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# EVALUATION OF NOISE LEVELS AND DISTANCES FROM A BUSINESS CENTRE WITH A MAXIMUM NOISE LEVEL OF (83.35±0.91) dBA

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## ABSTRACT

A high sound level from a business centre has adverse effects on our environment. It is very pertinent to professionally site a business centre away from residential areas. This work therefore evaluates the noise levels and distances from a business centre with a maximum noise level of (83.35±0.91) dBA. Measurements of noise levels with respect to distance, *x* from the business centre were considered. The data obtained were analysed and environmental noise models were developed by using the relevant displayed parameters like the maximum noise level of the business centre, the attenuation coefficient and the coefficient of determination. The results obtained from the models developed, $L_{(modelled)}$ were compared with the results obtained from the physical measurements, $L_{(measured)}$ and there was no significant difference between them. The results reveal that the noise from the business centre affected the area up to a distance of 50 m. This is because at 50 m, $L_{(measured)}$ is 56.2 dBA and $L_{(modelled)}$ is 55.4 dBA instead of the WHO tolerant noise level of 55 dBA for a non-work place. Hence, this kind of business centre should be sited beyond 50 m from the residential areas.

## INTRODUCTION

In the United States of America, the Environmental Protection Agency (EPA) identified noise as a hindrance since in the 1970s (Menkiti and Ekott, 2014). Then, the agency carried out a main study of noise and has continued to bring up to date its results. This means that the study of noise is a continuous phenomenon. As with all pollutants, noise degrades the value of our environment and is known to produce various negative effects both on structures and on humans. Noise has escalated to the point where it is currently the most important peril to the superiority of our existence. This increase in noise can be attributed to the ever increasing number of people in the globe and the growing levels of economic affluence (Menkiti, 2001).

Environmental noise is described by World Health Organisation (WHO) as community noise or residential noise or domestic noise (WHO, 1999). The most important sources of community noise are air, rail and road traffic, neighbourhood, municipal work, and the construction plant, among others. Usually, noise from neighbourhood originates from building and installations associated with the food preparation business like cafeterias, restaurant, and discotheques; from recorded or live music; from playgrounds and car parks; from sporting events including motor sports; and from household animals for example barking dogs. The major sources of indoor noises include aeration systems, home appliances; office machines, and neighbours, among others (Ekott, 2018).

In this context, noise is defined as unpleasant sound (Schmidt, 2005). However, noise can be described as the unwanted sound in the unwanted location at the unwanted occasion. The degree of “unwantedness” is usually a psychological issue since the effects of noise can range from temperate irritation to everlasting hearing loss, and may be rated in a different way by special observers (Ekott, 2018). For this reason, it is often exigent to establish the benefits of dropping a specific noise. Noise does affect the inhabitants, humans, fauna, etc. in the natural environment. Some definite places influence noise contacts; so, it is invasive that it became difficult to run away from it. The public opinion polls almost constantly rank noise in the list of the most bothersome residential irritations. The industrial noise is one of the most annoying sources of noise complaints (Ekott, 2011). Community noise intrusions like traffic noise can obstruct speech communication, interfere with sleep and relaxation and disturb the capacity to perform difficult tasks (Kiely, 1998).

In 1993, a study carried out by Cornell University indicated that children exposed to noise during classes experienced problem with various cognitive developmental delays in addition to words discrimination. Specifically, the writing learning mutilation called dysgraphic is usually related to stress on environment during classes (Clark, Head and Stansfeld, 2013 and Stansfeld *et al*., 2005) Noise has been connected to vital cardiovascular health risks. In 1999, the WHO drew a conclusion that the existing evidence shown predicted a weak relationship between hypertension and long term exposure to noise beyond 67 – 70 dBA (Ising, *et al*., 1999). More current studies have recommended that noise levels of 50 dB(A) at night may also increase the risks of myocardial infarction by constantly enhancing production of cortisol (Essiett *et al*., 2010). The British Columbia Work's Compensation Board (WCB) has set 85 dB as its highest tolerant level in the work place. Above this limit hearing protection should be used. It states that the threshold of pain is attained at 120 dB and it classifies 140 dB as excessive hazard level. WHO safety noise levels are similar while EPA of Nigeria tends to have even a stricter standard of 70 dB as a maximum safe level of noise in work place. They gave the safe level around home to be 50 – 55 dB (Ekott and Menkiti, 2015).

