Environmental Noise Attenuation in Port Harcourt Metropolis Using Fences

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Abstract: - **Whenever environmental pollution is mentioned, what comes to the mind of individuals, scholars and other concerned groups, are water, land and air pollution. Environmental noise as a form of pollution has always been downplayed in some countries while fences, buffer zones, acoustic panels, noise regulations were considered as measures to check noise pollution in other countries. Excessive noise often diminishes the quality of life for people who live in cities. This has resulted in the use of noise barriers as a means of reducing noise effect especially among busy route urban dwellers. The situation is not different as urbanization and human economic activities accelerating noise level has also increased. This has led to the adoption of possible measures to check noise i.e building of fences as barrier against the sound (noise) wave concerted effort is required to check and recommend the most preferred fences types that would attenuate noise level. The digital noise meter (EXTECH) instrument 'Digital Sound level Meter with RS232' was used to measure noise level in decibels dBA. Measurement also involved the use of measuring tape and digital camera. It is therefore recommended that most appropriate fences for noise attenuation be used in the bid to attenuate noise. Major findings of this work are that: different fences attenuate noise at different rate in decibel (dBA) and that some fences i.e half block and iron crossed bars do not attenuate noise significantly.**

Key Words: **Environment, Attenuation, Noise, Urbanization, Fences, Pollution**

I. INTRODUCTION

Excessive noise can impair hearing, and may also put stress on the heart, the circulatory system, and other parts of the body. Worker exposure to excessive noise over an extended period may result in a permanent loss of hearing. The introduction of a noise source into a given environment can be potentially hazardous, as well as objectionable to nearby tenants and residents – depending on its sound level. Numerous laws have been enacted at both national and local government levels to limit excessive noise. Such regulations are typically grouped together based upon the landuse characteristics and the proximity to residential or other sensitive areas. The failure of these laws if enacted in developing countries has resulted in the adoption of private measures either consciously or unconsciously to mitigate the impact of these noise. These measures include among others the building of fences as a barrier against unwanted sound (noise). The fence barrier is aimed at coming in-between the noise situation which involves a system composed of three basic elements of source, path and the receiver.

Rapid growth of cities has a spatial and socio-economic implication which provides the basis for social and environmental research. For instance, the increasing size and the high population density of urban centres, has exposed urban dwellers to the problems of environmental pollution such as environmental noise, which is a type of pollution not seen but heard. From day to day, our environment seems to be getting louder due to increased sound of varying intensities ranging from noise of cars, busses, trucks, generating plants. Environmental noise in and around buildings, communities where people live and work has gradually and steadily increased in magnitude and diversity especially as civilization advances. In most cases, huge efforts and great sum of money are often invested to solve this problem, but the Problem persist even in area where extensive resources have been used for regulating, assessing and dampening noise source or for creation of noise barriers which is evident everywhere. The proliferation of traffic way in many cities especially Port Harcourt metropolis is a landmark that there is increasing noise level across urban centers unawareness of noise control measures among individuals, industries in the country. Residential buildings near the traffic way are putting up abatement measures to control noise thus engineers and architects are developing noise barriers that are aesthetically pleasing to both motorist along the traffic way and the passer-by on the other side of these barriers. The number of urbanization affected by environmental noise is increasing and conditions are worsening because of the high rate of urban growth and the incapacity of related authorities such as government, private institution to provide adequate solutions. Excessive noise very often diminishes the quality of life for people who live in these cities.

To achieve a meaningful reduction in noise, one must start with accurate information about the source. Effective noise barrier can reduce noise level from source, thus there is need to investigate the problem of environmental noise in Port Harcourt sequel to the fact that noise output varies in accordance to the source, the degree of transmission, absorption, reflection of noise by barrier walls. Therefore the investigation of the environmental noise attenuation level of different fence types in Port Harcourt form the central focus of this study.

Study Area: Port Harcourt Metropolis is located in the south-south part of Nigeria, which stretches within latitude 4^0 44' 58.888''N and 4^0 56' 4.625'' through longitude 6^0 52' 7.231''E and 7^0 7' 37.749''E. However the metropolis encompasses; Port Harcourt, Obio Akpor Local Government Area; It had a humble beginning as a fishing settlement with an initial population of 5000 persons. The city is on a firm ground 66Km from the Atlantic Ocean. At its inception, the city limit extended from UTC junction to new layout market. Consequent on rapid industrial and commercial growth of the city in the 1960s, Port Harcourt expanded to include other settlements at its outskirt. Relief of the study area is undulating in other words the high and low lands, which characterized a place. Hence, Port Harcourt is dominated by low lying coastal plains, which structurally belongs to the sedimentary formation of the recent Niger Delta, with an elevation less than 15.24m (Oyegun et al 1999). The low relief of the region results in strikingly gentle slope, which have the effect of making the flow velocity of the rivers very low. This situation results in the formation of well-developed rivers meanders.

