Assessment of Transient and Spatial Noise Pollution Levels at Selected Junctions in Port Harcourt Metropolis, Rivers State

ABSTRACT:

This study focused on assessing of transient and spatial noise levels at selected Port Harcourt Metropolis junctions. Spatial noise measurement and vehicle count were conducted at Eleme and Akpajo junctions. Comparative analyses of noise level and noise pollution level using line graph/t-test and determination of decline rate of noise pollution level using regression analysis were carried out. Comparative analyses of noise levels at the two study locations using traffic count were also done. The noise pollution level was compared with National Environmental Standards and Regulations Enforcement Agency (NESREA) and World Health Organization (WHO) noise standards and a safe zone determined at study locations. Maximum and minimum noise recorded were 88.99dB(A) and 50.05dB(A) at Eleme junction, 87.51dB(A) and 49.02dB(A) at Akpajo junction. Findings showed that the noise pollution level was relatively higher than noise level with distance away from the junctions; however, there was no significant difference between noise level and noise pollution level. Maximum noise pollution level average decline rate of -0.3691dB was observed at Eleme junction in the morning, while the minimum noise pollution level average decline rate of -0.2656dB was observed at Akpajo junction, in the morning hours. External sources also contributed to noise level at the junctions. Those living or doing business within 100m and 120m of Akpajo and Eleme junctions, respectively are at risk of having noise-induced auditory, physiological and behavioral problems. There is need for continuous monitoring of noise level at study locations. Regular health assessment of people living within the study locations. Noise control regulations should be made and enforced by the Government.

Key words: Assessment, Transient, Spatial, Traffic count, Port Harcourt Metropolis, Traffic noise.

1. INTRODUCTION

Exposure to high level of noise could lead to harmful effects such as hearing impairment, physiological impacts, communication interference, task interference, sleep interference and personal behavior impact. Hence, victims of high noise levels are likely to suffer from high blood pressure, ulcer, respiratory modification, neurological disorder, increased proneness to accident and reduced work efficiency. It is estimated that 3% of cases of ischaemic heart disease in large cities are attributable to road traffic noise (Babisch, 2014). There are ever more studies that point to a significant association between urban noise and severe cardiovascular events, such as myocardial infarction and stroke (Selander et al., 2009). The risk factors which are directly related to cerebrovascular accidents are hypertension, arteriosclerosis and low heart-rate variability index(Tobías et al., 2015).

Traffic flow is a major source of noise pollution in Port Harcourt Metropolitan city because of increased pollution from industrialization and concentration of both road networks and city dwellers. Noise has been recognized as a major problem for the quality of life in urban areas all over the world because of the increase in the size of the cities, number of cars and industrialization. It is not simply a local problem, but a global issue affecting everyone and calls for precautionary measures in an environmental planning situation. With the rapidity of urbanization and population growth, magnitude and harshness of noise has also continued to increase (Babisch, 2014).

Therefore, assessing transient and spatial noise from traffic source will help determine if those exposed to traffic noise within the study locations are at risk of the negative impact of high noise levels. Again, it will create awareness on the level of noise road users and city dwellers are exposed to and its health implication. Furthermore, relevant information and data that will assist the Government to safely restructure the transport system and road network to reduce road traffic noise will be provided.

2. MATERIALS AND METHODS

2.1 Study Area

Eleme and Akpajo junctions (Sample locations for the study) are strategically located on the Federal Road connecting the southern and western part of the country known as the EAST - WEST ROAD. The East-West Road linked multinational companies such as the New and Old Port

Harcourt Refinery Limited at Alesa-Eleme, Indorama Eleme Petrochemical and Fertilizer Company Limited, Notore fertilizer Company Limited and Nigeria Port Authority both at Onne- Eleme. Logistic activities by these companies which include transportation of workers and passengers; conveying of petroleum, petrochemical and fertilizer raw materials and finished products; movement of import and export containers constitute concentrated traffic flow at study locations and thus, create noise induced harmful effect on road users and residents. The map of the study area is as shown in Figure 1.

