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IMPLICATIONS OF RESIDENTIAL HOUSING EXPOSURE TO URBAN ENVIRONMENTAL NOISE ON RESIDENT'S WELLBEING IN MINNA, NIGERIA

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Abstract
Environmental noise constitutes a major contributor to environmental pollution, with its unintended consequences posing a serious challenge to public health in the built environment. This study assessed the perception and the implications of urban environmental noise on urban residents' wellbeing. Data was collected using a sound pressure level meter and a self-developed questionnaire. Findings from eight hundred and eighty (880) responses obtained through random sampling were analysed and benchmarked against national (50 dBA) and international (55 dBA) standards by the WHO. The results showed that noise from places of worship and traffic noise were rated high, with about 75 percent of the respondents indicating that environmental noise negatively impacts their wellbeing. The study suggested the need for improved environmental quality in the built environment. It advocated for synergistic interventions from architects, other built environment professionals, and environmental protection agencies to tackle urban environmental pollution in residential environments. The contribution of this research lies in the necessity for further investigation, since it has important ramifications for architects, urban planners, and urban managers.

Keywords: Built Environment, urban environmental noise, residential housing, public health, resident's wellbeing

Introduction

Environmental noise is slowly becoming more common but still not widely recognised as a form of pollution, especially in poorer nations. With its unintended effects challenging public health in the built environment, noise is a major contributor to environmental pollution. One of the main concerns influencing quality of life in urban areas around the world in recent years is noise pollution (Hunashal & Patil, 2012; Akan, 2012; Frei et al., 2014). After air pollution and water pollution, WHO (2005) ranked city noise as the third most dangerous form of pollution. According to Trombetta *et al.* (2011), faster urban growth is correlated with rising levels of noise pollution in economically developing nations. As a result, noise pollution in the environment has become worse due to the rapid development of urban areas.

When compared to other urban environmental issues, noise pollution is currently growing at an unprecedented rate, and those who are exposed to it are more frequently affected. One of the difficulties associated with urban environmental issues is that noise has steadily grown to be a significant environmental contaminant, endangering people's quality of life, particularly in residential areas. Babisch (2002) characterised noise as a powerful stressor whose prolonged or repetitive exposure results in dysregulation or otherwise typical psychoneurohormonal stress responses, raising blood pressure, accumulating visceral fat, and generating deleterious physiologic alterations.

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According to Babisch *et al.* (2005) and van Kempen *et al.* (2002), this causes hypertension, coronary heart disease, and myocardial infarction. Therefore, the effects of large-scale development brought on by growing urbanization and an increase in the number of people exposed to typical noise levels worldwide are viewed as potentially detrimental.

The main causes of noise pollution in Nigeria's cities are industrial machinery, road traffic, and generators (Oyedepo, 2012). Due to the severity of the noise pollution issue, effective and well-thought-out solutions are required. While it is known that excessive noise in the built environment has a number of negative effects on health, researchers haven't focused enough on the issue to properly treat and stop the epidemic of many diseases linked to this noise pollution (Oyedepo, 2012). Mead's (2007) research showed that exposure to environmental noise might cause tinnitus, hearing loss, disturbed sleep, and other harmful consequences to health. Others, including Landrigan *et al.* (2002) and Goines & Hagler (2007), have also noted that employees who work in noisy environments are more likely to experience circulatory issues, heart disorders, hypertension, and neurosensory and motor impairment.

Therefore, given the health risks posed by environmental noise as afore mentioned and the need to improve the quality of life of urban residential housing environments' exposure to noise pollutants in Minna metropolis, this study assessed the perception and the implications of urban environmental noise on urban residents' wellbeing. The objectives are (i) to identify residential environments most prone to noise pollution; (ii) to determine the implications of noise pollution on residents' well-being; and (iii) to propose urban noise management strategies for residential environments with a view to limiting its adverse effect on the urban populace. This study examines the effect of noise pollution and its perception on urban residents' health by putting forward the following two hypotheses:

Hypothesis One

H_0: There is no relationship between the length of stay of the respondent and the effect of noise pollution on their health.

H_1: There is a relationship between the length of stay of the respondent and the effect of noise pollution on their health.

Hypothesis Two

H_0: There is no relationship between educational qualification and the perception of noise pollution

H_1: There is a relationship between their educational level and their perception of noise pollution.

In this study, a quantitative approach was used to collect pertinent data from the respondents and the field. The study's predicted result is that it may give built-environment specialists like architects, planners, urban managers, and geographers some directions and suggestions for addressing environmental noise pollution problems. The value of this research lies in highlighting the need for additional study because it has significant implications for urban managers, planners, and architects.

