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Evaluation of Ambient Noise Levels in Port Harcourt Metropolis, South-South, Nigeria

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Abstract: *Noise levels was evaluated using Extech 407780A precision integrated digital sound level meter in selected locations in Port Harcourt metropolis. The Leq values obtained were observed to exceed the allowable limit of 65dB (A) recommended by WHO (1999) and ISO (1996). The day-time and night-time noise levels revealed that the 65 dB (A) (day-time) and 55dB (A) (night-time) for commercial, busy road junctions and passenger loading bus stops were all exceeded. Similar trend was observed in residential areas where the 55 dB (A) (day-time) and 45 dB (A) (night-time) noise levels were all exceeded. The noise quality description of the city indicated hazardous noise levels for both day-time and night-time in commercial, busy road junctions and passenger loading bus stop, but showed good and satisfactory qualities in the residential areas for day-time and night-time, respectively. To ascertain if there is any significant differences in noise level exposure throughout the day, analysis of variance for a single factor experiment , using F- distribution was carried out on the noise descriptors (L_{10} and L_{90}) and (TNI and NPL). At 95% confidence level, the result revealed that there was significant difference in the level of exposure at different locations ($P<0.05$). This implies that the people living in the metropolis are exposed to relatively different degrees of environmental noise from road traffic which may lead to imminent health risks.*

Keywords: *Noise evaluation, different locations, WHO and ISO, Port Harcourt metropolis.*

I. Introduction

The word noise is derived from the Latin word "nausea" implying "unwanted sound". Environmental noise has been given various definitions by different authors. Defra (2003), and Anomoharan (2004), defined noise as an unwanted or harmful outdoor sound created by human activities. Ebeniro and Abumere (1999), viewed environmental noise as an unwanted acoustic signal or sound dumped into the environment without regard of its adverse effect on both man and the environment. In most cases the acoustic signal, sounds louder than normal acceptable levels.

Acceptable levels of noise have been pecked by different agencies in different countries to suit themselves. These levels have been set for institutions, busy roads junctions/major intersections in cities, residential areas, commercial, social gathering etc. Once the sound levels exceed the allowable limit, the environment is said to be noise polluted. The sensation produced as sound, passes through the ear set up by some vibrating objects. The extent, to which a given noise is annoying, depends on many factors, such as pitch, irregularities, duration, rhythm, unexpectedness or whether the noise has meaning for the particular observer. However, by far the most important factor is loudness. This loudness depends both on the physical sound pressure measured in decibels (db), and on the sensitivity of human ear which varies widely with frequency. The range of frequency the human ear responds to is from 20Hz to 20,000Hz, called the audio frequency range, below this range we have the infra-sound and above it we have ultra-sound.

Noise is generated from both indoors and outdoors. The sources of outdoor may be attributed to construction sites, road traffic, or the noise generated from aircrafts, trains, industries and factories etc (Oyedepo, 2012). Indoor noise may have sources like telephones, electrical and other appliances. The noise generated, causes noise pollution which is the third most hazardous type of pollution, right after air and water pollution in big cities (WHO, 2005). Noise pollution is a byproduct of urbanization and industrialization, vehicular traffic or increased vehicle in circulation and population, commercial activities, intrusive sounds especially from the use of public address system by churches, social gatherings, marriages and captive generation equipment. Noise is now worldwide recognized as a major problem for the quality of life in urban areas, due to increase in noise pollution, yet noise pollution has been considered less important than other contaminants in the environment (Mansouri *et al*., 2006).

Noise is a common feature in Port Harcourt metropolis which is as a result of the presence of several industrial activities going on in and around the city. The high level of noise generated by industrial plants and machineries cannot be overemphasized. Moreover, the discovery of oil and allied industries, have increased the migration of people from all walks of life to the city. This in turn has increased commercial activities, vehicular traffic and transportation problems, which are major sources of noise.