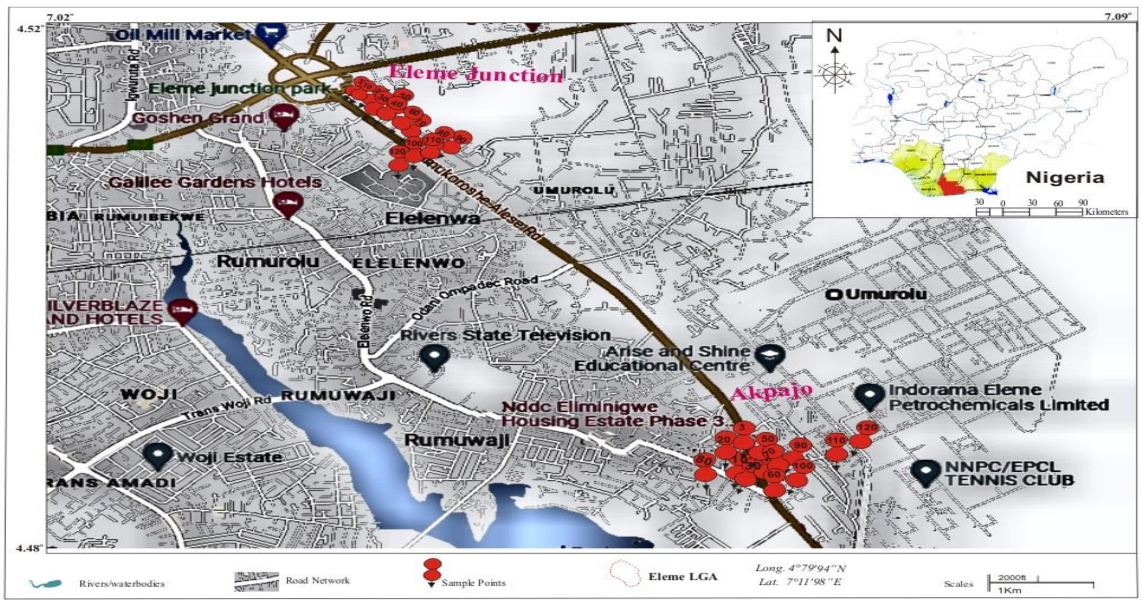


Figure 1: Map of Port Harcourt Metropolis showing sampling locations.

Source: Adapted from NDDC, (2007) and Goggle map, (2022)

2.2 Data Collection and Analysis

Noise level study at selected junctions in Port Harcourt metropolis was done using qualitative and quantitative research design method. Several literatures were consulted in conducting this research work. Among the journals reviewed are National and International noise standards, Rail transport noise, Airport noise pollution, Market noise pollution etc. Noise readings were collected using a

Smart sensor (AR844) with serial No.: 01032650 digital sound level meter. To ensure the validity and reliability of the data collection instrument, the instrument was calibrated by an in-built calibrator. Calibration was done before each measurement period. GPS software application was used to obtained coordinates at the sample points. Distance measurement was done using a measuring tape. Transient noise data was measured by reading the digital sound level metre at 10 seconds regular intervals to get 12 noise level readings at each sampling point, the sound level metre was set at a measuring range of 30 – 130dB. Noise readings were taken at a distance of 3 metres from the source and then 10 metre apart up to 120 metres, given a total of 13 sampling points to obtain the spatial noise level.

Traffic count was also carried out at study locations, various vehicle types such as trucks, tankers, tippers, buses, cars, tricycles and motorcycles were counted. Noise measurement was conducted from 7 am to 8 am and 4 pm to 6 pm on Monday and Wednesday at study locations. Traffic count carried out from 7 am to 10 am and 4 pm to 6 pm on Monday and Wednesday at study locations.