Researchers have shown that constant noise above 55 dBA causes serious annoyance and above 50 dBA moderate annoyance at home (WHO, 2007). In a non-work place and for health and safety purposes, 55 dBA is set as a safety noise level for outside and 45 dBA inside. Hospital and school permissible levels of noise are 35 dBA (WHO, 1999). In Britain, the current and advanced Ministry of Agriculture regulations established in January 2002 state that propane cannons can be no closer than 150 metres from residential areas, and 100 metres from other kinds of noise makers. These machines generate noise at levels between 115 and 130 dB. At 100 meters the noise generated is above 80 dB, and greater than 75 dB at 150 metres, which is much greater than specified safe levels for around the residence. In fact, beyond 80 dB is near to the level at which ear protection should be used (Menkiti and Ekott, 2014). Noise beyond harmless levels leads to numerous health impacts which include high blood pressure, annoyance, sleep loss, stress, hearing impairment, loss of productivity and the ability to concentrate, among others.

Consequently, the study of noise is highly imperative so as to create awareness on the adverse effects of noise on the environment for the betterment of our society. In this work, the evaluation of environmental noise levels as they vary with distances and the development of models for predicting and controlling environmental noise pollution from a business centre with a maximum noise level of (83.35±0.91) dBA shall be carried out.

## MATERIALS AND METHODS

### Physical Measurements

All the noise measurements were made using the sound level meter (SLM), modelWensnWS1361 with ½ inch electret condenser microphone. This model has a measuring range 30 to 130 dBA, C weighting with measuring range 35 to 130 dBC and 0.1dB resolution with fast/slow response. It is equipped with a built in calibration check (94.0 dB) and tripod moving. It has an accuracy of ± 1.5 dB. It has AC and DC outputs for frequency analyser level recorder, Fast Fourier Transform (FFT) analyzer, graphic recorder and others. It also has electronic circuit and readout display and a weight of 308 g. The microphone senses the small air pressure variations related to sound and converts them into electrical forms. These signals are then passed to the electronic circuitry of the instrument for processing. The readout displays the processed sound levels in dB. The sound level meter picks the sound pressure level at one instance in a certain location. Measurements were taken by adjusting the sound level meter to A-weighting network in all the sampling locations. The sound level meter was calibrated by the manufacturer. During the noise level measurements, the microphone of the sound level meter was positioned at a distance of 5 m from the business centre at a height of 1.2 m above the ground and windshield was always used for accuracy. Work place noise level measurements were taken on slow response. Here, the response rate is the time period over which the instrument averages the sound level before displaying it on the readout. Fast response was used for fast varying noise. Measurement of workplace sound pressure was made in an uninterrupted noise field in the workplace, with the microphone located at the position normally occupied by the ear exposed to the highest value of exposure (EC, 1986).

**Measurement of Noise Levels with Distance**

In this case, a business centre with a maximum noise level of (83.35±0.91) dBA was identified and measurements of noise levels from it as they vary with distance were taken. All noise level measurements were carried out using the sound level meter stated above, while distance measurements were made using a measuring tape. Lastly, the equivalent continuous noise levels ($L_{eqs}$) for them were evaluated.

**Calculating the equivalent continuous noise level ($L_{Aeq}$)**

The $L_{Aeq}$ is the steady noise level over a certain period of time that generates very similar quantity of A-weighted energy as the varying level over identical period.

Formula used for calculating the equivalent continuous noise level $L_{eq}$ of a noise source, $N$ at a particular distance, x is presented in equation (1) (Kiely, 1998).

$$L_{eq} = 10 \log_{10}\{\frac{1}{T}\{10^{0.1L_N}\Delta T_N + 10^{0.1L_B}\Delta T_B\}\} \quad 1$$

The noise level of a noise source, $L_N$ is presented in equation (2) (Cunniff, 1977; Kiely, 1998; Ekott *et al.*, 2018).

$$L_N = 10 \log_{10}(10^{0.1L_{TOTAL}} - 10^{0.1L_B}) \quad 2$$

where, $T$ =Time period over which $L_{eq}$ is determined

$\Delta T_N$ =Time period over which noise level of a noise source is measured

$\Delta T_B$ =Time period over which background noise level is measured

$L_N$ =Noise level of a noise source in dBA

$L_B$ =Background noise level in dBA

$L_{TOTAL}$ =Total noise level in dBA. and,

$T$ = 5 minutes, $\Delta T_N$ = 2 minutes, $\Delta T_B$ = 3 minutes

**Noise modeling**

The data obtained were analysed and the linear regression method was applied. Hence, linear fitting models were developed for it by using the relevant displayed parameters. Finally, a general model for evaluating, controlling and predicting environmental noise pollution from a source of this type was developed.

