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Assessment of Noise Levels in Lafia Modern Market, Nigeria

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Abstract: *An assessment of the noise levels in Lafia Modern Market, Nigeria was done using a microprocessor digital sound level meter. All measured noise levels were found to fall within internationally prescribed safe levels though a bit higher than the 65 dB(A) noise level recommended for commercial areas.. Though noise levels differed from one region of the market to another and for the Times (periods) there was no significant difference in days. Noise levels were higher during the 12.00-14.30 period and were found to drop by 9 % during the 15.00-17.30 period Noise levels were highest at the Meat/dairy products region with the highest mean noise level of 71.49 dB(A) and least at the Cosmetics/Provision region of the Market with a mean noise level of 66.67 dB(A). Furthermore, it was discovered that noise levels were highest on Wednesday but least on Sundays being a day of rest for some traders and shoppers.*

Keywords: *Noise level, F-statistics, Noise and health implications.*

I. Introduction

Noise is a loud and unpleasant sound and an environmental pollutant [1,2]. Noise in our environment has been on the increase due to increased commercial, industrial and social activities [3] and can be disruptive and sometimes very annoying however, the fact that very high sound levels can be detrimental to our health is often ignored but reports have shown that loud sound can increase one's stress level, precipitate health issues like depression, hearing loss, high blood pressure, heart diseases [4,5], and can even affect a developing foetus [6]. In order to control sound levels in public places, Organisations such as World health organization (WHO) and other regulatory bodies like the Federal Environmental protection agency (FEPA) and the American public health agency as well as the Occupation Safety and health administration (OSHA) [7] have prescribed allowed and safe sound levels that must be adhered to in order to prevent health challenges. Though some developed countries enforce adherence to these safe noise levels the same cannot be said about under developed or developing countries like ours. One of the places where a lot of noise is generated is in Markets and its environs where shoppers and traders gather daily to buy and sell their wares. Apart from these, heavy trucks and Lorries that drop off goods for traders as well as grinding machines used for grinding grains in markets also contribute to the high noise levels experienced in our Markets. Researches to assess and evaluate noise levels and its impact in Nigerian markets have been carried out in some major Markets of Akwa Ibom State, Nigeria [8] Wurukum Market in Makurdi, Benue State, Nigeria [9] and in Ariaria Market Aba, Imo State Nigeria [10]. Similar studies have also been carried out at Trans-Amadi Market Port Harcourt, Rivers State [11] and at Kara

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market Sokoto, in Sokoto State, Nigeria [12] but since none has been done for Lafia Modern Market in Nasarawa State Nigeria, this study will do that.

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In this research, the Lafia modern market was divided into five (5) regions namely: Cosmetics & Provisions, Meat & Diary products, Clothing/Textile materials, and Kitchen Utensils & Household wares and Fruits/Veggies and five points were mapped out for each region. Two periods of the day (12.00-14.00 and 15.00-17.30) were chosen for the study which lasted for a period of 4 weeks. A microprocessor digital meter (**N228251**) held at a height of 1.5 m above the ground level was used for measuring the noise level for each point and 5 seconds after arriving at a measurement point. Obtained results have been analysed using relevant statistical tools and are as presented.

II. Materials and Methods

Materials

(i) A micro-processor digital sound level meter (**N228251**)

(ii) Laboratory Record book

Methods

This study was done for four (4) weeks (January 9th – February 5th, 2023). The Mapped out market regions were: Fruits & Veggies (A), Cosmetics & Provisions (B), Clothing/Textiles(C), Kitchen Utensils/Household wares (D), Meat & Dairy Products (E). For each region, five points which were 3 m apart were mapped out. Five days of each week namely: Sunday, Monday, Wednesday, Friday, and Saturday and two time periods (12.00 – 14.30) and (15.00 -17.30) were also chosen for the study. For each day and for each of the two periods of the day for the five regions of the Market, the mean , standard deviation (SD), maximum (Max) and minimum (Min) noise levels were obtained (Tables 1 and 2). Data obtained was analysed using F-statistics and three null hypotheses were stated. To accept or reject any hypothesis, a one- way, two- way and three- way analysis of variance (ANOVA) was conducted. Obtained results are displayed in Tables 3-9 and discussed. A bar chat for noise level variation for the two periods of each day was also plotted (Figure 1).