From the noise data obtained, the following were conducted: Comparative analyses of noise level (Vibration in the air that we pick up with our ears) and Noise Pollution Level (the level of noise that is considered unwanted and disturbing, that affects the health and well-being of humans and other organisms) using graphical representation and t-test. Determination of decline rate of noise pollution level using regression analysis. Comparative analyses of noise level at the two locations using traffic count and Safe noise zone determination with reference to national and international noise level standards of 55dB.

It is important to distinguish between noise level that are measured with noise meter and recorded in decibel, dB(A) while Noise Pollution Level (NPL) is determined from the analysis of transient noise with the following procedure (Nwaogazie, 2021):

(i) Step 1: rank noise levels in order of first position assigned to the smallest and last position assigned to the largest NL and the ranking positions are converted to probability values using Weibull's method (Equation 1):

$$P = m/n \quad (1)$$

Where: P = probability in percentage, m = rank position and n = total no. of items (measured NL)

(ii) Step 2: Obtain % of Time equal or exceed (%T) using Equation 2:

$$\%T = (1-P)100 \qquad (2)$$

iii) Step 3: Plot a graph of NL against %T; and read off NL at 10, 50 and 90% yielding values of NL_{10}, NL_{50} and NL_{90}, respectively.

iv) Step 4: Compute noise pollution level, NPL using Equation 3:

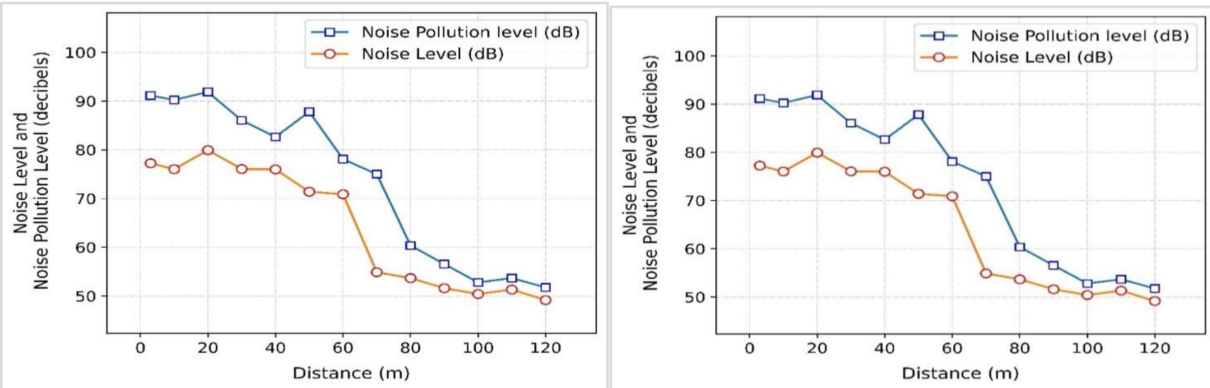
$$NPL, dB(A) = NL_{50} + (NL_{10} - NL_{90}) + \frac{(NL_{10} - NL_{90})^2}{60} \qquad (3)$$

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Comparative Analyses of NL & NPL

The result of the trend of the noise level and noise pollution level for Eleme junction morning hours and Akpajo junction evening hours are presented in Figure 2. It was observed that the noise pollution level was relatively higher than the noise level for all the distances away from Eleme and Akpajo junctions.



(a) Eleme Junction (Morning)   (b) Akpajo Junction (Evening)

Figure 2: NPL & NL Distributions at Eleme and Akpajo Junctions

The result of t-test presented in Tabe 2 shows that there is no significant difference in the noise level and noise pollution level, p-value are greater than 0.05 for Akpajo morning and evening hours, Eleme morning and evening hours respectively. The result from t-test provide sufficient evidence in stating that the noise level and noise pollution level are similar. However, there is a slight difference which is not significant.

Table 1 Descriptive Statistics of NL at Eleme Junction in the Evening hours on Monday.