## RESULTS AND DISCUSSION

**Analysis of noise levels and distance measurements from a business centre with a maximum noise level of (83.35±0.91) dBA**

The results of the findings (Table 1 and Fig. 1) show that from a distance of 70 metres, the business centre is not a major source of noise in the area. This is due to the fact that at the distance of 70 metres, the respective approximate values of noise level with business centre, business centre noise level alone and the equivalent continuous noise level ($L_{eq}$) are 48.8 dBA, 47.8 dBA and 45.3 dBA. Using the WHO standard, these levels may not cause either serious annoyance or moderate annoyance at a non-work place. Also, it is shown that all except background noise level decrease as distance increases. The values of the background noise levels show that in the absence of the business centre the area is conducive for living. Hence, a business centre of this kind should be sited beyond 50 metres from residential area.

Table 1: Noise levels and distance measurements from a business centre with a maximum noise level of (83.35±0.91) dBA

| Distance, x (m) | Background noise level (dBA) | Total noise level (dBA) | Business centre noise level (dBA) | Equivalent continuous noise level, (dBA) |
|---|---|---|---|---|
| 5 | 37.8 | 78.6 | 78.599639 | 74.6207805 |
| 10 | 36.4 | 76.3 | 76.299556 | 72.3208221 |
| 15 | 35.7 | 74.7 | 74.699453 | 70.7208733 |
| 20 | 36.9 | 72.0 | 71.998658 | 68.0212709 |
| 25 | 37.0 | 69.2 | 69.197382 | 65.2219082 |
| 30 | 37.3 | 67.3 | 67.295655 | 63.3227708 |
| 35 | 36.9 | 63.9 | 63.891326 | 59.9249304 |
| 40 | 38.2 | 61.5 | 61.479639 | 57.5307448 |
| 45 | 40.1 | 58.6 | 58.538217 | 54.651165 |
| 50 | 41.0 | 56.3 | 56.169901 | 52.3842164 |
| 55 | 39.9 | 53.8 | 53.619372 | 49.9081725 |
| 60 | 40.8 | 51.8 | 51.440555 | 47.9897489 |
| 65 | 39.5 | 50.3 | 49.922858 | 46.4975604 |
| 70 | 42.1 | 48.8 | 47.755351 | 45.2616764 |
| 75 | 43.0 | 45.5 | 41.911355 | 42.5966698 |
| 80 | 41.6 | 43.0 | 37.402225 | 40.363066 |
| 85 | 40.9 | 41.7 | 33.959195 | 39.2308702 |
| 90 | 38.1 | 38.9 | 31.159195 | 36.4308702 |
| 95 | 35.6 | 36.0 | 25.444292 | 33.6522298 |
| 100 | 35.0 | 36.1 | 29.597686 | 33.5448812 |

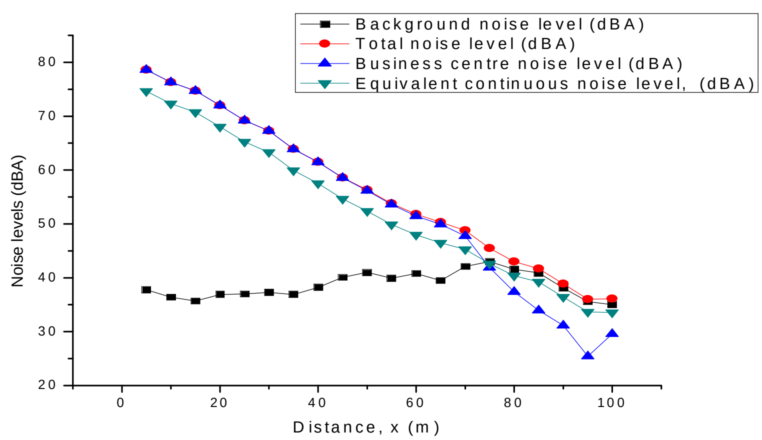


Fig. 1: A plot of the business centre with a maximum noise level of (83.35±0.91) dBA against distance

**Model development of noise levels and distance measurements for a business centre with a maximum noise level of (83.35±0.91) dBA**

Table 2 and Fig. 2 give the results of the analysis of the noise levels of a business centre with **a** maximum noise level of (83.35±0.91) dBA. It is shown that the noise levels of the business centre, and distance, x are strongly correlated with the coefficient of determination, $R^2$=0.986. The linear fitting model in dBA deduced from the analysis is as follows.