Globally, the consequences of noise pollution have been studied from a variety of angles, in a variety of cities, and with a variety of methodologies. In Taiwanese hospitals, Juang *et al.* (2010) investigated the impact of noise pollution on patients and medical staff. Their research indicated that the average daily sound levels measured within hospitals during the daytime were between 52.6 and 64.6 dB. They did this using a sound level meter and a self-administered survey questionnaire on noise pollution. These numbers exceeded Taiwan's current 50 decibel environmental noise limit for the daytime. In the meantime, Martins *et al.* (2006) have already expressed concern about how prolonged exposure to noise puts people at risk for health consequences such as headaches compared to those who do not. According to a study by Claeson *et al.* (2013), air pollution raises health risks for people and causes health complaints. According to Wakefield *et al.* (2001), the general public is generally unaware of the difficulties caused by noise pollution.

Oyedepo *et al.* (2013) did a study in Nigeria on the analysis of traffic noise in Akure, Ondo State. They employed digital sound level meters to assess noise reported in decibels during the morning and evening hours. The research objective was to measure and assess the noise pollution caused by traffic along the road. Their findings demonstrate that noise pollution from traffic is typically at or over outdoor limits in most places and can have a negative impact on welfare activities. In research conducted in Gettysburg, Pennsylvania, by Kapp *et al.* (2014), traffic noise pollution was examined. Over the course of three weeks, noise pollution was measured in dB (A) using a sound meter at a total of nine (9) sampling sites, six (6) of which were located in the town and three (3) of which were on the college campus. Their findings show that noise pollution in the town in which the highest recorded noise level was 99.6 dBA was found to be louder than 70 dB (A) above the noise threshold set by the World Health Organization to indicate possible hearing damage overtime.

Data about noise in Nairobi, Kenya, was gathered through field measurements by Wawa and Mulaku (2015). The authors investigated the mapping of noise pollution using GIS, a sound level meter, and a portable GPS. During site visits for sampling, coordinates were recorded along with readings. According to the study, the central business district's (CBD) average noise levels ranged from 61 dB to 78 dB, rising from the west to the east, and were primarily caused by vehicles. Their research was successful in locating and establishing a number of noise hotspots, mostly to the east of the CBD. Similar research was conducted by Abbaspour *et al.* (2015) on the hierarchal assessment of noise pollution in district 14 of Tehran Metropolitan City. At each of the eighty-eight (88) stations, the equivalent sound pressure level was measured using a sound level meter, and at the same time, GPS was utilized to record the location of the measurement point. Their findings revealed that out of 88 measurement points, 63 stations' average equivalent sound levels were higher than 70 dB. (A).

It was concluded from the results of the studies from the literature reviewed above that, in addition to traffic noise, there were other elements that contributed to noise pollution in urban areas, such as diverse land uses, population distribution, and types of passageways. While they might not have the same level of consequences in cities, it is regrettable that studies on noise pollution have given little consideration to the implications of urban environmental noise in residential settings. Hence, this study identified and addressed the gap within the literature that while many studies have been conducted on the impact of noise in the environment, less attention is given to the implications of urban environmental noise in residential settings particularly in sub–Saharan Africa.

Material and Methods

Geographically, the study area is located in the city of Minna, the capital of Niger state, in the north central geopolitical zone of Nigeria. Minna is located at latitude $9^0$37’ North and longitude $6^0$33’ East and occupies an area of about 884 hectares. According to the 2006 Nigerian census, the estimated population was 304,113, but the city is currently estimated to have a population of about 479, 000. This study was conducted in two stages: (i) using noise measurement equipment in both exposed and non-exposed areas of the Minna metropolis; and (ii) conducting health investigations in seventeen (17) residential environments. This research work was carried out with the use of the following instrument for data collection:

(i) A sound level meter was used to collect the noise readings over the selected random points, which have been used in a similar noise study by Kapp *et al.* (2014) and Abbaspour *et al.* (2015). For this work, Extech 407730 was useful. The model characteristics include an accuracy of ±2dB accuracy, A and C weighting, and a 40 to 130dB measuring range.

(ii) The hand-held geographic positioning system (GPS) was used for taking the coordinates of points where noise level was recorded. This instrument (handheld geographic positioning system) was also used by Wawa and Mulaku (2015) in research work on noise.

(iii) A well-structured questionnaire was used for data collection. It collected useful data and information from respondents, which helped to understand their opinions about noise pollution in their environment and how they have been affected. A structured questionnaire was also used in a similar noise study carried out by Mishra *et al.* (2010).

Data Collection

The sound level meter was stationed at the different sampling points at specific times of the day, which included 8:00am to 8:15am, 12:00pm to 12:15pm, 4:00pm to 4:15pm, and 6:00pm to 6:15pm. These time periods were considered because they indicate the time in which specific activities are carried out around Minna. 8:00am indicates the time of movement to work in the morning, 12:00pm indicates the time when work activities would have started; 4:00pm shows the time when some workers close from work and also closing time for students; and 6:00pm indicates the time at which activities for the day end. To assess the level of exposure to road traffic noise in each of these locations, noise maps were created. An area to which a certain class of values expressed in decibels (dB [A]) corresponds is limited by noise maps, which describe external ambient noise using indicators that are determined by reference periods and represented by lines that indicate the same rating levels (isophone lines).

