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Modelling the Subjective Road Traffic Noise Annoyance Levels in Nairobi City, Kenya

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Abstract

This study aimed to survey and evaluate the subjective noise annoyance levels in Nairobi City. Being the capital city of Kenya in East Africa, Nairobi is undergoing rapid growth, like many developing cities globally. Road traffic levels are witnessing a phenomenal increase, accompanied by a corresponding change in the ambient soundscape across the city. Previous research has shown that Road Traffic Noise (RTN) is the most prevalent pollutant that disturbs the quality of life in urban environments, hence the justification of the present research. The research team deployed customized questionnaires, which were distributed among samples across 42 locations. The questionnaires had two scales, the 0 - 10 Richter Scale and a 5-point verbal qualifying scale. A total of 384 participants were sampled from the main population frame, and each location had at least 9 survey questionnaires for each set. The Department of Civil and Construction Engineering, University of Nairobi, coordinated data collection across the city between 6th July 2025 and 12th July 2025. The data clerks conducted a purposive sampling for a face-to-face interview using the two scales. The two scales were combined, and on analysis, the level of highly annoyed (HA) individuals ranged between 10% and 100%. Further using *OriginPro* 2025*b* Software and MS Excel, different exposure-response relationships were developed to show how the equivalent sound pressure level varied with the number of highly annoyed individuals. It was found that, as the equivalent sound pressure level increased, so did the number of highly annoyed individuals. The low coefficient of determination (R^2) values obtained compared well with those of other similar previous studies, which indicates that Nairobi has a high RTN environment. Further, the residents have adapted to chronic RTN exposure, which has lowered their perceptual sense of elevated sound pressure levels on the reported annoyance. Therefore, this study does provide a baseline for city authorities to develop and implement RTN's abatement measures and policies aimed at making neighborhoods quieter. In addition, the new policy may transcend sustainable traffic flow management.

Keywords

Road Traffic Noise, Annoyance, Exposure-Response

1. Introduction

With the rapid rise in urbanization, cities have faced a corresponding increase in vehicular traffic, unplanned urban sprawl, and deteriorating infrastructure. These factors all contribute to environmental degradation, including noise pollution [1]. Over 100 million people in Europe alone have been estimated to be exposed to noise levels higher than 55 dBA, with over 30 million more exposed to even higher levels above 65 dBA thresholds, which are known to be associated with increased rates of health risks [2]. The most common, yet understudied, effect of urbanization is Road Traffic Noise (RTN). It is a major source of noise pollution, followed by rail and airport noise [3]. RTN is an ongoing environmental stressor that has an impact on people's quality of life and public health. Globally, the World Health Organization (WHO) has acknowledged RTN as a significant public health concern, and it has been linked to a range of adverse effects, such as annoyance and health-related issues, such as cardiovascular diseases. In urban areas, where residents are exposed to high levels of noise, psychological annoyance is among the most frequently reported outcomes [4]. Although noise is a measured phenomenon, it is largely subjective, as its perception and impact vary significantly between individuals. A sound level that disturbs one person may be tolerable or even pleasant to another. As a result, many researchers argue that documenting how individuals perceive and react to noise should extend beyond objective acoustics metrics and include subjective responses such as annoyance [5].

Noise annoyance is defined as the emotional or cognitive disruption that occurs when people perceive noise as upsetting, distracting, or inappropriate [6]. This disruption may manifest as irritation, anger, or helplessness, particularly when noise interferes with day-to-day activities, sleep, or communication. Due to its prevalence and measurability, noise annoyance is often used as a proxy indicator of noise-related harm in environmental health studies. There are several approaches to evaluating how people respond to noise exposure. Among the many techniques adopted, community-based surveys have been widely used to gather personal and subjective responses from the community. The use of questionnaires in such surveys offers several advantages, such as affordability and efficiency. Subjective questionnaires remain a commonly utilized means for assessing perceived annoyance and disturbances to sleep caused by noise.

To support consistent evaluation of such responses, international standards, such as ISO/TS 15666:2003, published by the International Commission on the Biological Effects of Noise (ICBEN), have offered verified frameworks for assessing annoyance via organized social surveys. These technologies have been widely implemented across Europe, Asia, and North America, allowing for the development of successful noise control measures.

2. Previous Related Work

Researchers such as [7] conducted one of the earliest benchmark studies and determined the dose-response relationships between average noise exposure levels, such as the day-night average level (L_{dn}), and the percentage of highly annoyed individuals (%HA). Later on, other researchers, Miedema and Vos (1998), expanded and refined the earlier study, making it more scientifically robust and globally applicable by using a significantly larger and varying dataset, applying meta-analytical techniques with statistical weighting, and expanding the dose-response relationship to include multiple noise metrics such as day-evening-night noise level (L_{den}), day-night average noise level (L_{dn}), and the equivalent continuous average noise level (L_{eq}).

Other studies, such as in Germany [8], significantly contributed to the field of environmental noise research by focusing on cardiovascular risks as an impact of chronic noise exposure, particularly RTN, and linking %HA as a health indicator. In Switzerland, [9] added precision in modeling annoyance and sleep disturbance, incorporating survey and exposure data from populations. These studies found that &HA increases nonlinearly with increasing noise exposure, especially beyond 55 - 60 dB(A). They also emphasized that annoyance is not merely a function of sound pressure levels, but it is also shaped by non-acoustic factors such as personal sensitivity, gender, and age.

