

A Study of Sources And Control of Environmental Noise Pollution on Selected Areas of osogbo, the Capital of osun State Nigeria.

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Abstract: Climate change and its negative environmental challenges to humanity has for decades taken the centre stage globally, receiving attentions on ways to take care of the menace and keep the damaging effects to manageable and tolerable level. However, noise pollution, another major environmental hazard militating against human habitation particularly in the developing countries of the world, is not receiving enough attention by the concerned authorities at all tiers of governance. This paper seeks to identify the major sources of noise in the built environment in selected study areas of Osogbo, the Osun State Capital of Nigeria. Also, levels of sound intensity (dB) in selected buildings in the study areas were measured over a period of time. The average noise intensity levels so obtained were compared with the internationally acceptable standard suitable for human healthy living. The paper adopted a combination of survey and empirical research methods of data collection in the study areas. It was found that noise from vehicular and pedestrian traffic, commercial activities such as advertising vendors and religious buildings (Churches and Mosques) constitute major causes of noise in the study area. The average noise intensity (dB) obtained internally and externally from the selected buildings in the study areas is far above the acceptable international standard for healthy living, hence the various hazards and the socio/economic problems prevalent in the study areas. The paper recommends some measures to the affected stakeholders, particularly government agencies on means of reducing to tolerable level effects of problems associated with noise pollution.

Keywords: Built Environment, Climate Change, Environmental Pollution, Noise.

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I. Introduction

There are several simple definitions of Noise by different authors and sources as captured below. What is common to all are the negative, disturbing and disease generating effects of noise to humanity. Wikipedia, (2010) defined noise pollution as a displeasing human, animal or machine-created sound that disrupts the activity or balance of human or animal life. Ogunsote (1991) also described it as an unwanted or damaging sound which interferes with human activities with resultant effects on their health and safety. Microsoft Encarta (2007) defines environmental noise pollution as the exposure of people or animals to levels of sound that are annoying, stressful, or damaging to the ears. A typical natural environment devoid of human presence consists of plants and animals ecosystem, usually with other natural elements like mountain and water bodies (springs, rivers & lakes) in balanced proportions. The environment is naturally serene with intermittent sound from the singing birds, rustling leaves of plants, the calls by animals and natural booming of thunder storm during raining season. They do combine together to break the serenity of the environment albeit at insignificant level. The intervention of humans into the ecosystem do herald all forms of pollution to the environment through his numerous science aided modern, civilized ways of life, like means of transportation, communication, and industrialization. In essence, we can say that all forms of pollution with emphasis on environmental noise pollution are products of modernism, without which the Garden of Eden environment could have been sustained.

Noise as a form of environmental pollution is taking a worrisome epidemic dimension, most especially in the undeveloped and developing parts of the world. But unfortunately, according to Goines and Hagler (2007), despite the fact that the health effects of noise have been explored over many decades, and the body of evidence linking noise to various health effects is therefore more extensive than most other environmental hazards, very few countries of the world appear to consider the health risks of noise in their policy making.

II. Literature Review

In an attempt to have a good grip of the topic, local and international works of notable authors were studied. This was made possible by accessing websites of world class publishers of academic research works some of which are listed below:

Scholarly research works on “Environmental Noise Pollution, Sources, Effects, and control” with emphasis on the study of some notorious cities of the world where noise is already constituting dangerous phenomenon with its numerous health and socio-economic negative effects, served as guide in our research effort.

3.1 Notable Works and Authors/Website

- 1) Environmental noise pollution in the city of Curitiba, Brazil Author: PHT Zenin, FB Diniz, WA Barbosa. - Applied Acoustics 2002.
- (2) Causes and Effects of Noise Pollution – Conserve Energy Future – www.conserve-energy.future.com/causes.
- (3) Environmental Noise Pollution in the United States.
- (4) Environmental Noise. Pollution: Monitoring and Impacts on Human – Health in Dehradun City Utaralchand India – www.iiste.org/journals/index.php/.../630
- (5) Environmental Noise Pollution: Eoin King – www.science-direct.com.
- (6) Environmental Noise Pollution in Ilorin Metropolis Nigeria m.covenant-university.edu.ng.