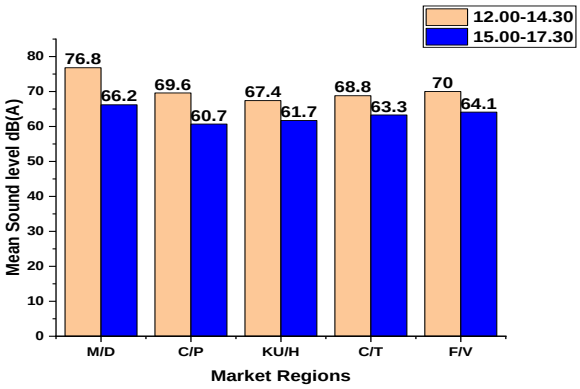
III. Results and Discussions

The mean, standard deviation as well as the maximum and minimum noise levels for each day of the week for all the mapped out regions of the market are as shown in Table 1 while Table 2 shows the mean, mean of maximum and mean of minimum sound levels in dB(A) for each region and period. Though the measured values fall below the standard safe noise level for humans as prescribed by the American public health agency which is 85 dB (A) [11,12] and 90 dB(A) prescribed by the occupation Safety and health administration (OSHA) and Federal Environmental Protection Agency (FEPA) [13] the noise levels for some regions of the market was higher than the 65 dB(A) prescribed for commercial areas [11] . The results also showed that for all of the five regions, the noise levels were higher during the 12.00-14.30 period but dropped by 8 % -9 % during the 15.00-17.30 period (Figure 1). The bar chart of the noise level variation for the two periods of each day (Figure 1) also shows that noise levels were higher during the 12.00-14.30 periods and this level dropped by 9 % during the 15.00-17.30 periods.

Table 1: Showing noise levels in dB(A) and the standard deviation (SD)for five chosen days of the week, two chosen periods of the day and for five mapped out regions of the Market

Regions	12.00 – 14.30					15.00 – 17.30			
	Days	Mean	SD	Max	Min	Mean	SD	Max	Min
A	Sun	67.5	3.41	73.2	62.4	62.9	3.11	69.8	58.4
	Mon	71.5	5.23	84.4	62.0	66.5	6.29	82.0	57.2
	Wed	71.9	3.79	80.1	64.8	63.9	4.38	75.6	68.4
	Fri	68.0	5.06	79.1	60.8	63.4	5.09	75.8	57.4
	Sat	70.9	4.62	78.1	60.8	63.6	5.83	75.9	54.3
B	Sun	65.4	5.84	75.4	52.9	61.9	4.42	72.8	55.8
	Mon	72.3	5.05	83.2	64.3	66.7	4.77	76.0	58.7
	Wed	70.5	2.59	77.5	66.5	65.3	4.26	75.4	57.7
	Fri	69.7	4.68	78.0	59.7	61.5	3.98	70.5	55.6
	Sat	70.3	4.95	79.6	60.3	63.1	5.40	76.3	55.6
C	Sun	65.9	6.37	75.6	52.1	61.5	5.02	69.8	52.8
	Mon	66.6	4.22	75.2	59.8	62.5	4.78	72.3	52.8
	Wed	70.1	4.38	80.0	63.3	64.0	3.95	71.3	57.9
	Fri	71.1	4.28	79.7	64.5	65.3	5.58	77.0	54.9
	Sat	70.1	5.15	77.5	60.8	63.3	5.30	73.1	52.2
D	Sun	65.8	3.84	71.2	58.3	62.5	3.45	70.4	58.0
	Mon	65.1	3.84	75.9	59.8	59.5	4.55	70.8	50.0
	Wed	68.2	4.46	78.0	60.9	63.6	4.82	74.8	54.2
	Fri	68.3	4.54	74.4	60.2	61.1	2.71	65.8	55.4
	Sat	69.8	5.00	77.7	60.2	61.8	4.08	72.3	55.9
E	Sun	77.1	3.75	83.8	69.0	68.4	4.45	78.6	61.2
	Mon	75.3	6.52	85.2	64.2	66.2	6.98	80.3	56.7
	Wed	78.8	4.66	83.6	66.2	66.7	3.79	73.4	59.0
	Fri	77.3	4.01	83.6	68.9	64.9	4.13	73.3	58.8
	Sat	75.4	4.72	85.1	64.0	64.8	5.27	74.9	55.7

