International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

EVALUATION OF HEALTH RISK LEVELS ASSOCIATED WITH TYPES OF RESIDENTIAL NOISE IN NIGER-DELTA, NIGERIA: USING URBAN AREAS OF AKWA IBOM STATE AS CASE STUDY

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DOI: 10.5281/zenodo.7722796

ABSTRACT

Residential noise, which is among the main public health issues, should be professionally evaluated in order to produce the real picture of the health problem associated with each type. This research therefore presents the evaluation of health risk levels associated with types of residential noise in Niger-Delta, Nigeria: using urban areas of Akwa Ibom State as case study. Selected locations which included TC, HI and SH, among others were considered for the noise level measurements and the data obtained were compared with the World Health Organisation (WHO) and other standard values. The selected locations were further assessed through administering of copies of a risk evaluation questionnaire to relevant respondents and the data were statistically analysed. The results revealed that TC had the highest average noise level of 115.01 dBA, but it was not located in residential areas. It was observed that HI and SH had respective average environmental noise levels of 47.28 dBA and 61.40 dBA, which means that with good acoustic materials, the insides of HI and SH were safe. The health risk level evaluation indicated that people in the areas were exposed to many sources of noise, where CA and LR top the list.

Keywords: Akwa Ibom State, evaluation, health risk levels, Niger-Delta, Nigeria, residential noise pollution

1. INTRODUCTION

Residential noise is a main public health concern which features among the most environmental threats to health [1]. The irritation caused by noise varies greatly between people. For instance, what is considered music by one person may be noise to another. The degree of bother from a certain sound depends not only on the duration and its sound level but also on the listener and on the activity being carried out at that time. The type of sound (continuous, intermittent or impulsive) and the time of day are also significant. To determine the overall community annoyance at a particular sound involves the sociological, political and demographic characteristics of the community in addition to the characteristics of the sound. It is not possible to state noise levels below which no one will be annoyed and above which everybody will be annoyed [2]. The most important sources of residential noise are air, rail and road traffic, neighbourhood, municipal work, and the construction plant, among others. Usually, noise from neighbourhood originates from building and installations associated with the food preparation business like cafeterias, restaurant, and discotheques; from recorded or live music; from playgrounds and car parks; from sporting events including motor sports; and from household animals for example barking dogs. Residential noise is described as community noise or environmental noise or domestic noise [3], [4], [5]. Some major sources of indoor noises include aeration systems, home appliances; office machines, and neighbours [2].

The Federal Environmental Protection Agency (FEPA) of Nigeria [6] maintains that an industrial worker should not be exposed to a noise level of 90 dBA beyond 6 h/day, while a noise level of 90 dBA should not be tolerated beyond 8 h/day. It gives an exposure time of less than or equal to 0.25 h/day. However, residential noise has escalated to the point where it is currently the most important peril to the superiority of our existence. This increase in noise can be attributed to the ever increasing number of people in the globe and the growing levels of economic affluence [7]. In the United States of America, the Environmental Protection Agency (EPA) identified

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

noise as a hindrance since in the 1970s [8]. Then, the agency carried out a main study of noise and has continued to bring up to date its results. This means that the study of noise is a continuous phenomenon. As with all pollutants, noise degrades the value of our environment and is known to produce various negative effects both on structures and on humans.

The protection of workers from the risks related to exposure to noise at work is contained in the European Union (EU) Directive (86/188/EEC). The objective of the directive is to reduce the level of noise experienced at work by taking action at the noise source. Two exposure levels used are daily personal noise exposure of a worker and weekly average of the daily values, $L_{EP,w}$ [9]. $L_{EP,w}$ is presented in equation (1).

$$L_{EP,w} = 10\log_{10}\{\frac{1}{5}\sum_{k=1}^{m} 10^{0.1(L_{EP,d})K}\} \qquad 1$$

where, $(L_{Ep,d})_k$ = the values of $L_{EP,d}$ for each of the m working days in the week being considered. The EU directive specifies that when the daily exposure level exceeds 85 dBA, the worker is to be advised of the risks and trained to use ear protectors. If the daily exposure level exceeds 90 dBA, a programme to reduce levels should be put in place.