III. The Study Area

Osogbo, the capital of Osun State Nigeria, was before the creation of Osun State a commercial centre of the old Osun division in the then Western region, Western State and later Oyo State. Some factors, such as the north-south rail line, the satellite towns such as Ifon, Ilobu, Ofatedo, Erin Osun, Iba, Oba-Ile make the town attractive and viable as both commercial and administrative centre. Manufacturers representatives, wholesale agents such as C.F.A.O, Leventis, and numerous retailers maintain their presence in the town up till today.

The hub of Osogbo which also doubles as the CBD (Central Business District) is the popular Old Garage roundabout. According to Figure 1, the three Roads for this study viz. Old garage – Oja-Oba, Old Garage-Okefia, and Okefia-Olaiya Junction are all related directly or indirectly to this commercial nerve centre. The three roads before the creation of Osun State and the making of Osogbo as the capital were all lined with residential Storey Buildings of Brazilian architecture. The building maintained good setbacks from the road with the exception of buildings along Old-Garage - Oja-Oba road. Recently the Oke-fia - Olaiya road has been dualized and efforts by the state government to dualize the other two is in top gear.

A factor common to the three roads is that the residential buildings along the road are fast yielding to commercial use with many of them being partially or totally converted to commercial use. The newly constructed Millennium park, Filling Stations, Banks and Eateries and Shopping Malls along these roads have combined to constitute heavy presence of road users (vehicle, motorcycles and pedestrians) with phenomenon of traffic jam and noise pollution hitherto not known to the areas of study.

IV. Sources Of Environmental Noise Pollution

The major sources of noise can be broadly divided into two viz. External and Internal sources. However a study by an American Scholar Gregory (1998) identified three categories of sources of noise to include:

- (1) Sources associated with the operation of building services.
- (2) Sources associated with the activities and office equipments
- (3) Sources of environmental sound from outside the building.

The first two can be referred to as internal sources while the third category belongs to the external sources.

5.1 Internal Sources of Noise

These are the types of noise associated with human activities within the building, operation of building services and equipments. These may include, human movement, door slam, conversation, electrical appliances (radio, television, phone calls) air conditioners, motorized home appliances, power generating sets (Ogunsote 2010). The sources are either direct noise or sources of vibration that usually interfere with the occupants of built environment’s activities and comfort. Some of these, by their volume or impact are tolerable and desirable while most of them are undesirable, cause discomfort may be harmful and hazardous. Ephraime (2002).

5.2 External Sources of Noise

These are the major sources of environmental noise most especially in this part of the world where concerned government agencies most especially, The Environmental Protection Agency are not doing enough to control human activities. They are the types of noise that may be difficult to control from the source. The major sources are traffic and automobiles, industrial plants, pedestrians, religious institution (Mosques & Churches) advertising agents; hawkers, and roadside record stores.

V. Research Methodology

The research adopted a two way approach viz.

(a) **Survey Method** of the study area using a structured questionnaire administered on occupants of selected buildings on both sides of the three roads within the vicinity of the Central Business District (CBD) of Osogbo the capital of Osun State Nigeria. The variables examined include

- (1) Type of Building
- (2) Sources of Noise
- (3) Setback from Road
- (4) Types of Barrier
- (5) Type of landscaping
- (6) Noise effects.

The essence of this survey is to ascertain different sources of noise in the study area both external and internal. It is also useful to gauge the effects of the noise on the well being of the residents.

(b) **Empirical Research Method:** This involved the measurement of Noise Intensity (dB) externally and internally, during the day and night time over a period of two months in four selected buildings at targeted locations in the study area.

Two noise level meters were used for the measurement.

- (a) CEL-350 DRADGE Series (AMS HADEN) product.
- (b) Uber (android) environmental noise reader.

The noise intensity measured in each building over time day & night, external & internal was averaged and tabulated in tables 4, 5 and 6.

The results were compared with the products of literature reviewed which captures (a) Maximum Permissible Noise Levels at Different areas (Table 8) and (b) Effects of Noise on Human Beings. (Table 7)

These efforts allowed for reasonable deductions and appropriate recommendations.

6.1 Data Collection And Analysis

Three roads were used as study areas to ensure robust data due to the fact that most of the buildings are either been converted hundred percent from residential to commercial or are mixtures of the two. The buildings involved in the study are the one linearly situated on both sides of the roads, for convenience purpose.