Daytime	**Distance**	**mean**	**median**	**std**	**min**	**max**	**skew**
	3	79.98	80.10	6.08	70.60	91.50	0.27
	10	76.89	74.70	6.39	70.40	89.40	0.80
	20	87.51	87.90	6.65	77.30	98.40	-0.12
	30	81.33	78.05	6.27	75.50	92.60	0.90
	40	76.34	75.55	5.35	70.70	88.90	1.23
	50	76.81	75.95	4.80	70.20	86.40	0.58
Evening	60	76.27	73.80	5.58	69.80	85.00	0.56
	70	54.78	54.65	2.10	52.20	58.60	0.39
	80	54.07	52.60	3.15	50.40	58.60	0.35
	90	50.38	49.85	2.21	47.90	55.40	1.01
	100	49.68	49.70	0.91	48.50	51.00	0.11
	110	50.44	50.25	1.48	48.60	54.10	1.35
	120	49.02	49.20	0.91	48.00	50.30	0.14

Table 2 t-test Analysis of NPL & NL for Akpajo and Eleme Junctions

Statistic	Akpajo Morning	Akpajo Evening	Eleme Morning	Eleme Evening
Difference	-6.294	-9.192	-7.351	-7.018
t (Observed value)	-1.279	-1.619	-1.376	-1.586
|t| (Critical value)	2.064	2.064	2.064	2.064
DF	24	24	24	24
p-value (Two-tailed)	0.213	0.118	0.181	0.126
alpha	0.05	0.05	0.05	0.05

3.1.2 Determination of decline rate of NPL

The result of the average and Instantaneous rate of noise pollution level at Akpajo and Eleme is presented in Tables 3 and 4. The result of the average decline rate of noise pollution level showed that there was a decline in the noise pollution level with respect to distance away from the junction. The maximum average rate of decline was observed at Eleme in the morning hours (-0.3691dB/m) while the minimum was observed at Akpajo in the morning hours(-0.2656dB/m). Maximum instantaneous rates were observed at 100m, 90m, 120m and 120m at Akpajo morning and evening, Eleme morning and evening, respectively.

Table 3: Instantaneous Decline Rate of NPL at Akpajo and Eleme

Distance from Junction (metres)	**Akpajo Morning**	**Akpajo Evening**	**Eleme Morning**	**Eleme Evening**
	Functions			
	$y = 1E^{-4}X^3 - 0.0303X^2 + 1.7203X + 58.161$	$y = 8E^{-5}X^3 - 0.0206X^2 + 1.208X + 68.87$	$y = -8E^{-4}X^5 + 0.0151X^2 - 1.12X + 115.26$	$y = -2E^{-5}X^3 - 0.0001X^2 + 0.1318X + 80.824$
3	1.5412	1.08656	-1.03156	0.13066
10	1.1443	0.82	-0.842	0.1238
20	0.6283	0.48	-0.612	0.1038
30	0.1723	0.188	-0.43	0.0718
40	-0.2237	-0.056	-0.296	0.0278
50	-0.5597	-0.252	-0.21	-0.0282
60	-0.8357	-0.4	-0.172	-0.0962

70	-1.0517	-0.5	-0.182	-0.1762
80	-1.2077	-0.552	-0.24	-0.2682
90	-1.3037	-0.556	-0.346	-0.3722
100	-1.3397	-0.512	-0.5	-0.4882
110	-1.3157	-0.42	-0.702	-0.6162
120	-1.2317	-0.28	-0.952	-0.7562

Table 4: Average decline rate of NPL at Akpajo and Eleme

Junction	Daytime	Average Rate of Change (dB/m)
Akpajo	Morning	-0.2656
Akpajo	Evening	-0.3366
Eleme	Morning	-0.3691
Eleme	Evening	-0.2866

3.1.3 Comparative analyses of NPL at Eleme and Akpajo

The traffic count and noise level readings for the study locations are presented in Figure 3.