Table 2 shows the mean noise level drop for regions A to D was in the range 5 % - 12 % with a mean sound level reduction of between 8 % and 9 % while for region E (Meat& Dairy products) the sound level drop ranged from 11% - 16 % with a mean of 14 %. The higher noise levels observed in the Meat and Dairy products region could be partly due to the large number of shoppers who visit there for their protein needs and partly due to the breaking of bones with axes and machetes.



Key: M/D→Meat/Diary; C/P→Cosmetics/provisions; KU/H→ Kitchen utensils/Hardware; C/T →Clothing/Textiles; Fruits/Veggies

Figure 1. Bar chart of Table 2 showing different market regions and their mean noise levels

Table 2: The mean, mean of maximum and mean of minimum noise levels in dB(A) for each region and period (Culled from Table 1)

	12.00 - 14.30			15.00 - 17.30		
Regions	**Overall Mean**	**Mean of Max. N.L**	**Mean of Min. N.L**	**Overall Mean**	**Mean of Max. N.L**	**Mean of Min. N.L**
Meat/Dairy	76.8	83.5	66.5	66.2	76.1	58.3
Cosmetics/Provisions	69.6	78.7	60.7	63.7	74.2	56.7
Kitchen utensils/hardware	67.4	75.4	59.9	61.7	70.8	54.7
Textiles/Clothing	68.8	78.9	60.1	63.3	72.7	54.1
Fruits/Veggies	70.0	79.0	62.2	64.1	75.8	58.9

Key: N.L → Noise level; Regions→Regions of the Market

To analyse the data (Table 1) using the F- statistics the following hypotheses were stated:
H_{01} = There is no significant relationship between noise levels and regions (location)
H_{02} = There is no significant relationship between noise levels and Days of the week
H_{03} = There is no significant relationship between noise levels and times of data collection.
In order to accept or reject the three null hypotheses stated above, a one-way, two-way and three-way analyses of variance were conducted and obtained results (Tables 3 – 9) are as follows:

Table 3: Regions

	Sum of squares	**df**	**Mean square**	**F**	**Significance**
Regions	226.019	4	56.505	3.421	0.016
Error	743.224	45	16.516		
Total	969.243	49			

The F-tabulated value with degrees of freedom (4,45) given as $F_{(4,45)} = 2.53$. From Table 3, the F-statistics is 3.421. Thus, since $F_{calculated} = 3.421$ is greater than $F_{tabulated}$ = 2.53 , we reject the null hypothesis and say that there exists a significant difference of noise levels from one region to another and that the degree of

noise levels vary from one region to another. This outcome re-affirms the P-value (0.016) from Table 3 and $0.016 < 0.05$ implies that there exists a significant difference of noise levels from region to region.

Table 4: Days

	Sum of squares	df	Mean square	F	Significance
Days	38.765	4	9.691	0.469	0.758
Error	930.478	45	20.677		
Total	969.243	49			

From Table 4, $F_{calculated} = 0.469$ while $F_{tabulated}$ = 2.53 which is also $F_{(4,45)} = 2.53$ and since $F_{calculated}$ is less than $F_{tabulated}$, we do not reject the null hypothesis and say that there is no significant difference between noise levels from one day to another. This is obvious with the P-value of 0.758 greater than the standard accepted 0.05 P-value implying that there is no significant difference in days regarding the daily noise levels recorded. This can be seen from the close mean values of the different days shown in Table 10(b).

Table 5: Time (Period of the day)

	Sum of squares	df	Mean square	F	Significance
Time	499.280	1	499.280	50.994	0.000
Error	469.963	48	9.791		
Total	969.243	49			

From Table 5, $F_{calculated} = 50.994$ while $F_{tabulated}$ using degrees of freedom (1,48) is 4.00. Furthermore, the P-value significance is 0.000 which is less than 0.05 implying that there exists a significant difference in noise levels with respect to periods (Times) of the day. This implies that measured noise levels vary with the periods of the day and as can be seen from Table 2,there exists a 9 % difference in noise levels during 12.00 – 14.30 and 15.00 – 17.30 periods.

