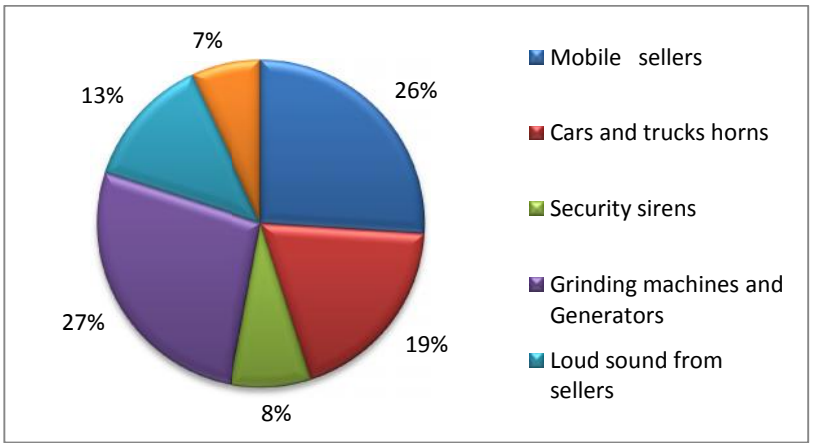

Fig. 8. Percentage contribution of each noise source in the market

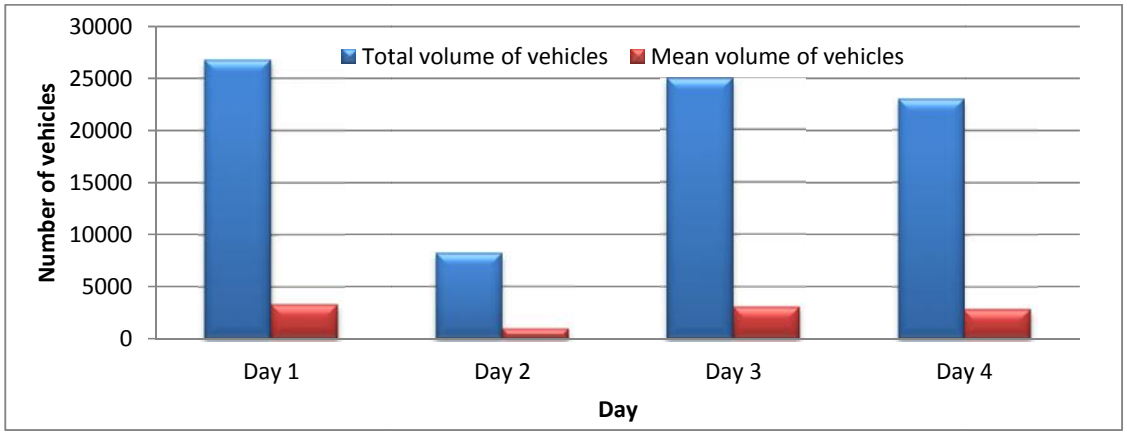

Fig. 9. Total and mean volume of vehicles

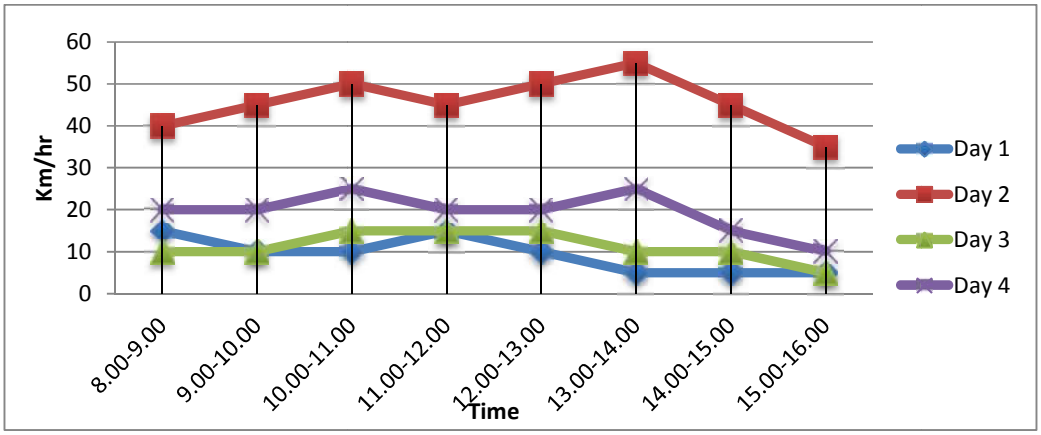

Fig. 10. Average speed of vehicles (Km/Hour)

