THE IMPACT OF RAILWAY NOISE ON THE RESIDENT: ADAMA CONTEXT

Aron G/egziabher Hagos

A Thesis submitted to

The Department of Architecture, Urban Design, and Planning

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Urban Planning and Design

Office of Graduate Studies

Adama Science and Technology University

Adama, Ethiopia

July; 2021

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Approve of Board of Examiners

I, the advisor of the thesis entitled "**The Impact of Railway Noise on the Residence:** Adama Context." and developed by **Aron G/egziabher**, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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Major Advisor	signature	date

We, the undersigned, members of the Board of Examiners of the thesis by **Aron G/egziabher** have read and evaluated the thesis entitled **The Impact of Railway Noise on the Residence:** Adama Context." and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in **Urban Planning and Design**.

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Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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Declaration

I hereby declare that this MSc Thesis entitled “**The Impact of Railway Noise on the Residence:** Adama Context.” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation

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Name of the student	Signature	Date

Recommendation

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "**The Impact of Railway Noise on the Residence:** Adama Context." prepared under my guidance by **Aron G/egziabher** submitted in partial fulfillment of the requirements for the degree of Mater's of Science in **Urban Planning and Design**. Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

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Major Advisor	Signature	Date

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LIST OF ACRONYMS AND ABBREVIATIONS

AAP	American Academy of Pediatrics
ANSI	American National Standards Institute
ASR	Annual Statistical Report
ASTU	Adama Science and Technology University
AZDOT	Arizona Department of Transportation
CFR	Code of Federal Regulation
CSA	Central Statistics Agency
DALYs	Disability-adjusted Life Year
DEM	Digital Elevation Model
dBA	Noise level is thus described in decibels A
DOI	Digital Object Identifier
EC	Ethiopian calendar
EEA	European Economic Area
e.g	Example
EOS	Entrepreneurial Operating System
EPA	Environmental Protection Agency
ERC	Ethiopia Railways Corporation
EU	European Union
FFT	Fast Fourier Transform
FTA	Federal Transport Authority
FRA	Federal Railroad Administration

GDP	Gross Domestic Product
GIS	Geographic Information System
Hz	Hertz
ISO	International Organization for Standardization
Leq	Equivalent Noise Level
Lmax	Maximum level of a noise
Lmin	Minimum level of a noise
MATLAB	Matrix Laboratory
MBVA	Marginal Benefit Value Per Unit Area
MS	Microsoft
NICU	Neonatal Intensive Care Unit
NSRs	National Spatial Reference System
RQA	Recurrence Quantification Analysis
SEL	Sound Exposure Level
SRM	Standard and Reference Materials
TEL	Transit Exposure Level
TNBA	Total Commotion Benefit Per Unit Area
US	United States
WHO	World Health Organization

ABSTRACT

Noise pollution is a major problem in urban areas and the research shows in developing countries noise causes hazardous health impacts on human beings. More than 55% of the urban noise came from transportation. In the past five years, Ethiopia-Djibouti railway passes through Adama city and exposed the local residence to unstudied noise pollution, which include unmeasured noise level and unknown direct health impact on the community. Similarly, it has been confirmed that there is no legal provision in Ethiopia concerning this topic until now. Due to this the research, aims to identify the noise level of the railway noise in different houses near the railway line in a 50 m radius and analyze its impacts on the residents living nearby. For identified noise level it uses noise level meter measurement in different time intervals then for analyzes the impact it uses international standards and local references by using questionaries. The research conduct using the deductive approach and the triangulation method in an exploratory manner. The selected site is almost flat and almost similar building material used, which is very advantageous for measurement. secondly, the noise level measured in 6 different groups total of 18 houses shows the noise level of the site is in the range between 44.2 dB up to 79.1 dB; Based on the Swiss federal office standard, the noise level of spots in six groups is above the permissible noise level and it can cause health impacts to the residences; then the third compares the most subdued place with the near railway residence and it found the dwelling who live in the quietest place is much healthier than the dwelling who live close to the railway line. The final analysis conducts only the residents who live near railways and it shows most residences have sleep problems, stress, annoyance, and hearing problems. Generally, railway noise pollution isn't a secondary concern for an urban environment, it causes physical, emotional, and physiological impacts on the people. It recommended the EIA should study in detail, at list railway lines should away from the residence zone within 60 m radius, noise mitigation methods should implement and another unstudied variable should study and prepare standards and proclamations.

Keywords: health-impact; noise measurement; railway-noise-level; railway-noise-impact; urban transport;

CHAPTER ONE

1. INTRODUCTION

Noise pollution is a major problem in urban areas and this noise causes a hazardous health problem in human beings, Internationally, some studies have been done on the railway noise effect on residence. Noise exposure has short-term and long-term effects on the communities (Philbin, et al, 2006). Especially in Europe, the main transit mode is a railway, and the people who live very close to the station or railway comparatively have a high chance of health risk on the hearing organ and the overall wellbeing (Yasin, 2019). This research shows that this target population encounters blood pressure, sleep disorder, and hearing problems in the long term. It also causes other problems respiration rate and hearing in long-term neurodevelopment, apnea, decrease in hypoxia-based brain perfusion, and sleep disorders (Wachman, 2010-11). Transportation is a significant part of the urban environment which is causing nearly 55% of the overall urban noise (Pandya & Dharmadhikari, 2002). When a huge number of high-speed railways improve public transportation, they have various environmental effects, especially for the residents who live close to railways.

As Ethiopia is enduring accelerated economic and population expansion, an all-inclusive transport system is necessary for the country's growth (Ethiopia Non-Motorized Transport Strategy, 2020). The rapid economic, population growth, a sustainable and environmental interest tensioned the government to propose railway transportation modes in the country. In Ethiopia's case, the Ethiopia-Djibouti railway passes many residential areas such as Adama kebele 11, 10, but the noise effect on the residence is unknown, this inspires me to study this subject.

In this research, it is planning to inquire into railway noise and vibration impact on the resident, who lives adjacent to the railway line. After understanding and identifying necessary quantitative values, it would be interpreted on the physical, mental, and psychological direct effects on the residences. This research is conducted because no research has been perused in the selected topic and specific location. For further expansion, it needs well-studied documents, proposed solutions with standards and guidelines for noise propagation, so this research is used as a reference for further investigation in the field.

1.1. Background of the Study

The railway is one of the transportation modes, which transports passengers and goods on wheeled vehicles running on rails. This mode of transportation became commenced in the mid-16th century in Germany then developed the first civic inter-city railway road in the universe to use only the steam locomotives. The Liverpool and Manchester Railway was opened in 1830 (Donaghy, 1996). The spread of diesel locomotives railway drives concern on the environmental and health issue. Due to this reason, electrified trains were introduced during the 1960s, but still, the impact is not known well (Richmond Union Passenger Railway, 2008).

The noticeable increase in noise levels and the serious attention among public communities toward noise problems contributed to the establishment of regulations that restrict transportation noise levels. For example, in Europe, regulations were set to restrict road traffic and aircraft noise since the 1970s. However, railway noise limits were not legally defined in Europe until 2002 (European Union, 2012). The American Academy of Pediatrics (AAP) recommends a Leq (equivalent noise level) of 45 dBA and L max of 65 dBA in the NICU (Vincent, 2020). During Joshi et al.'s investigation of the noise levels in neonatal intensive care units, noise levels were significantly higher than standard recommended levels (the Leq was within the range of 60–90 dBA) (Dobie, 2018). Therefore, a proper protocol should be considered to recognize the causes of noise pollution in the NICU to reduce the noise levels.

The railroad attaching Ethiopia with Djibouti through Dire Dawa is a 780 km meter major line started in 1917. It is the only railway line that attaches landlocked Ethiopia with Djibouti seaports. A pre-feasibility study performed in 2007 emphasized the significance of refurbishing the line from an economic and financial point of view. The environment assessment has been done by the Chinese staff and they also operations on the line for five years, while providing specialist training for local employees (Ethiopia-Djibouti railway line modernization, 2020).

National and international regulations are important to achieve a sustainable suitable environment in the railway system. Based on the literature review it shows a lack of research on the railway noise impact in Ethiopia and other documents as; guidelines for construction or maintenance of existing railway structure.

1.2. Problem Statement

Noise pollution is a major problem in urban areas and this noise sparks a perilous health illness in human beings. Ethiopia-Djibouti railway modernization project connects landlocked Ethiopia with Djibouti Port. It passes through Adama city, the previous capital of the Oromia regional state, has faced unstudied noise pollution near to the railway station. Due to economic Advantage and residence zone in the plan, it occurred settlement around the railway line and there are many residents live nearby, but still know we do not know the railway noise level on the residence houses, noise mapping in different residence locations, the direct health effect on the residences and the environmental problem to the community as general.

Unfortunately, it has been confirmed that there is no legal provision in Ethiopia concerning this topic until now. Similarly, the town has no clear policy and guideline about the permissible noise level depending on the different function of standards and also lacks strategies to mitigate noise problems in the residential zones for the suitable urban environment in the town.

The purpose of solving the problem is to make sure the future expansion of the railway should consider the safety of the residences and the environment regarding the noise issue. This also encourages another researcher to study these specific fields to produce a legal provision on the railway noise at the country level.

1.3. The Objective of the Study

1.3.1. ***General Objective.***

To measure railway noise levels and understand their impact on the residents that are living adjacent to the railway line.

1.3.2. ***Specific Objectives.***

1. To identify the noise level of the railway in the study area.
2. To understand the noise impact on the adjacent resident.

1.4. Research Question

1. What is the noise level of the railway in the study area?
2. To what extent does the railway noise affect the residence live near to railway line?

1.5. Significant of the Study

In this study the noise level has been measured, the result uses as an initial reference for railway noise level and understanding the impact in more profundity on the resident. The result of the measurement is also used for existing local research input on the main title. On this is research vibration, visual and segregation impacts are not covering; this helps other researchers to explore in more depth depending on this current gap, which is how to overcome this commotion and the potential approach or methods on the clatter barrier optimization process and mitigation measures to minimize project-related impacts. Generally, it will contribute a solid understanding of railway transportation noise problems in Adama and the impact on residents living close to the railway line.

1.6. The Scope of the Study

The site was selected based on the three criteria, which are the existence of a railway line, resident zone in structure plan, and a well-organized community. Based on the criteria, it was selected to study the impact of railway noise on the residents in Adama, near Michael Church around a 50 m radius. The study also consists of identifying the level of the noise and studying the potential effect on the dwelling's mental, physical, and social wellbeing and analysis of this impact on different location groups and proposed key areas to be further studied in the field.

1.7. Description of the Study Area

The site is located in the Oromia region in Adama City near the railway station. Based on the site selecting criteria, the selected site is located in the range of 8º 27 ' 88 " - 8º 31 ' 70 " N and 39 º17 ' 15.90" - 39 º17 ' 20.25" E, Adama with a range of elevation of 5308 ft—5319 ft.

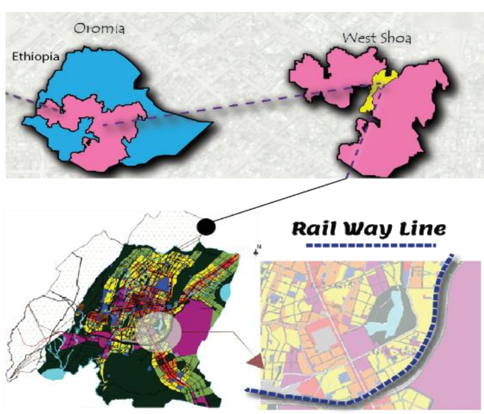

Figure 1. Structure plan with railway lines and land use.

1.8. Limitation of the Study

The main limitation of the study was the lack of conducting a focus group discussion, due to the corona virus pandemic and published documents on the internet related to the Ethiopia-Djibouti railway modernization project. Thus, the study was conducted based on the questionnaire and the documented collated from the railway office in Addis Ababa.

1.9. Organization of the Research

The thesis is organized into five chapters. Each chapter systematically and effectively examines the content and data of the study accordingly. The fundamental chapter in the thesis is further demonstrated as follows.

Chapter One: Introduction to the study introduces the thesis by lighting the main topic of the study, research problems, objectives, questions, significance, scope, description of the study area, limitation, and organizing.