The southwest wind transport s its moisture to the region. It blows trough Port Harcourt between the months of February through November. During this period, the region receives its rain. The North East trade wind blows through the Sahara desert passes through Port Harcourt between the months of November through February. During this period Port Harcourt experiences dry season. The two winds meet at the inter-tropical convergence zone (ITCZ) when the contact is on land and inter-tropical discontinuity (ITD) when the contact is over the ocean. Port Harcourt is endowed with abundant of sunshine because its location is close to the equator. Though the amount of solar radiation received at the surface is substantially reduced due to cloudiness caused by the coastal location, which also induced slight diurnal, monthly and annual variation in the temperature of Port Harcourt over 33^0c.

The landuse and vegetation map of the study area drawn from satellite imagery in 1976 shows that the total built up area/space of the city and its environment was only 16.25Km^2 . By 1995, an updated edition of same map showed that the built-up area of the region had increased to 282.25Km^2 ,indicating that the size of the city has increased by seventeen times in two decades (Oyegun et al 1999). This shows that the city and its region have witnessed an unprecedented growth. For instance, the traffic volume or trip generated by an area will depend on the intensity of activities in the attracting centre and difficulty of travelling to the centre. Population size of Port Harcourt metropolitan area according to the 2006 census was put at 703,416 persons comprising 369,212 males and 324,204 females (NPC, 2006).

II. MATERIAL AND METHODS

The target population is all fences in Port Harcourt metropolis. The study area is an urban centre with increased land use activities. The study population is made up of all fences erected in Port Harcourt metropolis probably aimed at noise attenuation. The selection of sample was done using simple random sampling technique to ensure equal representation and chances of selecting each fence types. The data on noise level was collected with the use of a noise meter (Digital Sound Level Meter) and metric tape to obtain distance from the fence to Noise source. The fences selected were then classified in accordance to types for the purpose of analysis. The tape was used to ensure equidistance in all sampled measurement. For instance, measurements were taken at a specific distance behind the fence (at the receiver's side) and at a specific distance from the noise source. This is taken to ensure specific distance applicable to all measurements and readings using the tape. Hence, sound level in decibel was measured using the noise meter at 4ft from the ground to avoid ground effect (sound reflectance or absorption by the ground), 8ft from the noise source and 2ft near (outside the fence at the noise side) and from the barrier at the receiver end (behind the barrier) averaging was done by recording the level exceeding continuous sound level (Leg) using the sound meter.