In a widely cited analysis, some researchers in [10] reviewed over 70 studies and reaffirmed the validity of logistic exposure-response relationships, highlighting variations between transportation modes and population characteristics. Their work helped refine policy thresholds and stressed the need to incorporate non-acoustic variables in annoyance modeling. Building on this framework, other studies, such as those by [11], used subjective surveys and hearing tests to develop a data-driven model for forecasting RTN annoyance. In addition to acoustic elements like the equivalent sound pressure level, their model also considered perceptual aspects such as urban shape, sociodemographic traits, visual exposure to traffic, and past familiarity with the location. Similarly, some researchers [12] developed predictive models linking RTN exposure to annoyance and noise-induced health effects in the National Capital Territory of Delhi, India. Their work employed various statistical modeling approaches, such as linear and non-linear exposure–response functions, in order to quantify the relationship between measured noise levels and reported annoyance or health outcomes.

Despite the growing body of research, cities in Sub-Saharan Africa, characterized by poor urban planning, mixed land use, limited policies on noise regulations, and high population density, have relatively few studies that focus on subjective annoyance, especially from RTN. Studies in cities like Accra [13] and Greater

Cairo [14] found that community residents are highly annoyed by environmental noise, especially RTN. They linked annoyance to the unpredictability and perceived lack of control over noise sources, such as uncontrolled public transportation systems, informal marketplaces, or frequent car horn usage. Cities like Nairobi, experiencing a surge in traffic congestion, informal transport systems, and ambient noise, lack localized data on how such exposure affects residents. Most studies have focused on the acoustic measurement of RTN [15].

As a result, the link between recorded Road Traffic Noise and subjective annoyance in these environments remains poorly understood and largely undocumented. This study sought to address this gap. To fulfill the objective, the study team did surveys using customized tools and evaluated the subjective responses of Nairobi city residents to Road Traffic Noise. The main aim of the study was to determine the severity of annoyance associated with differing levels of RTN's exposure in different parts of the city and to develop a localized model that correlates subjective annoyance reactions with road traffic noise exposure in Nairobi. The model incorporates a variety of predictors gathered through structured questionnaires based on the guide in the International Technical Specification ISO/TS 15666:2003(E), and noise measurements using a Sound Level Meter (SLM). This adds to a more comprehensive, evidence-based approach to urban noise management. The significance of this study is its potential to inform urban planning by centering on the lived experiences of Nairobi City residents, increasing public awareness of RTN and its impact on the community, and aiding in the implementation of noise abatement and mitigation strategies

3. Methodology

3.1. Study Area and Site Selection

The study area covered the entire Nairobi, the capital city of Kenya. Its spatial coverage is defined by a 14 km radius from the city center. Geographically, Nairobi is defined by a latitude of 1˚09′ and 1˚27′ South, a longitude of 35˚59′ and 37˚57′ East, covering an area of approximately 696 km^2, see **Figure 1**. National Census data collected in 2019 indicates that the city's population has increased from 2.1 million in 2009 to 4.4 million in 2019 [16].

For this study, 42 selected sites spanning a diverse range of urban settings, including high-density residential zones, commercial, industrial, and institutional zones, see **Figure 2**. These areas were chosen due to their heterogeneity in traffic volumes, road types, and surrounding land use typologies. The selected roads accommodate a wide variety of vehicles, comprising: Bicycles, Motorcycles, Saloon Cars, Pick-ups, SUVs, Public Service Vehicles (PSVs), Buses, Light Trucks, Medium Trucks, Heavy Trucks, and other forms such as tractors, contributing to non-uniform and often excessive noise, and traversing different neighborhoods. This diversity mirrors the complex urban morphology of Nairobi, making it a compelling case study. The table in **Appendix 1** summarizes each site along with the rationale for its selection.

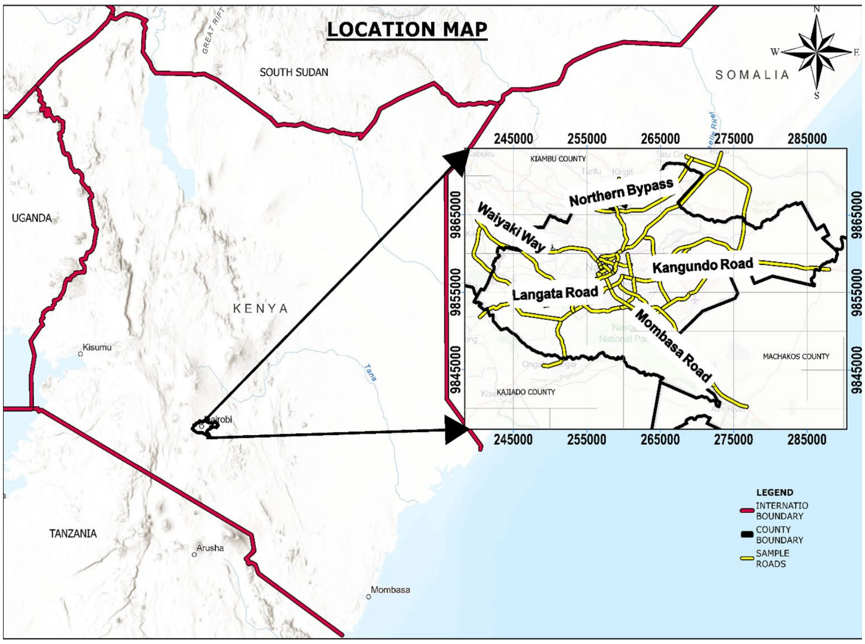

Figure 1. Nairobi city, Kenya (Source: Author).