Chapter Two: Literature Review is a chapter that discusses key definitions about noise and the fundamental concepts, source of the railway noises, best practice for measurement the railway noise, a common problem, the noise impacts, the method of investigation, and measurements. It also includes both empirical and theoretical frameworks about railway noise and the impact on mental, physical, and social effects of society.

Chapter Three: Research Methodology is a chapter that discusses the methodology of the research. The chapter explains the methods used for the study and the process of data collection and analysis in detail.

Chapter Four: Result and Discussion is a chapter that discusses the results of qualitative and quantitative data findings. The subjective quantitative data are gotten from field observation, topographic maps, and noise meter instruments. The qualitative data are analyzed based on a questionnaire survey, field observation notes, and printed documents.

Chapter Five: Conclusion and recommendation is the concluding part of the research. The chapter made a conclusion based on the findings from the measurements, the case study of Adama, near to the railway line and based on the collected data, comparing to international guideline and local interpretation, the study concludes the results and discussion as well as it stated four recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Introduction

This chapter is to give a general theoretical framework about railway noise and the impact; related to this, it also presents facts of previous findings, ambiguity, and arguments about the concept that has been researched. In Addition, it explains more empirical concepts about the general concept of railway noise calculation, dependent and independent variables for noise study, mental, physical, and social effects of the noise. This method assistance to analyze the impact effectively.

2.2. Definition

2.2.1. ***<u>Primary Railway Noise Sources.</u>***

2.2.1.1. <u>Wheel/Rail Interaction.</u>

Railway produces sound primarily due to the vibration produced by the tiny roughness around the wheel and rail surfaces. This frisson radiation is produced from the wheels and the rail, and also from other vibration outsides such as portions of the boogies and suspension, rail car sides, and so on (Trocme et.al, 2002).

The primary physical process responsible for the vibration that radiates as noise is the contact between the train wheel and the rail figure 2 shows a sketch (Gajicki, et.al, 2013). When the wheel is rolling on the rail; the small unevenness of both wheels and rail causes a force on both of them.

These forces excite vibrations throughout the whole system which in turn radiate sound. This noise generation mechanism is known as rolling noise.

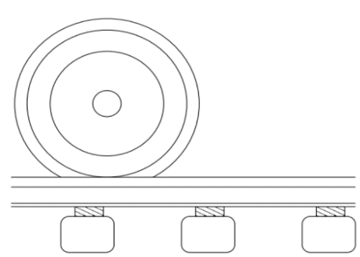

Figure 2. As shown in the sketch of wheels – rail interaction and the track including sleepers and pads.

The mechanical power flow through the system can be described by the simple flowchart in figure 3 The power is produced by the force on the contact patch and via the vibration patterns of the wheel, rail, and sleepers (Ogren, 2006).

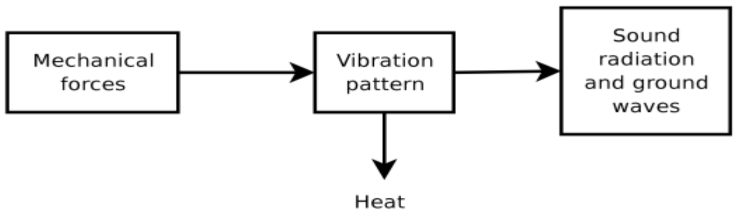

Figure 3. From the contact the power flow blotch that connects the wheel and rail

2.2.1.2. Wheel /Rail Roughness.

The small unevenness or roughness on the wheel and rail surface is the physical structure behind the forces on the contact patch that causes the vibration and hence the sound radiation which is illustrated in figure 4. The study of crews and deformations due to mechanical contact between bodies, in general, is called a contact mechanism (Johnson, 1987).

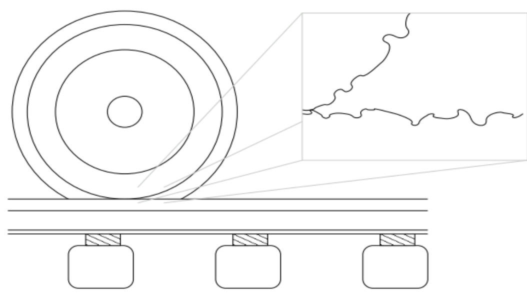

Figure 4. Sketch of wheels – rail interaction and the track including sleeper and pads.

Depending on the speed of the train a certain length scale will cause vibrations of different frequencies according to

$$f = v/\lambda$$

where f is the frequency in Hz, v is the train speed in m/s, and λ is the length scale or wavelength in meters. In Krylov (2001) it is stated that the length scales important for noise radiation are between 5 mm and 20 mm, with amplitudes from 1 µm upwards.

2.2.1.3. <u>*Secondary Noise Source.*</u>

The secondary source is noisy machinery on the train such as cooling fans and power transmissions. If poorly designed they may contribute to the total noise emitted by the vehicle. They may also be very important if they are not audible on the running vehicle when it is moving. Then there is no rolling noise or aeroacoustics source that can mask the noise from fans or other auxiliary equipment.

2.2.1.4. <u>*Airborne Noise from Railway Lines.*</u>

The thematic system according to train construction handbook and work regulation Airborne and structure-borne noise and vibrations caused by short-distance and prediction models for airborne noise, structure-borne noise, and vibration from railroad lines (Vos, 1996).

2.2.1.5. <u>*Moving Sound Source.*</u>

Moving sound sources are essential parts of outdoor environmental auralization. The moving vehicles. The noise generated by pass-by vehicles contributes to the noise pollution in outdoor atmospheres, which forms a significant danger to popular health. Auralization is turned out to be an effective technique that enables people to perceive simulated sounds intuitively instead of describing acoustic properties with abstract numerical quantities (Vorländer, 2018).

2.2.1.6. <u>*Tonal or Impulsive Sounds.*</u>

The Canadian Standards Association, ISO, U.S. EPA, and the WHO indicate that tonal and impulsive noise can be irritating and destructive to receptors (WHO, 1999). For sounds that are audibly tonal or impulsive at the receptor location, the convenient adjustment factors should be evaluated. The acoustical expert must use professional judgment in applying these factors. If a correction factor is used, reasoning must be offered to support its use.

2.2.1.7. <u>*Single Events.*</u>

Several railway operations, including train pass-by, emit repetitious noises of a significant level for brief periods that can impede sleep, transmissions, and the well-being of the residents of neighboring properties (WHO, 1999). The following metrics may be examined as part of the assessment procedures to enrich the noise evaluation:

1. Maximum events sound level(s); Lmax, in dBA.

2. Sound Exposure Level(s) due to single events; SEL, in dBA.

2.2.2. ***Noise Emissions.***

The noise emissions of trains are determined by:

- The rolling noise — (speed range 50 km/h <v <350 km/h)
- The machine noise — (speed range v <60 km/h)
- The aerodynamic noise — (speed range v> 350 km/h, according to (Schall 03 (1990) Richtlinie zur Berechnung der Schallimmissionen von Schienenwegen) The rolling noise is largely influenced by:

  (a). The running speeds;

  (b). The train length;

  (c). The type of braking (block brakes, disc brakes), which affects the roughness of the wheel surface;

  (d) Special features on the vehicle (such as sound reducing wheel-mounted disc brakes);

  (e) The condition of the running surface (roughness of rail and wheel running surfaces);

  (f) Special track features (ballasted superstructures with wooden or concrete sleepers, ballast fewer tracks, 1 with or without sound-absorbing treatment);

  (g) Special features on the line (e.g., bridges and railroad crossings);

The major sources for the radiation of the rolling noise are wheels and rails. The wheel emits in the frequency range above 1,000 Hz, and the rails are mostly below 1,000 Hz. It has to be considered that also the type of the wheel affects the sound radiation. The sound emission of railway lines is characterized by the sound emission level Leq, E. (Thompson, 2009).

2.3. Noise level Measurement

2.3.1. ***Measurement Equipment.***

Sound level gages and acoustic calibrators would fulfill provisions traceable to national (e.g. CSA or ANSI) and/or worldwide criteria (such as ISO). They should also be calibrated by a seasoned lab (usually every two years for sound level meters and one to two years for calibrators). A kind 1 sound level meter (reliability Sound-Level Meter with toleration of ± 1 dB between 100 Hz and 4000 Hz) is the preferred tool for particular noise and impulsive incidents. A kind 2 sound level gauge (a General-Purpose Sound Level Meter with acceptances of ± 1.5 dB between 100 Hz and 1250 Hz, up to ± 3 dB at 4000 Hz), which has less draconian openness, may be used for inquiries involving long-term noise observing (Janssens, et.al, 2006).

2.3.2. ***Sound Level Meter.***

A sound level meter is the most popularly used tool to measure sound levels. The simplest sound level meter is encompassed of a microphone, a frequency-weighting filter, an energy level adapter (root-mean-square, or rims detectors), and a logarithmic measurement. More advanced sound-level meters incorporate standardized octave-band or fractional-octave-band filters and provide additional metrics and analytical abilities (Canadian Transportation Agency, 2019).

Different levels of the particular method are used to distinguish the vehicle and rail noise to understand each noise separately for better understanding, this because the pass-by level of a particular vehicle is not determined uniquely by the vehicle itself, but that track parameter and especially ‘rail roughness’ have a strong influence. The pass-by level of a particular vehicle is not determined uniquely by the vehicle itself, but that track parameters and especially ‘rail roughness’ have a strong influence. To tackle these problems, the split of the vehicle/track pass-by noise and their reciprocal impact can be chased to various ‘levels,’ see Table 1. At ‘level 0’ no dissolution is available. The evaluations that gratify this level of assessment should be pass-by sound pressure levels quantified with a single microphone. This data could be post-comprehended to give an estimate of the sound strength level of the supplier. Such evaluations are frequently obtained and can accommodate several purposes (Janssens, et al, 2006).

Table 1: Overview of several levels of railway noise characterization

	Obtained quantities			Application and Notes
	Total	Vehicle	Track	
Level 0 (no separation)	Lptot			Overall levels, a large spread
Level 1 (sound separation)	Lptot	Lpveh	Lptr	For assessing track or vehicle noise control measures
Level 2 (sound and roughness separation)	Lptot	Lrveh, LHreh, Lpveh	Lrtr, LHtr, Lptr	For independent characterization of tracks and vehicles
Level 3 (sound roughness and dynamic separation)	Lptot	Lrveh, LHreh, Lpveh, mobility and others	Lrtr, LHtr, Lptr, mobility and others	Partly using calculation when vehicle not available

A technique at this level 2, targets not only to distinguish the total sound level during a train pass-by into a vehicle part and a track part but also to supply the wheel and track roughnesses. The amounts to be quantified now are overall pass-by sound stress level, and sound pressure level of the vehicle, the sound pressure level of the track, wheel, and track roughness spectra (as a function of wavelength). This can be anticipated by taking measurements close to the track (i.e., 7.5 m) and prescribing some minimum conditions with which the measurement site must comply (Dittrich & Janssens, 2000). Besides the vehicle and track roughness, it is also known from rolling noise theory that the dynamics of the vehicle and track can also influence one another significantly. This could be expressed at a 'level 3' of detail. A measurement method at this level of detail must, in addition to the noise and roughness levels, provide data on wheels, track and contact spring dynamics (Thompson, et al, 1999). However, for the range of common track and wheel types, it can be expected that the influence of different dynamic characteristics can be neglected. Only in cases that involve very small wheels, resilient wheels, or exotic rail types, is a significant effect on the noise expressed as a dB level to be expected. Therefore, a measurement approach at this level of detail is not pursued here. The remainder of the paper is concerned with 'level 2' characterization.

2.3.3. ***<u>The Intervention of Noise Level.</u>***

In a study by Aurélio et al., the average noise level in the NICU was 64.8 dBA. Health care professionals believe that their behaviors are noise sources with the greatest frequency in the form of unavoidable handling and movements and conversation (Lee, et al, 2012).