The result showed a traffic count of 5179, 3343, 5234 and 3353 for Akpajo junction on Monday and Wednesday morning and evening hours. Traffic count of Eleme junction on Monday and Wednesday morning and evening hours were 3667, 2683, 3808 and 3024. The corresponding noise level readings were 71.858, 79.983, 80.417 and 74.492 for Akpajo junction and 88.992, 79.542, 87.408 and 81.975 for Eleme junction. The results from Figure 3 shows that noise level was higher at Eleme Junction as compared with Akpajo junction; however, the traffic count is lower at Eleme junction than Akpajo junction.

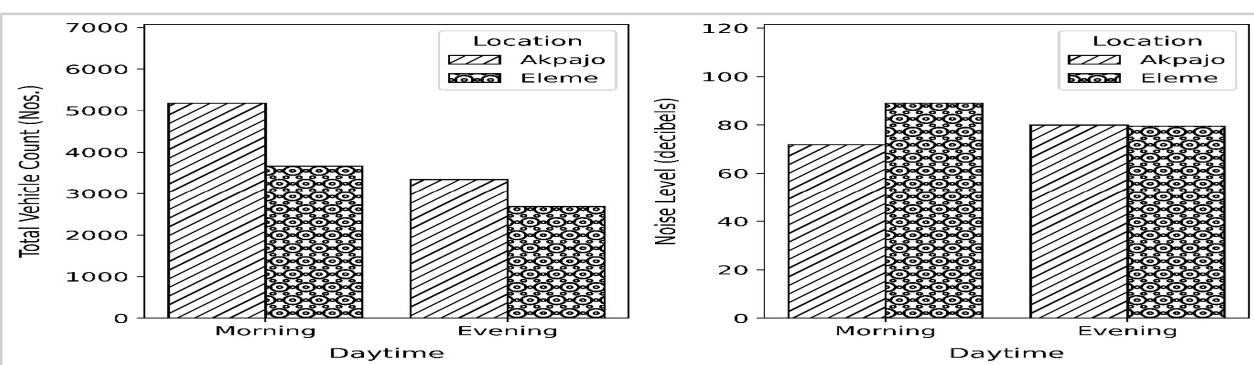


Figure 3: Traffic count and NL on a Typical day at Akpajo and Eleme junctions

3.1.4 Safe Noise zone determination

Table 5: NPL and distance at Eleme & Akpajo Junctions

	Eleme Morning	Eleme Evening	Akpajo Morning	Akpajo Evening
Distance(m)	NPL(dB)	NPL(dB)	NPL(dB)	NPL(dB)
3	99.06856	88.01040167	85.40720667	91.13680167
10	95.43570667	85.425615	84.70908167	90.24620167
20	93.56700167	82.59926	94.97536	91.88352667
30	84.68232667	83.77136	80.33896	86.061015
40	86.01810667	82.00960667	84.87264	82.63792667
50	82.984375	86.20202667	81.82592667	87.82568167
60	81.38288167	79.51086	76.29072667	78.08680667
70	85.93730667	83.41948167	60.47816667	75.00744
80	79.28352667	75.75690667	60.18042667	60.36010667
90	70.27206	61.04260167	58.78962667	56.55290667
100	59.28934	59.384375	55.61824	52.78800667
110	57.70104167	55.80214	58.09204167	53.669735
120	55.88326	54.47700167	54.33712667	51.75180167

Table 5 shows Noise Pollution level obtained at Eleme and Akpajo junctions. Comparism of noise pollution level with international noise standard (world Health organization) and National noise standard (National Environmental Standards and Regulations Enforcement Response) were presented in Table 6. Safe zone distances are also determined at study locations at Eleme and Akpajo junctions.