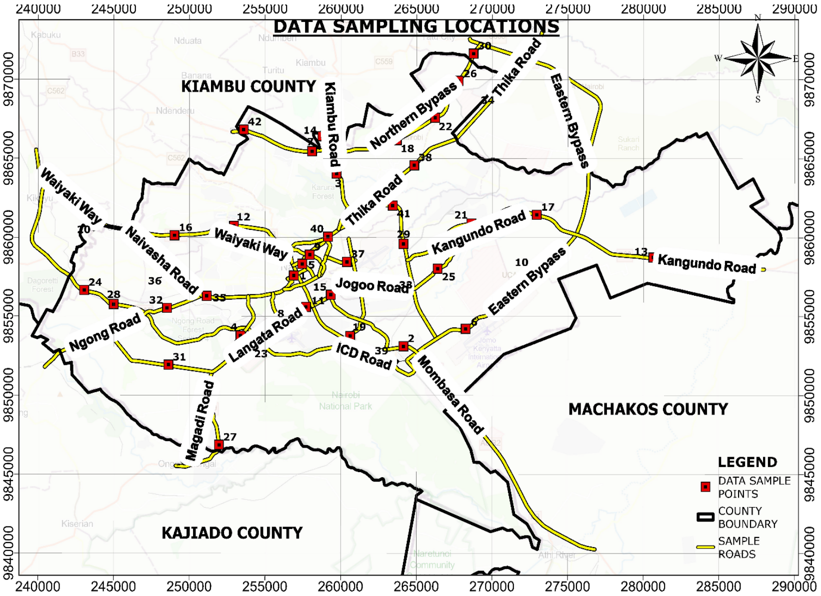

Figure 2. 42 Sampling points (Source: Author).

3.2. Data Acquisition

Based on a formula for determining sample size in large populations as formulated by [17], 384 participants were chosen to represent Nairobi's population of over a million. To guarantee inclusiveness, the sampling strategy strived for demographic diversity in terms of age, gender, residential location, and duration of stay. The ISO/TS 15666:2003(E) technical specification, which offers globally recognized standards for evaluating noise annoyance in social surveys, was followed in the standardization and design of the survey form, as shown in **Appendix 2**. Participants were able to rate their degree of annoyance with RTN using pre-formulated questions and predetermined response options. Two scales were used, the 5-point verbal scale and the 11-point scale as proposed by ICBEN [10]. The field-administered questionnaires and structured interviews were used to gather data from people either living, visiting, schooling, or working in that area.

Purposive sampling was adopted to ensure representation across different age groups, genders, and residence durations at each site. Within each location, participants were selected based on random availability in public and residential spaces rather than predefined quotas. To minimize selection bias, interviews were conducted at different times of day, and respondents were drawn from diverse activity groups, including residents, workers, students, and visitors.

Annoyance surveys were conducted once per site during a seven-day field campaign using concurrent measurement teams, each comprising a trained data clerk. Each site was assigned a single monitoring day, assuming that residents' subjective responses to RTN remain relatively stable over short periods, thereby providing a representative snapshot of community annoyance at each location. On average, approximately seven sites were covered daily through parallel field deployment, allowing all 42 locations to be completed within the study window.

In parallel, noise levels were measured directly using a calibrated Class 1 Lutron SL 4033SD Sound Level Meter (SLM) (see **Figure 3**), which conforms to IEC 61672-1 standards, across 42 selected sites in Nairobi. Fast response mode, which is ideal for capturing the rapidly fluctuating nature of RTN, was selected, and an A-weighting filter setting was employed to take into consideration how the human ear reacts to sound. To calculate important acoustic metrics, such as the L_{eq}, high resolution was ensured by logging data at 2-second intervals throughout each sampling session. The measurements taken provided A-weighted equivalent continuous sound levels (L_{eq}), forming the foundation for assessing RTN exposure across Nairobi city. At each of the 42 selected sites, noise levels were measured for fifteen-minute intervals every hour, starting from 6:00 A.M. to 6:00 P.M. This resulted in 13 recordings per site per day. These readings were averaged to obtain the daily average L_{eq}.

Figure 3. Sound level meter.

3.3. Evaluation of Subjective Annoyance Responses

To evaluate RTN annoyance, subjective responses were analyzed using an approach developed by [7] to compute and plot the percentage of the population "highly annoyed" by noise exposure to obtain an annoyance exposure-response function. This approach was further refined by researchers such as [10] [12] [18], whose work supported the World Health Organization's updated guidelines. This study applied this framework to compute and plot %HA, enabling the derivation of an annoyance exposure-response curve.