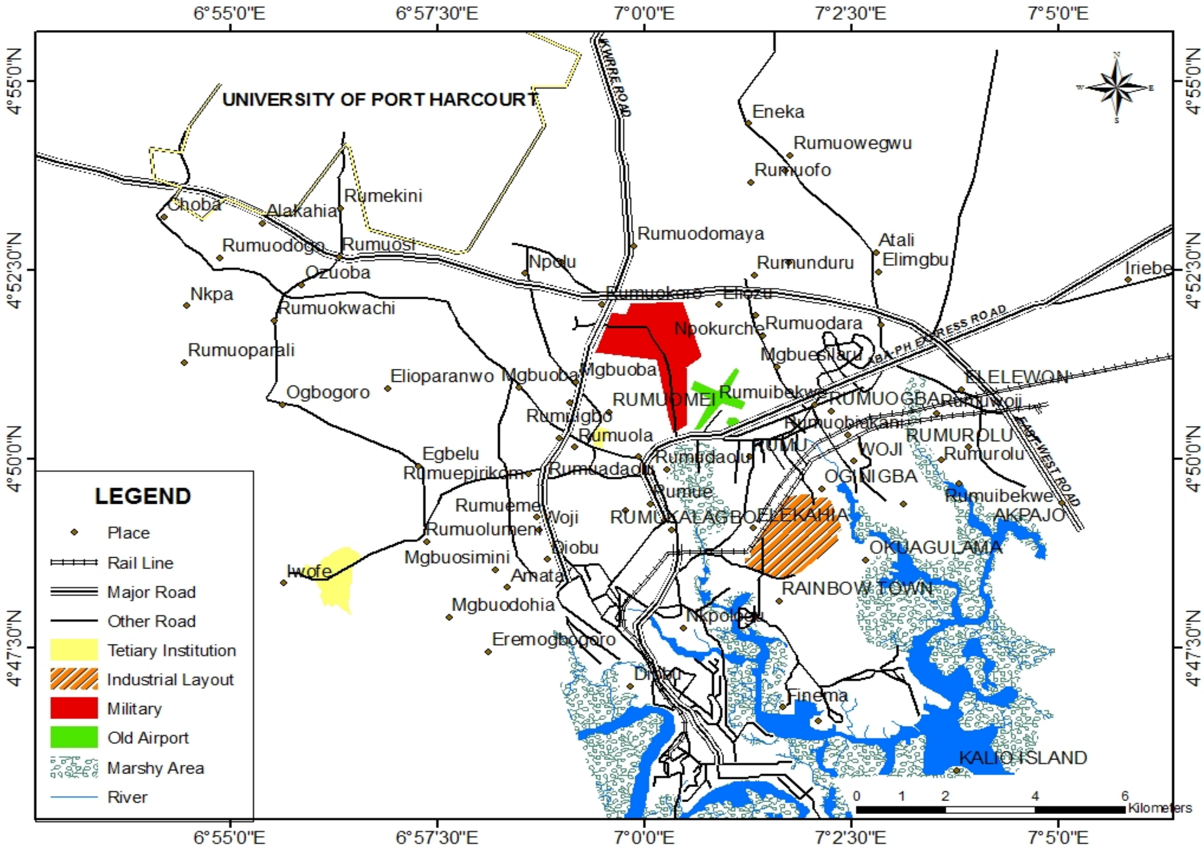

Figure 1 Study Area

III. RESULTS AND DISCUSSION

The relationship between noise attenuation ability of each fence types at 95% confidence level was tested using the student t test.

Table 1. Measured Noise Level in dBA for Zinc Fence

	Zinc Fence (dB)	
	measured at source and	**Measured 2 ft from barrier at receiver end**
1	82.98	70.2
2	81.8	69.4
3	80.4	68.2
4	82.3	69.2
5	89.2	60.1
6	87.2	70.2
7	78.4	60.4
8	79.2	71.5
9	89.2	60.2
10	81.6	70.1
11	88.1	70.4
12	77.4	70.1
13	76.2	69.2
14	74.1	60.2

15	90.7	70.1
16	70.1	70
17	83.1	71.6
18	80.5	71.9
19	81.3	72.1
20	80.7	61.2
21	80.2	60.1
22	89.4	70.1
23	80	69.8
24	84.6	69.3
25	88.2	71.2
26	80.1	66.7
27	80.2	70.8
28	80.2	70.5
29	85.9	65.3
30	90	62.3
31	80.2	69.21
	82.37032258	67.82612903

Table 2: Sample Analysis Testing for Zinc Fence.

Group Statistics

Samples		N	Mean	Std. Deviation	Std. Error Mean
Noise_Level_measured_in_dB_Zinc_Fence	Noise level at Source	31	82.3703	4.92673	.88487
	Noise level behind barrier at receivers end	31	67.7939	4.16560	.74816

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Noise_Level_measured_in_dB_Zinc_Fence	Equal variances assumed	.397	.531	12.579	60	.000	14.57645	1.15877	12.25858	16.89433
	Equal variances not assumed			12.579	58.386	.000	14.57645	1.15877	12.25726	16.89565

Noise level were measured at two points, first is the source point and another point at the receivers end (behind the zinc barrier). The mean test of the samples reveals a mean value of 82.3703 (dB) for noise level measured in decibel at source and 67.793 (dBA) for noise level measured in decibel at receivers end (behind the zinc barrier).

To determine if the mean of the noise level at source and that of the receivers end is significantly different, we looked at the equality of means. The t – value observed gave a value of 12.579 with a degree of freedom (df) of 60 and a p - (significant) value of 0.00. The p - value of 0.00 is less than 0.05 which means that there is a significant difference between the noise level measured in decibel at source and that measured in decibel at the receivers end (behind the zinc barrier).

This implies that the zinc fence attenuates noise significantly as shown at 60 df and by the t – observed value of 12.579 with a p – value of 0.000.