Table 6: Noise Level versus International and National Standards

Noise Regulatory Body	Facility	Maximum Permissible Noise Limit	Duration	Safe Zones

				Eleme Morning	Eleme Evening	Akpajo morning	Akpajo Evening
WHO	Outdoor Living area	55dB	16 Hours	Nil	120m	120m	100m
WHO	Industrial, Commercial, shopping and traffic area	70dB	16 Hours	100m	90m	70m	80m
NESREA	Mixed residential (with some commercial and entertainment)	55dB	16 Hours	Nil	120m	120m	100m
NESREA	Residential + Industrial or Small-scale production + Commerce	60dB	16 Hours	100m	100m	90m	90m
NESREA	Industrial (Outside perimeter fence)	70dB	16 Hours (6am -10pm)	100m	90m	70m	80m

3.2 DISCUSSION

Section 3.2 considers comparative analyses of noise level and noise pollution level, decline rate determination, comparison of study locations noise level, and safe noise zone determination.

3.2.1 Comparative Analyses of NL & NPL

According to the results presented in Figure 1 and Figure 2. It was observed that noise pollution level was relatively higher than Noise level for various distances away from the junctions. This is in agreement with D. W. Robinson proposed definition of Noise pollution level as equal to L_{eq} + K(□), where L_{eq} is the average sound level, k is a constant which is equal to 2.56 and □ is the standard deviation (Robinson, 1971). However, there is no significant difference between Noise pollution level and noise level as presented in Table 5.

3.2.2 Determination of decline rate of NPL

From Table 4, the average rate decline of -0.3691dB/m was observed at Eleme junction in the morning hours. This was because external noise sources apart from traffic such as Gas station generator, car washing machine were not in operation by 7 am during noise measurement. Minimum average rate of decline of -0.2656dB/m at Akpajo junction in the morning hours was influenced by a megaphone (Public Address System) mounted at 30m away from the junction. Generally, there was a decline in noise levels at distances away from the junction which is similar to a research work on Effect of distance from road intersection on developed traffic noise levels, the equivalent noise levels at distances 50 and 100 m from the intersection were found to be 1.5to 2.0 dB less than those at 0 m (Abo-Qudais & Alhiary, 2004).

3.2.3 Comparative analyses of NPL at Eleme and Akpajo

The results from Figures 3 showed that noise level was higher at Eleme Junction as compared with Akpajo junction; however, the traffic count is lower at Eleme junction than Akpajo junction. Eleme junction has a high noise level because of the contribution of external sources of noise which include car washing machine sited at 20m, auto mechanic workshop sited at 80m, and mini gas station generator sited at 100m away from the junction respectively. Low noise level at Akpajo was influenced by a noise reduction wall barrier located at 70m away from the junction. External sources contributed to the noise level at the junctions in addition to traffic noise. External noise sources contribution to noise level is in agreement with Ogunsote's classification of noise sources, stating that external sources of noise is not limited to traffic noise(Ganiyu & Ogunsote, 2010). The effect of the noise reduction barrier is in agreement with noise reduction techniques by (Nwaogazie, 2000).

3.2.4 Safe Noise zone determination

Safe noise zones as shown in Table 6 showed that safe noise zone for residential purpose at Eleme junction was 120m away from the junction while that of Akpajo junction was 100m. Safe zone for industrial purpose ranges from 90m to 100m at Eleme junction and 70m to 80m at Akpajo junction. The determination of noise zones is similar to a research work using a noise map of oil mill market showing different noise zones such as <100dB, 100-101.9dB, 102-103.9dB, 104-105.9dB,106-108.0, >108.0(Ugbebor et al., 2017).

4. CONCLUSION

The range of noise level measured at Eleme and Akpajo junctions are (79.542-88.992) and (71.858-80.417); and the corresponding vehicle count are in the range of (2683-3803) and (3343-5179), respectively. Comparative analyses on the difference between noise pollution level NPL & NL, indicates a relative difference that is not significant. The average decline rate of NPL is 0.3691dB/m at Eleme junction and -0.2656dB/m at Akpajo junction respectively. The safe zone was determined by the application of WHO and NESREA noise limit standard. There is need for continuous monitoring of noise level at study locations. Regular health assessment of people living within the study locations. Noise control regulations should be made and enforced by the Government. This research work was limited by finance (hiring of noise measuring instrument) and insecurity at study locations.

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