In Nigeria, however, where there are now so many innovations which increase the noise environment of the general public, the impression given is that noise is not a problem. But this is a very wrong impression; noise is indeed becoming a major problem

In contrast to many other environmental problems, noise pollution continues to grow and accompanied by an increasing number of complaints from people exposed to the noise. This growth in noise have direct as well as cumulative adverse health effects and also the quality of life enjoyed by people in most industrialized cities and urban areas all over the world (Serkan *et al*., 2009). This is not different from Port Harcourt metropolis, especially along main road arteries. Depending on its duration and volume, the effects of noise on human health and comfort are divided into four categories: physical effects, such as hearing defects which may be temporal or permanent; physiological effects, ranging from increased blood pressure(Bronzaft, 2000), irregularity of heart rhythms ; psychological effects such as disorders, sleeplessness and going to sleep late (Stanfield & Matheson, 2005).Others include irritability, stress, anxiety; and finally interference with verbal communication and reduction in working efficiency (Ahmed *et al*., 2006 and Ugwuanyi *et al*., 2004).

Despite these adverse effects of noise pollution in Port Harcourt metropolis, most people have not recognized noise as an insidious pollutant or attributed any serious physiological impacts to it; though they may consider it as a nuisance during sleeping hours. The reason for this state of affairs could be lack of sufficient knowledge of its effects on human and of dose-response relationships, as well as lack of sufficient data, especially in developing countries like Nigeria. Practical actions to limit and control the exposure to environmental noise are therefore essential so that the citizens can have a better understanding of the noise environment and sounds cape they live in.

The aim of this study is the evaluation of ambient noise levels in Port Harcourt metropolis South-South, Nigeria, and this will be achieved through the following objectives:

(1)To determine the spatial and temporal noise levels in selected sites in Port Harcourt metropolis.

(2) To investigate if there is significant difference in noise pollution levels (L_{NP}) and traffic noise index (TNI) in the selected sites.

(3).To determine the noise quality description and risk zones of the various selected sites of the city

II. Methodology

2.1 Study Area

Port Harcourt metropolis is located in the Niger Delta, south-south geopolitical zone of Nigeria. The city, lies between longitudes $6^0$55´E and $7^0$55´ E, and latitude $4^0$35´N and $5^0$10´N (Figure 1).

Port Harcourt features a tropical_monsoon_climate with lengthy and heavy rainy seasons and very short dry seasons. Only the months of December and January truly qualifies as dry season months in the city. The harmattan, which climatically influences many cities in West Africa, is less pronounced in Port Harcourt. Port Harcourt's heaviest precipitation occurs during September with an average of 367 mm of rain. December on average is the driest month of the year; with an average rainfall of 20 mm. Temperatures throughout the year in the city is relatively constant, showing little variation throughout the course of the year. Average temperatures are typically between 25 °C - 28 °C in the city

The 2006 population census put the population at 1,255,387 and projected at 1,337,800 in 2009 (Nigeria population commission, 2006).

In Port Harcourt metropolis, there are various land use patterns such as industrial, residential, commercial, road construction etc. There are a variety of road networks. These include highways of different categories, railways and waterways (seaport and jetties) and airports. The main industrial area of the city is Trans Amadi where there are clusters of industries that boost the economy of the state, while the residential areas include Port Harcourt Township known locally as "Town", G.R.A phases 1-5, Abuloma, Amadi-ama, Amadi Flats, and Borokiri.

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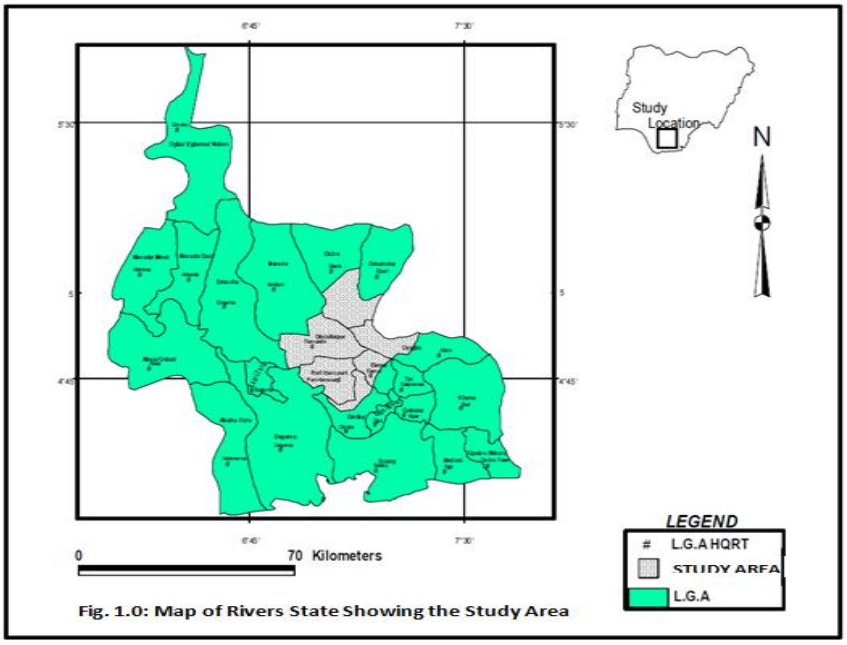