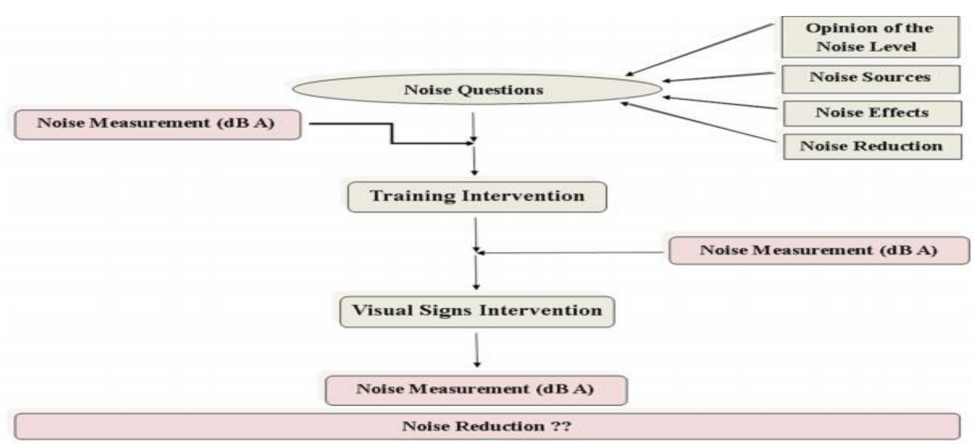

Figure 5. Intervention framework

Based on the findings of Santos et al., during quiet time, the noise levels are within the limits recommended by Brazilian and international standards (Santos, et al, 2015). During Joshi et al.'s investigation of the noise levels in neonatal intensive care units, noise levels were significantly higher than standard recommended levels (the Leq was within the range of 60–90 dBA) and the morning shift was among the noisiest shifts in the NICU. Therefore, a proper protocol should be considered to recognize the causes of noise pollution in the NICU to reduce the noise levels (Joshi & Tada, 2016).

2.3.4. ***Suppression Measures.***

That was the explanation that to find the effect of vibrations and to plan preventative measures we had to use arrangements from the Directive of the Swiss Federal Office (BEKS, 1999).

BEKS standard evaluated the impact of low-frequency noise from railway traffic and stipulated noise levels for newly built railway lines and separately for the lines subjected to remodel and repair plans. Allowable levels of low-frequency noise by zone, period of the day, and a class of railway lines are shown in Table 2.

Table 2: Permissible low-frequency noise level according to BEKS

Zone	A newly built railway line				Modernized railway line			
	Day (dB)	(6°°-22°°)	Night (dB)	(22°°-6°°)	Day (dB)	(6°°-22°°)	Night (dB)	(22°°-6°°)
For Dwelling only	35		25		40		30	
Mixed use	40		30		45		35	
Industrial	60		60		60		60	

2.3.5. ***Most Suit Measurement.***

2.3.5.1. Pass-by and Idling Noise Measurement

Pass-by and stalling noise levels may be grabbed at a set reference distance from the railway tracks or at the receptor location. Sound level measurements should be organized in the far-field. Quantifications in the open-air comfort area should be performed 1.5 m above the ground and at least 1-2 meters from any contemplative surface to avoid reflections that could pollute readings. The report should contain an explanation and outline of the source and measurement place. Key distances and dimensions must be specified. The measurement proceeds at a certain reference distance may be extrapolated to the receptor location being assessed using a guideline-based mathematical formula or a noise forecast model outlined (Hanson & Barsikow, 2000).

For alone measurements, the administrators should be equipped with proper environmental protection, as considered in subsection 2.1 above. In addition, supplementary audio recordings (e.g., wav, mp3, video cassette recorder, digital audio tape, Etc.) are required to ensure that the noise under dispute was captured without contamination from other noises (Canadian Transportation Agency's, 2019).

A list of sound level descriptors, for frequented and alone measurements, is provided in Table 3 (Gajicki, et al, 2013).

Table 3: Sound Level Descriptors for Pass-by Measurements

Measurement Description	Sound Level Descriptors to Record	Comments
Attended	Leq, SEL, Lmax, Lmin	Offer in-depth notes on the rail operations captured in the evaluation. If any other informants are not recounted to the rail practices in disagreement is audible, they would also be recorded.
Unattended	Leq, Lmax, Lmin, Ln% (L1, L10, L50, and L90)	Time frame times would be no greater than 20 minutes in duration. Measurements would not include other noise sources than those under assessment. If the data includes other sources (e.g., nearby highway or industry) then proper alterations should be made to isolate the noise under evaluation.

Source: Gajicki, et al (2013)

Based on the U.S. Environmental Protection Agency (EPA) in their railroad Noise compliance regulations 40 CFR 201, and Federal Railroad Administration (FRA) railroad Noise emission compliance regulations, 49 CFR 210. These standards call for a microphone to be placed 1.8 meters (5.9 feet) above ground level at a distance of 30 meters (100 feet) from the center of the track during a moving train pass by (Federal Railroad Administration, 2019).

2.4. Analysis Railway Noise

In this case, the paper mentions possible impacts to the environment in terms of vibration and low-frequency noise during the oppression of the railway line. The calculation of vibration and low-frequency noise promotion and annoyance analysis were made using simulation modeling software packages "VIBRA-1".

The calculation of vibration propagation and annoyance analysis were made using simulation modeling software packages “VIBRA-1” (Miedema and Vos, 1998). Passenger and freight traffic will be consolidated and split in Batajnica station within the group of tracks belonging to the Belgrade Railway Intersection. In addition, Batajnica shall be the untreatable station for urban-residential railway traffic in the City of Belgrade.

That was the explanation that to find the impact of vibrations and to plan preventative measures we had to use provisions from DIN 4150-2 and Directive of the Swiss Federal Office (BEKS, 1999).

Distance from track (m)	Mean value of vibrations		Low frequency noise		Mean duration of vibrations (s)
	Day (mm/s)	Night (mm/s)	Day (dB)	Night (dB)	
5	0.140	0.154	33.8	37.8	22.1
10	0.092	0.090	28.8	32.5	22.1
15	0.068	0.062	25.6	29.0	22.1
20	0.052	0.046	23.2	26.5	22.1
25	0.042	0.036	21.2	24.4	22.1
30	0.034	0.029	19.4	22.6	22.1
35	0.027	0.024	17.8	20.9	22.1
40	0.023	0.020	16.4	19.5	22.1
45	0.020	0.017	15.2	18.3	22.1
50	0.018	0.015	14.2	17.3	22.1

Figure 6. Example of mean values of vibrations and low-frequency noise in the paintwork area in Nova Pazova (entry) station

The noise standards depend on the location of the noise-sensitive receiver (NSR), the characteristics of its surrounding environment, and the time of day under consideration. Area-sensitive ratings (ASR) are used to describe the type of area within which the NSR is located and the degree of the effect of particular influencing factors (e.g., major roads or industrial establishments) on the NSR in concern (Lee, et al, 2012).

The acceptable noise levels at the façade of NSR for the respective ASRs at different periods are as follows:

Table 4: The assessment point is normally at position one meter from the external façade.

Time period	ASR =A	ASR =B	ASR =C
7 a.m. to 11 p.m.	60	65	70
11 p.m. to 7 a.m.	50	55	60

Source: Lee, et al (2012)

2.5. Impact of Noise & Rail Vehicle

2.5.1. ***<u>Sound Power and Sound Pressure.</u>***

The human ear perceives the small pressure changes in the atmosphere as sound, so the quantity sound pressure level is what is relevant for the receiver. It describes the strength of the noise at a certain receiver position. On the other hand, the sound pressure level varies with different distances and directions to a rail vehicle. Therefore, sound pressure level is not suitable for describing the source strength and is sometimes given in unit B (Bell) instead of dB to avoid confusing it with the sound pressure level (Ogren, 2006).

In many cases, the sound power level is circumvented when specifying noise emission limits. In (Kalivoda, et al, 2003) there are examples of noise limits from Europe, and all are given as the sound pressure level measured at a certain distance from the track (25 or 7.5 m) at certain speeds. It would make more sense to specify the sound power level when the source is addressed, i.e., emission limits, and use the sound pressure level when the receiver is addressed, i.e., noise exposure limits (see figure 7).

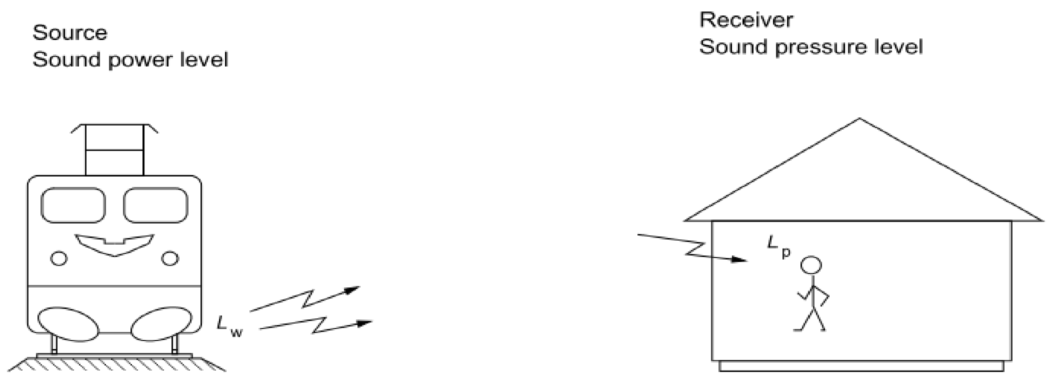

Figure 7. Noise emission vs. exposure and sound power level L*w* vs. sound pressure level Lp.

On the other hand, the sound power is indirectly specified together with a directivity when the limit is based on one microphone position at certain distances. The directivity would have to be handled in an approach where the sound power level is used anyway. A train that radiates most of its noise upwards will have to be handled differently compared to a train that radiates noise uniformly (Ogren, 2006).

2.5.2. ***Noise Exposure.***

Although the main focus of this report is on emission, it is relevant to briefly look at the exposure limits and metrics to understand how they influence the complexity of the problems related to noise and railway traffic. Most European countries operate with two limits on the equivalent level, one for the daytime and one for the nighttime. Some countries also use a morning and evening period (Kalivoda, et al, 2003).

To include both general annoyance and sleep disturbance in one metric, the level day-evening-night L_{den} was developed (Miedema and Vos, 1998). It is defined as a weighting of three equivalent levels for three time periods. A 12 h day period L_d, a 4 h evening period L_e and an 8 h night period L_n. The L_{den} calculated from the above levels as

$$L_{den} = 10log_{10}\left(\frac{12}{24}10^{0.1L_d} + \frac{4}{24}10^{0.1(L_e+5)} + \frac{8}{24}10^{0.1(L_n+10)}\right) - L_{r,tot} \quad \text{(Equation 1)}$$

The main benefit with the L_{den} is that it is very simple to use, a single metric. As consequence there is a risk of oversimplification, that many important aspects are lost, however, in the European commission director 2002/49/EG (European Union, 2012) it is selected as the noise indicator to be used for mapping and general handling of noise exposure issues in the future.

2.5.3. ***Combine Transfer Function Measurement.***

From an individual train pass-by, the integrated effective roughness can be assessed. The aggregate transfer function is found by deducting this roughness from the measured sound level,

$$L_{H,tot} = L_{P,tot} - 10log_{10}\left(\frac{N}{L}\right) - L_{r,tot} \quad \text{(Equation 2)}$$

The basic measurement setup coincides with one microphone and one accelerometer. The microphone position is 7.5 m from the track center and 1.8 m above the railhead. To avoid interference from accompanying wheel types, at least two vehicles of one type are required. The equivalent sound pressure level $L_{P,tot}$ (fto) is measured by taking the average sound pressure level over the interval Tp. The vertical rail acceleration is measured underneath the center of the rail foot. The rail acceleration $L_{a,meas}$ (fto) should be averaged over Tx to obtain $L_{r,tot}$ (V/fto) (Ogren, 2006).

2.5.4. ***<u>Impact of the Railway</u>***

For understanding the impact of the railway on the residence; different case studies were taken and select most related to the study.