To compute the percentage of highly annoyed individuals (%HA), thresholds were set to classify a participant as "highly annoyed".

For the 11-point numerical scale, responses of 8, 9, or 10 were classified as "highly annoyed", following the ICBEN recommendation by Fields *et al.* (2001), which defines the upper 28% of the scale (8 - 10) as the standard cut-off for %HA in community noise studies [10] [19]. For the 5-point verbal scale, responses of "very" and "extremely annoyed" were similarly categorized as highly annoyed, following the approach refined by other studies [18]. Though the agreement between some responses varied, a participant was classified as highly annoyed if they met the threshold on either scale. The final %HA values for each site were calculated as in **Equation (1)**:

$$\%\text{HA} = \frac{\text{Number of participants classified as highly annoyed}}{\text{Total number of participants}} \times 100\% \qquad (1)$$

On the other hand, the SLM logged 2-second SPL values directly into an Excel spreadsheet throughout each fifteen-minute interval of measurement. The L_{eq} was computed on Excel using the logarithmic energy averaging formula as in **Equation (2)**:

$$L_{eq} = 10\log_{10}\left(\frac{1}{N}\sum_{i=1}^{N} 10^{\frac{Li}{10}}\right) \qquad (2)$$

where N is the number of sound level readings taken during the fifteen-minute sample and Li represents each SPL reading taken every two seconds. The hourly L_{eq} values for each location were computed. For each location, the L_{eq} values for all hours were averaged to obtain a daily L_{eq} measurement.

3.4. Exposure-Response Relationships

To develop the annoyance exposure–effect relationship curves, the data from the 42 sampling points were analyzed, each consisting of the L_{eq} and the corresponding (%HA). Three kinds of exposure-effect relationships were developed to model the underlying trend as applied in similar studies [6] and help assess the strength and direction of the association between measured RTN levels and the reported annoyance.

3.4.1. Linear Regression Relationship

A simple linear regression model was developed to show the relationship between the L_{eq} and the percentage of highly annoyed individuals (%HA), which was applied using **Equation (3)**:

$$\%\mathrm{HA} = \beta_0 + \beta_1 \cdot \mathrm{L}_{\mathrm{eq}} \tag{3}$$

Where β_0 is the intercept, and β_1 is the slope coefficient, which indicates the rate of increase in annoyance with increasing noise levels.

3.4.2. Polynomial Regression Relationship

To account for potential non-linearity in annoyance responses, a polynomial regression of order three model was developed to show the relationship between annoyance responses and the L_{eq} using **Equation (4)**:

$$\%\mathrm{HA} = \beta_0 \cdot \mathrm{L}_{\mathrm{eq}}^3 + \beta_1 \cdot \mathrm{L}_{\mathrm{eq}}^2 + \beta_2 \tag{4}$$

3.4.3. Logistic Regression Relationship

Logistic regression, also known as the dose-response curve, was applied using **Equation (5)**:

$$P(\mathrm{HA}) = \beta_1 + \left\{ \frac{\beta_2 - \beta_1}{1 + 10^{\left(\left(LOG(Y) - \mathrm{L}_{\mathrm{eq}}\right) \times p\right)}} \right\} \tag{5}$$

Where $P(\mathrm{HA})$ is the probability of being highly annoyed, β_1 is the lower asymptote of the curve (typically 0%), and β_2 is the upper asymptote of the curve (typically 100%). $LOG(Y)$ represents a reference sound level, and p, which represents the steepness parameter, are to be estimated.

The model assumes that the percentage of highly annoyed people increases non-linearly with noise exposure, typically taking the form of a sigmoid (S-shaped) curve.

The regression models presented in **Equations (3)-(5)** focus exclusively on acoustic exposure (L_{eq}) to establish a baseline exposure–response relationship consistent with standard noise-mapping approaches. Non-acoustic variables such as age, gender, and duration of residence are analyzed descriptively but not incorporated as covariates due to the aggregated site-level %HA metric and limited individual-level sample size per location. Future studies with larger datasets may apply multivariate regression to improve model performance.

3.5. Annoyance Mapping

The levels of annoyance and the average RTN across Nairobi City were mapped using ArcGIS/QGIS software to show how they vary across the city, helping in the identification of areas with higher or lower levels of RTN and RTN-related disturbance, thus serving as a basis for noise mitigation strategies.

4. Results

From the methodology section, %HA and L_{eq} were computed for each site using **Equation (1)** and **Equation (2)**, respectively, as shown in the table in **Appendix 3**. Linear, Polynomial, and Logistic regression models were applied to explore the relationship between RTN exposure and reported subjective annoyance.

4.1. Linear Regression Relationship

The linear regression model is shown in Figure 4, and the equation developed is shown in the table in **Appendix 4**. The model reflects a weak correlation between RTN and the percentage of highly annoyed individuals.

4.2. Polynomial Regression Relationship

The polynomial regression model is shown in Figure 4, and the equation developed is shown in the table in **Appendix 4**. This polynomial equation suggests a non-linear relationship between noise exposure and annoyance.