Table 6: Regions and Days

Source	Sum of squares	df	Mean square	F	Significance
Regions	226.019	4	56.505	3.289	0.020
Days	38.765	4	9.691	0.564	0.690
Error	704.459	41	17.182		
Total	227810.780	50			

Table 6 shows a two-way ANOVA table of regions and Days. The F-statistics for Regions was 3.289 while that for Days was 0.564. These when compared to the $F_{tabulated}$ $F_{(4,41)} = 2.53$ implies that there exists a significant difference in noise levels from one region of the market to another while there is no significant difference in noise levels with respect to days. This is affirmed with the P-value of $0.690 > 0.05$

Table 7: Regions and Time (Periods of the day)

Source	Sum of squares	df	Mean square	F	Significance
Regions	226.019	4	56.505	10.192	0.000
Times	499.280	1	499.280	90.055	0.000
Error	243.944	44	5.544		
Total	227810.780	50			

Table 7 shows the two-way ANOVA for Regions and Times (Periods of the Day) for noise level comparison. $F_{calculated}$ for Regions is 10.192 while $F_{calculated}$ for Times is 90.055. But $F_{tabulated}$ $F_{(4,44)} = 2.53$ and

$F_{tabulated}$ $F_{(1,44)} = 4.00$ and since both calculated values of F for both regions and Times are greater than $F_{tabulated}$ for both Regions and Times, it can be concluded that there exists significant differences in noise levels with respect to Regions and Times. Hence there is a variation of measured noise levels with Regions of the Market as well as Times (Periods of the Day).

Table 8: Days and Periods of the day (Time)

Source	Sum of squares	df	Mean square	F	Significance
Days	38.765	4	9.691	0.989	0.424
Times	499.280	1	499.280	50.947	0.000
Error	431.198	44	9.800		
Total	227810.780	50			

Table 8 shows the two-way ANOVA for sound levels with respect to Days and Times (Periods of the day). $F_{calculated}$ for days is 0.989 while . $F_{calculated}$ for times is 50.947. Furthermore, $F_{(4,44)}$ =2.53 and $F_{(1,41)} = 4.00$ which when compared with the calculated F-statistics implies that only F-statistics for times is greater than 4.00 and hence the noise levels with respect to times are significant while for days the noise levels are not significant. The significant P-value for days = 0.424 > 0.05 implying that there is no significant difference in noise levels for days but there exists a great difference in times(periods of the days).

Table 9: Regions, Days and Time (Periods of the day)

Source	Sum of squares	df	Mean square	F	Significance
Regions	226.019	4	56.505	11.016	0.000
Days	38.765	4	9.691	1.889	0.131
Times	499.280	1	499.280	97.336	0.000
Error	205.179	40	5.129		
Total	227810.780	50			

Table 9 shows a three-way ANOVA for Regions, Days and Times (periods of the day). From the column of significant P-values, Regions and Times source values are 0.000 each showing a significant relationship between sound levels with respect to Regions and Times, while that of days is 0.131 > 0.05. This implies that there is no significant difference in noise levels with respect to days. These can also be expressed using the F-statistics of 11.016 and 97.336 respectively for Regions and Times which are greater than $F_{tabulated}$ of 4.08. $F_{calculated}$ for days is 1.889 less than $F_{tabulated}$ of 2.61 showing that there is no significant difference noise levels with respect to days.

The descriptive output result shown as output for Regions (Table 10 a) shows that the highest mean noise level obtained was 71.49 dB(A) for the Meat/Dairy products region at 95 % confidence interval of between 67.38 dB(A) and 75.60 dB(A). This implies that there exists a significant degree or measure of the highest noise level at the Meat/Dairy product region with a mean value of 71.49 dB (A). This is competitively followed by the Fruits/Veggies Region, and then the Cosmetics/Provision Region with mean values of 67.01dB(A) and 66.67 dB(A) respectively, while the Clothing/Textiles region and the Kitchen utensils/Hardware presented the least mean sound levels of 66.04 dB(A) and 65.57 dB(A) respectively. Therefore the Meat/Dairy Region as well as the Fruit/Veggies had mean values of noise levels above the mean of means.