To link the noise level with the different land use types in Minna, a land use map of Minna or visual method (field interpretation) was used to relate the noise level to different land uses in the study area. The land use map or visual method shows the area with the highest or lowest level of noise due to the activities going on in such an area. To identify the causes of noise pollution. Questionnaires were used to collect information from respondents to know what causes noise pollution in their environment. A field survey was also carried out to determine the various causes of noise pollution. To determine the focus area for noise management in Minna, this was achieved using the noise map generated from objective one to show areas with noise levels above NESREA noise standards.

Stratified random sampling was adopted for this study. Thirty (30) sampling points were required to carry out the noise level reading, the map of Minna was divided into strata using fishnet which provided 20 points for noise reading and was later transferred to Google map of Minna to identify those points selected (Figure 1). This method was carried out with the use of ArcGIS10.1. Purposive sampling also referred to as judgment or selective sampling: 20 sampling sites were chosen purposively for noise reading after which 20 points have been selected using the fishnet method in ArcGIS10.1. To determine how residents in urban soundscapes perceive and react to noise, a cross-sectional study was carried out. The study population was made up of adults over the age of 20 who volunteered to participate by filling out a questionnaire. They received instruction booklets outlining the study's purpose and nature. To gather pertinent data regarding noise pollution, the researchers created a well-structured questionnaire that was then distributed by research assistants to the study area's residents. This was administered based on the age of people ranging from 16 years of age and above. The questionnaire was distributed randomly to 900 people.

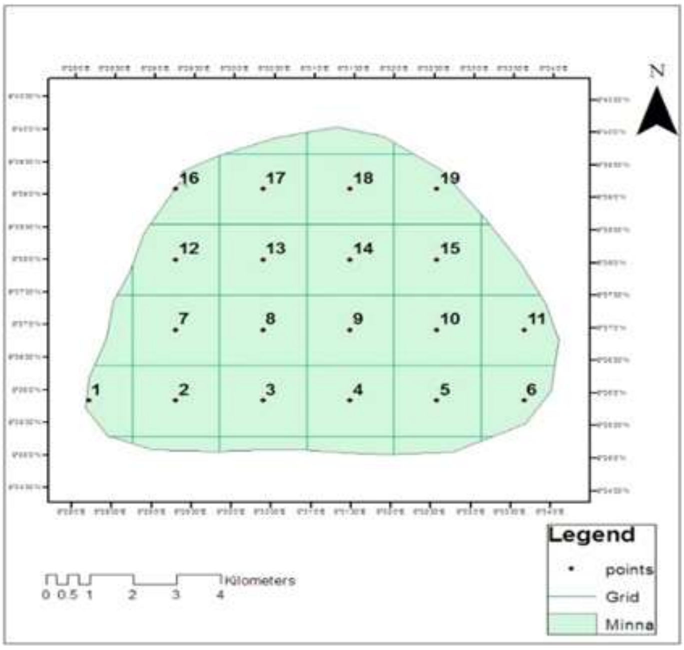

Figure 1. Random points for noise reading using fishnet ArcGIS

Data Analysis and procedure

Based on the descriptive study, a demographic profile of the populace was created that took into account how they perceived noise sources, environmental issues, and the consequences of exposure to the urban soundscape. The Chi-square test was used to find correlations between the respondent's time spent in the environment and how their well-being was affected by noise pollution. Descriptive data analysis was used to analyse the data collected. The noise level collected was used to create a map showing the temporal distribution of noise and the intensity of noise in the study area. The inverse distance weighting interpolation technique is utilized for temporal data processing (IDW). A particular deterministic method for multivariate interpolation using a predetermined distributed collection of points is known as IDW. A weighted average of the values available at the known points was used to generate the values allocated to the unknown points.

The focus area for noise management in Minna was determined using the reclassified noise map, which was compared in accordance to NESREA's (National Environmental Standards and Regulations Enforcement Agency) permissible noise level for various land uses using the reclassifying tool in ArcGIS. The reclassified map was overlaid on the land use map of Minna to determine the land uses and their associated noise. Areas with noise above the NESREA (2009) noise level standard were the areas to focus on for noise management. The causes of noise in the various areas derived from the structured questionnaire were useful in determining the noise management strategy. The demographic profile of the population was examined using descriptive data analysis in relation to how each group perceived noise and its consequences on their well-being. The possible impacts of this noise exposure in the domestic environment were examined using the Chi-square test to determine connections between exposure and perception of sources. For the questionnaire, reliability statistics were conducted for the items in the questionnaire and the Cronbach alpha value obtained was 0.5. This falls within the acceptable value and implies that the finding is reliable.