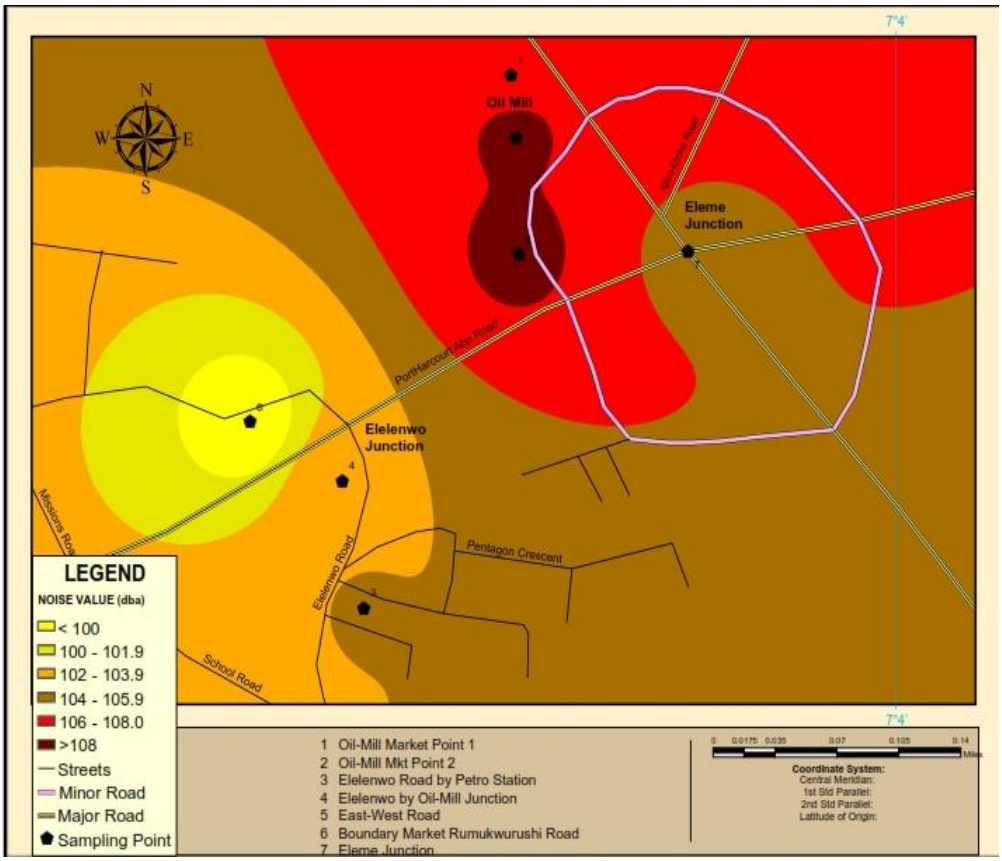

Fig. 11. Model showing noise mapping of the oil mill market

3.2 DISCUSSION

Noise levels measured during the 4-day field monitoring (Figs. 2 to 4) were generally high and are potentially hazardous to human health. Noise exceedance factors computed for each day of noise measurement in the market showed high noise rating with significant health impacts (Table 3). The high noise levels obtained in the market could constitute serious health hazards such as hypertension, hearing acuity, tinnitus, annoyance, vasoconstriction and cardiovascular diseases among merchants. Continuous exposure to noise at levels up to 108dB (A) can cause high blood pressure or noradrenaline and adrenaline levels in people. High Leq noise value

(123.6±2.3 dB A) computed for the market constitutes a risk factor for noise related health effects such as fatigue, cardiovascular disease, tension, indigestion, and emotional anxiety. The total noise pollution level (Lnp = 117.1dB A) indicates that high noise pollution prevails in the market. This portends serious health problems as merchants could be suffering from noise induced hearing loss, presbycusis, annoyance, anxiety, depression cardiovascular and physiological effects as well as other health related problems associated with noise pollution of this magnitude. Some groups of people in the market which may also be at greater risks of the above problems impacting on their lives include children, the elderlies (60 years and above) and people who are susceptible or sensitivity to high noise levels. The high intensity sound emanating from grinding machines and sirens can cause a ringing or resonant sensation in the ear resulting in an ear infection called tinnitus. Prolonged exposure to grinding machines and generators noise can also produce vibrations and motion in the inner ear fluid which may results in hearing loss.

High noise levels (98.2dB A) obtained around Rumukwurushi town can affect the performance level of pupils in primary schools in the town. Prolonged exposure can raise the levels of cortisol in pupils which will eventually affect their learning process resulting in poor performance among them. Also, residents in Rumukwurushi town living close to the market for a long time need to be aware that they may be somewhat at high risk of noise related health problems such as stress, hypertension, anxiety and annoyance.

3.3 Study Finding

The study revealed that the Oil mill market is dominated by very high level of noise pollution that may negatively impacts on the health of traders and merchants as well as residents in close proximity to the market.

4. CONCLUSION

The competitive nature of commercial activities among merchants in the Oil mill market generated enormous noise. Noise is a common characteristic among merchants in the market and serves as a key factor in attracting customers' attention. Shouting, ringing of bells, use of public address systems (mobile and fixed) are used as means of getting at customers. Results of field measurement and data analysis indicated that very high noise levels prevailed in the Oil mill market. Computed Leq and noise pollution levels showed very high noise values that far exceeded regulatory standards and are potentially hazardous to human health. Traders and merchants doing business in the market are therefore exposed to high noise pollution with significant risk of noise related health problems such as hearing loss, hypertension, hearing acuity, tinnitus, annoyance, vasoconstriction and cardiovascular diseases as well as other physiological and psychological noise effects.

5. RECOMMENDATIONS

1. State and/or Local Governments should carry out awareness campaigns among traders on the effects of noise on their health. Health assessments should be conducted among traders and merchants in the market to tests and detect signs of noise related illness.
2. More by-pass roads should be created to divert vehicles from the main Eleme junction. This will reduce the volume of traffic in the study area.
3. Noise control by-laws or regulations should be enforced so as to regulate the activities of mobile advertisers or sellers in the market.
4. Traders who intend to spend more than two hours in the market should be encouraged to use ear protection devices. These devices can be provided by local government authority or non-governmental agencies on humanitarian basis.
5. Further research study is recommended to investigate the auditory and non-auditory health effects from environmental noise exposure among traders and merchants in the market.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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