Data were collected and analyzed as follows:

6.1.2 Type Of Building

(1) There were five different types of buildings in the three study areas, and can be classified as Residential, Commercial, Religious, Institutional and Mixed. A common characteristic to the residential buildings in the study areas is that, the residents are either tenants that use the buildings for mixed purposes mostly residential and commercial, or families of the original owners who cannot afford to rent accommodation elsewhere. These are mostly people who have no choice but to tolerate and live with all forms of inconveniences from noise pollution at the city center.

The breakdown of the building types road by road is captured in Tables 2, 3 and 4 below;

Table 1: Types of Buildings

Road 1 (Old Garage - Oja Oba Road). Road 2 (Old Garage - Oke-fia Road)

Road 3 (Okefia-Ola-Iya Road).

Table 1 (01)

Type of Building	Number of building of Road I	Percentage %
Religious	02	2.2%
Commercial	20	22.2%
Industrial	05	5.5%
Residential	50	55.5%
Mixed use	10	11.11%
Institutional	05	5.5%
Vacant Plots	02	2.2
Total	90	100%

(Source: Researchers field Survey 2016)

Table 1 (02) Road 2(Old Garage – Okefia Road)

S/N	Type of Building	Nos of Buildings	Percentage %
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01	Religions	03	06%
02	Commercial	10	20%
03	Industrial	02	04
04	Residential	24	48
05	Mixed Use	10	20%
06	Institutional	00	02%
07	Vacant plots	01	02%
	Total	50	100%

Source: Researchers field survey 2016

Table 1 (03). (Road 3: Okefia-Olaiya Junction Road)

S/N	Types of Building	No of Buildings	Percentage %
01	Religious	04	4.90
02	Commercial	20	24.69
03	Industrial	06	7.40
04	Residential	30	37.03
05	Mixed use	20	24.69
06	Institutional	01.	1.23
07	Vacant Plots	00	
	Total	81	100%

6.1.3 Sources of Noise

Four different sources of noise were identified in the study areas. Virtually all the respondents complained about noise from vehicular and pedestrian sources, from advertising agents, hawkers and music/movie cassette retailers. These sources are external in nature. Because of the fact that the areas of study are high density in nature, multiple tenants, low income buildings, majority of the respondents complained bitterly about abuse of the use of music/movie players. Respondents also reported the obvious noise disturbance emanating from conversion of residential spaces to commercial use such as computer centers, football watching venues, shops, tailoring workshops and in acute cases place of worship (churches). All these constitute internal sources of noise.

Table 2: Sources of Noise

2(a) External Sources: Total No of Respondents 300.

S/N	Sources of Noise	Number of Respondents	Percentage %
01	Vehicular traffic	300	100%
02	Religious activities	300	16%
03	Commercial activities	200	67%
04	Industrial activities	30	10%

2b. Internal Sources: Total Number of Respondent is 300

S/N	Sources of Noise	Number of Respondents	Percentage %
01	Human Conversations	100	33%
02	Human movement lactivities	100	33%
03	Music/Movie player	200	67%
04	Commercial activities	200	67%
05	Religious activities	80	27%

(Source: Researchers field Survey 2016)

Note: There is overlapping in the internal and external sources according to Table 2a and 2b because of mix-use of residential buildings for commercial and religion and others.

6.1.4 Interpretation of Tables 2a and 2b.

It is obvious from Tables 2a and 2b that noise from commercial activities from both internal and external sources ranked first followed by noise disturbance from vehicular human traffic. Noise from Human activities within the buildings ranked third followed by religious activities from outside and within the buildings studied.

Table 3: Likely negative effects of Noise on the Residents of affected building. (No of Respondents 300)

S/N	Negative Effects of Noise	No of Respondent	Percentage %
01	Insufficient hours of sleep	200	67%
02	Shallow depth of sleep	250	83%
03	Inactiveness at place of work (sluggishness)	100	33%
04	Poor standard of health (hearing loss, insomania)	50	16%
05	Poor Economy (reduction of income)	50	16%

Source: Researchers' field survey 2016.

6.1.5 Interpretation of Table 3: By Table 3 above 83 percent of the respondents complained of lack of sound sleep, followed by 67% that complained of insufficient hours of sleep. Other complaints such as inactiveness at place of work, poor performance of children at school, poor income and poor health respectively are attributes of lack of enough sleep which are all caused by different grades of exposure of NOISE as captured in Figure 1..