Fig. 1.0: Map of Rivers State Showing the Study Area

2.2 Experimental Procedure

Instrumentation for the field measurements consisted of integrating sound level meter which meets IEC 61672 – 1, 60651/60804 type 2 and ANSI SI.4 type 2 with frequency range and measuring level range of 31.5 Hz-8 KHz and 35 – 130 dB, respectively. The measurements were made at street level (at busy road junctions/intersections, commercial, passenger loading bus stops/parks, and residential areas), using an Extech 407780A precision or integrated digital sound level meter. The instrument was automatically calibrated to the A-weighting network and the slow response was always used. The instrument was held comfortably in hand with the microphone pointed at the suspected noise source at a distance of 1.2m above the ground level and 1.5m away from any reflecting object. However, the sites were chosen to allow for a good comparison. Measurements were taken from late December, 2014 through January, 2015 i.e for a period of two months under suitable meteorological conditions, i.e in the absence of wind and rain. The readings were taken at the precise moment, after every 30 seconds interval there was no holding back in order to obtain, for example a higher reading as a lorry passes by. The time for which measurements were taken lapsed from between 8:30am to 7:10pm. This time interval was further divided into four periods: morning (8:30am -8:40am), afternoon (1:00 pm -1:10 pm), evening (4:00 pm – 4:10pm) and night (7:00 pm – 7:10 pm). The basic type of measurement procedure employed was the sampling procedure, where the data were recorded on a data sheet/form by noting the reading on the meter every 10 minutes (sampling time). These readings included the L_{Aeq} (A-weighted instantaneous sound pressure level), statistical indicators (L_{10}, L_{50} and L_{90}) and TNI. From these readings commonly used community noise assessment quantities like the day time average sound level, L_D; night time average sound levels, $L_{N;}$ the day-night average sound level, $L_{DN;}$ and the noise pollution level, L_{NP} were computed using the appropriate formula as shown below:

$$L_{Aeq}=10\log_{10}[\frac{1}{N}\sum_{i=1}^{N}\left(anti\log\frac{L_{Ai}}{10}\right)n_i \quad (1)$$

$$L_D=10\log_{10}\left[\frac{1}{2}\left(anti\log\frac{L_{AeqM}}{10}+anti\log\frac{L_{AeqA}}{10}\right)\right] \quad (2)$$

$$L_{DN}=10\log_{10}\left[\frac{1}{24}\left(15xanti\log\frac{L_D}{10}+anti\log 9xanti\log\frac{L_N+10}{10}\right)\right] \quad (3)$$

$$L_N=10\log_{10}\left[\frac{1}{2}\left(anti\log\frac{L_{AeqE}}{10}+anti\log\frac{L_{AeqN}}{10}\right)\right] \quad (4)$$

$$L_{NP}=L_{Aeq}+(L_{10}-L_{90}) \quad \text{or} \quad L_{Aeq}+2.5\sigma \quad (5)$$

$$TNI = 4\,(L_{10}-L_{90})+(L_{90}-30) \quad (6)$$

Where;
L_{Aeq} = the A weighted equivalent sound pressure level,
L_{AeqM} = the equivalent sound pressure level for the morning measurement,
L_{AeqA} = the equivalent sound pressure level for the afternoon measurement,
L_{AeqE} = the equivalent sound pressure level for the evening measurement,
L_{AeqN}= the sound pressure level for the night time measurement,
L_N = the night time noise level,
L_D = the daytime noise level,
L_{DN} = day-night noise level,
L_{10} = the noise level exceeded 10% of the time,
L_{90} = the noise level exceeded 90% of the time,
L_{50}=the noise level exceeded 50% of the time
L_{NP} = noise pollution level,
TNI= the traffic noise index.
Source: (Saadu et al., 1998)