Results and Discussions

From the results obtained, most of the respondents are male, with 65.1% being male and 34.9% being female. Also, 36.8% are from the age group of 25–34 years old, and 17% are from 35–44 years old, and 35.9% are aged 16–24 years old, and only 7.8% are aged 45–54 years old. From the results of the survey, 32.4% of the respondents have O-level results and 27.8% are graduate or HND holders, 8.3% are postgraduate students, and 19.5% are vocational or ND holders, with only 11.9% having no formal education. 41% of the respondents are students, and 25.5% are traders, and 21.8% are civil servants. To achieve objective 1, which is to "*determine the residential neighbourhood most prone to noise pollution in Minna*". The spatio-temporal distribution of noise map established over Minna metropolis was determined to be able to identify the residential neighbourhood areas most prone to noise pollution across the metropolis. The spatio-temporal distribution of the noise map created across the Minna metropolis is shown in Figures 2–5. Figure 2 depicts the spatiotemporal distribution of noise across Minna and its environs in the morning, with the red colour indicating the greatest noise level at 94 dBA. while the lowest noise level recorded is 52 dBA, indicated by the yellow colour tone.

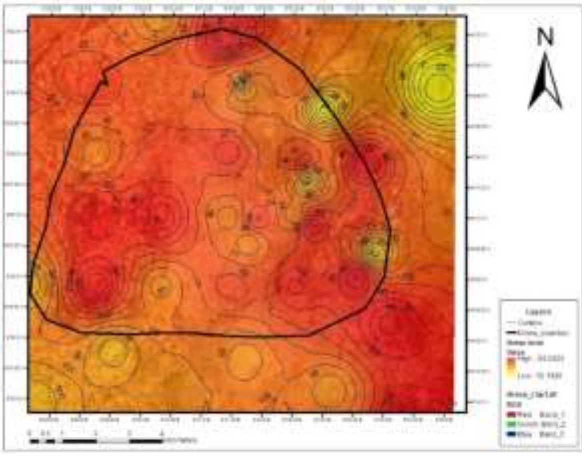

Figure 2. Noise map for morning time (8:00am)

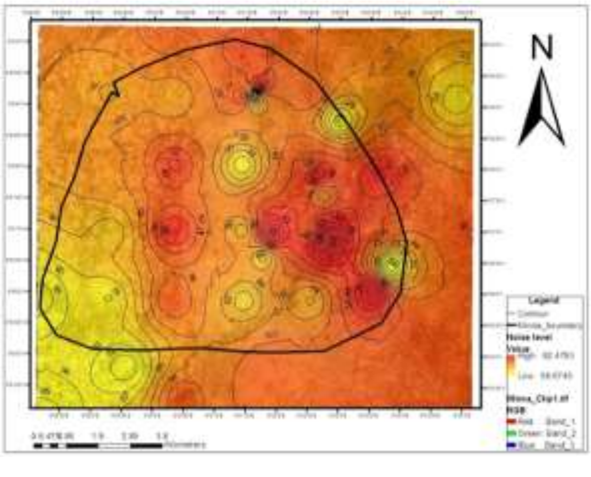

Figure 3. Noise map for midday (12:00 noon)

The highest noise level at this time is prominent in the south-east, some parts of the upper south-west and the lower part of the north-east. Meanwhile, the extreme north-east and the lower part of the south-west have lower noise. Hence, residential neighbourhoods which fall into these areas will experience various noise levels according to the values obtained. This finding corroborates with that of Oyedepo *et al.* (2013), whose work on noise pollution assessment in Nigeria was carried out by measuring noise levels at different hours of the day and found that interpreted noise for residential indicates that the highest noise level was observed at different locations and the lowest level at another location during the day time. Similarly, the compacted contours also depict areas with high noise, while the scattered contour line shows the noise spreading. Similar contour values indicate places with similar noise. The high level of noise during the morning time in Minna could be explained to be associated with the time where daily activities in Minna are gathering up due to the rush hour.

Areas with low noise values could be attributed to the land use type and the low level of activities in such areas. Some areas that had deep red now have a light or yellow colour, indicating a reduction in noise. This indicates that activities causing noise have moved from noise-concentrated areas to the centre of human activities. Figure 3 reveals the highest noise level recorded at noon to be 92dBA and the lowest noise level, which is 58 dBA. The hot red tone indicates areas with very high noise, and the yellow colour indicates areas with very low noise. The south-east, the lower part of the north-east and some parts of the north-west and south-west of the region experience the highest noise, while the south-west and some parts of the north-west, north-east and south-east experience very low noise. This is also similar to the contour lines; the dense contours are areas with high noise, and the loose contour lines show areas with low noise level. It can be seen from the noise spread over Minna at noon that noise pollution is now concentrated in the central part. This represents areas where most human activities are at their peak. Thus, when the two maps in Figure 2 and 3 (i.e., for morning and noon time) were compared, the result indicates that noise pollution has reduced in some areas with higher noise.

The noise map shown in Figure 4 indicates the result of the noise recorded at that time. The findings show that the selected locations with red colour recorded up to 96 dBA are exposed to a higher level of noise pollution than the areas with yellow colour that recorded up to 56 dBA. The extreme south-west and a few parts of the south-east and north-east experience low noise, while the rest experience very high noise. The 6:00pm map depicts further spread of noise over Minna. This looks fairly similar to the 8:00am noise map, whereby noise has spread over the whole of Minna and its environment. This could be due to the return of human activities to the various spaces.