The public opinion polls almost constantly rank noise in the list of the most bothersome residential irritations. The industrial noise is one of the most annoying sources of noise complaints [10]. Community noise intrusions like traffic noise can obstruct speech communication, interfere with sleep and relaxation and disturb the capacity to perform difficult tasks [9]. In this context, noise is defined as unpleasant sound [11]. Noise can be described as the unwanted sound in the unwanted location at the unwanted occasion. The level of "unwantedness" is usually a psychological issue since the effects of noise can range from temperate irritation to everlasting hearing loss, and may be rated in a different way by special observers [2]. For this reason, it is often exigent to establish the benefits of dropping a specific noise. Noise does affect the inhabitants, humans, fauna and others in the natural environment. Some definite places influence noise contacts; so it is invasive that it became difficult to run away from it [12].

Studies have recommended that noise levels of 50 dB(A) at night may also increase the risks of myocardial infarction by constantly enhancing production of cortisol [13], [7]. In 1993, a study carried out by Cornell University indicated that children exposed to noise during classes experienced problem with various cognitive developmental delays in addition to words discrimination. Specifically, the writing learning mutilation called dysgraphic is usually related to stress on environment during classes [14], [15]. Noise has been connected to vital cardiovascular health risks. The British Columbia Work's Compensation Board has set 85 dB as its highest tolerant level in the work place. Above this limit hearing protection should be used. It states that the threshold of pain is attained at 120 dB and it classifies 140 dB as excessive hazard level. The WHO safety noise levels are similar while EPA of Nigeria tends to have even a stricter standard of 70 dB as a maximum safe level of noise in work place. They gave the safe level around home to be 50 – 55 dB [16].

The results of various researches have shown that constant noise above 55 dBA causes serious annoyance and above 50 dBA moderate annoyance at home [17]. In a non-work place and for health and safety purposes, 55 dBA is set as a safety noise level for outside and 45 dBA inside. Hospital and school permissible levels of noise are 35 dBA [3]. Among others, noise beyond harmless levels leads to numerous health impacts which include high blood pressure, annoyance, sleep loss, stress, hearing impairment, loss of productivity and the ability to concentrate.

In this research therefore, the evaluation of health risk levels associated with types of residential noise in Niger-Delta, Nigeria: using urban areas of Akwa Ibom State as case study shall be carried out. This is to create more awareness on the risks of noise on our environment for the betterment of our society and for national development.

2. MATERIALS AND METHODS

2.1The study area

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Akwa Ibom State is in Southern Nigeria. It lies within longitude $7^{0}30^{1}$ and $8^{0}20^{1}$ E and latitude $4^{0}30^{1}$ and $5^{0}30^{1}$ N. It has an estimated area of 6,500 km^2. Akwa Ibom State is bounded on the South by Atlantic Ocean (Gulf of Guinea), on the East by Cross River State and on the Southwest by Rivers State and Abia State [18]. The selection was made based on economic activities and population density. For example, by 2006 the population density of Uyo with a landmass of 284.72 km^2 stood at 1,087/km^2 [19].