2.3 Statistical Techniques: Descriptive statistics of mean ± S D, coefficient of variance and Standard Error were employed to test for the validity of the method used in the evaluation. Inferential statistics of analysis of variance for a single factor experiment, using F-distribution was carried out on the various noise descriptors to determine if there was statistically a significant difference in the exposure levels of the various locations studied. All these were applied through 2007 excel package.

III. Results and Discussion

3.1 Results

Table1. Average equivalent continuous noise level (L_{Aeq}), day-time and night-time Noise levels in the monitored locations in Port Harcourt metropolis.

S/N	Monitored Locations	GPS Location	Period	L_{Aeq}	Ave	L_D	L_N	L_{DN}
1	1st Artillery(commercial)	N 04^0 84´ 83.4´´ E007^0 03´79.6´´	Morning Afternoon Evening Night	85.3 102 101 79.2	91.88	99.08	89.18	99.12
2	Rumuola(Commercial)	N04^0 49´ 58.2´´ E 007^0 00´ 16.7	Morning Afternoon Evening Night	93 100 82 81	89.75	89	81.53	95.71
3	Air force(Passenger loading bus stop)	N04^0 50´ 10.3´´ E007^0 00´58.4´´	Morning Afternoon Evening Night	93 99.2 89 91	93.05	97.12	90.11	98.49
4	2nd Artillery (Passenger loading bus stop)	N04^0 84´ 5.10´´ E007^0 04´18.8´´	Morning Afternoon Evening Night	88.31 96.5 85.2 97.3	91.83	94.51	94.23	100.07
5	2nd Artillery(Busy road junction/intersection)	N04^0 84´ 47.6´´ E007^0 04´09.0´´	Morning Afternoon Evening Night	94 98 92.1 101.2	96.32	96.45	98.51	100.47
6	Air force (Busy road junction/intersection)	N04^0 50´ 10.6´´ E007^0 01´01.5´´	Morning Afternoon Evening Night	85 98 99 100.1	95.53	95.53	99.11	100.51
7	GRA Iyaminima St (low residential)	N04^0 49´ 10.3´´ E006^{0}59´ 58.0´´	Morning Afternoon Evening Night	52.1 56.6 56 55.6	55.08	54.91	55.81	62.19
8	Orogbum crescent St (low density residential)	N04^0 49´ 09.2´´ E006^{0}59´ 50.6´´	Morning Afternoon Evening Night	57.2 58.1 60.5 61	59.20	57.67	60.76	66.84
9	Tere-ama (high density residential)	N04^0 46´ 58.4´´ E007^{0}02´ 23.3´´	Morning Afternoon Evening Night	58 58.5 63.4 64.8	61.23	58.23	64.16	70.08
10	Differi St in femie (high density residential)	N04^0 46´ 58.6´´ E007^{0}02´ 23.3´´	Morning Afternoon Evening Night	59 59.7 62.7 64.4	61.45	59.36	63.63	69.58

Source: Author's field survey, January, 2015.