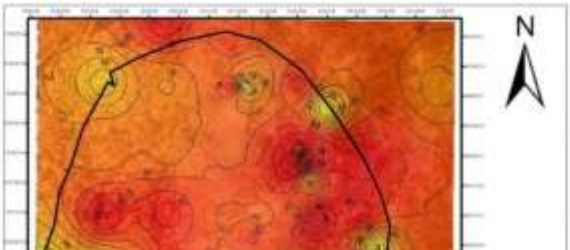

Figure 4. Noise map for evening time (6:00pm)

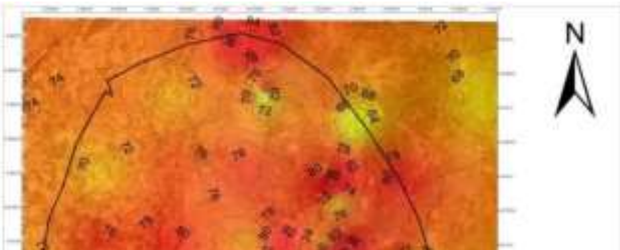

Figure 5. Noise map for overall mean noise level

Figure 5 explains the overall mean noise level experienced in Minna and its environment, with the highest noise of 90 dBA indicated in red and the lowest noise of 58 dBA indicated in yellow. The outcome demonstrates that in Minna, locations with a red tone and packed contour lines are those that are exposed to very high noise levels, while areas with a yellow tint and dispersed contour lines are those that are less noisy. Table 1 shows the maximum permissible noise level for the general environment from daytime to midnight and vice versa, obtained from the National Environmental Standards and Regulations Enforcement Agency (NESREA) permissible noise level for various land uses. The values in the table were used to establish the tolerable noise level for land uses that was observed in the city.

Table 1. Maximum Permissible Noise Level for General Environment

Facility	Noise limits dB (A)	
	Day 6:00a.m to 10: 00p.m	Night 10:00p.m to 6. 00a.m
Institutes for learning, offices etc.	45	35
Residential areas	50	35
Mixed residential (with some commercial and entertainment)	55	45
Residential + industry	60	50
Industrial	70	60

Source: NESREA (2009)

To achieve objective 2, which is to "*determine the implications of noise pollution on residents' well-being*", residential areas within the areas where noise measurements were taken were identified. The values for the noise level recorded were calculated and benchmarked against the standard noise limit as shown in Table 1. The result is presented in Figure 6, showing the residential neighbourhood of Minna and its different noise levels. The values obtained include the minimum, maximum, and mean noise for the entire neighbourhood. According to NESREA (2009), the reference parameters of 50 dB(A) (Table 1) were compared to the World Health Organization's recommendation of 55 dB(A) for residential areas. This comparison showed that the residential neighbourhoods' urban noise levels were intolerable in terms of acoustic comfort. As it can be seen in Figure 6, all of the values exceeded the standard noise limit for residential areas. This shows that these areas, alongside the residential environment in these areas, are exposed to very high levels of noise, which can be harmful to the health. Incidentally, responses from the respondents showed that noises from places of worship and traffic noise were the most pronounced and were consequently rated higher than other sources of noise. This outcome is comparable to that of Abbaspour *et al.* (2015) who evaluated noise pollution in Tehran Metropolitan City's metropolitan regions on a hierarchical basis. They demonstrated that in addition to traffic noise, other elements such as land use, population density, and the type of routes also contributed to noise pollution in urban areas, albeit not to the same extent. Unfortunately, this has received less attention in research that evaluates noise pollution.

