Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 9 Issue 11, November - 2022

Modelling Of Generator Noise Level In A Communication Mast Base Station

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***Abstract*— Noise is part of the environmental pollution due to irregular frequency. The noise produce by communication base station generator tends to affect the occupant closed to the base station. This study modelled the noise level of generator installed in a communication base station. The noise level data was measured at regular interval of 5m when the generator is off and when the generator is ON. The continuous noise level and the generator noise level was computed. Linear regression was used to model the generator noise level. The results show that the noise level of the generator and the continuous noise level decreases as the distance from the base station increases. However, the background sound at 5m interval is irregular this is due to the moving objects at particular time of measurement. The noise level of the generator and continuous noise level at 5m interval is 60.9 and 67.1 for case study 1 and 2 respectively this is not safe for human hear based on World health Organization (WHO) recommendation. Likewise at an interval 10m the noise level of the generator and continuous noise level are 54.7 and 61.9db respectively. This implies that for case study one, occupant in building at 10m away are safe, while for case study two occupant in building at 10m away from the base station are not safe. This may be due to the type and condition of operation of the generator installed in the case study two. The accuracy of the model prediction was tested the results shows that model developed for case study one varies from 15.1% to 0.77% and for case study two varies from 12.2% to 3.4%. This research therefore recommends that communication regulating bodies should not set distance as the only standard to avoid noise pollution from the base station. The type and working condition for the generator to be installed should also be considered.**

Keywords*— Noise; Genereator; Modelling; Prediction.

I. INTRODUCTION

The World Health Organization (WHO) classifies environmental noise as home, residential, or communal noise [1]. The most significant sources of neighborhood noise are things like air, train, road traffic and use of generator as well as activities in construction industry. Since the 1970s, the Environmental Protection Agency (EPA) in the United States of America has recognized noise as a barrier [2]. The organization then conducted a significant research on noise and has kept its findings up to date ever since. This indicates that research on noise is an ongoing process. Like other pollutants, noise degrades the quality of our environment and is known to have a number of detrimental consequences on both buildings and people.

The biggest threat to the superiority of our life right now is noise, which has gotten so bad. The world's expanding population and rising levels of economic wealth are the major cause of the increase in noise [3].

According to a 1993 Cornell University research, children who were exposed to noise in the classroom also had difficulties with word discrimination and other types of cognitive developmental abnormalities. Dysgraphia is a type of writing learning mutilation that is specifically linked to environmental stress in the classroom [4]. Noise is defined in this sense as an unpleasant sound [5]. However, noise might be defined as the undesirable sound in the undesirable setting at the undesirable time. Since the consequences of noise might vary, the level of "unwantedness" is typically a psychological concern.

IN 1999 according to WHO there was insufficient evidence to support a causal link between long-term exposure to noise levels over 67 to 70 dBA and hypertension [6]. More recent research has suggested that nighttime noise levels of 50 dB(A) may also increase the risk of myocardial infarction by continuously increasing cortisol production [7]. Likewise, British Columbia Work's Compensation Board (WCB) established 85 dB as the maximum level that would tolerate in the workplace. Hearing protection should be worn above this threshold. It claims that the pain threshold is reached at 120 dB and that 140 dB is considered a high danger level. While EPA of Nigeria tends to have an even tighter threshold of 70 dB as a maximum safe level of noise in the workplace, WHO safety noise limits are comparable. The recommended range for the safe level near homes is 50 to 55 Db [5] The increase in the use of nonrenewable energy to power the communication tower has been a concern to citizens of many African countries such as Nigeria. Many researchers are concern with the electromagnetic radiation emitted by the tower. However, there has been argument that EM radiation will has no effects at a particular frequency and at a distance to a building. However, different countries has a standard that regulates the activities of the communication industries on how mask should be installed. Most of the international regulating body are concerned with the radiation level, sound level and the tower height. In Nigeria the activities is saddled by Nigerian communication commission, which regulates the activities that involved in installation and operation of communication mask such as distance from mask from building, EM emitted, the type and sound produce by the generator. The NCC adopted an EM radiation standard which may not totally represent the

Nigeria situation if research is conducted based on the uniqueness of the environmental factors in the country.

Many Nigerians are agitating against the installation of communication tower close to their properties due to one of the following reasons such as radiation, sound level of the installed generator and fear of natural disaster affecting the tower. The noise produce by the generator may not be suitable to human ear at a particular threshold, which may have a long term effect on the ear. Noise is any loud, discordant or disagreeable sound. Human perception of loudness also conforms to a logarithmic scale; a 10-decibel increase is perceived as roughly a doubling of loudness. Thus, 30 decibels is 10 times more intense than 20 decibels and sounds twice as loud; 40 decibels is 100 times more intense than 20 and sounds 4 times as loud; 80 decibels is 1 million times more intense than 20 and sounds 64 times as loud. Noise can cause hearing loss, lack of sleep, irritability, heartburn, indigestion, ulcers, high blood pressure, and possibly heart disease. Prolonged or frequent exposure to noise tends to make the physiological disturbances chronic. In addition, noise-induced stress creates severe stresses in daily living and contributes to mental illness. In Nigeria the rate of installation of communication tower in any location without putting into consideration the occupant is alarming. Therefore there is a need to model the noise level produce by generator against distance in order to ensure the zone of safety for occupant and property closed to tower powered by diesel engine generator. The objective of this research is to model the generator noise level in a communication base station to ensure occupant safety.