Table 3. Measured Noise Level in dBA for Nalf Block and half Iron/metal cross bar Fence

	Nalf Block and half Iron/metal cross bar	
	in decibel at source	**in decibel at receiver end**
	(2ft to barrier	**(2ft from barrier)**
1	78.4	78.4
2	76.9	76.9
3	86.9	86.5
4	89.2	89
5	87.3	87.1
6	77.3	77.3
7	94.9	94.5
8	94.1	94.1
9	90.5	90.4
10	80.2	80.1
11	85.8	85.3
12	84.5	84.1
13	84.9	84.2
14	88.8	88.8
15	87.3	86.1
16	86.4	86.3
17	92.2	91.8
18	94.2	93.5
19	91.2	91.1
20	90.3	90.2
21	79.8	79.4
22	90.4	90.1
23	91.2	91.1
24	93.2	93.1
25	96.8	96.4
26	89.6	89.2
27	86.1	86
28	87.6	86.2
29	89.6	89.1
30	83.2	83
31	90.1	80
	87.70645161	87.07419355

Table 4: Sample Analysis Testing for Half Block and Half Iron Cross Bars

Group Statistics

Samples		N	Mean	Std. Deviation	Std. Error Mean
Noise_Level_measured_in_dBA_Half_block_metal/iron_crossbar_Fence	Noise level at Source	31	87.7065	5.19069	.93228
	Noise level behind barrier at receivers end	31	87.0742	5.29666	.95131

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Noise_Level_measured_in_dBA_Half_block_metal_crossbar_Fence	Equal variances assumed	.075	.786	.475	60	.637	.63226	1.33196	-2.03207	3.29658
	Equal variances not assumed			.475	59.976	.637	.63226	1.33196	-2.03209	3.29660

Noise level were measured at two points, first is the source point and another point at the receivers end (behind the Half Block and Half metal/iron crossed bar fence barrier). The mean test of the samples reveals a mean value of 87.7065 (dBA) for noise level measured in decibel at source and 87.0742 (dBA) for noise level measured in decibel at receivers end (behind the Half Block and Half metal/iron crossed bar fence barrier).

To determine if the mean of the noise level at source and that of the receivers end is significantly different, we looked at the equality of means. The t – value observed gave a value of 0.475 with a degree of freedom (df) of 60 and a p - (significant) value of 0.637. The p - value of 0.637 is greater than 0.05 which means that there is no significant difference between the noise level measured in decibel at source and that measured in decibel at the receivers end (behind the Half Block and Half metal/iron crossed bar fence barrier).

This implies that the Half Block and Half metal/iron crossed bar fence does not attenuate noise significantly as shown at 60 df and by the t – observed value of 0.475 with a p – value of 0.637

Table 5. Measured Noise Level in dBA for Plastered Block Fence

	PLASTERED BLOCK FENCE	
	in decibel at source	in decibel at receiver end
	(2ft to barrier	(2ft from barrier)
1	88.5	50.1
2	87.2	49.5
3	89.3	59.4
4	87.5	66.3
5	80.2	65.2
6	74.5	60.3
7	70.1	58.7
8	84.3	66.2
9	83.1	63.4
10	83.2	68.4
11	83.5	68.3
12	78.2	55.2

13	83.6	69.3
14	83.2	69.4
15	88.1	43.2
16	88.9	60.2
17	89.3	63.4
18	90.4	68.7
19	83.9	45.2
20	86.2	60.1
21	79.8	62.1
22	81.6	69
23	90.2	70.2
24	91.2	41.2
25	60.2	50.3
26	70.1	50.1
27	78.9	51.3
28	74.5	47.1
29	70.2	49.2
30	7.01	40.2
31	69.2	40.2
	79.22935484	57.46451613

Table 6: Sample Analysis Testing for Plastered Block Fence

Group Statistics

Samples		N	Mean	Std. Deviation	Std. Error Mean
Noise_Level_measured_in_dBA_ Plastered_block_Fence	Noise level at Source	31	79.2294	15.42798	2.77095
	Noise level behind barrier at receivers end	31	57.4645	9.88529	1.77545

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Noise_Level_measured_i n_dBA_Plastered_block_ Fence	Equal variances assumed	.020	.889	6.614	60	.000	21.76484	3.29095	15.18195	28.34773
	Equal variances not assumed			6.614	51.080	.000	21.76484	3.29095	15.15822	28.37145

Noise level were measured at two points, first is the source point and another point at the receivers end (behind the plastered block fence barrier). The mean test of the samples reveals a mean value of 79.2294 (dBA) for noise level measured in decibel at source and 57.4645 (dBA) for noise level measured in decibel at receivers end (behind the plastered block fence barrier).