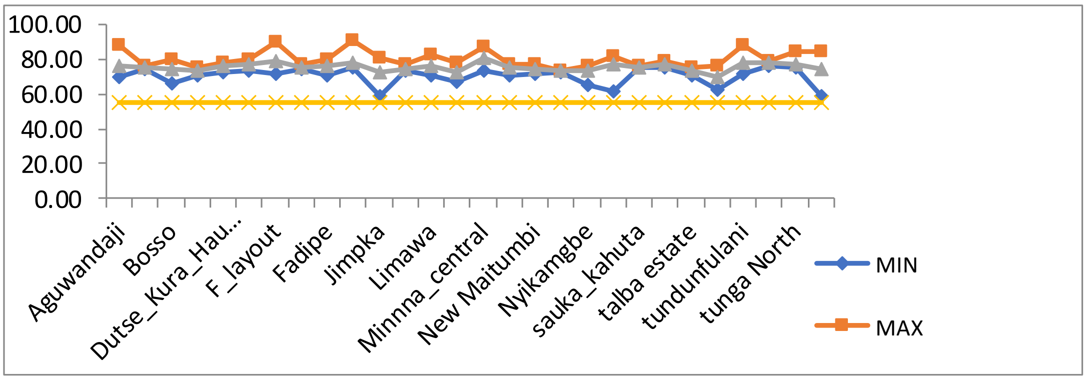

Figure 6. Minna residential neighborhoods and their noise level

In addition to the findings above, to determine the implication of the noise pollution on the residents who live in the high-level noisy area as shown in Figure 6, the residents were asked in the questionnaire to indicate from various options of possible effects of noise pollution on their wellbeing. According to the questionnaire responses shown in Table 3, 79% of the respondents said that noise pollution had an impact on their wellness. About one third (31.1%) indicated that noise pollution causes general disturbance (irritation) for them. This was followed by 24.4 percent indicating that it causes headache for them. To other respondents (10.1%) noise pollution is causes them loss of sleep/insomnia while for others (7.5%) it causes stress. The findings of Mead (2007), Martins *et al.* (2006), and Paneto *et al.* (2017), who focused on the "connection between urban noise and the health of users of public places," are comparable to those of these studies. In a study similar to this one, Paneto *et al.* (2017) asked 375 participants to complete a questionnaire. The results revealed that the most common responses to noise exposure were irritation (58%) and headaches (20%). (20 percent). Meanwhile, Martins *et al.* (2006) found that people who experience long-term noise exposure are more susceptible to headaches than those who do not.

Table 3. Implications of noise pollution on the respondents' well-being

	How would you describe the effect of noise pollution on your wellbeing	Frequency	Percent	Rank
Valid	No disturbance (can tolerate)	185	21.0	3
	General Disturbance (irritation)	274	31.1	1
	Headache	215	24.4	2
	Hypertension	24	2.7	6
	Loss of Sleep/Insomnia	89	10.1	4
	Stress	66	7.5	5
	Hearing loss due to continuous noise	10	1.1	8
	Physically and mentally affected	17	1.9	7
	Total	880	100.0	

In order to know the extent of the effect of noise pollution on the residents who indicated that noise pollution impacts their wellbeing, how the length of stay of the respondents in the residential environment affects their wellbeing was investigated. The length of time the respondents had lived in the area was requested of them. A cross tabulation was performed to know if the length of stay of the respondents in the residential environment is associated with the effect of noise pollution on the respondents. Results from Table 4 reveal that the majority of the study's population, or 79 percent, answered questionnaires in a way that showed they were aware of the negative consequences of noise exposure. This level of awareness is considered to be high. Hence, the result from the cross tabulation shows how the length of stay in the residential environment contributes to the effect of noise pollution on respondents' wellbeing.

From Table 4, 363 respondents who had been in the environment between 1–5 years experienced headaches, hypertension, loss of sleep, stress, and hearing loss, while 98 respondents who had spent over 20 years in the environment had also experienced irritation, headache, hypertension, loss of sleep, stress, and hearing loss. Each of the respondents has experienced one effect of noise pollution or the other as the length of stay increases in the environment. To confirm these findings, the relationship between the length of stay of the respondents in the environment and the effect of noise pollution on their wellbeing was further examined through the following hypothesis:

H_0: There is no relationship between the length of stay of the respondent and the effect of nose pollution on their health.

H_1: There is a relationship between the length of stay of the respondent and the effect of nose pollution on their health.

Table 4. Length of stay in the environment and the effect of noise pollution on respondents' health

		How long have you lived in your current neighbourhood (in years)					
		1-5	6-10	11-15	16-20	20+	Total
How would you describe the effect of noise pollution on your wellbeing	No disturbance (can tolerate)	83	51	20	14	17	185
	General Disturbance (irritation)	132	68	26	17	31	274
	Headache	80	51	36	19	29	215
	Hypertension	2	10	6	5	1	24
	Loss of Sleep/Insomnia	46	20	10	10	3	89
	Stress	9	29	9	12	7	66
	Hearing loss due to continuous noise	3	1	0	3	3	10
	Physically and mentally affected	7	3	0	0	7	17
Total		362	233	107	80	98	880

Table 5 shows the result of the Chi-Square tests that were carried out to know if the relationship is significant. There is a significant and positive relationship between the length of stay in the environment and the effect of noise pollution on the respondent's well-being since the significant value is less than 0.05. Therefore, as the length of stay increases, the effect of noise pollution also increases on the health of the respondents.

Table 5. Chi-Square Tests to know if there is significant relationship between the length of stay of the respondent in the environment and the effect of noise pollution on their wellbeing

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	94.916[a]	28	.000
Likelihood Ratio	96.212	28	.000
Linear-by-Linear Association	11.176	1	.001
N of Valid Cases	880		

a.12 cells (30.0%) have expected count less than 5. The minimum expected count is .91.