In recent years, high-speed train surgeries have been growing, yet their environmental impact is still not well investigated and realized. (Sarikavakl & Boxall, 2019). The high noise level affects people's lives and it examines the nearby resident and it found that the people encounter health problems more often than people living far from the railway. The resident affects measure in terms of the sleep disturbance and annoyance level. From the research sample, the younger resident encounters some sleep problems and less annoyance compared with the older people. Mainly the noise caused by trains and traffic is associated with general feelings of displeasure, discomfort, and annoyance, the older people who live on the resident are more annoyed by the vibration than the airborne noise (Nunes, et al, 2007). Railways are one of the main sources of noise, with a particularly strong negative impact on the environment and the health of children and adults (Muzet, 2007).

Environmental noise externalities, rail noise, and vibration can cause minor and major adverse events. Pathological and evident conditions due to noise pollution mention the well-being influences correlated with proceeding loss, physiological stress responses, the hazard of cardiovascular, neurological, and digestive tract organ illnesses (Barroso, et al, 2005). Cardiovascular impacts of noise rate second in conditions of disability-adjusted lifestyle year (DALYs) behind irritation (Lercher, et al, 2011). Noise pollution, particularly rail and street traffic noise establishes an economic strain on society, because of immediate and incidental costs for protection, health care, and rehabilitation. Noise counts for 30 percent of untimely aging. When revealed to loud noise a person cannot focus his thoughts, gets exhausted quickly, and absorbs more caloric energy. Noise worsens hygienic working conditions and reduces labor efficiency (Ustinaviciene, et al 2004).

Railway noise causes a hazardous health problem in human beings and encounters blood pressure, sleep disorders, and hearing problems in the long term. Noise also causes a delay in the growth and development of newborns. Noise, as an environmental stressor, can affect these changes, not only impairment in auditory but also affects physiological state by speeding up the respiratory rate and pulse (AlKheder, et al, 2019).

Noise pollution is a growing environmental concern not only because of potential health impacts on exposed human populations but also because it can affect the distribution of wildlife on the land causes various effects which are conceptualized in the pyramid of noise. Mortality is located at the top of the pyramid, and cardiovascular diseases and insomnia, stress indicators such as autonomous response and stress hormones, and feeling of discomfort are located on the pyramid with an increasing number of affected people, respectively.

In Europe, it is estimated that noise results in over 10,000 cases of premature death each year, 20 million adults are annoyed, 8 million suffer sleep disturbance and over 900,000 cases of hypertension cases have been recorded. (EEA Report, 2014.) According to World Health Organization (WHO) studies, it is stated with sufficient evidence that noise annoys levels above 55 dB (A) and 85 dB (A) in office and industry, respectively; 55–116 dB (A) causes hypertension, 75 dB (A) causes hearing loss and a noise level above 81 dB (A) may cause deafness. The measurement for occupational noise is the A-weighted decibel, and it is averaged over an 8-hour working day (LPAeq, 8h). Minimum noise exposure is defined as noise where the level is less than 85 dB (A) (LPAeq,8h), moderately high noise exposure is 85–90 dB (A) (LPAeq,8h) and high noise exposure is the values over 90 dB (A) (LPAeq,8h) (WHO, 2004).

2.6. Summary and Gaps of the Literature

According to Philbin. et al (2006) the railway noise has short-term and long-term effects on the communities and as Hanson & Barsikow (2000) most suitable instrument used for measurement noise level is the noise level meter. Based on the U.S. Environmental Protection Agency (EPA) in their railroad Noise compliance regulations 40 CFR 201, and Federal Railroad Administration (FRA) railroad Noise emission compliance regulations, 49 CFR 210. These standards call for a microphone to be placed 1.8 meters (5.9 feet) above ground level.

Generally, the above-reviewed literature has its perspective and methodologies to investigate the railway noise impact on the environment. Dominantly the studies have focused on the air-born noise and vibrational as a major factor for railway noise transmission. But there is not found a local study on noise level on Ethio-Djibouti railway in Adama context.

CHAPTER THREE

3. Material and Methods

3.1. Introduction

The philosophy used in this research is positivism and dualism. Railway noise knowledge developed the residence experience and the existing nature of reality. The scientific method observable facts and measurement values, like generalization number and causal explanation on the phenomena. It is valuing free research and the researcher detected neutral and independent of what is researched, it seeks to understand the existing scenario. The study area choices by the researcher's free will and the outcome controlled by the external forces and the research understood the human as the individuals and the effect of the noise will determine on each individuals' residents. The research evaluates the effect of railway noise on the physical and emotional or spiritual well-being of individuals. Typically, the deductive research approach will be used with highly structured data with the support of measurement.

3.2. For First Objective

3.2.1. ***Methods Used for First Objective***

3.2.1.1. Site Analysis Methods

For this analysis observation, questioning employees and aerial photographs are the source of data. For determining the number of an active rail line, vehicle type, and the width of each line, it recorded by site observation 3 times per day for each more than 20 min. For a better understanding of some issues, it was asked the employees in the railway. The site photos are also taken to fill some missing points while site observation. Then it follows to use computer software to generate the specified location DEM (Digital Elevation Model). This helps to generate the elevation model, the contour, and the slope of the area.

3.2.1.2. Noise Analysis Methods

The First step for measurement noise level and noise pressure in the selected house façade. The distance measure from the right and left of the railway centerline, which considers as the reference line, the measurement conduct in the perpendicular degrees. Then classification each residence house based on the distance from the railway line, the classification was conducted in six groups. The group is named "Group A", "Group B", "Group C", "Group D", "Group E", and “Group F”. Each categorized respectively as 5-meter separated from the reference line, 10-meter interval from the reference line, 20-meter intervals from the reference line, has a 30-meter distance from the railway centerline, has a 40-meter separated from the reference line, and 50-meter distanced from the reference line to the front face of the houses. From each group, it selects 3 houses randomly for measurement noise level and noise pressure.

After selected 3 houses from each group, it started measuring the noise level first then noise pressure next. For noise level measurement, start with the setup of the noise level measurement instrument in each house façade with a 1-meter setback in 1.8-meter high. To avoid the instrument from any kind of handshake or climate effect, it used a tripod and audio cover for minimizing any kind of climate factor. In each measurement, the recording data has been saved on the computer. The data is saved directly to the computer. The computer saved the measured data by the data time of the measurement and the unique name is given when the measurement starts. For getting accurate noise levels, it measures 3 times for each house. The measurement time differs from one to the other the first measurement is daytime; the second measurement is in the afternoon and the third measurement is at night.

Figure 8. A perpendicular distance from the railway line for selected houses.

3.2.2. ***<u>The Material Used for First Objective</u>***

3.2.2.1. <u>Site Analysis Material</u>

For analysis of the site through the observation period, it used to be A4 with a width of 29.7 cm and a height of 21 cm (landscape) paper used for recording. And note some necessary information related to the subjects like some interview ideas from the employee working in the railway; to write the records used pen and for incase, it records the employee interview in the mobile recording device for checking any missing information. In the site picture period, it used smartphones (Samsung J2) for taking pictures of the site. Used ArcGIS 10.5 and Google Earth for accurate information and generate geo-location and some vital information like elevation, slope, and the contour of the site. In the selected research site to get the accuracy value of the DEM (Digital Elevation Model), it used two methods the first method is already prepared DEM and trim the area based on the site-specific coordinate using ArcGIS 10.5 only. The second method I used was Google Earth for the selected specific site using add path tools in the top toolbox and export to the https://www.gpsvisualizer.com/ website to generate the elevation model. Then import the generated file to the GIS and generate custom DEM for a specific location. After that Using the spatial analysis tool in the GIS software it generates the elevation model, the contour and the slop of the specific location and comparatively both method and used more accurate.

3.2.2.2. <u>Noise Analysis Material</u>

For measurement of the distance of the house from the railway line it uses Google Earth measurement tools; with an accuracy level of 95% and maximum close up this helps me to know the location of the specific house referencing the railway line. Besides the distance of each, it also shows the latitude and longitude differences from the railway line (reference line) and used illustration software for better visualization.

For measurement of the noise level of railway, noise is used sound meter. The value of each measured data was saved into the computer. The connecting wire used to connect the sound meter instrument to the computer is the sound meter logger. For preventing handshakes, it used a tripod and sound cover for the maximum quality level.

3.3. For Second Objective

3.3.1. ***Methods Used for Second Objective***

Analysis of the noise level dB values in the different groups and each house. Overview of the result value from the DIN 4150-2 and Directive of the Swiss Federal Office (BEKS 1999) and World Health Organization studies (WHO, 2004). Then compare level vs. time, analysis the frequency for knowing which frequency is dominated in the railway noise.

For data safety and for avoiding careless questionnaire filling, the questionnaire fields were filled by the researcher. This helps the participants to minimize the effort need for reading and understand the question. Plus, in the current condition, the people are not willing to share staff, due to the corona pandemic.

3.3.2. ***Material Used For Second Objective.***

The analysis of the data from the interview, structured and semi-structured questionnaire will be carried out using descriptive statistics and the results of both open-ended questionnaire and close-end questionnaire analysis using Julie Yu, Harris Cooper, 1983. After collecting the data, its analysis using SPSS software

3.4. Sampling

It used different kinds of sampling for different methods of collecting data. The questionnaire survey used a non-probability sampling method. For the railway line sampling, it's selected a single railway line and sample train vehicles for each type of vehicle. For selecting the householder, it uses simple random sampling and for the selected family member it's used a specific convenience sampling method.

To estimate the total population to study and for the site specification, it's used 50 m radius convention (Federal Railroad Administration, 2019) and the data collected using well-structured questionnaires that are giving using self-filling by the researcher or face-to-face interviewing with sample family members in selected householders, train drivers and a train dispatcher. The questionnaire was prepared in the English language then translated into the local language (Amharic). The interview proceeds in the local language and is translated into the learning language (English).

3.5. Data Type

The elementary data type utilized in the research is observational data. The observational data are grabbed through the finding of conduct or activity. It was collected using techniques such as human observation, open-ended inspections, the use of a tool or sensor, and record information. The characteristics of data are being captured in real-time and a data securing plan is also important in case of any damage or loss. The second data type used is the experimental data type, it used for understanding the cause or impact of the railway on the resident in different demographic groups, using instruments, personal testimonies, and snowball methods. This data type is more important to evaluate the first data type in terms of valuable analysis. The final data type is compiled data types, this data type involves using existing data points, often from different data sources, to create new data through some sort of transformation, such as an arithmetic formula or aggregation. For example, combining area and population data from the selected study area (Michel church railway in the radius of 200 m).

3.6. Analysis Techniques

The research uses bivariate analysis and content analysis for each variable. This analysis understands each variable impact on the target output. After understanding the impact of each variable then comparing one variable with the other variable using racial disparity analysis techniques, this is critical to managing different variables one with the other. This compares fashion in the descriptive statistics manner into a powerful argument. Displaying two-variable side by side often seems to show an association, but it doesn't show the relation and the strangeness of the relation, so it plans to use correlation, this is the measure of the strength and direction of the association between two variables, it uses because it shows the direction and strength of this association. After corroborating data, it will analyze data using theory. After testing the significance and hypothesis of the finding, then draw inferential.

3.7. Ethical Consideration

The effectiveness and legitimacy of a research work mainly depend, among other factors, on the consideration of ethical issues. It is a crucial part of the research process. So; in doing the studies, it proceeded all ethical and legal requirements regarding research attendees. Participants both individuals and groups being observed must provide informed consent of their participation in the study and are normally provided obscurity and confidentiality.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Results for the First Objective

4.1.1. *Site Analysis Result*

From the observation, both passenger and freight vehicles are actively used in the Adama station. It counts every day 7–10 freight rail vehicle passes by and 1 passenger rail vehicle passes by. Each passenger vehicles travel in a two-day row every even date it goes from Adama to Dire Dewa and on every odd date it travels from Dire Dewa to Adama. There are different sizes of vehicles used based on the function and load item, but commonly there are 4 kinds of vehicles used.

From site measurement, the passenger tracks separate within a 4.50 m interval between tracks (with 4.00 m broad establishment). Additional two (freight) tracks positioned at 4.0 m and 6.40 m away from the existing left track are expected in the exit. The right-hand cargo track above the double-track road for rider traffic shall be grade-split. The right freight track over the emerging two tracks, both freight paths will run at an interval of 6.40 m from the paths for passenger traffic.