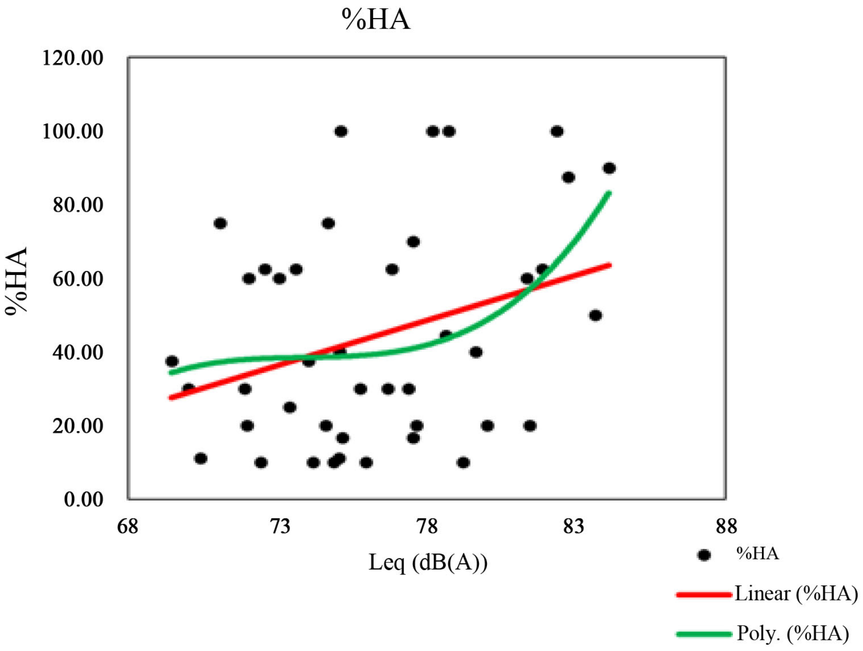

Figure 4. Linear and polynomial regression relationships.

4.3. Logistic Regression Relationship

The logistic regression model developed is shown in the table in **Appendix 4**. The result aligns with the findings of other studies found in [10] [6]. Both previous studies emphasized the appropriateness of sigmoidal or non-linear exposure-response functions in urban noise research. Although the model exhibited a low R^2, the fitted curve still provides a foundational understanding of annoyance trends in a densely populated and acoustically dynamic city like Nairobi (Figure 5).

Model performance was evaluated using coefficients of determination (R^2), as reported in **Appendix 4**. The very low R^2 values obtained across the linear, polynomial, and logistic models indicate that L_{eq} alone explains only a small proportion of the variability in annoyance responses. Formal hypothesis testing of regression coefficients was not performed in this study and is acknowledged as a limitation to be addressed in future work through inferential statistical analysis.

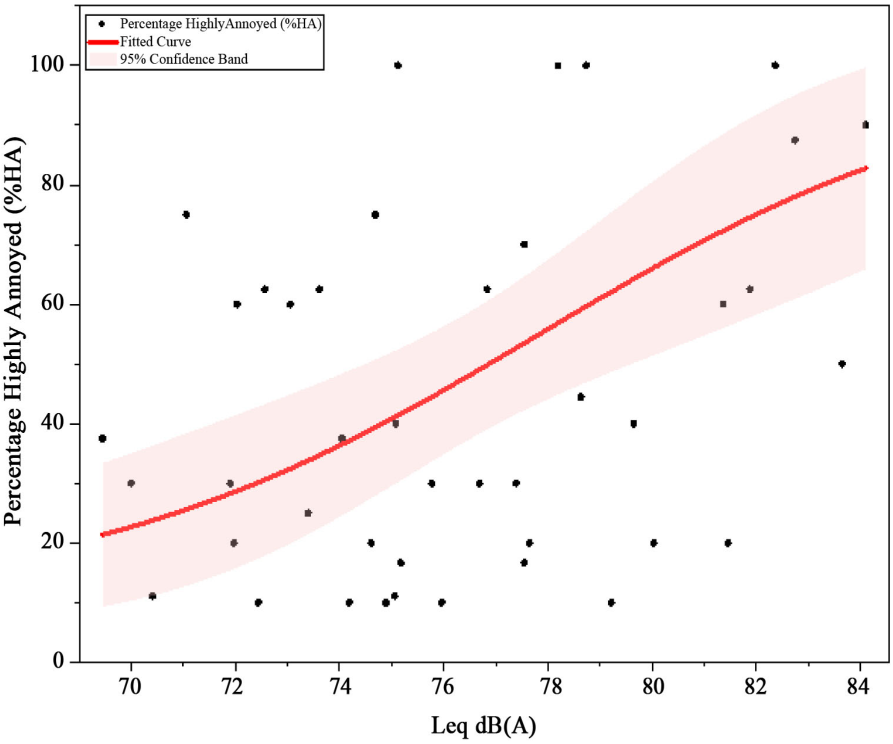

Figure 5. Dose-Response curve.

4.4. Spatial Analysis

RTN and %HA values were spatially analyzed, and the resulting map revealed distinct annoyance patterns in comparison with RTN levels across Nairobi City, see **Figure 6** and **Figure 7**.