Table 10(a): Descriptive for Regions

REGIONS	N	Mean	Std. Deviation	Std. Error	95 % Confidence interval for Mean		Min.	Max.
					Lower	Upper Bound		

					Bound			
A	10	67.0100	3.52624	1.11509	64.4875	69.5325	62.90	71.90
B	10	66.6700	3.86496	1.22221	63.9052	69.4348	61.50	72.30
C	10	66.0400	3.40366	1.07633	63.6052	68.4748	61.50	71.10
D	10	65.5700	3.25715	1.03000	63.2400	67.9000	61.10	69.80
E	10	71.4900	5.74581	1.81698	67.3797	75.6003	64.80	78.80
Total	50	67.3560	4.44752	0.62897	66.0920	68.6200	61.10	78.80

The descriptive output for noise levels with respect to the days (Table 10 b) shows that Wednesdays are the noisiest days with mean noise level of 68.30 dB(A) followed by Mondays with mean score of 68.22 dB(A) than those of Saturdays and Fridays with mean values of 67.31 dB(A) and 67.06 dB(A) respectively and lastly Sundays with mean value of 65.89 dB(A). The analysis shows that the noise levels are always highest on Wednesdays followed by Mondays, then Saturdays and Fridays with Sundays being the day with the least noise level which is obvious as most shops are closed for business on Sundays.

Table 10(b): Descriptive for Days

DAYS	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95 % Confidence interval for Mean**		**Min.**	**Max.**
					Lower Bound	**Upper Bound**		
SUN.	10	65.8900	4.59987	1.45461	62.5995	69.1805	61.50	77.10
MON.	10	68.2200	3.85279	1.21836	65.4639	70.9761	62.50	75.30
WED.	10	68.3000	4.74693	1.50111	64.9043	71.6957	63.60	78.80
FRI.	10	67.0600	4.92346	1.55693	63.5380	70.5820	61.10	77.30
SAT.	10	67.3100	4.53981	1.43561	64.0624	70.5576	61.80	75.40
Total	50	67.3560	4.44752	0.62897	66.0920	68.6200	61.10	78.80

Table 10(c): Descriptive for Times

TIME	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95 % Confidence interval for Mean**		**Min.**	**Max.**
					Lower Bound	**Upper Bound**		
12.00-14.30	25	70.5160	3.83489	0.76698	68.9330	72.0990	65.10	78.80
15.00-17.30	25	64.1960	2.20803	0.44161	63.2846	65.1074	61.10	69.50
Total	50	67.3560	4.44752	0.62897	66.0920	68.6200	61.10	78.80

The descriptive output result for the times (Table 10c) when these noise levels were collated reveals that between 12.00 -14.30, the noise levels mean value is 70.52 dB (A) while between 15.00 – 17.30 the mean noise level dropped to 64.20 dB(A). Thus, between 12.00 – 14.30 there is a higher degree of noise level when compared to between 15.00 – 17.30 and during the evenings about 8.97 % drop in the noise level occurs. This means that 8 % to 9 % of the level of noise reduces as the day approaches the evenings probably because many of the traders and the shoppers have left the Market after carrying out their business transactions for the day.

IV. Conclusion

Noise levels assessment was carried out for Lafia Modern market and it was observed that the noise levels for all regions of the market fall within internationally acceptable levels though in some regions of the market they were slightly higher than what is recommended for commercial areas. Noise levels were found to differ from region to region with the Meat/Dairy products region recording the highest mean maximum noise level of 76.1 dB (A) but there was no significant difference in noise levels in days. The higher noise levels observed in the Meat/Dairy products region could be due to the use of axes/ machetes for breaking large animal bones. The use of electric meat cutting machines should be introduced to minimize the noise levels in this region.

A higher degree of noise exists between 12.00-14.30 than between 15.00-17.30 with a drop of 9 % in noise as the day approaches the evenings when some traders and shoppers may have finished their transactions for the day and left. The analysis shows that the noise levels are always highest on Wednesdays (midweek) followed by Mondays, then Saturdays and Fridays with Sundays being the day with the least noise level which is obvious as most shops are closed for business on that day.

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