From the direct visit, many residences are living in the area, including all kinds of demographic groups such as children, women, youngsters, old people, and so on. The site is very venerable to railway noises, from the observation there is no mitigation method for minimizing the noise impact or any technology doubted from the other developed countries.

There are different kinds of residences have built in the area, with similar building materials. Most of the houses are built with HCB building material for walls and fences of their boundaries, in addition, there are also houses build-up using mad bricks as Ethiopian traditional houses. Most of the house's roof type is a flat roof, but there is also some hip type of roof shown in the site, the roof material used commonly is iron sheet and roof brick (see figure 9). There are some hence for protection children and animals to get into the residence, but this hence is not continuous in all areas, in some areas it is fully open. Most of the houses are very close to the railway line and they are located 10–50 m distance from the center of the railway line.

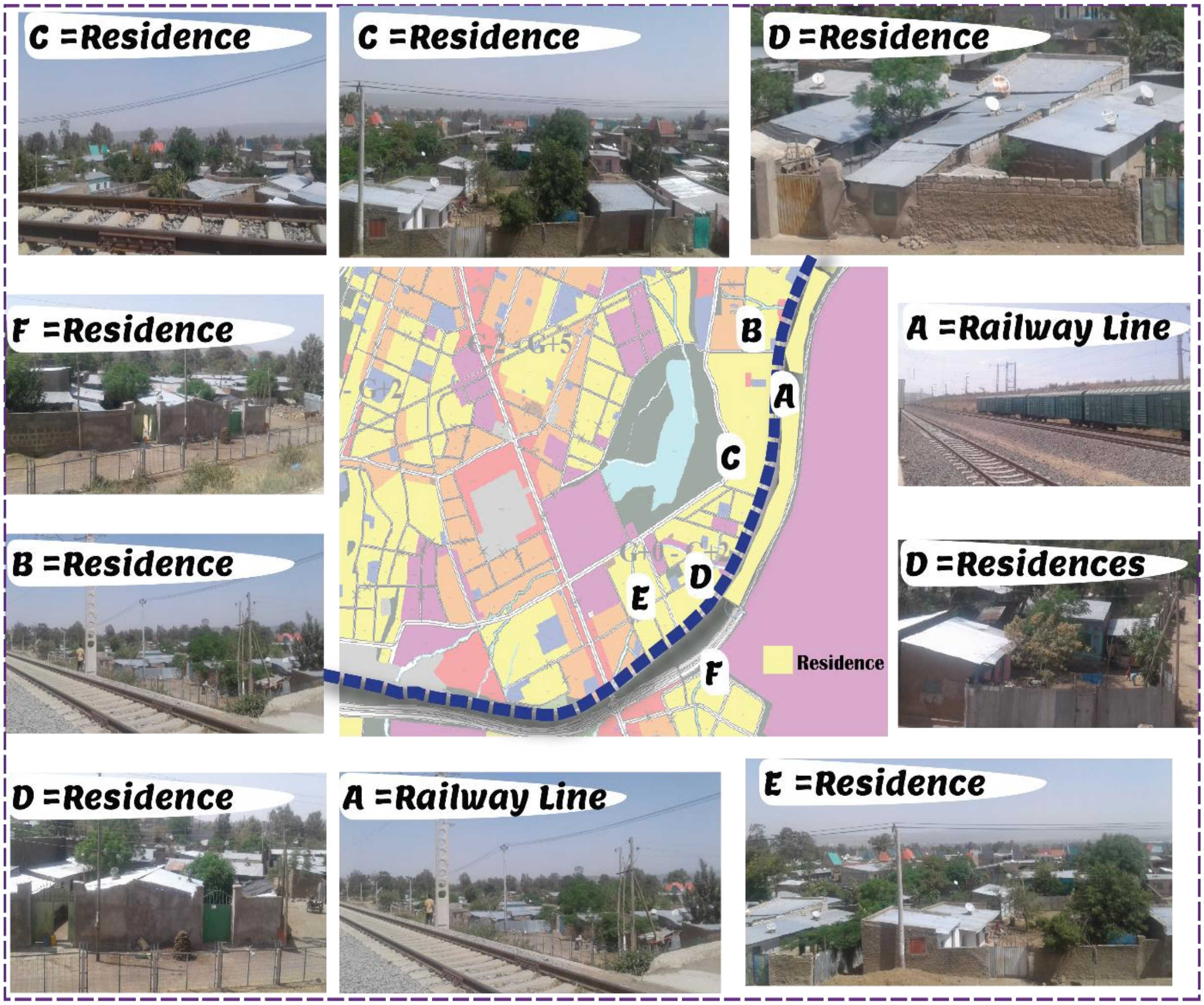

Figure 9. Site images with structure plan of the selected area.

As shown in the image figure 10 analysis of the site for getting a general idea about the elevation difference one with others. The attribute table inside the ArcGIS shows the maximum of 1619.89 m and with a minimum of 1615.36 m in the general. This shows that the selected site is almost flat comparatively. The topographic configuration of the project site is relatively flat which gradually increases in elevation as goes from the west -north to southeast direction with a range elevation. The difference of elevation from the minimum to the maximum is 4.45 m this implication the site's suitability.

The selected site can be characterized by flat to gentle topography, which is suitable for settlement and sound transmission without creating any kind of echo or reflected and refraction sound to the environment.

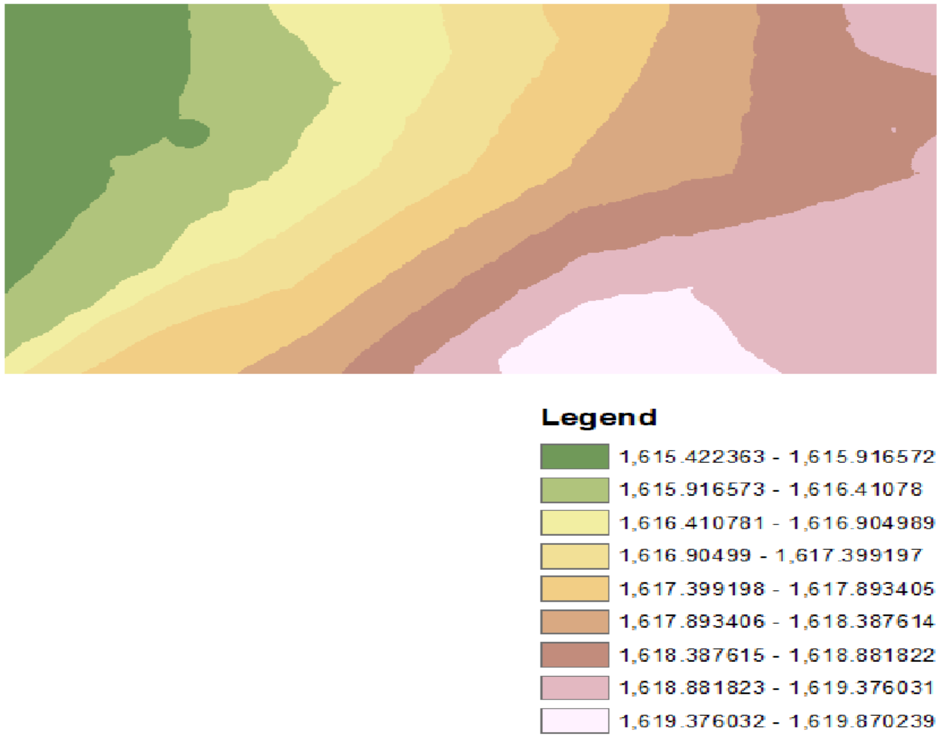

Figure 10. site elevation (M)

In general, the site is very suitable for measurement all necessary data with high accuracy and fewer mistakes. The noise level and noise pressure on each house's façade can easily determine from the different locations. Most of the sites and the houses located in the site are characteristic as similarity, which is very advantageous by excluding unnecessary variables to the measurement and analysis process on the research. One of the basic transformations of sound is due to the nature of reflection, absorption, and deflection. As shown in the result above in figure 10 the elevation difference of sites is very suitable for minimizing the transformation characteristic of the noise, by minimizing the reflection, absorption, and diffraction coefficient.

4.1.2. ***Noise Analysis Result***

"A" coded are houses, which located the 5-meter from the railway line, and the recorded result of each spot is listed in table 5 below.

As shown in table 5 and figure 11, the average afternoon recorded the maximum of 94.8 dB and the minimum of at night 54.9 dB. In the general in the afternoon time, the noise level is high compared to the other period, and a low noise level is recorded at night.

Table 5: Code A (5 m away) noise level result

Code	At Day			At Afternoon			At Night		
	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)
A^1	67.6	76.9	86.9	67.8	81.6	94.8	62.8	74.4	83.8
A^2	66.8	77.2	88.4	68.9	78.9	92.3	54.9	71.5	82.4
A^3	66.4	76.6	87.2	68.3	76.8	89.8	63.8	72.8	82.8

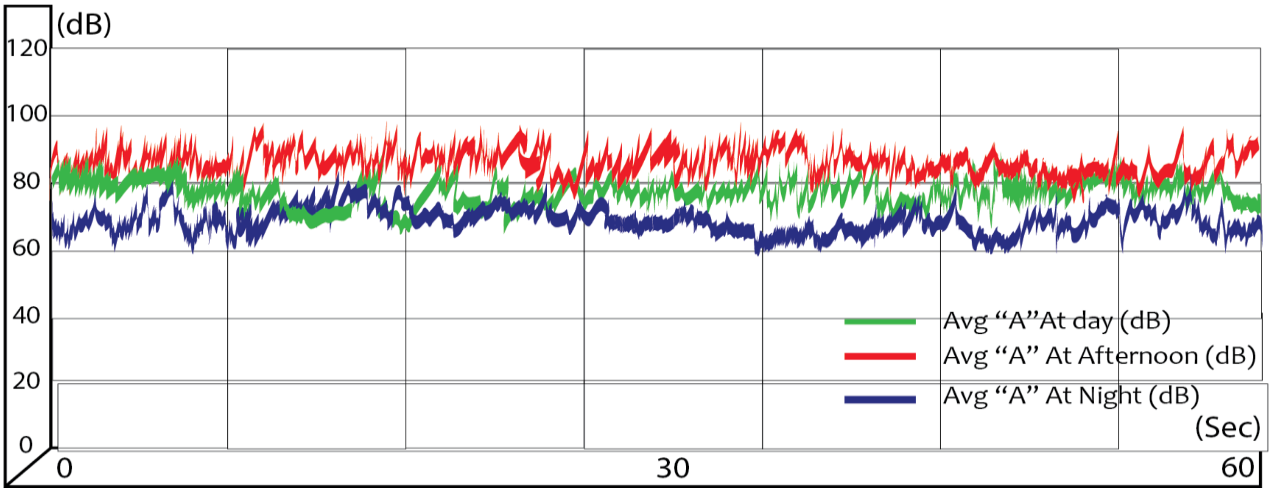

Figure 11. Code A (5 m away) average noise level for day time, afternoon, and night

"B" coded are selected houses, which located in the 10-meter, from the railway line and the recorded result of each spot listed in table 6 below.

Table 6 and figure 12 illustrated, the noise levels on each period are almost similar; In the afternoon and night, the average maximum and minimum recorded are respectively listed as 89.2 dB and 51.8 dB. In the general in the afternoon, the time has recorded a high noise level and night-time a low noise level compared to the other period.