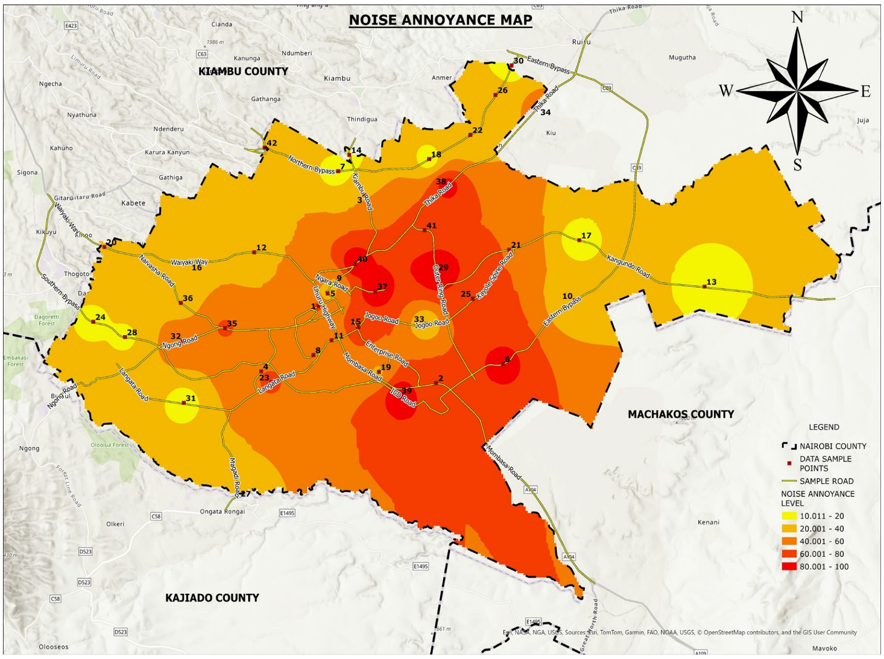

Figure 6. Map of Nairobi showing the percentage of highly annoyed individuals, %HA.

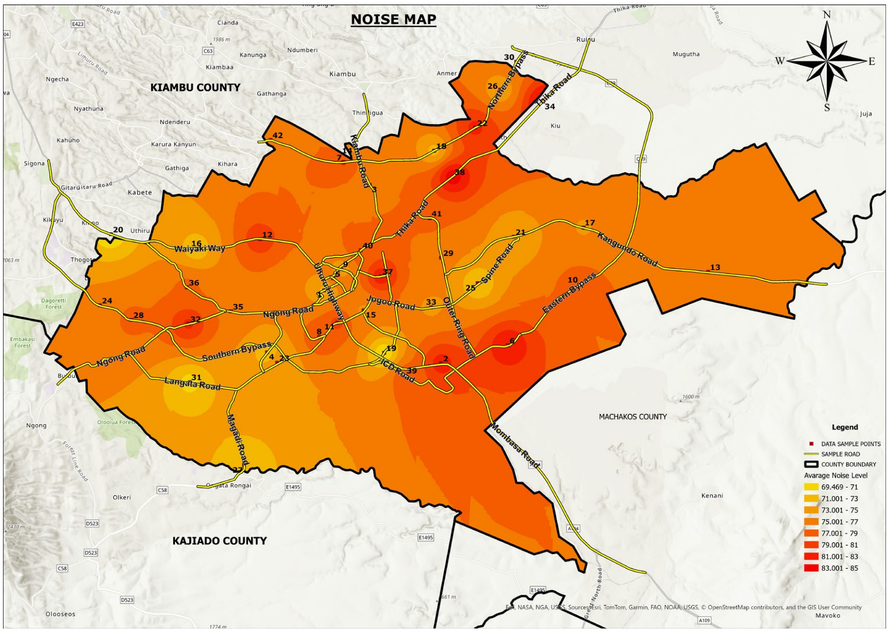

Figure 7. Map of Nairobi showing the RTN levels.

5. Discussion

From the results, a positive relationship was observed between RTN exposure (L_{eq}) and the reported levels of highly annoyed individuals (%HA). From the linear regression relationship, the model reflects a weak correlation between the number of highly annoyed individuals and the RTN levels. These findings are in line with those reported by similar studies [20], which noted that linear models may underestimate annoyance at higher noise levels. The polynomial regression relationship showed that a nonlinear relationship exists between the percentage of highly annoyed individuals and the RTN levels. Application of the logistic regression model provided a sigmoid-shaped curve illustrating a general exposure–response tendency between L_{eq} and %HA across the 42 sampling sites. However, the very low R^2 values (0.019 - 0.148) indicate that RTN alone explains only a small proportion of the variance in subjective annoyance. Therefore, while a positive trend is observable, RTN cannot be considered a strong predictor of annoyance levels in Nairobi City, and additional non-acoustic factors likely play a dominant role. Although the regression models demonstrated weak positive trends, the low R^2 values shown in **Appendix 4** confirm that RTN exposure accounts for only a small portion of the variance in subjective annoyance. Unlike other studies where moderate correlations were found (moderate R^2 values) [12], the disparity between the found values in this study and those of previous literature is likely attributable to the unique acoustic environment of Nairobi, proving that Nairobi has consistently higher baseline ambient noise levels.