Table 2: Noise quality description of monitored locations in the city

		Day time noise		Night time noise	
s/n	Locations	L_D dB(A)	Description quality	L_N dB(A)	Description quality
1	1st Artillery (commercial)	99.08	Hazardous	89.18	Hazardous
2	Rumuola (commercial)	89	unsatisfactory	81.53	Hazardous
3	Air force (passenger loading bus stop	97.12	Hazardous	90.11	Hazardous
4	2nd Artillery(passenger loading bus stop	94.51	Hazardous	94.23	Not allowed
5	2nd Artillery(busy road junction/major intersection	96.45	Hazardous	98.51	Not allowed
6	Air force(busy road junction/major intersection)	95.53	Hazardous	99.11	Not allowed
7	Iyaminima st GRA,(low density residential area)	54.91	Good quality	55.81	Satisfactory
8	Orogbum crescent st GRA,(low residential area)	57.67	Good quality	60.76	Satisfactory
9	Tere-ama, Abuloma (high density residential area)	58.23	Good quality	64.16	Satisfactory
10	Differi road, femie(high density residential area)	59.36	Good quality	63.63	Satisfactory

Table 3: Noise descriptors (TNI, LNP, NC and L_{90}, L_{50}, L_{10}) variations at different monitored locations at different time intervals.

s/n	Site locations	Morning						Afternoon						Evening						Night					
		TNI	NPL	L_{90}	L_{50}	L_{10}	NC	TNI	NPL	L_{90}	L_{50}	L_{10}	NC	TNI	NPL	L_{90}	L_{50}	L_{10}	NC	TNI	NPL	L_{90}	L_5	L_{10}	NC
1	Rumuola (commercial)	118	106	83	90	96	13	121	118	79	94	97	18	113	100	71	76	89	18	105	96	75	77	90	15
2	1stArtillery(commercia)	109	126	71	80	88	17	145	143	71	90	97	26	138	143	72	91	96	24	92	119	70	76	92	13
3	Air force Bus stop	102	105	84	90	96	12	124	119	74	92	94	20	96	103	82	87	93	14	109	106	79	87	94	15
4	2nd artillery Bus stop	121	129	71	81	91	20	137	142	75	87	98	23	105	130	75	81	90	15	124	137	74	90	94	20
5	2ndArtillery(roadjunctin)	140	119	70	83	95	25	129	139	71	89	93	22	122	134	72	85	92	20	143	144	73	90	98	25
6	Airforce(road junction)	95	97	79	82	89	12	114	113	84	94	99	15	125	118.5	79	93	98	19	114	115	84	96	99	15
7	Iyaminima st GRA (lowdensity residential)	75	67.1	45	48	60	15	66	68.6	48	51	60	12	89	75	43	49.5	62	19	66	67.6	48	54	60	12
8	Orogbum Crescent st,GRA (low density residential)	89	74.2	51	52	68	17	88	85.1	50	52.9	69	17	93	78.5	51	54.7	69	18	97	80	51	54.5	70	19
9	Tere-ama Trans-amadi. (High density residenialt)	79	72	53	54.5	67	14	88	72.5	52	55	66	14	82	78.7	56	59	70	14	81.5	74.3	53.5	61	68	14.5
10	Differi road (high density residential)	88	76	50	54.7	67	17	94	77.7	52	54.7	70	18	76	74.7	58	60.1	70	12	70	74.4	60	62.6	70	10	

Table 4. Statistical evaluation of L_{Aeq} measured at different periods of the day (n=10)

s/n	Periods of the day	**Mean ± SD**	Coefficient of variance(CV)	Standard Error(SE)
1	Morning	76.51 ± 17.5216	0.22901	5.5408
2	Afternoon	82.66 ± 21.0915	0.25516	6.6697
3	Evening	79.09 ± 16.9420	0.21421	5.3575
4	Night	79.56 ± 17.3340	0.21787	5.4815

3.2 Discussion

The equivalent continuous noise levels (L_{Aeq}), average sound levels for day-time, night-time and day-night times were all found to be higher than the permissible limit of 65dBA as prescribed by ISO (1996) and WHO (1999) Standards (Table1). Similar exceedence was observed when compared with Indian ambient noise standard, for both day and night time. These values were exceeded in the commercial, passengers loading bus stops and busy road junctions/major intersections which are in agreement with the works of Omubo-Pepple *et al.* (2010), who did a similar work in Port Harcourt metropolis. It further confirmed the statement that noise pollution in Nigerian cities is found to be relatively high when compared to recommended levels by World Health organization (WHO), and Federal Highway Administration (FHWA)(Oyedepo,2012). The result was also in agreement with previous studies on noise levels investigated in other cities of the world (Zeid *et al*., 2000; Zannin *et al*., 2002 and Li *et al*., 2002).