Table 6: Code B (10 m away) noise level result

Code	At Day			At Afternoon			At Night		
	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)
B^1	56.6	71.9	82.9	58.4	77.3	89.2	55.9	69.5	77.6
B^2	57.9	73.2	85.4	55.8	74.8	86.8	52.9	68.5	76.8
B^3	60.4	74.6	83.9	56.3	72.8	85.2	51.8	66.9	77.2

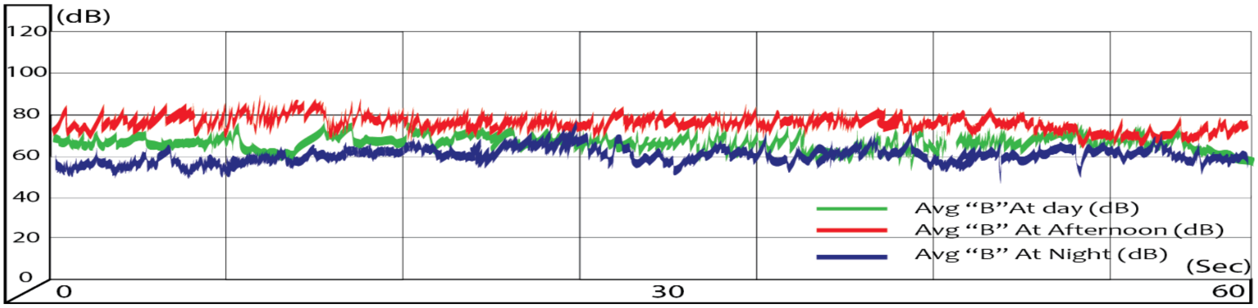

Figure 12. Code B (10 m away) average noise level for day time, afternoon, and night

"C" coded are selected houses, within the 20-meter from the railway line and the recorded result of each spot listed in table 7 and figure 13 below. The maximum of 83.8 dB and the minimum of at night 51.1 dB are listed. In the general in the afternoon time, a high noise level and at the nighttime a low noise level recorded compared to the other period.

Table 7: Code C (20 m away) noise level result

Code	At Day			At Afternoon			At Night		
	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)
C^1	53.6	70.2	79.7	56.8	75.9	81.9	53.9	67.9	76.2
C^2	55.9	71.5	80.4	53.1	73.1	82.5	51.1	67.0	75.0
C^3	59.4	72.3	81.9	54.2	73.3	83.8	52.4	64.8	76.6

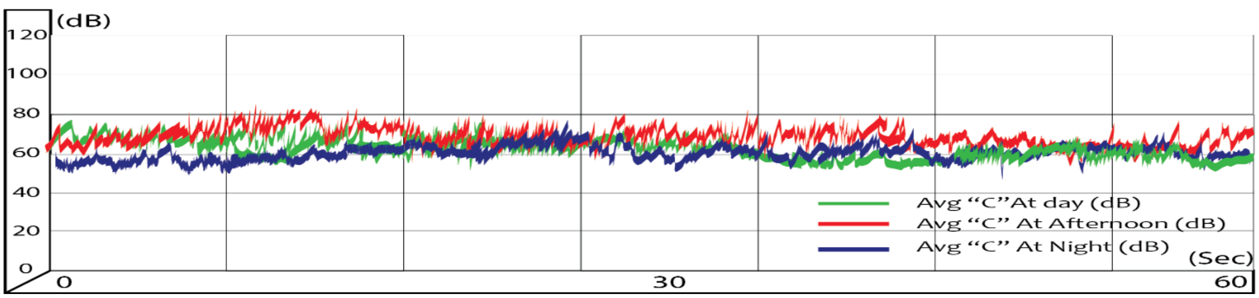

Figure 13. Code C (20 m away) average noise level for daytime, afternoon, and night.

'D" coded are selected houses, which located in the 30-meter from the railway line, and the recorded result of each spot is listed in table 8 below.

Table 8 and figure 14 illustrated, the maximum of 79.8 dB recorded and the minimum of 48.7 dB at night. In the general afternoon time, there is a high noise level compared to the other period and a low noise level recorded at the night-time period.

Table 8: Code D (30 m away) noise level result

Code	At Day			At Afternoon			At Night		
	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)
D^1	49.8	64.8	74.7	56.8	67.9	78.4	48.7	63.9	72.8
D^2	50.6	66.5	75.4	53.1	68.2	77.5	48.9	64.8	73.0
D^3	52.3	68.3	76.9	54.2	69.0	79.8	49.5	65.2	73.6

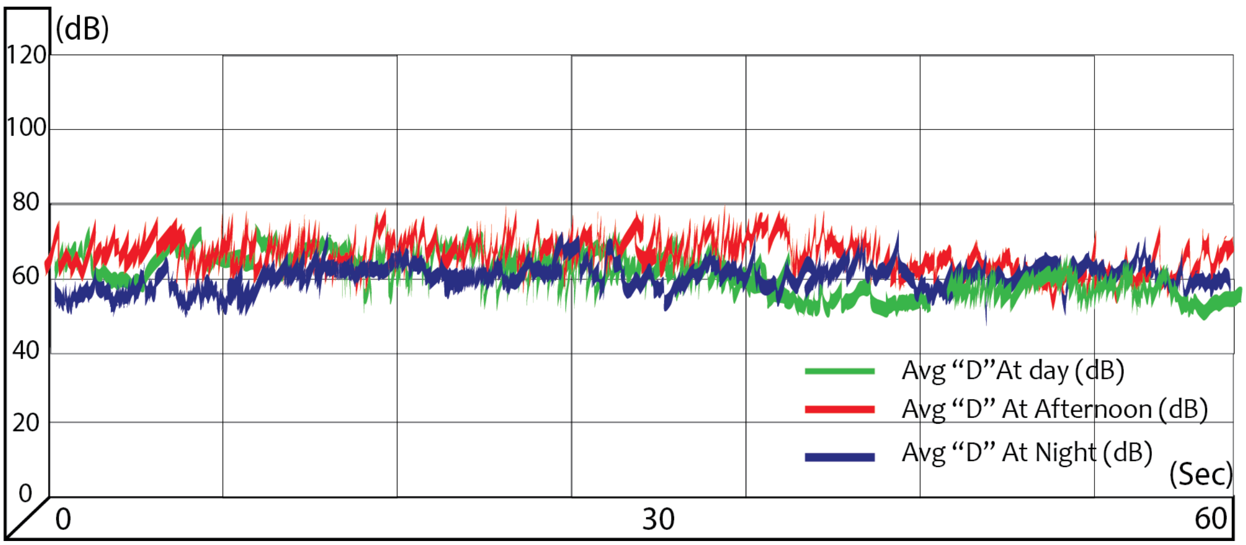

Figure 14. Code D (30 m away) average noise level for day time, afternoon, and night

"E" coded are selected houses, within the 40-meter from the railway line, and the recorded result of each house is listed in table 9 and figure 15 below. The maximum of 79.8 dB and the minimum of 48.7 dB at night. In the general afternoon time, there is a high noise level compared to the other period and a low noise level recorded at the night-time period.

Table 9: Code E (40 m away) noise level result

Code	At Day			At Afternoon			At Night		
	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)
E^1	43.8	62.8	72.7	56.8	67.9	78.4	31.7	55.9	69.8
E^2	42.6	60.5	71.4	53.1	68.2	77.5	33.9	59.8	71.0
E^3	48.3	65.9	75.0	54.2	69.0	79.8	35.5	63.2	73.2

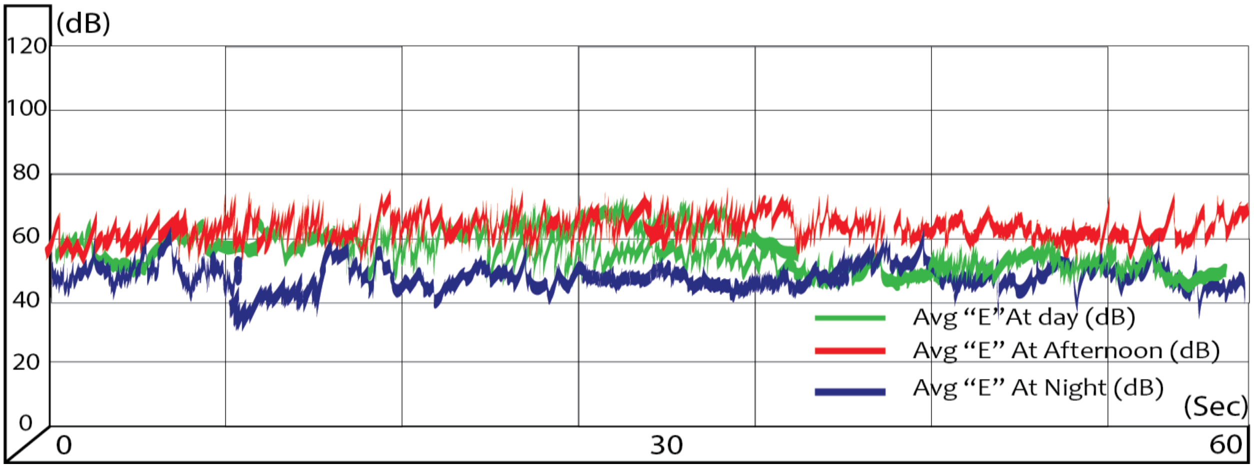

Figure 15. Code E (40 m away) average noise level for day time, afternoon, and night

"F" coded are selected houses, within the 50-meter from the railway line, and the recorded result of each spot is listed in table 10 and figure 16 below. The maximum of 68.3 dB and the minimum of 26.9 dB at night. In the general afternoon time, there is a high noise level compared to the other period and a low noise level recorded at the night-time period.

Table 10: Code F (50 m away) noise level result

Code	At Day			At Afternoon			At Night		
	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)	Min (dB)	Avg (dB)	Max (dB)
F^1	30.2	46.8	62.4	34.4	49.9	64.4	26.9	42.2	58.8
F^2	32.6	48.5	63.9	37.1	51.2	66.5	28.2	44.6	59.5
F^3	34.5	51.9	66.2	41.2	55.0	68.3	29.5	45.8	62.2

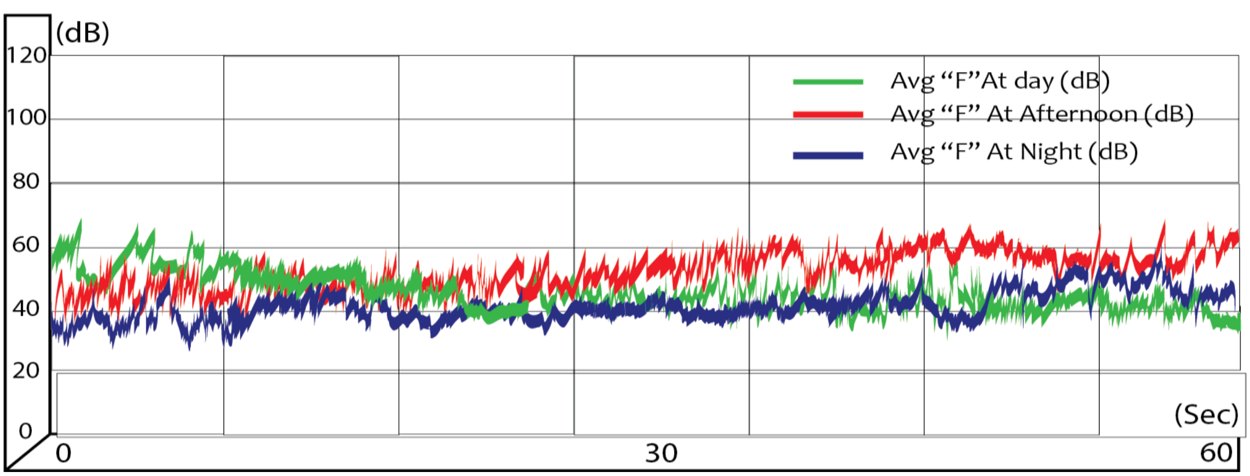

Figure 16. Code F (50 m away) average noise level for day time, afternoon, and night

Table 11: The total average of noise levels.