Table 6. Relationship between educational qualification and the respondents' perception of noise pollution

			Educational Qualification
Kendall's tau_b	How would you describe your knowledge about noise pollution	Correlation Coefficient	.242**
		Sig. (2-tailed)	.000
		N	880
	How important is the issue of noise pollution to you personally?	Correlation Coefficient	.179**
		Sig. (2-tailed)	.000
		N	880
	Do you perceive any problem of noise pollution in your neighbour?	Correlation Coefficient	-.150**
		Sig. (2-tailed)	.000
		N	880
	Does any particular noise annoy you on a daily basis?	Correlation Coefficient	-.020
		Sig. (2-tailed)	.495
		N	880
		N	880

Further investigation was conducted to ascertain the relationship between an occupant's educational level, occupation, and perception of noise pollution. 28.3% of the respondents took the issue of noise to be very important; 25.3% took the issue of noise as moderately important; and 18.9% took it as slightly important; while only 21.8% did not regard noise pollution as an issue. 57.2% of the respondents perceived an issue with noise pollution in the area, while only 32% did not perceive it. To ascertain whether there is a relationship between educational attainment and the respondents' impression of noise pollution as indicated by the following hypothesis, Kendall's tau b analysis was conducted.

H_0: There is no relationship between educational qualification and their perception of noise pollution
H_1: There is a relationship between their educational level and their perception of noise pollution.

Table 6 shows the findings of Kendall's tau b analysis to ascertain the association between respondents' perceptions of noise pollution and their level of education. The findings indicate a substantial correlation between educational background and how residents describe their familiarity with noise pollution. The crucial value is less than 0.05, so the null hypothesis is rejected. The relationship is observed to be moderate and positive, with pho being 0.242. This implies that an educated person will be more knowledgeable about the impact of noise pollution on their well-being than a respondent who is less educated. It was also discovered that educational qualification has a significant relationship with the importance of noise pollution to the respondent personally. The relationship is observed to be weak and positive, with pho being 0.179. This implies that a well-educated person will take the issue of noise pollution more seriously than a less educated individual, which may be due to the fact that they know the implications of its effect on their well-being**.**

To achieve objective 3 of this study, which is to "*propose urban noise management strategies for residential environments with a view to limiting its adverse effect on the urban populace*", The study investigated the residential areas for noise management in Minna and its environment. Figure 7 shows the result of the analysis conducted, which indicates the priority residential environment for noise management in Minna metropolis.

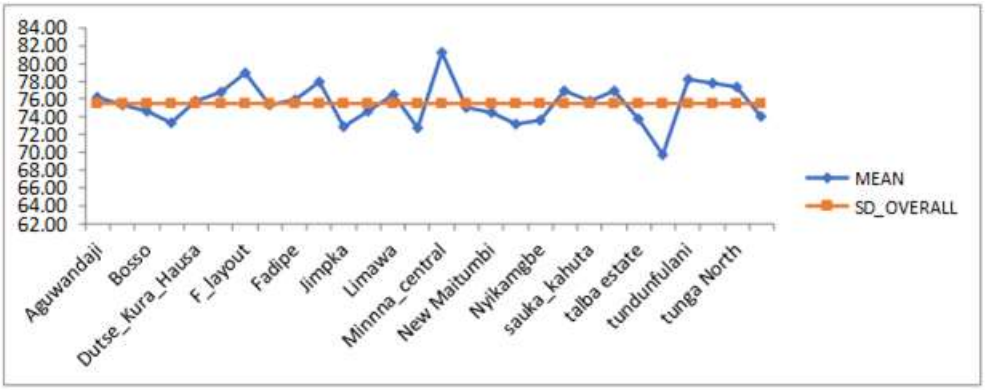

Figure 7. Residential neighborhood most prone noise for noise management

The residential environments as shown in Figure 7 with points which exceed the standard deviation for the noise level calculated include: Anguwandaji, Dutse_Kura_Hausa, Dutsen_Kura_Gwari, F_layout, Gbeganu, Fadipe, GRA Jimpka, Kpakungu, Limawa, Maitumbi, Minnna_central, Nasarawa, New Maitumbi, New GRA, Nyikamgbe, Sabon Gari, Sauka_kahuta, Shango, Talba estate, Tayi_village, Tundunfulani, Tunga low-cost and Tunga North. Thus, it may be said that these home settings can be classified as an area that is acoustically polluted. The areas with points below did not exceed the standard deviation. As a result, residential areas with sound levels below the standard deviation can be considered optimal and acoustically regulated settings. As a result, other evaluations might use their specifics as a point of comparison. Thus, Minna's priority regions for noise management are those places above the standard deviation that can be categorised as acoustically contaminated areas. Table 7 shows the respondents' rate of the degree of annoyance of noise to them.