The observed high noise levels in the commercial areas studied, is attributed to the presence of audio musical shop, advertising their products, and the activity of a vulcanizer in the vicinity. In addition, noise emanating from a loud speaker in a church located within the vicinity, constituted an intrusive noise at the time of prayer. Again, it could be attributed largely to the closeness of the commercial centre to the main roads. In such places, there is usually traffic noise from vehicles horns, engine, speeding vehicles and traffic volume involving improper stoppages/packing of vehicles approaching the centre to buy their wares (Kumar *et al*., 2011).Similarly, there were also high noise levels in both passenger loading bus stops and busy road junctions/major intersections in the studied locations, which could be attributed to heavy road traffic volume. The intractable traffic could be slow moving (as in traffic hold-ups), or interrupted (by traffic lights or warden at a junction). Whichever is the case, the noise emanating from intractable traffic is usually high depending, of course, on the traffic volume and magnitude of commercial activity in the area. For example, at Air force passenger loading bus stop and Air force busy road junction/major intersection, in the afternoon and evening, road traffic is the major cause of the high ambient noise levels, while vehicles horns, human voices (in

conversation and bus conductors calling people), and radio from cars are the sources of intrusive noise (Paul & Fredericks, 2001).

In addition, it could be attributed to the presence of public service sectors being close to the main roads. Unal (2004), reported that heavy presence of public sectors such as schools, hospitals, parks where majority of the active population works are most times susceptible to high noise level. This is the scenario in air force junction, where most cars are parked wrongly along the road, causing other road users to improperly stop to alight and pick their children during school hours in the mornings and afternoons after school hours.

Furthermore, the total number of vehicular flow per day and the percentages of heavy vehicles also determine the noise levels in urban areas. As, the number of heavy duty trucks, buses and motor bikes increase, so also the noise levels (Calixto *et al*., 2003 and Bijay *et al*., 2013). It could therefore be inferred that high noise levels experienced at artillery busy road junction/major intersections, and air force passenger loading bus stop/parks at night, was due to the rush to get home quickly by both commuters and motorists, thereby increasing the number of vehicular flow. Hence, noise is a function of the percentage of heavy duty vehicles i.e the higher the heavy duty vehicle percentage, the higher the noise level. Other sources of noise could be urbanization or settlement pattern along the roads, increased population, industrialization, and intrusive noise from audio music shop, public address system/loud speaker from religious activity close to the junctions/bus stops. In both low and high residential areas, the L_{Aeq}, day-time, night-time and day-night time noise levels were comparably lower than those of commercial, passenger loading bus stops and major road intersection/junctions. Average noise level was lowest in low residential areas than high density residential areas. The main sources of noise are transient, such as those of cars, motorcycles, coming on site and gradually disappearing and heavy duty generators. This suggests that there is a lower acoustic energy and annoyance in this area. This could be due to the housing system, mostly in single apartment, lower traffic density and population, and absence of heavy public service sectors. However, when compared with international standards, this level is slightly above the acceptable level of 55 dB (A) (day) and 45 or 50 dB (A) (night) (Mohammed, 2009).

The high noise levels measured even in areas considered to be primarily residential area are due to the fact that, there is no strict "zoning", to define the residential, commercial, and industrial areas, thus one finds all three areas mixed up, especially the residential and the commercial.

3.2.1 Comparison of Day Time and Night Time Noise Levels with Standard

The day-time and night-time average noise levels were compared with WHO and Indian standard (Tables 2) of noise quality description for day-time and night-time duration. The results revealed that both day-time and night-time noise levels, exceeded the satisfactory index of WHO (61 – 75 dBA) and falls in the hazardous quality limit of 91 – 110dBA. It also exceeded the 65dBA (day time) and 55dBA (night) bench mark for commercial areas; similarly 55dBA (day time) and 45dBA (night time) for residential areas. This shows that these are risk zones and that the noise levels can cause physiological and psychological problems both to human and animals around that vicinity especially traffic wardens, pedestrians, residents and those doing business there (pirrera *et al*., 2010 and Graham *et al*., 2009). The high day-night noise level means that even after work, residents will still be exposed to high noise level which can lead to sleep disturbance and annoyance amongst other health problems.