Code	Avg_{day}(dB)	$Avg_{Afternoon}$ (dB)	Avg_{night}(dB)	Total Avg (dB)
A^1	76.9	81.6	74.4	77.63
A^2	77.2	78.9	71.5	75.86
A^3	76.6	76.8	72.8	75.4
	76.9	79.1	72.9	
Total Avg for Code A (5 m away)				76.3
B^1	71.9	77.3	69.5	72.9
B^2	73.2	74.8	68.5	72.16
B^3	74.6	72.8	66.9	71.43
	73.23	74.96	68.3	
Total Avg for Code B (10 m away)				72.16
C^1	70.2	75.9	67.9	71.33
C^2	71.5	73.1	67.0	70.53
C^3	72.3	73.3	64.8	70.13
	71.33	74.1	66.56	
Total Avg for Code C (20 m away)				70.66
D^1	64.8	67.9	69.5	67.4
D^2	66.5	68.2	68.5	67.73
D^3	68.3	69.0	66.9	68.06
	66.53	68.36	68.3	
Total Avg for Code D (30 m away)				67.73
E^1	62.8	67.9	55.9	62.2
E^2	60.5	68.2	59.8	62.83
E^3	65.9	69.0	63.2	66.03
	63.06	68.36	59.63	
Total Avg for Code E (40 m away)				63.68
F^1	46.8	49.9	42.2	46.3
F^2	48.5	51.2	44.6	48.1
F^3	51.9	55.0	45.8	50.9
	49.06	52.03	44.2	
Total Avg for Code F (50 m away)				48.43
Total Avg				66.49

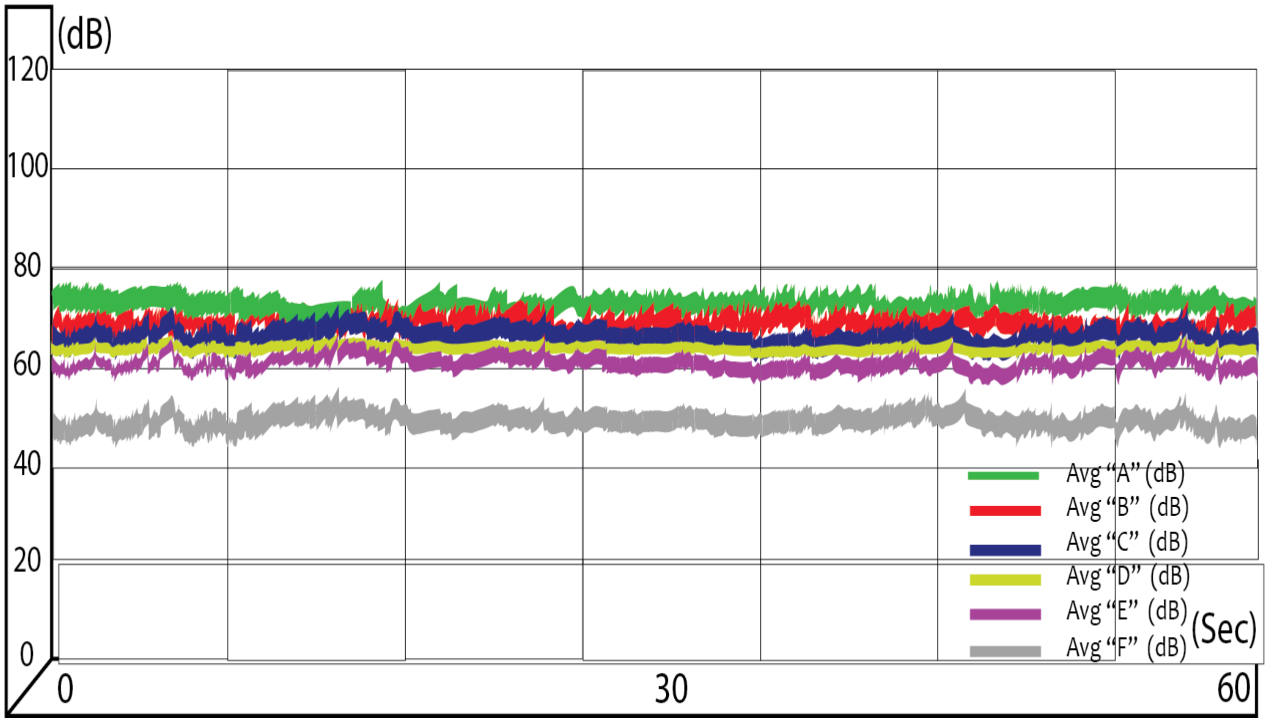

Figure 17. The total average of noise levels for an “A,” “B,” “C,” “D,” “E,” “F”

As shown in table 11 and figure 17 the total average of the noise level on the different Codes and time frames. For-noise level measurement it categorized based on the 6 groups with a code name of “A” up to “F”, based on the distance from the railway line. Code “A” has the maximum average in the afternoon with the value of 79.1 dB and the total average for all records is 76.3 dB. For code “B” average of 74.96 dB record in the afternoon, which is the maximum compare to the average of day and night records. for the total average is 72.16 dB from all time frame records. For code “C” the maximum value of the noise level register in the afternoon with the value 74.1dB and the total average of all records is 70.66 dB. For code “D” Similarly, the afternoon record is the maximum compare to the other two date times. The maximum value of the code “D” in the afternoon is 68.36 dB it almost the same as the average night record which is 68.3 dB, based on the data collected from the three different time frames the total average of the code “D” is 67.73 dB. Code “E” record values show the maximum record value record in the afternoon with 68.36 dB and the total average of the code “E” is 63.68 dB. The last record shows the code “F” it is minimum value records compare to the all above records similar to the others in the afternoon the maximum value record with a value of 52.03 dB and the total average of 48.43 dB, generally, the total average of the record values is 66.49 dB.

4.1.3. ***Discussion.***

Analysis of the result based on the DIN 4150-2 and Directive of the Swiss Federal Office (BEKS 1999) and World Health Organization studies (WHO, 2004).

According to the Directive of the Swiss Federal Office (BEKS 1999), the permissible noise level is listed in the literature review. For newly build railways the permissible noise level for residences at daytime is 35 dB and at night 25 dB. For a modernized railway line, the permissible noise level for dwelling at day time is 40 dB and at night-time is 30.

According to World Health Organization (WHO) studies, it is stated with sufficient evidence that noise annoys levels above 55 dB (A) and 85 dB (A) in office and industry, respectively; 55–116 dB (A) causes hypertension, 75 dB (A) causes hearing loss and a noise level above 81 dB (A) may cause deafness. (WHO, 2004).

Table 12: Noise levels on the Adama railway line different distances.

Code	Distance from the track (m)	Noise level			Mean of noise levels (dB)
		Day time (dB)	Afternoon (dB)	Night (dB)	
A	5	76.9	79.1	72.9	76.3
B	10	73.23	74.96	68.3	72.16
C	20	71.33	74.1	66.56	70.66
D	30	66.53	68.36	68.3	67.73
E	40	63.06	68.36	59.63	63.68
F	50	49.06	52.03	44.2	48.43

Based on the Swiss federal office standard, the noise level of spots A, B, C, D, E, and F are above the permissible noise level. As shown in table 12 the location “A” the recorded noise level at day time is 76.9 dB and the noise level at night is 72.9 dB, while the accepted noise level for the dwelling at day time is 40 dB and the accepted noise level for the dwelling at night time is 30 dB. This shows that the daytime result exceeds by 36.9 dB amount and at night the result exceeds 42.9 dB amount, this implies almost double noise levels measured compared to the standard allowed noise level. Same true with all other location results, if we take the location “F” record that 49.06 dB at day time and 44.2 dB at night; as the standard noise level for day time is 40 dB and 30 dB at night time In general, all recorded data are more than the allowed standard, this means it’s not suitable for residence purposes.

4.2. Results for Second Objective

4.2.1. ***Comparing Noise Level According to International Standards***

Based on the World Health Organization (WHO) studies, noise annoys levels above 55 dB, and the result of location “A,” “B,” “C,” ’D,” “E” cause annoyance; as shown in the table 13 the red color noted can annoy.

As WHO 55–116 dB causes hypertension and can cause hypertension. Table 13 from the result found in Adama railway line within the different range of location “A,” “B,” “C,” ’D,” “E” can cause hypertension.

Table 13: The result found can cause hypertension and annoyance

Code	Distance from the track (m)	Noise level			Mean of noise levels (dB)
		Day time (dB)	Afternoon (dB)	Night (dB)	
A	5	**76.9**	**79.1**	**72.9**	76.3
B	10	**73.23**	**74.96**	**68.3**	72.16
C	20	**71.33**	**74.1**	**66.56**	70.66
D	30	**66.53**	**68.36**	**68.3**	67.73
E	40	**63.06**	**68.36**	**59.63**	63.68
F	50	49.06	52.03	44.2	48.43

As WHO 75 dB causes hearing loss and from location “A” at day time and afternoon can cause hearing loss. As shown in table 14 the red color noted can cause hearing loss.

As WHO a noise level above 81 dB may cause deafness, but all recorded are less than 81 dB, this implies the noise level produced in the railway is not causing deafness.

Table 14: The noise causes hearing loss based on the WHO studies compared with the result found.

Code	Distance from the track (m)	Noise level			Mean of noise levels (dB)
		Day time (dB)	Afternoon (dB)	Night (dB)	
A	5	**76.9**	**79.1**	72.9	76.3
B	10	73.23	74.96	68.3	72.16
C	20	71.33	74.1	66.56	70.66
D	30	66.53	68.36	68.3	67.73
E	40	63.06	68.36	59.63	63.68
F	50	49.06	52.03	44.2	48.43

4.2.2. ***Local People Perception Questionary one Result***

In table 15 shown, from 16 near railway residences, 37.5% are highly disturbed, 31.3% are very highly disturbed, 25% are normally disturbed and the remaking 6.3% are very low disturbed.

Table 15: Location * Disturbance

			How do you rate your sleep disturbance				Total
			Very High	High	Normal	Comparatively Low	
Location	Abragodana	Count	0	1	1	0	2
		%	0.0%	50.0%	50.0%	0.0%	100.0%
	Near a railway	Count	5	6	4	1	16
		%	31.3%	37.5%	25.0%	6.3%	100.0%
Total		Count	5	7	5	1	18
		%	27.8%	38.9%	27.8%	5.6%	100.0%

From 18 to 50 aged of total 6 respondents 66.7 are highly disturbed and above 50-year-old respondent, 50% of them are very highly disturbed and 50% of them are normally disturbed. Of the total of 18 respondents, 38.9% are highly disturbed, 27.8% are very highly disturbed similarly 27.8% are normally disturbed and 5.6% are lowly disturbed (see Table 16).

Table 16: Age * How do you rate your sleep disturbance? Crosstabulation

			How do you rate your sleep disturbance				Total
			Very High	High	Normal	Comparatively Low	
Age	< 18	Count	2	3	2	1	8
		%	25.0%	37.5%	25.0%	12.5%	100.0%
	18–50	Count	1	4	1	0	6
		%	16.7%	66.7%	16.7%	0.0%	100.0%
	50 above	Count	2	0	2	0	4
		%	50.0%	0.0%	50.0%	0.0%	100.0%
Total		Count	5	7	5	1	18
		%	27.8%	38.9%	27.8%	5.6%	100.0%

Table 17 illustrated below, from 20 samples of Abragodana 75% are thinking they are not over-warmed/annoyed easily, the remaining 25% are considering themselves as over warmed easily. From 20 samples near a railway, 55% consider themselves as over warmed/ annoyed easily and the remaining 45% do not consider themselves as over warmed. From the total 40 samples 60.0% are thinking, they are not over-warmed or easily annoying personalities.

Table 17: Location * Annoyed Test

			Did you consider yourself an over warmed or easily annoyed person?		Total
			Yes	No	
Location	Abragodana	Count	5	15	20
		%	25.0%	75.0%	100.0%
	Near a railway	Count	11	9	20
		%	55.0%	45.0%	100.0%
Total		Count	16	24	40
		%	40.0%	60.0%	100.0%

In table 18 below, from 20 samples in Abragodana, 85% of them think, no one in their family members is exposed to annoyance and the remaining 15% think 1 of their families is exposed to annoyance. From 20 samples near a railway, 60% of them thinks 2 of their family members are exposed to annoyance; 30% of them think 1 of their family members is exposed to annoyance and the remaining 10% of them think 3 of their family members are exposed to annoyance.

Table 18: Location * Family members exposed to annoyance

			How many of your family members are exposed for annoyance?				Total
			0	1	2	3	
Location	Abragodana	Count	17	3	0	0	20
		%	85.0%	15.0%	0.0%	0.0%	100.0%
	Near a railway	Count	0	6	12	2	20
		%	0.0%	30.0%	60.0%	10.0%	100.0%
Total		Count	17	9	12	2	40
		%	42.5%	22.5%	30.0%	5.0%	100.0%

Table 19 and figure 18 are illustrated below, from 20 samples of Abragodan 20% of them think their voice tone is loud and 80% of them think their voice tone is normal. From 20 samples near a railway, 80% of them consider their voice tone is loud and they remain 20% of them consider their voice tone normal. In the total of 40 samples, 50% of the respondent think their voice tone is loud and the remains also consider their voice tone is normal.