II. METHODOLOGY

Measurement

Noise data of the generator was collected at regular interval of 5m from the communication base station using the DB sound meter and tape rule. The maximum distance considered is 35m. However, the standard considered by NCC for a property to be close to the communication base station is 10m. The measurement was carried out in different site location where communication tower is powered by nonrenewable energy source such as diesel engine generator as presented in Figure 1 and Figure 2. The environmental noise level was measured when the generator is not OFF for every 2 minutes and the total noise level was measured when the generator is on for every time interval of 1 minute.

The noise level of a noise source and Equivalent Continuous Noise Level

The noise level and the equivalent continuous noise level was estimated using equation (1) and (2)

$$L_g = 10log_{10}(10^{0.1L_{total}} \_ 10^{0.1L_B}) \qquad (1)$$

L_{total} is the total noise level measured

L_B is the background noise level measured when the generator was off

The equivalent continuous noise level is computed using equation 2.

$$\boldsymbol{L_{eq}} = 10log_{10}(\frac{1}{T}10^{0.1L_g}T_N + 10^{0.1L_B}T_B) \qquad (2)$$

T is the total time when the background measurement and the total noise Level was obtained.

$$T = T_N + T_B \qquad (3)$$

T_N is the time when generator was ON and measurement was taken.

T_B is the time when generator was OFF and measurement was taken.

L_g is the noise level of the generator alone

L_B is the noise level of the background when generator is off.

Noise Modeling

The gathered data were examined, and the linear regression approach was used. Therefore, by utilizing the pertinent exhibited properties, linear fitting models were created for it. Finally, a generic model was created for assessing, regulating, and forecasting environmental noise pollution from a generator source using equation. The residuals of the model output was used to determine the model error compared with the actual values.

$$Pl_g = Bx + C + \varepsilon \qquad (4)$$

PL_{Lg} is the predicted noise level of the generator source, B is the model constant, C is the intercept and ε is the error in the model.

III. RESULTS

Sound Level Measurement

The Results the sound level were presented in Figure 3 and 4.

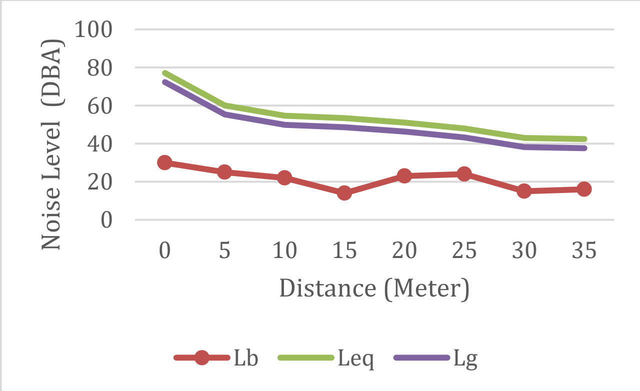

Figure 3: Case 1: Continuous, background and generator sound level against distance.

The results in Figure 3, shows the sound level of the generator alone, the continuous noise level and the background sound level in the first case study. The continuous noise level and the generator noise decreases as the distance increases while the background sound of the surrounding varies in an irregular manner, this may due to the movement of objects at different time interval in the study location. Also, the highest noise level obtained is not suitable to the human hear at the base station. However, at distance 5meter away from the base station the continuous sound level is 60.9dbA, this against the recommendation by WHO. The recommended range for the safe level near homes is 50 to 55dB. (Ekott and Menkiti, 2015). This implies that installation of communication tower closed to a property at 5m interval can still cause hazard effect to the occupant of such property. Also, at distance 10m from the base station the sound level is 54.7db the value is less than the recommended value by WHO this implies that building at 10meter range may experience safety level of sound.

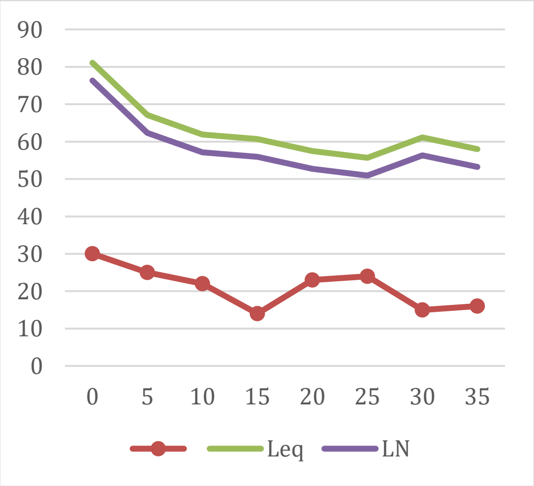

Figure 4: Case 1: Continuous, background and generator sound level against distance.