2.2Physical Measurements

Selected locations around homes and offices in the area were considered for the noise level measurements. These were sites that occupied sources that generated or appeared likely to generate noise. The locations included timber markets with different types of saws (TC), health institutions (HI) (like hospitals, clinics, health centres), airport area (AP), churches with musical instruments (CH), markets (MT), roads/streets (RS), car parks (CP), schools near busy roads or schools with power generators (SH), workshops/factories (WF) and compact disk seller shops (CS). All the noise measurements were made using the sound level meter (SLM), model WensnWS1361 with ½ inch Electret condenser microphone. This model has A weighting with a measuring range 30 to 130 dBA, C weighting with measuring range 35 to 130 dBC and 0.1dB resolution with fast/slow response. It is equipped with a built in calibration check (94.0 dB) and tripod moving. It has an accuracy of ± 1.5 dB. It has AC and DC outputs for frequency analyser level recorder, Fast Fourier Transform analyzer, graphic recorder and others. It also has electronic circuit and readout display and a weight of 308 g. The microphone senses the small air pressure variations related to sound and converts them into electrical forms. These signals are then passed to the electronic circuitry of the instrument for processing. The readout displays the processed sound levels in dB. The sound level meter picks the sound pressure level at one instance in a certain location. Measurements were taken by adjusting the sound level meter to A-weighting network in all the sampling locations. During the noise level measurements, the microphone of the sound level meter was positioned at a distance of above 1 m from the main source at a height of 1.2 m above the ground and windshield was always used for accuracy. Work place noise level measurements were taken on slow response. Here, the response rate is the time period over which the instrument averages the sound level before displaying it on the readout. Fast response was used for fast varying noise. Measurement of workplace sound pressure was made in an uninterrupted noise field in the workplace, with the microphone located at the position normally occupied by the ear exposed to the highest value of exposure [20], [7]. Then, the data obtained from the noise level measurements were compared with the WHO and other standard values.

2.3Evaluation of the risk levels

This section involved survey as a series of interviews of different sectors of the population of the area. The idea was to have an insight into what types of sources people identify as noise and how they are bothered by the noise. The levels of noise measured identified the locations that needed further study. This section addressed the impact of noise on residents. A risk evaluation (heard and bothered) questionnaire was developed and used. Different sources of noise included in the questionnaire were aircrafts (AR), animals (AL), cars (CA), churches (CR), children (CL), tricycles/motor cycles (TM), compact disk sellers (CD), lorries (LR), traders (TS), night clubs (NC), power generators (PG), ships/engine boats (SE) and workshops/factories (WF). The interviewees were asked to tick the type(s) of noise they were exposed to and to indicate how the noise type(s) affect them. Therefore, a total of 1,185 copies of the questionnaire were distributed but 1,030 copies of it were collected and used. Lastly, equations (2) and (3) were used to calculate the health risk levels in percentages [21]:

$$\% \text{ Heard} = \frac{\text{Number Heard} \times 100}{\text{Total Number of Respondents}} \qquad 2$$

$$\% \text{ Bothered} = \frac{\text{Number Bothered} \times 100}{\text{Total Number of Respondents}} \qquad 3$$

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3. RESULTS AND DISCUSSION

3.1Physical measurements

Table 1 and Figure 1 show the analysis of noise level measurements in the selected locations. The results of the physical measurements reveal that TC had an average noise level of 115.01 dBA. This is very risky, though it was not located in residential areas. However, the duration of exposure to this level of noise by the workers has to be professionally considered. For instance using the noise exposure limits for industrial workers in Nigeria

[6], an exposure time of ≤ 0.25 h/day must be adopted. Also, ear protector should be worn.The results of the survey show that HI had an average noise level of 47.28 dBA. It was observed that with good acoustic materials, the insides of HI can have even below WHO tolerant level of 35 dBA. In the area, AP produced an average environmental noise level of 91.78 dBA. Here, the exposure time by the workers should not exceed 6-8 h/day. The annoying average noise levels of CH and MT were 82.73 dBA and 73.40 dBA respectively. These values are above the WHO tolerant level of 55 dBA for outdoor living areas. These levels can have various adverse effects on the populace depending on the exposure time base. It was observed that RS generated an average residential noise level of 77.89 dBA instead of the WHO tolerant level of 55 dBA for a non-work environment. The investigations establish that SH had an annoying average environmental sound level of 61.40 dBA. It was observed that with good acoustic materials, the insides of SH can have even below WHO tolerant level of 35 dBA during classes. This therefore means that if poor good acoustic materials are used, the value (61.40 dBA) can have adverse effects on speech intelligibility, information extraction and message communication during classes [3]. An average noise level of 81.04 dBA was introduced to the residential areas by CP. In this case, CP should not be sited around the residential areas because the value is hazardous to both human and structures. In residential areas, WF produced an annoying average sound level of 87.75 dBA. Using the EU directive, the worker is to be advised of the risks and trained to use ear protectors. However, CS had an annoying average sound level of 72.60 dBA instead of WHO safe level of 55 dBA for a non-work area. Therefore, CS should not be located in residential areas. The results of the finding agree with the results of many previous findings [16] , [13]. Consequently, copies of the risk evaluation questionnaire were distributed in these areas in order to determine how people were affected by different sources of noise that they were exposed to.