To ascertain the significant differences in the noise level exposure in the locations monitored throughout the day (from morning to night time), analysis of variance for a single-factor experiment, using F-distribution was carried out on the noise descriptors (L_{10} and L_{90}). At 95% confidence level, the mean square ratio (MSR) calculated for L_{10} is 159.3707 while the tabulated value of mean square ratio is 2.6415. Similarly, at the same confidence level, the mean square ratio calculated for L_{90} is 77.2539 and the tabulated value remained the same as 2.6415. Since in the two cases, the mean square ratio (MSR) calculated is greater than the mean square ratio tabulated, the noise levels exposure differ significantly from one location to another ($P<0.05$).

Analysis of variance for single factor experiment, using F-distribution was also carried out on the other noise descriptors (TNI and NPL), to further ascertain significant differences in the noise level exposure in the entire monitored locations at the same confidence level. The mean square ratio (MSR) calculated for TNI is 16.7712 while the tabulated is 2.6415. Similarly, at the same confidence level, the mean square ratio (MSR) calculated is 30.1810 and the tabulated remaining the same as 2.6415. Since in the two cases, the mean square ratios are greater than the mean square tabulated, the noise level exposure differ significantly ($p<0.05$) from one monitored locations to another. It can be observed that there are statistically significant differences in the noise level exposure from one location to another when the above noise descriptors are used. Finally, the noise descriptors have revealed that people living in Port Harcourt metropolis are exposed to different degrees of environmental noise from road traffic (Table 2). Commercial areas and low density residential areas have the highest and lowest annoyance responses due to traffic noise respectively. It should be noted that a TNI of 74 dB (A) has been reported to be associated with less than 3% annoyance in social survey (Ahamad *et al.*, 2006).

Similarly, commercial areas have the highest NPL (142dB (A)), while low density residential areas have the lowest NPL (67.1dB (A)).

3.2.2 Method Validation

In order to validate the method used to obtain the noise levels in different periods of the day, the data were subjected to descriptive statistics (table 4). The mean ± SD, for the monitored periods were 76.51 ± 17.5216 (morning), 82.66 ± 21.0915 (Afternoon), 79.09 ± 16.9420 (evening), and 79.56 ± 17.3340 (night). The coefficient of variance were 0.22901,0.25516,0.21421 and 0.21787 for morning, afternoon, evening and night respectively; while the standard error of the morning, afternoon evening and night are 5.5408,6.6697,5.3575 and 5.4815 respectively for the measured values. The result revealed that the standard deviation, co-efficient of variance and standard error about the mean, were very small and closed to each other and comparable, indicating the accuracy of the proposed method of assessment. Validation is further confirmed by the low values of standard deviation, coefficient of variance and standard error (George *et al*.,2014), thus implying that the method used was correct, precise and simple.

IV. Conclusion.

The data obtained clearly indicates that the citizens of Port Harcourt metropolis are exposed to quite a high unacceptable noise level for both day-time and night-time, which could be interfering with a number of vital activities and may even affect health.

The continuous exposure of the citizenry to these levels of noise for a long period may impair their hearing or cause noise induced hearing loss, which may be permanent or temporal. It implies that in the nearest future, people who do business or live in the noise infested areas may go deaf apart from other health problems like insomnia. The noise exposure levels differ significantly from one location to the other and were also higher than the prescribed international standards.

The noise quality description of the city shows that the day-time noise levels were hazardous in the passenger loading bus stops, busy road junctions/major intersections, and commercial areas but, differ slightly in one of the commercial areas, where it is unsatisfactory. Similarly, there was variation in quality description of the city in the night-time. The noise generated in the commercial areas was hazardous, followed by one of the passenger loading bus stop (Air force), while the other locations all had "not allowable" noise quality. In the residential areas, both for low and high density, the day time quality is satisfactory and good at night time. Despite these descriptions, the noise levels in all the monitored sites were higher than the recommended international limit.

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