This outcome underscores the complex nature of noise perception in cities like Nairobi, where even the quieter areas exceed internationally recognized annoyance thresholds, and in areas deemed to be louder, the level of annoyance may be low. This trend suggests desensitization or adaptation of RTN among community residents, thus weakening the statistical relationship between exposure and annoyance responses. Rather than being a limitation, this finding highlights the need for city authorities to develop RTN policies and targeted noise mitigation strategies. Aside from the RTN exposure levels, age, gender, and residence duration were also found to be influencing factors in annoyance levels. Younger sampled participants generally reported low levels of annoyance, possibly due to higher tolerance levels or different perceptions of RTN. Most senior and middle-aged individuals reported higher annoyance levels, suggesting increased sensitivity to RTN.

On the other hand, female participants tended to report higher annoyance levels than male participants, a pattern that mirrors the findings of some researchers [19]. In addition to these factors, individuals with longer residence duration at a particular site reported lower levels of annoyance even at higher noise levels, possibly due to adaptation over time. Newly settled individuals were more sensitive to the existing RTN levels, thus reporting higher levels of annoyance at even relatively low noise values. It was also observed that in areas with sparse settlement, such as peri-urban or roadside areas without much residential infrastructure, the annoyance levels were generally lower. This reinforces the role of both contextual and psychological factors in shaping annoyance responses, thus emphasizing that while L_{eq} remains a key acoustic indicator, non-acoustic variables also determine annoyance responses. Mapping both %HA and RTN levels spatially helps identify noise annoyance hotspots, which help in noise abatement strategies by city authorities.

These findings highlight the need for future studies to adopt multivariate modeling frameworks that integrate acoustic and non-acoustic variables such as age, gender, residence duration, and contextual factors. The absence of formal statistical significance testing represents a limitation of this study, and future research should incorporate coefficient p-values and confidence intervals within multivariate frameworks.

6. Conclusion

This study successfully applied noise measurement and subjective annoyance surveys to assess the impact of RTN across 42 selected locations in Nairobi. By analyzing the relationship between the RTN levels and the percentage of highly annoyed individuals in Nairobi city using different regression relationships, the study identified a weak positive association between increasing RTN levels and residents' annoyance; however, the low coefficients of determination indicate that RTN alone is not a strong predictor of subjective annoyance. Spatial mapping further showed annoyance hotspots in Nairobi with their corresponding RTN levels, which were noted to be mainly at densely populated residential areas, as compared to sparsely populated areas. Demographic factors such as gender, age, and duration of residence also played a role in residents' responses. These insights underscore the need for targeted noise abatement strategies and policies by the city authorities in order to improve the quality of life as urbanization grows.

Disclaimer (Artificial Intelligence)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Conflicts of Interest

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1

Table showing the sampling locations and the rationale for selection.

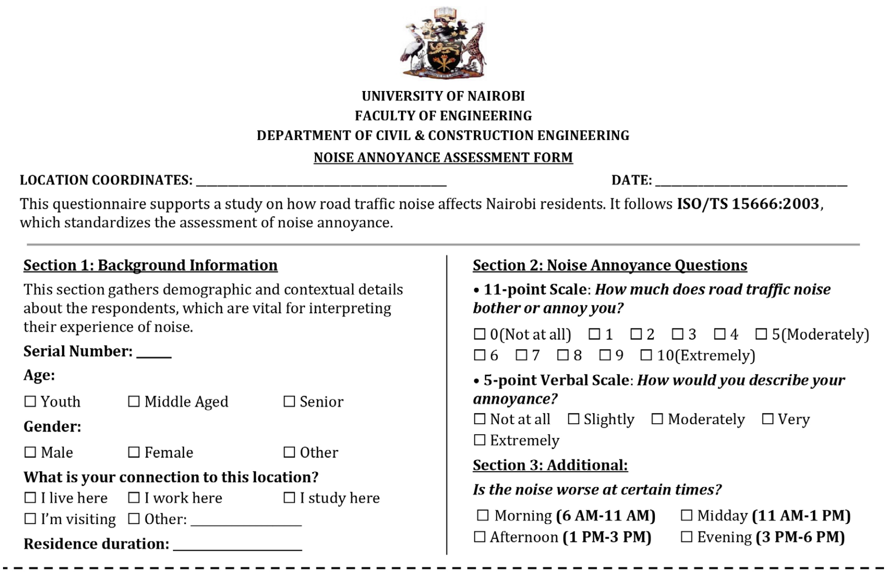
Location	Reason for Selection
1	Near the Central Business District, where there is high pedestrian and traffic interaction.
2	Busy commercial area along Mombasa Road, near junctions and high vehicle turnover.
3	Major arterial road linking suburbs to the Central Business District.
4	Connector road with moderate traffic; residential and school zones nearby.
5	Within the Central Business District, high urban noise levels.
6	Located in a busy industrial and residential zone.
7	Upmarket residential area; contrast with higher noise regions for baseline analysis.
8	Key throughway with mixed land use nearby.
9	High-density residential and commercial area near the Central Business District.
10	Fast-developing residential zone near a major bypass; captures emerging urban traffic.
11	Fast-growing satellite town; traffic congestion from Kiambu and Limuru roads.
12	Mixed-use area.
13	Major highway.
14	Populated residential and commercial area.
15	Duplicate site on the same corridor under different conditions.
16	Industrial and logistics zone; exposure to heavy goods vehicle traffic.
17	Dense urban settlement along Waiyaki Way; congestion and informal transport hubs.
18	Industrial facility zone
19	Suburban residential area.
20	Religious facility near high-traffic road; event-related traffic surges.
21	Residential estate with frequent matatu activity.
22	Represents a peri-urban corridor.
23	Major traffic artery bypassing the Central Business District.
24	Monitor noise exposure near healthcare facilities.
25	A major bypass road, suitable for studying noise from high-speed long-distance traffic.
26	Commercial center; medium-level traffic exposure in a residential setting.