6.2 The empirical research on noise intensity (db) in the study area

For the purpose of this data gathering, four houses from one of the three study areas were selected. Using sound and noise level meter CEL-350 DBADGE Series, & noise intensity outside and inside the selected buildings was measured day and night over a period of two weeks. The average noise intensity so measured in the four selected buildings in the study areas is captured in Tables 5 below:

Table 5: Noise Intensity Db In 4 Selected Houses In The Study Area (Day & Night) For A Period Of 2 Weeks (Study Area (A) - Old Garage - Oja Oba Axis)

S/N	Type Of Building	Location	Noise Intensity Db			
			Day		Night	
			Outside	Inside	Outside	Inside
01	Residential	Proximity To Motor Park	130	105	100	85
02	Residential/Commercial	Proximity To Market	120	80	95	70
03	Residential/Religious	Proximity To Filling Station	135	75	96	65
04	Residential/Commercial	Proximity To Post Office	120	95	85	66

Source: Authors' field work (2016)

6.2.1: Interpretation Of Research Outcome In Table 5.

According to the international standard as captured in Table 6 and various past academic works on noise pollution, sound intensity (dB) from (0 – 100) dB is pleasant but noise is caused by sound intensity above 120 dB. Also, the upper limit of the threshold of hearing is 130 dB, but beyond 130 dB is the threshold of pain which may cause damage to hearing impairment and other health challenges. This is noise pollution. It is obvious from Tables 5, showing the noise intensity (dB) of the 4 selected buildings in the study areas that the harmful sound intensity of 120 db is seldom recorded both externally and internally. However, the average recorded sound intensity externally and internally day and night time are close to or slightly above the upper limit of the pleasant sound intensity range (1 – 100) db. The cumulative effect of this high sound intensity over a long period of time on the residents of the study areas, as captured in (Table 6) is harmful with series of health and socio-economic consequences. This assertion is corroborated by survey data on the negative effects of noise on the residents of the study areas (Table 3).

Figure 01: Effects of human exposure to Noise.

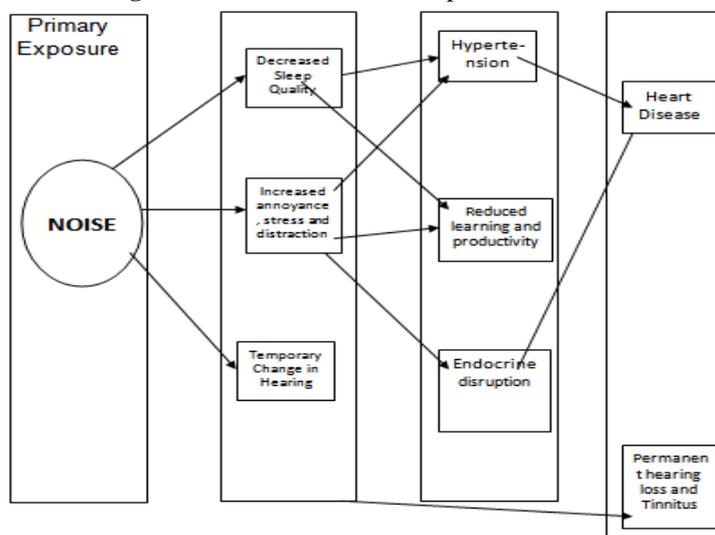


Table (6): Effects Of Noise On Human Beings

S/N	NOISE (dB)	EFFECTS OBSERVED
01	0	Threshold of audibility
02	110	Stimulation of reception in skin
03	120	Pain Threshold
04	130-135	Nausea, Vomiting/Dizziness, Nervous disorder
05	140	Pain in ear, Prolonged exposure causing insanity
06	140	Extreme limit of human noise tolerance
07	150	Significant change in pulse rate, prolonged exposure causing burning of the skin
08	160	Minor permanent damage, if prolonged
09	190	Major permanent damage in a short time.

Table (7): Maximum Permissible Noise Levels At Different Areas

S/N	SITUATION	PERMISSIBLE NOISE IN Db
01	Road Traffic near residential	70
02	Ear protection to be worn	85
03	Factory work for 8hr in a day, 6 days in a week	90
04	Prolonged noise causing permanent damage	100
05	Threshold of pain duration of 30 Sec. (maximum)	120
06	Maximum for impulse noise (sonic boom)	150
07	Absolute limit with ears protected	150
08	Ear drum rupture	180
09	Lung damage	194