The results in Figure 4, shows the sound level of the generator alone, the continuous noise level and the background sound level in the second site of measurement. The continuous noise level and the generator noise decreases as the distance increases while the background sound of the surrounding varies in an irregular manner, this may due to the movement of objects at different time interval in the study location. Also, the highest noise level obtained is not suitable to the human hear at the base station. However, at distance interval of 5meter and 10 meter away from the base station the continuous sound level is 67.1dbA and 61. 9dbA respectively this is against the recommendation by WHO the recommended range for the safe level near homes is 50 to 55dB. (Ekott and Menkiti, 2015). This implies that installation of communication tower closed to this property at 10m interval can still cause hazard effect to the occupant of such property.

Model Prediction Results

The results of the model prediction for the two case study is presented in figure 5, 6 and Table 1 and 2.

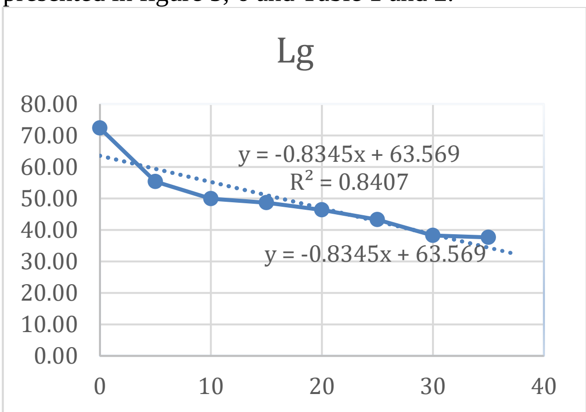

Figure 5: Case 1: Model prediction for the case 1

Table 1: The model prediction for the case 1

Observation	*Actual Value Lg*	*Predicted Lg*	*Residuals*
1	55.33	63.57941603	8.759540781
2	49.93	59.39673585	-4.065265026
3	48.63	55.22405566	-5.290606114
4	46.34	51.05137548	-2.421590866
5	43.26	46.87869529	-0.536475784
6	38.24	42.70601511	0.557214557
7	37.65	38.53333493	-0.290803037

The result in Figure 5, shows the sound level of the generator alone without the environmental sound level of site 1, the linear modelling of the sound source against the distance shows that there is high correlation between the generator sound and the distance. The modle suggest that the data obtained is 84.1% to expalin the obatined results. The model can be used to determine the sound level of a generator set at a regular distance interval without the environmental sound level. The error in the model is accounted for with the residuals and the predicted values in Table 1. The maximum and minimum error in the model is and 15.81% 0.77% respectively.

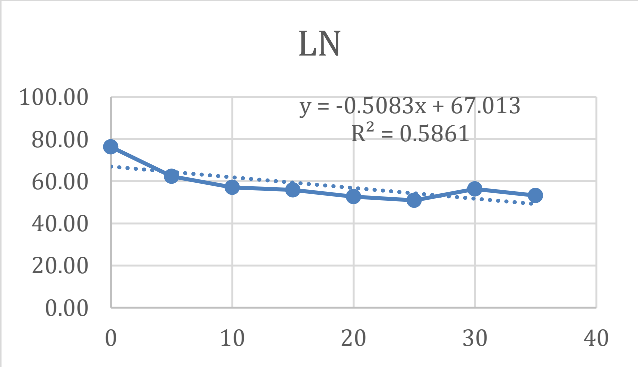

Figure 4: Model Prediction for Case 2.

Table 2: The Model Predicted for Case 2.

Observation	*Actual Value*	*Predicted LN*	*Residuals*
1	76.33	67.01	9.32
2	62.33	64.47	-2.14
3	57.13	61.93	-4.80
4	55.93	59.39	-3.46
5	52.73	56.85	-4.12
6	50.93	54.31	-3.37
7	56.33	51.76	4.56

The result in Figure 4, shows the sound level of the generator alone without the environmental sound level of site 2, the linear modelling of the measured data against the distance shows that there is high correlation between sound and the distance. The modle suggest that the data obtained is 84.1% to expalin the obatined results. The model can be used to determine the sound level of a generator set at a regular distance interval without the environmental sound level. The maximum and minimum error in the model is 12.2% and 3.4%.

IV. CONCLUSION

This research concluded that the generator sound level and the continuous sound level produced decreases as the distance increases. The study also indicates that generator at 5m and 10m away from a residential property affect the occupant in the area however, this may depend on other factors of the generator. The research findings also show that the models developed in this work can be used in evaluating and predicting the exact distance at which adverse effects of noise from this generator can cover and in controlling environmental noise pollution from a 20kW power generator Hence, the models are recommended to be used as reliable tools for environmental noise impact assessment. Also, the research recommends communication regulating bodies should not set distance as the only standard to avoid noise pollution from the base station. The type and working condition for the generator to be installed should also be considered.

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