To determine if the mean of the noise level at source and that of the receivers end is significantly different, we looked at the equality of means. The t – value observed gave a value of 6.614 with a degree of freedom (df) of 60 and a p - (significant) value of 0.00. The p - value of 0.00 is less than 0.05 which means that there is a significant difference between the noise level measured in decibel at source and that measured in decibel at the receivers end (behind the plastered block fence barrier).

This implies that the plastered block fence attenuate noise significantly as shown at 60 df and by the t – observed value of 6.614 with a p – value of 0.000.

Table 7. Measured Noise Level in dBA for Un-Plastered Block Fence

	UN-PLASTERED BLOCK FENCE	
	in decibel at source	**in decibel at receiver end**
	(2ft to barrier	**(2ft from barrier)**
1	80.1	60.2
2	82.3	65.2
3	70.2	63.4
4	74.7	68.9
5	79.2	65.2
6	81.3	68.9
7	85.9	65.1
8	85.4	63.1
9	86.9	69.1
10	81.5	63.1
11	85.1	41.3
12	76.1	43.1
13	91.2	41.5
14	87.4	63.1
15	88.9	62.1
16	91.4	55.1
17	80.6	59.3
18	68.7	50.8
19	80.1	65.3
20	82.1	61.2
21	80.1	53.6
22	81.3	43.9
23	80.2	50.1
24	85.6	40.1
25	91.4	41.2
26	71.2	58.1
27	85.9	51.2
28	82.2	45.2
29	71.5	51.2
30	80.3	48.1
31	76.5	42.1
	81.46129032	55.47741935

Table 8: Sample Analysis Testing for Un-plastered Block fence

Group Statistics

Samples		N	Mean	Std. Deviation	Std. Error Mean
Noise_Level_measured_in_dBA_Un_Plastered_block_Fence	Noise level at Source	31	81.4613	6.07507	1.09111
	Noise level behind barrier at receivers end	31	55.4774	9.72196	1.74612

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Noise_Level_measured_in_dBA_Un_Plastered_block_Fence	Equal variances assumed	15.341	.000	12.620	60	.000	25.98387	2.05899	21.86527	30.10247
	Equal variances not assumed			12.620	50.329	.000	25.98387	2.05899	21.84893	30.11881

Noise level were measured at two points, first is the source point and another point at the receivers end (behind the un-plastered block fence barrier). The mean test of the samples reveals a mean value of 81.4613 (dBA) for noise level measured in decibel at source and 55.4774 (dBA) for noise level measured in decibel at receivers end (behind the un-plastered block fence barrier).

To determine if the mean of the noise level at source and that of the receivers end is significantly different, we looked at the equality of means. The t – value observed gave a value of 12.620 with a degree of freedom (df) of 60 and a p - (significant) value of 0.00. The p - value of 0.00 is less than 0.05 which means that there is a significant difference between the noise level measured in decibel at source and that measured in decibel at the receivers end (behind the un-plastered block fence barrier).

This implies that the un-plastered block fence attenuate noise significantly as shown at 60 df and by the t – observed value of 12.620 with a p – value of 0.000.

Table 9. Measured Noise Level in dBA for Half Block and Half Zinc Fence

	HALF BLOCK AND HALF ZINC FENCE	
	in decibel at source	**in decibel at receiver end**
	(2ft to barrier	**(2ft from barrier)**
1	76.7	59.1
2	87.1	69.2
3	85.8	62.3
4	76.2	65.4
5	86.9	64.3
6	86.9	60.1
7	89.4	67.2
8	78.3	74.8
9	85.3	63.3
10	69.3	60.1
11	78.9	68.9
12	72.3	65.3

13	85.9	65.1
14	84.6	76.5
15	81.2	63.2
16	83.5	65.4
17	85.3	76.3
18	86.6	78.9
19	84.8	74.1
20	89.6	74.6
21	78.2	76.5
22	91.6	60.2
23	82.9	61.2
24	79.8	60.2
25	86.5	65.3
26	84.9	60.1
27	80.2	60.7
28	81.2	61.2
29	81.3	68.2
30	78.6	65.1
31	98.3	40.1
	83.16451613	65.57741935