VII. Effects Of Noise Pollution

7.1.(a). Contraction of blood vessels

- i) Making skin pale
 - ii) Excessive adrenalin in the blood streams which is responsible for high blood pressure
 - iii) Blaring sounds are known to cause mental distress
 - iv) Heart attacks, neurological problems, birth defects and abortion.
- (b). Muscle contraction leading to nervous breakdown, tension. These can lead to human inefficiency (Babisch et al., 2013 and Stonsfeld, 1992).
- (c). The adverse reactions are coupled with a change in hormone content (of blood, which in turn increases heart heat, constriction of blood vessels, digestive spasms and dilation of the pupil of the eye and lack of concentration (Lercher et al., 2002)
- (d). Adverse effects of health, work efficiency and behavior. Noise pollution may cause damage to the heart, brain, kidneys, liver and may produce emotional disturbance and fatigue (Joo et al., 2012).
- (e). Prolonged exposure to noise of certain frequency can cause impairment of hearing.
- (f). Ultrasonic sound can affect the digestive, respiratory, cardiovascular system (Starza et al. 2004).
- (g). Impulsive noise may cause psychological and pathological disorders.
- (h). Sudden noise especially by airplanes and jets may subject people to psychiatric illness.
- (i). The optical system of humans can be affected by noise pollution through (a) popullary dilation (b) impairment of night vision (c) decrease in rate of floor perception
- (j). Noise has effect on plants causing poor quality of crop yields. Some tree crops such as oranges, cola nut, etc are sensitive to noise.
- (k). Excessive noise is harmful to some animals' nervous system. They lose control of the mind and may be dangerous. Reason for locating zoological garden and poultry farms away from sources of noise.

7.2 Types of Measures Put In Place To Checkmate Noise Exposure

7.2.1: Building Fenestrations (Windows & Doors): Almost all the buildings in the study areas are of Brazilian Architecture with big sized doors and windows made of combination of wood and glass with upper vent lights to allow light or ventilation when the doors and windows are closed. The Tropical high humidity and hot weather demands that windows especially, are opened for most part of the day and night. Mechanical means of light and ventilation through electrical bulbs and electrical fans are not feasible due to very unreliable public source of electricity. The alternative electrical source through generators is equally outrageously expensive due to cost of fuel. The above illustration translates to the fact that the residents of the buildings in the study areas are greatly vulnerable to all sorts of noise from the external sources round the clock.

7.2.2: Building walls, floors Roof structures:

- **Walls:** The external and internal walls of the buildings are made of sandcrete blocks plastered and painted. They are good barriers to external and internally generated noise. But partitioned spaces with particle boards are vulnerable to noise transfer.
- **Floors:** The storey buildings have their first floor made of reinforced concrete slab.. The few old storey buildings with suspended floors have their floors made of wood, but covered with cement sand screed. The study reveals that almost all floors are sources of impact noise generation that is highly disturbing to occupants of the ground floor.
- **Roof:** All the residential buildings are roofed with corrugated iron sheet with flat asbestos ceilings. The noise generated during raining period is highly disturbing to the occupants of the space immediately below:

7.2.3: Landscaping Barriers (Hard and Soft)

The study reveals that neither hard landscaping element such as fence nor soft type in form of plants were found to protect the buildings from effects of external noise. This coupled with poor setback from the roads further worsens the noise pollution situation in the study neighborhood.

7.3: Road Setback

50 buildings were sampled, and each of the buildings had their setback from the road measured. Table 8 below shows that none of the buildings satisfies the minimum Town Planning regulated setback of fifteen meters from the edge of building to the centre of the road. The little setback is being shared by pedestrians and petty traders that display their trade along the roads.

Table 8: Buildings Set Back From Roads.

S/N	Distance from the Roadmap	Number of Buildings	Percentage %
01	0.1 – 1.0m	03	806
02	1.0 – 1.5m	11	22
03	1.5 – 2.0m	16	32
04	2.0 – 3.0m	17	34
05	Above 3m	03	06
	Total	50	100

Source: Researchers' field survey 2016.