Table 1: Average noise levels of the selected locations (2017)

Location	Average noise level (dBA)
TC	115.01
HI	47.28
AP	91.78
CH	82.73
MT	73.40
RS	77.89
CP	81.04
SH	61.40
WF	87.75
CS	72.60

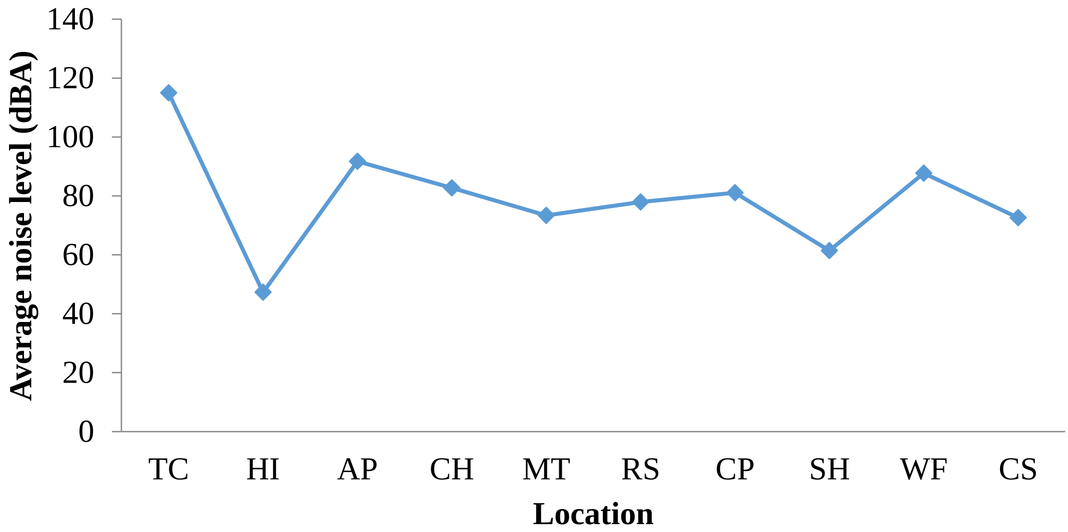

Figure 1: Average of noise level against location

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Impact Factor: 5.164
CODEN: IJESS7

3.2**The risk levels**

Table 2 and Figs. 2-7 show the results of social surveys that indicate the risk level caused by each of the noise types in the selected areas of the State. The results show that only 28% of the respondents were exposed to the noise of AR while 22% where bothered by it. This may be because the AP is sited a far distance from the residential areas. The noise of AL had 51% of the respondents exposed to it, while 30% were bothered by it.

Obviously, CA and LR top the list of the sources of noise that people are exposed to in the selected areas, averaging 90% and 90 % with 82% and 82 % bothered by them. This implies that CA and LR had the highest residential health risk levels. Here, more acoustic control measures like planting of many trees along roads and highways should be adopted. The results show that 81% of the respondents were exposed to the noise of CR and 76% were bothered by it. The noise of CL is the third in the list of noises heard with 85% while only 54% of the respondents were bothered by it. Noise of CD had 77% of the respondents exposed to it, while 64% were bothered by it. Noise of TS was heard by 75% of the respondents, while 65% were bothered by it. Noise of TM bothered 77% of the 87% exposed to it. The noise of TM ranks second in the list of noises heard by the people in the selected areas of the State and third in the list of noises that bothered the people in the areas. The noise of NC bothered 46% of the respondents and 52% were exposed to it. It is shown that 77% of the respondents were exposed to the noise of PG and 66% were bothered by it. This means that PG must not be operating in the residential areas. Noise of SE bothered 11% of the 14% exposed to it. Here, the percentage of respondents should be those doing one business or the other near rivers. The survey also shows that the noise of WF bothered 78% of the respondents while 82% were exposed to it. Hence, noise of WF is the second that bothers the people most in the selected areas. Generally, the results are similar to the work on the state of the environment in the European Community which states that ''In France, in 1986, approximately 25% of the population were exposed to an average daily noise level of more than 65 dB(A); in Germany the figure is 15 – 20 %'' [9], [21].