$$L_{(modelled)} = 83.35 - 0.558x \quad 3$$

Introducing the error term, $\epsilon_B$, equation (3) becomes:

$$L_{(modelled)} = 83.35 - 0.558x + \epsilon_B \quad 4$$

In equation (3), if x=0, the noise level of the business centre at source is:

$$L_{(\text{modelled})} = 83.35 \text{ dBA} \quad (5)$$

This value (83.35 dBA) represents the intercept (or maximum noise level) with a standard error of 0.91 dBA. The model has a slope (or attenuation coefficient) of –0.558 $dBAm^{-1}$ with a standard error of 0.015 $dBAm^{-1}$. Comparing the modelled noise levels of the business centre, $L_{(modelled)}$ with its measured noise levels, $L_{(measured)}$ (Table 2, Figs. 2-3) show that there is no significant difference between them. This means that they are strongly correlated. Hence, equation (3) or equation (4) can be used as a model for predicting and controlling environmental noise pollution from a business centre of this type.

Table 2: Comparison of modelled noise levels $L_{(modelled)}$ and measured noise levels, $L_{(measured)}$ of a business centre with a maximum noise level of (83.35±0.91) dBA against distance

| Distance, x (m) | $L_{(measured)}$ (dBA) | $L_{(modelled)}$ (dBA) | $L_{(difference)}$ (dBA) |
|---|---|---|---|
| 5 | 78.5996 | 80.5618 | -1.9622 |
| 10 | 76.2996 | 77.7679 | -1.4683 |
| 15 | 74.6995 | 74.9739 | -0.2745 |
| 20 | 71.9987 | 72.1800 | -0.1813 |
| 25 | 69.1974 | 69.3860 | -0.1886 |
| 30 | 67.2957 | 66.5921 | 0.7036 |
| 35 | 63.8913 | 63.7981 | 0.0932 |
| 40 | 61.4796 | 61.0042 | 0.4755 |
| 45 | 58.5382 | 58.2102 | 0.328 |
| 50 | 56.1699 | 55.4163 | 0.7537 |
| 55 | 53.6194 | 52.6223 | 0.9971 |
| 60 | 51.4406 | 49.8284 | 1.6122 |
| 65 | 49.9229 | 47.0344 | 2.8885 |
| 70 | 47.7554 | 44.2405 | 3.5149 |
| 75 | 41.9114 | 41.4465 | 0.4649 |
| 80 | 37.4022 | 38.6526 | -1.2503 |
| 85 | 33.9592 | 35.8586 | -1.8994 |
| 90 | 31.1592 | 33.0647 | -1.9055 |
| 95 | 25.4443 | 30.2707 | -4.8264 |
| 100 | 29.5977 | 27.4768 | 2.1209 |