VIII. Noise Control Measures

To an ordinary man on the street, the hazardous effect of noise is limited to the physical disturbance, however, persistent disturbance by noise is a root cause of several health issues that are fast making environmental noise pollution as lethal as other ravaging health problems such as AIDS, Malaria, Cancer and Tuberculosis. Problem posed by noise in the built environment is fast becoming a plague in Nigerian Urban Cities most importantly at this moment when the poor economic recession is collapsing businesses, thus, turning people to taking on all sorts of ventures mostly religious and commercial either in addition to their callings or as a necessity courtesy of retrenchment or as a result of non-regular payment of salaries. This fast spreading problem calls for urgent attention so as to create a pleasant and comfortable environment that will ensure better standard of living of our citizens. This big task is everybody's responsibility, however the scale tilts more on the side of government at all sectors by ensuring functional urban design, building designs and enforceability of planning rules and regulations that will control noise generation and reduce it to tolerable level. For external sources of noise, screening, effective planning regulation, and building designs and insulation of the noise source can be used as control measures. Internal sources of noise can be controlled by the reduction of noise at source by the use of noise absorbent surface materials, insulating building materials on the walls, ceilings and floors of building to reduce airborne and impact sound.

IX. Recommendation

This study reveals useful information about sources of noise in the study areas, external and internal. It also highlighted the hazardous effects the high level of noise to the health and general well being of the residents. The followings are some preventive measures that could help in reducing the impact of noise in the built environment to bearable or tolerable level.

9.1 Preventive Measures

9.1.1 Proper Planning

Religious and industrial buildings which are the two notorious sources of noise should be located away from residential areas. Development approving authorities must ensure proper layout to new sites on both government and private lands are enforce strict compliance.

9.1.2 Zoning:

Buildings with similar noise levels should be zoned together and away from other buildings with different noise levels. Religious and industrial buildings should be zone away from residential.

9.1.3 Adequate Set-back

The inverse square law of sound states that the intensity of sound in a free field is indirectly proportional to the square of the distance from the source (Ogunsote, 2016) Thus, the effect of noise reduces dramatically as the distance from the source of sound increases. This sound characteristic can be used to control noise in the built environment by enforcing planning regulations on new building projects along our roads.

9.1.4 Building Design:

Designers of residential buildings must obey the zoning rules by separating noisy spaces such as living rooms, dining, kitchen and generator house away from the quiet spaces such as the bedrooms and study room. Recommended setbacks from the road and adjacent properties should be adhered strictly to and should be enforced by the plan approving authorities. Standard building elements such as doors, windows, ceiling, should be specified and properly fixed to minimize effect of external and internal noise. Floors should be finished with noise absorbing materials such as rug and P.V.C Tiles so as to minimize impact noise.

9.1.5 Screening:

Screening elements such as fences, trees and shrub edges, are very effective in controlling noise from vehicular traffic. In developed countries, acoustic barriers are been introduced to protect housing estates located along major highways from noise.

9.1.6 Legislation and Enforcement

Relevant legislative organs at the three tiers of government, Local, State and Federal should as a matter of urgency make laws to curb the excesses of religious and commercial/industrial ventures. Agencies most especially Environmental Protection Agency should wake up and perform their responsibilities by arresting and prosecuting offenders of noise pollution in our built environment. Reported cases of violation should be taken up promptly without sentiments.

9.1.7 Public Awareness

The general public should be sensitized about the damaging effects of noise to their well being. They must be made to be aware of the existence of relevant laws relating to noise so as to know their rights and limitations. Government agencies concerned with noise control should be well funded, staffed and mobilized to move into action.

9.2 Control Measures

9.2.1 Source Control

Source modification such as acoustic treatment to machine surface, design changes to building elements such as floors, ceiling windows, and walls. Limiting operational timing is also important.

9.2.2 Transmission Path Intervention:

This includes containing the source inside insulating enclosure, construction of noise barrier such as wall fence, or planting of sound absorbing materials such as trees and shrubs along noise path. Finishing building interiors like walls, ceiling and floors with sound absorbing materials.

Receptor Control: This includes,

- a) Provision of personal protection devices such as, ear plugs for operating noisy machines.
- b) Protection of the receivers by altering the work schedule.

X. Summary And Conclusion

According to this study, substantial level of noise pollution is being generated in the study areas of Osogbo the capital of Osun State and by inference in other Nigerian Cities, with the consequent effect on the quality of the built environment. To effectively control the hazardous impact of noise pollution on the environment and the general wellbeing of the people, this paper has identified vehicular noise, pedestrian noise commercial and religious noise as major sources of noise pollution in a typical Nigerian Urban Centre and discussed how the noise can be controlled. This paper suggested some preventive measures, such as adequate setback, proper planning, building zoning, adequate legislation/enforcement, and public awareness and sensitization as necessary to control environmental noise pollution in our cities, and other communities.

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