Table 2: Evaluation of noise risk levels (%) (2017)

Noise Source	Number Heard	Number Bothered	% Heard	% Bothered
AR	286	231	28	22
AL	528	310	51	30
CA	924	843	90	82
CR	833	785	81	76
CL	875	554	85	54
CD	791	658	77	64
LR	928	848	90	82
TS	777	668	75	65
TM	899	788	87	77
NC	533	478	52	46
PG	793	684	77	66
SE	142	112	14	11
WF	849	804	82	78

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

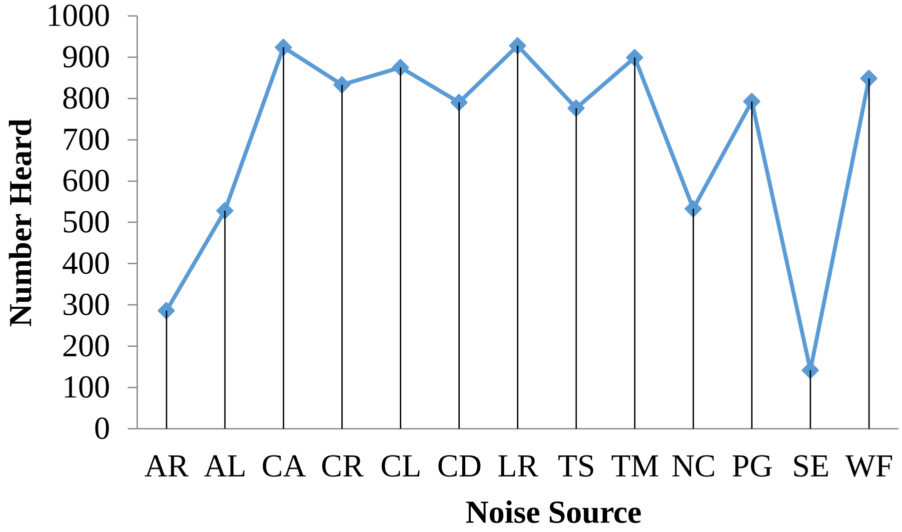

Figure 2: Number heard against noise source

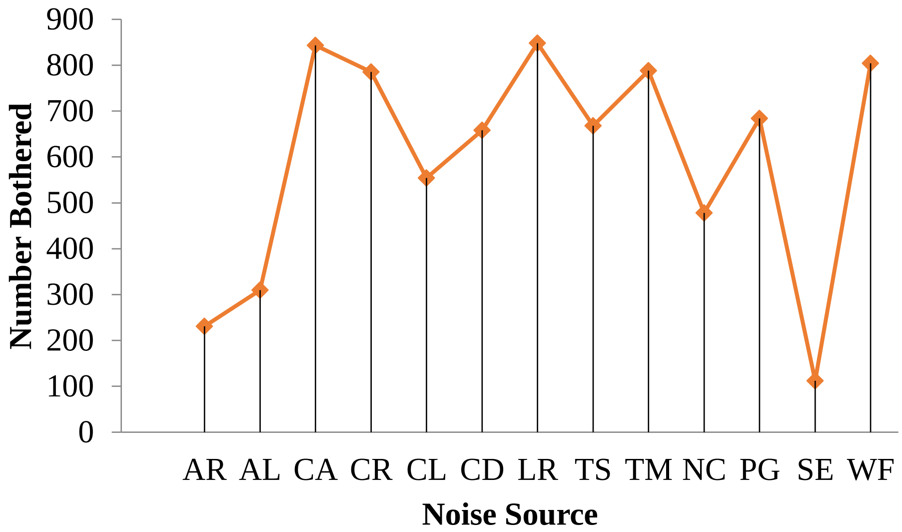

Figure 3: Number bothered against noise source

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Impact Factor: 5.164
CODEN: IJESS7