Continued

27	Sensitive area near medical and educational institutions.
28	University environment near busy roads; monitors academic exposure to RTN.
29	Duplicate area along a major bypass road for comparative data.
30	Majorly experiences truck and Psvs congestion.
31	Duplicate site along a major bypass for comparative study.
32	Near an educational institution.
33	Heavily used arterial road with commercial and institutional land use.
34	Densely populated, noisy corridor serving Eastlands commuters.
35	Major superhighway with consistent heavy traffic; high noise source.
36	Major retail center along Ngong Road.
37	Informal settlement with high human and vehicle activity.
38	Busy commercial hub with vibrant informal trade and traffic congestion.
39	Duplicate location along a major superhighway for comparative studies.
40	Industrial Cargo Depot Road with high truck volume and logistics-based traffic.
41	Near the congested Pangani interchange, high traffic noise.
42	Industrial area with continuous truck movement; captures occupational and ambient noise.

Appendix 2

Field questionnaire used during the subjective annoyance survey.



UNIVERSITY OF NAIROBI
FACULTY OF ENGINEERING
DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING
NOISE ANNOYANCE ASSESSMENT FORM

LOCATION COORDINATES: ______________________ **DATE:** ________________

This questionnaire supports a study on how road traffic noise affects Nairobi residents. It follows **ISO/TS 15666:2003**, which standardizes the assessment of noise annoyance.

Section 1: Background Information

This section gathers demographic and contextual details about the respondents, which are vital for interpreting their experience of noise.

Serial Number: _____

Age:

☐ Youth ☐ Middle Aged ☐ Senior

Gender:

☐ Male ☐ Female ☐ Other

What is your connection to this location?

☐ I live here ☐ I work here ☐ I study here
☐ I'm visiting ☐ Other: ______________

Residence duration: ________________

Section 2: Noise Annoyance Questions

- **11-point Scale**: ***How much does road traffic noise bother or annoy you?***

☐ 0(Not at all) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5(Moderately)
☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10(Extremely)

- **5-point Verbal Scale**: ***How would you describe your annoyance?***

☐ Not at all ☐ Slightly ☐ Moderately ☐ Very
☐ Extremely

Section 3: Additional:

Is the noise worse at certain times?

☐ Morning **(6 AM-11 AM)** ☐ Midday **(11 AM-1 PM)**
☐ Afternoon **(1 PM-3 PM)** ☐ Evening **(3 PM-6 PM)**

Appendix 3

Table showing the computed Leqs and the corresponding percentage of highly annoyed individuals, %HA per sampling location.

Location	Leq dB (A) from SLM	%HA
1	72.57	62.50
2	81.88167	62.50
3	75.08167	40.00
4	72.03333	60.00
5	75.775	30.00
6	82.745	87.50
7	79.21833	10.00
8	78.63333	44.44
9	74.045	37.50
10	77.64833	20.00
11	76.685	30.00
12	79.64833	40.00
13	80.02833	20.00
14	75.05833	11.10
15	74.19167	10.00
16	74.69	75.00
17	71.90667	30.00
18	74.89	10.00
19	72.44667	10.00
20	69.45167	37.50
21	70.00167	30.00
22	73.055	60.00
23	81.46	20.00
24	73.61667	62.50
25	75.17917	16.70
26	71.06167	75.00
27	73.4	25.00
28	71.97667	20.00
29	77.54833	16.70
30	75.12	100.00
31	75.965	10.00
32	70.41333	11.10
33	81.36417	60.00

Continued

34	74.6125	20.00
35	83.64667	50.00
36	76.83167	62.50
37	77.38833	30.00
38	82.365	100.00
39	84.1	90.00
40	78.19167	100.00
41	78.735	100.00
42	77.545	70.00

Appendix 4

Table showing exposure-effect relationships.

Model	Equation	R^2 Value
Linear	$y = 2.459x - 143.25$	0.1058
Polynomial	$y = 0.0407x^3 - 9.0313x^2 + 667.5x - 16409$	0.148
Dose Response	$y = 10 + \frac{(100 - 10)}{\left(1 + 10^{\left(LOG_{x_0} - L_{eq}\right) * p}\right)}$ where: $LOGx_0$ 77.84 ± 1.09762 p 0.1 ± 0.03253	0.0193