Table 7. Degree of annoyance of noise to you Cross tabulation

		Rate the degree of annoyance of noise to you							
		Very low	Low	Neither low or high	High	Extremely high	Total for high & extremely high	Rank	Total
Location	Angwandaji Minna	6	11	20	42	0	42	1	79
	Bosso	11	26	6	8	7	15	11	58
	Democratic Garden	2	2	5	6	3	09	14	18
	Dutse Kura	4	27	25	26	8	34	2	90
	F Layout	0	16	20	10	5	15	11	51
	Fadekpe	8	23	13	11	7	18	9	62
	Garima Junction	13	15	19	3	4	07	15	54
	Gudugudu Maitunbi	5	15	7	24	3	27	4	54
	Jikpon	0	19	28	27	6	33	3	80
	Limawa	2	9	22	25	1	26	5	59
	Mobil Central/Old Airport Road	1	6	6	11	1	12	13	25
	Mobile Park	10	9	6	4	0	04	16	29
	Nikangbe	4	8	24	22	2	24	6	60
	Talba Estate	7	21	16	14	2	16	10	60
	Tundun Fulani	1	12	23	20	4	24	6	60
	Tunga North	11	7	4	14	5	19	8	41
Total		85	226	244	267	58			880

Considering different locations in Minna metropolis, the rate of the degree of annoyance of noise in each location varies. For instance, in Angwandaji, 53% (i.e., out of 79 respondents, 42 considered the degree of annoyance of noise to be high). In Bosso, 26% (i.e., 8 considered it as high and 7 considered it as extremely high) In the Dutse Kura area, 29% (i.e., out of 90 respondents, while 26 considered it as high) In the Gudugudu Maitunbi area, 44% (i.e., out of 54 respondents, 24 considered the degree of annoyance of noise as high). In the Jikpon area, 34% (i.e., out of 80 respondents, 27 considered the degree of annoyance of noise as high). In the Limawa area, 42% (i.e., out of 59 respondents, 25 considered the degree of annoyance of noise as high). In the Nikangbe area, 37% out of 60 respondents considered the degree of annoyance of noise as high. In Tundun Fulani, 33% out of 60 respondents, 20 considered it high. The rate of the degree of annoyance that environmental noise causes the respondents was cross-tabulated with the residential location where they live. The sum of those who rated high and extremely high their degree of annoyance was found and ranked. Findings show that Angwandaji ranked 1st, followed by Dutse Kura 2nd, Jikpon 3rd, Gudugudu Maitunbi 4th, and Limawa 5th. This finding was supported by the measured mean sound pressure levels, which indicated that the residential neighbourhood had the highest noise level at 90 dBA and the lowest noise level at 58 dBA. All these residential areas were corroborated with the results earlier discussed above, as they are the same residential areas where the calculated noise level was above the mean standard deviation obtained. This finding implies that these residential areas are the area's most prone to noise pollution in Minna metropolis and are to be targeted for noise management.

Recommendations and Implications of the Study

Based on the findings above, this study suggests the need for improved environmental quality in the built environment. This could be achieved through a synergistic intervention from architects, other built environment professionals, and environmental protection agencies on tackling urban environmental pollution in residential environments. The following recommendations could be considered by relevant stakeholders to control noise pollution and as strategies to mitigate the health impacts of noise in the residential environment.

- Nature-based solutions (e.g., the creation of community gardens, parks, simple green infrastructure, green roofs, and green facades) should be introduced to residential environments to improve the health of the citizens.
- Barriers from vegetation (e.g., tree planting) can be introduced to increase mixing and dilution of pollution levels more quickly. Vegetative barriers will provide modest attenuation up to 0.52 dBA/10 m.
- The use of natural topography as a barrier and/or erecting commercial buildings between roadways and residential areas are valuable strategies to reduce noise pollution.
- Residential buildings should be designed with the integration of suitable absorbing noise materials for walls, doors, windows, and ceilings to reduce the infiltration of noise into the building.
- A noise management policy implementation plan should be developed by the municipal management for noise reduction in residential environments.

The implications of this study are that the methodology and the results obtained and presented could be of interest to experts working in the fields of architecture, urban planning, environmental noise control, and city management. In making decisions to address issues with urban planning and worries about noise pollution in the environment, it could support urban managers.

Conclusion

The study uses monitoring, mapping, and a questionnaire as a tool for effect evaluation to show the geographical temporal distribution of noise and the priority locations for noise management in Nigeria's cities and its residential neighborhoods. According to measured data, Nigerian cities and their surroundings are subjected to noise levels that range from very low to excessively high when compared to national and international standards. The study found that residential environments around the following areas in Minna, namely: Agwandaji, F-Layout, G.R.A, Minna central (Mobil roundabout), Tundun Fulani, Tunga north, and Tunga south, have the highest level of noise. Incidentally, responses from the respondents showed that noise from places of worship and traffic noise were the most pronounced and were consequently rated higher than other sources of noise. The significance of this research lies in the necessity for further investigation, since it has important ramifications for architects, urban planners, and urban managers. It implies that individuals in some urban areas are subjected to noise levels that are excessive for their health and well-being. Therefore, some corrective measures are required to keep the current situation from deteriorating further. Based on the study's findings, it can be said that Nigerian cities urgently require the implementation of noise control and standards in order to reduce the impact of urban environmental noise pollution in residential areas. This study recommends nature-based solutions, barriers from vegetation, use of natural topography as a barrier, integration of suitable absorbing noise materials, and the development of policy for noise reduction.

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Conflict of Interests

The author declares no conflict of interest

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