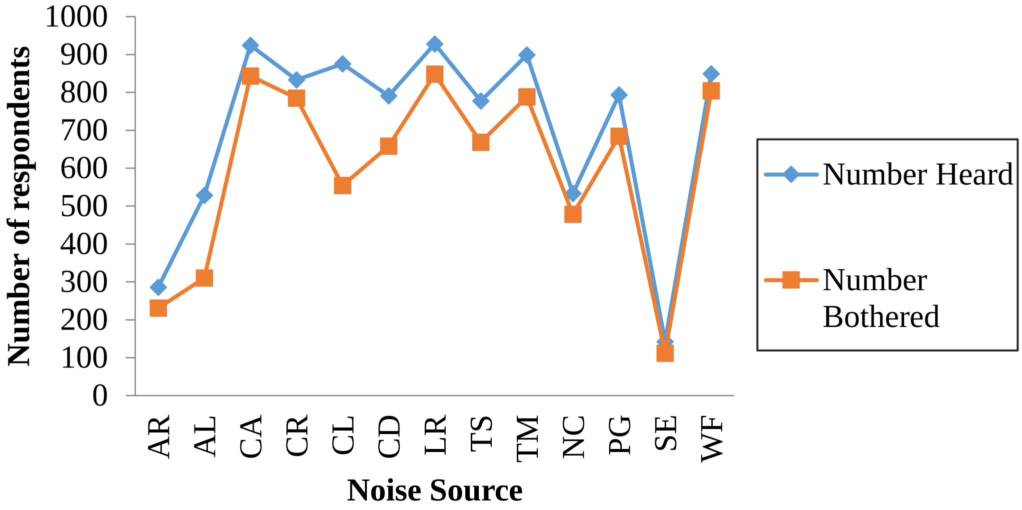

Figure 4: Number of respondents against noise source

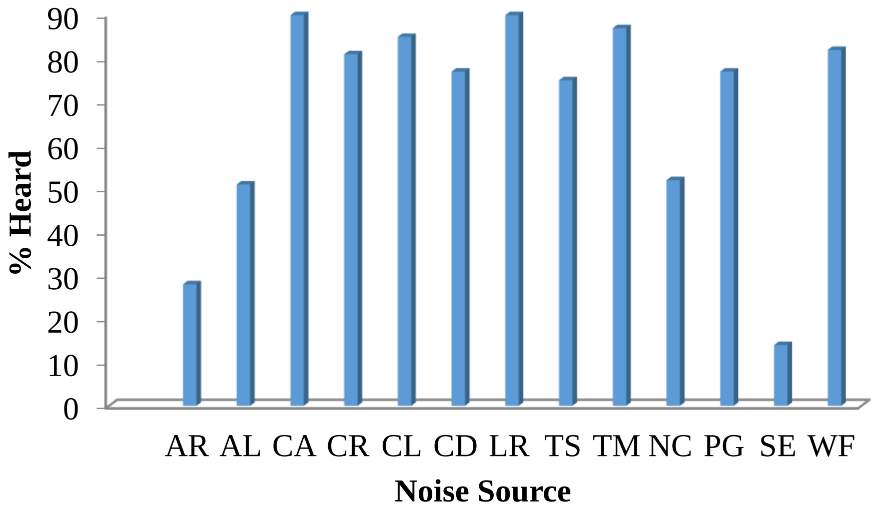

Figure 5: The % heard against noise source

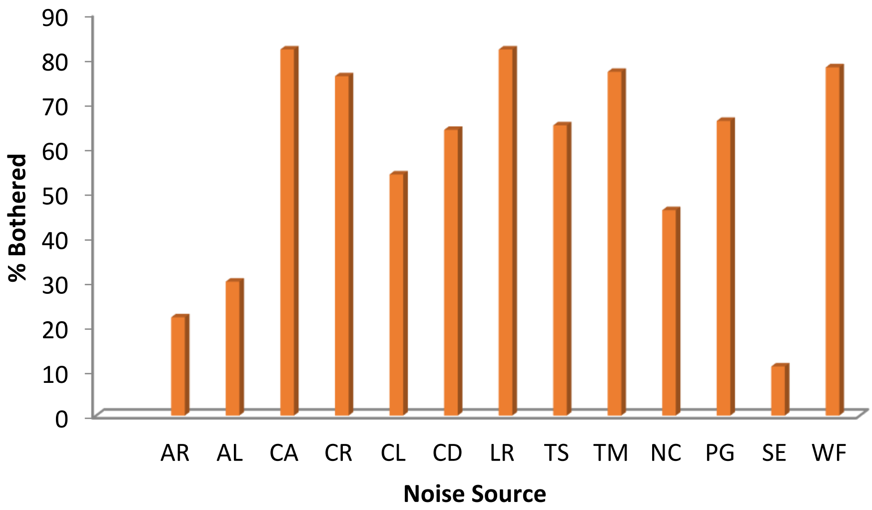

Figure 6: The % bothered against noise source

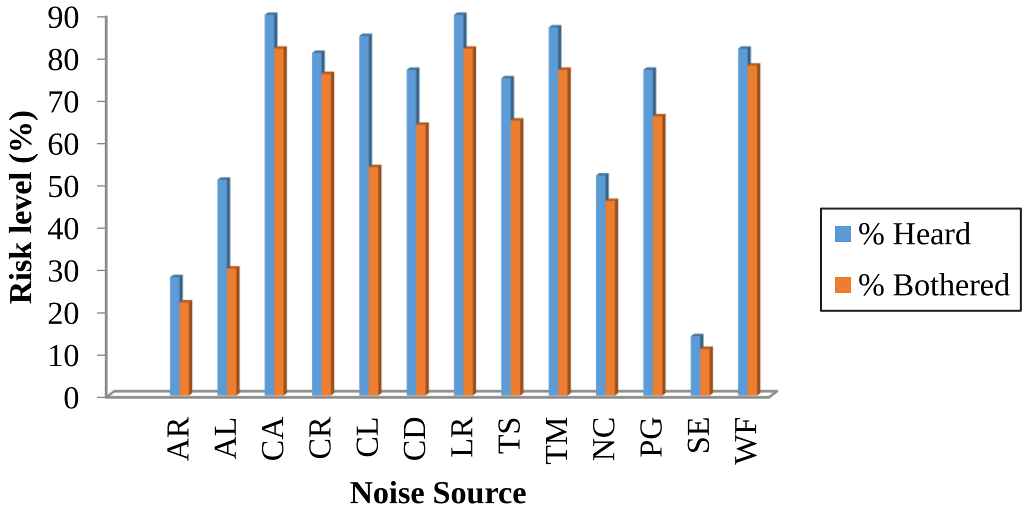

Figure 7: Risk level against noise source

4. CONCLUSION

The results revealed that TC had the highest average noise level of 115.01 dBA, but it was not located in residential areas. It was observed that HI and SH had respective average environmental noise levels of 47.28 dBA and 61.40 dBA, which means that with good acoustic materials, the insides of HI and SH can have even below WHO tolerant level of 35 dBA. The health risk level evaluation indicated that people in the areas were exposed to many sources of noise, where CA and LR top the list. In this case, planting of trees along streets, roads and highways can be adopted to reduce the levels of health risk associated with residential noise caused by the noise types.

5. ACKNOWLEDGEMENTS

We write to thank all those who contributed in one way or the other to make this research a success.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

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