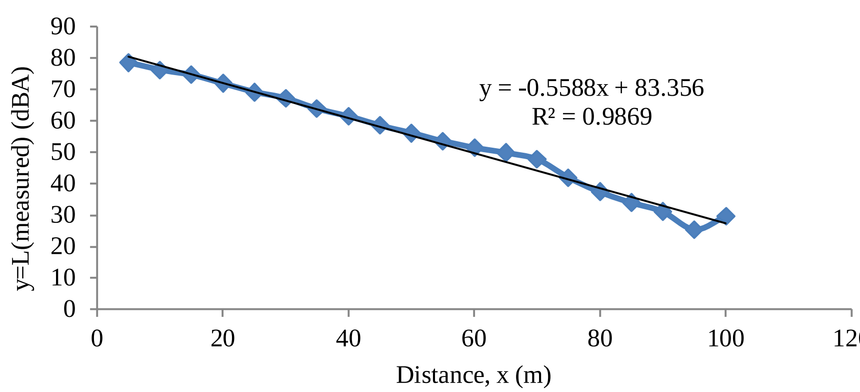


Fig. 2: The characteristics of the business centre measured noise level

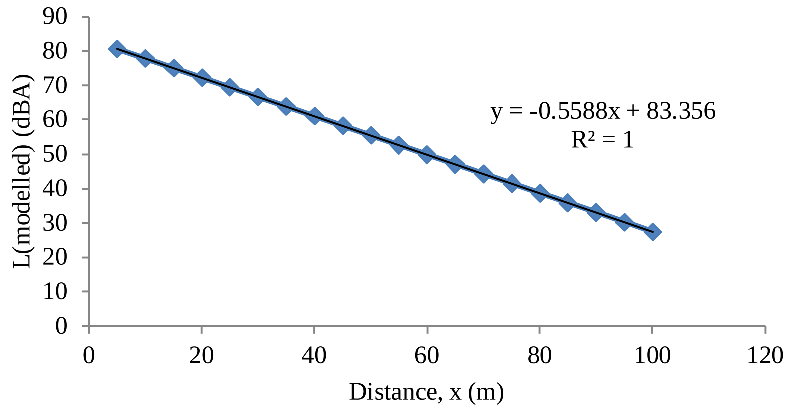


Fig. 3: The characteristics of business centre modelled noise level

## CONCLUSION

From the findings, it is concluded that the noise from the business centre with a maximum noise level of (83.35±0.91) dBA (i.e at source or $x = 0$ m) affected the area beyond a distance of 50 m. This is because at 50 m, the total noise level is 56.3 dBA instead of the WHO tolerant noise level of 55 dBA for a non-work place. Hence, the results indicate that this kind of business centre should be sited beyond 50 m from the residential areas. The results reveal that the equivalent continuous noise level, $L_{eq}$ decreased as $x$ increased. It was shown that there was no significant difference between $L_{(measured)}$ and $L_{(modelled)}$. Therefore, with the consideration of distance *(x)*, the models developed in this work are recommended to be used as more reliable tools for environmental noise impact assessments.

## REFERENCES

Clark, C., Head, J. & Stansfeld, S. A. (2013). Longitudinal effects of aircraft noise exposure on children's health and cognition: A six-year follow-up of the UK RANCH Cohort. *Journal of Environmental Psychology*, 35(3): 1 - 9.

Cunniff, P. F. (1977). *Environmental noise pollution*. New York: John Wiley and Sons, pp 35-39.

European Commission (EC) (1986). *The state of the environment in the European community.* Luxemburg: Publications of the European Communities, 76pp.

Ekott, E. E., Bassey, D. E. & Obisung, E. O. (2018). Modeling the Relation Between Noise Levels and Distance from a 500 kVA Power Generator. *World Journal of Applied Science and Technology*, 10 (1B): 124 – 130**.**

Ekott, E. E. (2018). *Evaluation and Modelling of Environmental Noise Pollution in some Local Government Areas of Akwa Ibom State, Nigeria*. Unpublished Doctor of Philosophy Thesis, Faculty of Physical Sciences, University of Calabar, Nigeria.

Ekott, E. E. (2011). *Impact of noise on the environment: Using Itu Local Government Area of Akwa Ibom State, Nigeria as case study*. Unpublished Master of Science Dissertation, Faculty of Science, University of Uyo, Nigeria.

Essiett, A. A, Akpan, R. E. & Uwak, S. O. (2010). Assessment of noise level in Ikot Ekpene Town, Nigeria. *International Journal of Biotechnology and Allied Sciences*, 5(1): 620 – 624.

Ising, H., Babisch, W. & Kruppa, B. (1999). Noise-induced endocrine effects and cardiovascular risk. *Noise Health*, 1(4): 37 – 48.

Kiely, G. (1998). *Environmental engineering*. Singapore: Irwin/McGraw-Hill, pp 390, 398-417.

Menkiti, A. I. (2001). Analysis of noise bother by survey method. *Global Journal of Pure and Applied Sciences*, 7(3): 545 - 550.

Menkiti, A. I. & Ekott, E. E. (2014). Determination of noise levels with respect to distance at selected workshops/factories in Itu Local Government Area of Akwa Ibom state, Nigeria. *IOSR Journal of Applied Physics (IOSR-JAP)*, 6(3): 43 - 53.

Schmidt, C. W. (2005). Noise that annoys regulating unwanted sound. *Environmental Health Perspectives*, 113(1), 1 – 3.

Stansfeld, B. M., Dockrell, J. E., Asker, R. and Trachmatzidis, I. (2005). The effects of noise on the attainments and cognitive development of Primary School children-final report for department of health and the department ETR. Retrieved January 14, 2014 from www.noisesolutions.com.

World Health Organisation (WHO) (1999). *Guidelines for community noise*. Retrieved June 25, 2017 from http://www.who.int/docstore/peh/noise/noiseindex.html.

World Health Organisation (WHO) (2007). *Night Noise Guidelines for Europe*. Bonn: WHO, Regional Office for Europe, Retrieved June 30, 2017 from http://www.euro.who.int/ data/assets/pdf_file/0017/43316/E92845.pdf.