Table 10: Sample Analysis Testing for Half Block and Half Zinc Fence

Group Statistics

Samples		N	Mean	Std. Deviation	Std. Error Mean
Noise_Level_measured_in_dBA_ Half_Block_half_Zinc_Fence	Noise level at Source	31	83.1645	5.76637	1.03567
	Noise level behind barrier at receivers end	31	65.5774	7.59108	1.36340

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper
Noise_Level_measured_in_d BA_Half_Block_half_Zinc_ Fence	Equal variances assumed	.691	.409	10.272	60	.000	17.58710	1.71215	14.16228	21.01191
	Equal variances not assumed			10.272	55.974	.000	17.58710	1.71215	14.15721	21.01699

Noise level were measured at two points, first is the source point and another point at the receivers end (behind the Half Block and half Zinc fence barrier). The mean test of the samples reveals a mean value of 83.1645 (dBA) for noise level measured in decibel at source and 65.5774 (dBA) for noise level measured in decibel at receivers end (behind the Half Block and half Zinc fence barrier).

To determine if the mean of the noise level at source and that of the receivers end is significantly different, we looked at the equality of means. The t – value observed gave a value of 10.272 with a degree of freedom (df) of 60 and a p - (significant) value of 0.00. The p - value of 0.00 is less than 0.05 which means that there is a significant difference between the noise level measured in decibel at source and that measured in decibel at the receivers end (behind the Half Block and half Zinc fence barrier).

This implies that the Half Block and half Zinc fence attenuate noise significantly as shown at 60 df and by the t – observed value of 10.272 with a p – value of 0.000.

Table 11. Measured Noise level in dBA for Brick Fence

	Brick Fence	
	in decibel at source	in decibel at receiver end
	(2ft to barrier	(2ft from barrier)
1	79.3	64.6
2	78.8	55.5
3	74.8	51.8
4	75.6	60.1
5	74.8	50.4
6	78.9	50.6
7	79.8	60.2
8	90.4	60.2
9	75.1	65.4
10	73.5	65.2
11	75.6	60.2
12	84.5	59.8
13	89.5	56.3
14	75.6	61.4
15	73.2	67.4
16	70.1	59.1
17	84.5	54.1
18	70.1	59.4
19	79.8	50.1
20	78.3	53.9
21	78.2	54.7
22	74.1	58.3
23	79.3	51.2
24	71.2	53.1
25	84.6	59.6
26	85.9	54.6
27	89.4	54.4
28	69.2	58.9
29	63.5	57.6
30	75.8	54.5
31	78.4	54.3
	77.8	57.31935484

Table 12: Sample Analysis Testing for Brick Fence

Group Statistics

Samples		N	Mean	Std. Deviation	Std. Error Mean
Noise_Level_measured_in_dBA_Brick_Fence	Noise level at Source	31	77.8000	6.28506	1.12883
	Noise level behind barrier at receivers end	31	57.3194	4.65764	.83654

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Noise_Level_measured_in_dBA_Brick_Fence	Equal variances assumed	1.264	.265	14.577	60	.000	20.48065	1.40501	17.67021	23.29108
	Equal variances not assumed			14.577	55.316	.000	20.48065	1.40501	17.66530	23.29599

Noise level were measured at two points, first is the source point and another point at the receivers end (behind the brick fence barrier). The mean test of the samples reveals a mean value of 77.8000 (dBA) for noise level measured in decibel at source and 57.3194 (dBA) for noise level measured in decibel at receivers end (behind the brick fence barrier).

To determine if the mean of the noise level at source and that of the receivers end is significantly different, we looked at the equality of means. The t – value observed gave a value of 14.577 with a degree of freedom (df) of 60 and a p - (significant) value of 0.00. The p - value of 0.00 is less than 0.05 which means that there is a significant difference between the noise level measured in decibel at source and that measured in decibel at the receivers end (behind the brick fence barrier).

This implies that the brick fence attenuate noise significantly as shown at 60 df and by the t – observed value of 14.577 with a p – value of 0.000.

IV. CONCLUSION

It could be deduced from the analysis that half block and iron/metal crossed bar made fences, does not attenuate noise. Other fences sampled attenuate noise adequately**.** Sequel to the spatio-temporal changes in the landuse of the study area and its effects on noise generation, there should be adequate regulations to controlling noise emission level. This measure can be attained by the use of permanent noise monitoring system, which could ensure automatic round-the-clock data acquisition. Frantic efforts should be put in place to avoid the justification of land use and unnecessary erecting of fences which may reduce aesthetic quality of the urban environment.

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Competing Interests

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