Table 19: Location * Voice Tone

			Voice Tone		Total
			Loud	Normal	
Location	Abragodana	Count	4	16	20
		%	20.0%	80.0%	100.0%
	Near a railway	Count	16	4	20
		%	80.0%	20.0%	100.0%
Total		Count	20	20	40
		%	50.0%	50.0%	100.0%

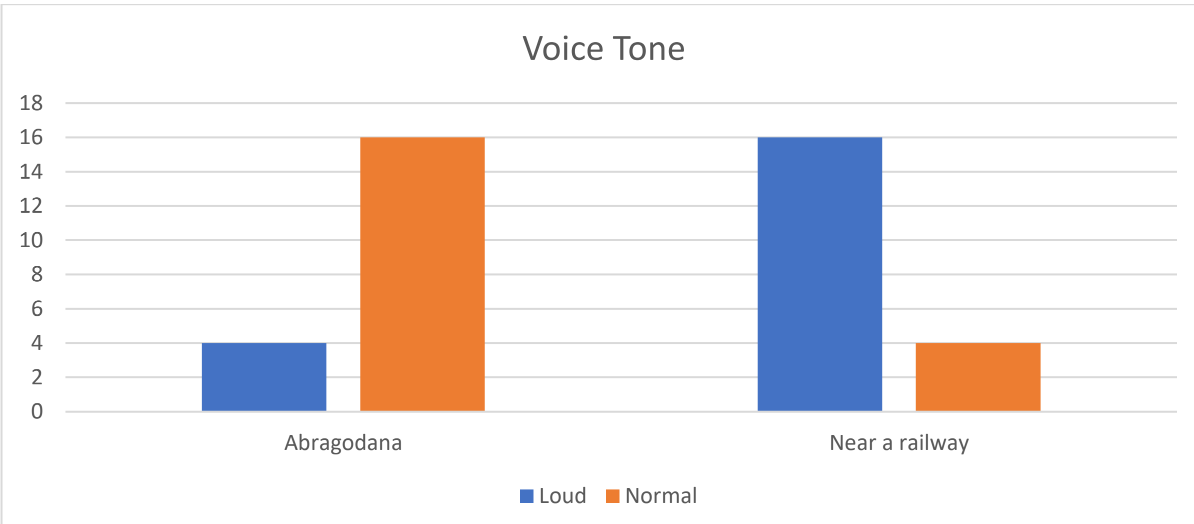

Figure 18. Locations * Voice tone

From 20 samples of Abragodana 45% of them consider almost none they demand repeat words while communicating and from 20 near railway samples, 45% of them request sometimes repeat words while communicating (see table 20).

Table 20: Location * Demand Repeat word crosstabulation

			Demand Repeat word				
			Almost none	Sometimes	Most times	I don't Notice	Total
Location	Abragodana	Count	9	7	1	3	20
		%	45.0%	35.0%	5.0%	15.0%	100.0%
	Near a railway	Count	1	9	6	4	20
		%	5.0%	45.0%	30.0%	20.0%	100.0%
Total		Count	10	16	7	7	40
		%	25.0%	40.0%	17.5%	17.5%	100.0%

As shown below in Table 21, from 20 samples of Abragodana 14 of them don't sleep in the daytime and the remaining 6 are sleeping in the daytime. From 20 samples near a railway 11 of them sleep in the daytime and the remaining 9 of them don't sleep in the daytime.

Table 21: Location * Sleep at Daytime Crosstabulation

			Sleep at Daytime		Total
			Yes	No	
Location	Abragodana	Count	6	14	20
		%	30.0%	70.0%	100.0%
	Near a railway	Count	11	9	20
		%	55.0%	45.0%	100.0%
Total		Count	17	23	40
		%	42.5%	57.5%	100.0%

From 6 samples of Abragodana, 66.7% of them sleep 1–2 days per week and they remain 33.3% sleep 3–5 days per week. From 11 samples 45.5% of them sleep 3–5 per week, 27.3% of them sleep 5–6 per week, 18.25 of them sleep all day and 9.1% of them sleep 1–2 days per week (see table 22).

Table 22: Location * How often Sleep in the Daytime? Crosstabulation

			How often Sleep at Daytime				Total
			1–2days/week	3–5days/week	5–6days/week	all-day	
Location	Abragodana	Count	4	2	0	0	6
		%	66.7%	33.3%	0.0%	0.0%	100.0%
	Near a railway	Count	1	5	3	2	11
		%	9.1%	45.5%	27.3%	18.2%	100.0%
Total		Count	5	7	3	2	17
		%	29.4%	41.2%	17.6%	11.8%	100.0%

Table 23: Location * felling away home? Crosstabulation

			felling away home				Total
			Very Sad	Sad	Normal	Happy	
Location	Abragodana	Count	4	7	7	2	20
		% within Location	20.0%	35.0%	35.0%	10.0%	100.0%
	Near a railway	Count	4	7	4	5	20
		% within Location	20.0%	35.0%	20.0%	25.0%	100.0%
Total		Count	8	14	11	7	40
		% within Location	20.0%	35.0%	27.5%	17.5%	100.0%

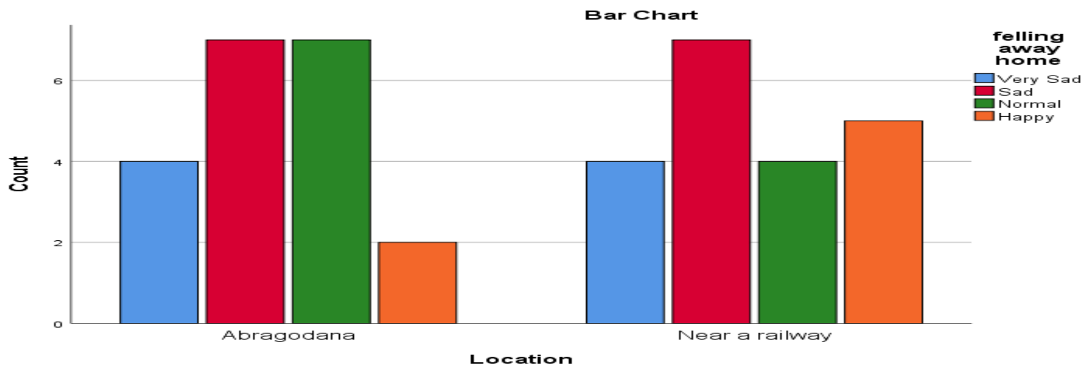

Figure 19. Locations * felling away home? Crosstabulation

As shown above in table 23 and figure 19 above, from 20 samples asked in Abragodana about what they fell away from their home; 35% of them feel sad, 35% of others also feel normal, and from 20 samples near a railway 35% of them felt sad, the other 25% of them felt happy and In general from 40 20% of the respondents are very sad, 35% are sad, 27.5% are normal, 17.5% are happy.

As shown in Table 24 below, from 20 samples taken from Abragodan 50 % of them respond no family member has blood pressure diseases, and from 20 samples asked near a railway 60% of them respond none. From a total of 40 samples asked about how many of your family members have blood pressure diseases; 55.0% respond to none, 35.0% answer 1, and 10.0% answer 2. 85% of the respondents don't think the blood pressure is caused by the railway noise.

Table 24: Location * Family members have blood pressure diseases

			How many of your family members have blood pressure diseases?			Total
			0	1	2	
Location	Abragodana	Count	10	8	2	20
		%	50.0%	40.0%	10.0%	100.0%
	Near a railway	Count	12	6	2	20
		%	60.0%	30.0%	10.0%	100.0%
Total		Count	22	14	4	40
		%	55.0%	35.0%	10.0%	100.0%

From 10 valid samples asked about when did the doctor inform the patient? And 4 of them respond 1–2 years, similarly, the other 4 of them respond 3–6 years and 2 of them answer up to 10 years. From 8 samples asked about when did the doctor inform the patient? Four of them are up to 10 years, 2 of them are 3–6 years and the other 2 of them are 1–2 years. From a total of 18 samples, 33.3% evenly distribute to the 1–2-year, 3–6 years, and up to 10 years (see table 25 and figure 20 below).

Table 25: Location * when did the doctor inform the patient? Crosstabulation

			When did the doctor inform the patient?			Total
			1–2years	3–6 years	up to 10 years	
Location	Abragodana	Count	4	4	2	10
		%	40.0%	40.0%	20.0%	100.0%
	Near a railway	Count	2	2	4	8
		%	25.0%	25.0%	50.0%	100.0%
Total		Count	6	6	6	18
		%	33.3%	33.3%	33.3%	100.0%

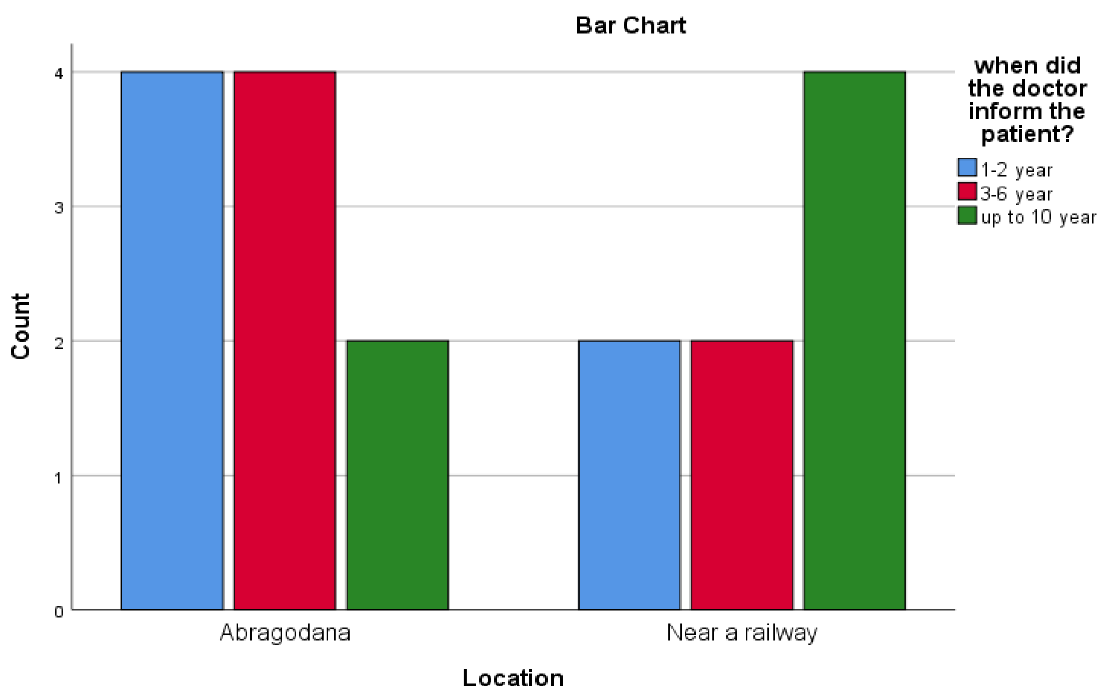

Figure 20. Locations * The doctor informs the patient Crosstabulation

4.2.3. ***Local People Perception Questionary Two Result***

Table 26 illustrated below, 60 respondents asked about the importance of noise studies, and 43.3% of them think it is very necessary; 30% of them think it is extremely necessary; 21.7% of them think it is less necessary and 5% of them think it's unnecessary.

Table 26: The importance of studying the impact of noise

	Frequency	Percent
Unnecessary	3	5.0
less Necessary	13	21.7
very necessary	26	43.3
extremely necessary	18	30.0
Total	60	100.0

As shown in table 27 and figure 21 below, 60 respondents are asked how often they thought to leave their house as the result of the railway noise, and 43.3% respond sometimes; 35.0% of answer so many times; 11.7% of them answer 1 time and 10% of them answer none.

Table 27: The effect of railway noise to leave your home

	Frequency	Percent
So many times,	21	35.0
sometimes	26	43.3
1 time	7	11.7
None	6	10.0
Total	60	100.0

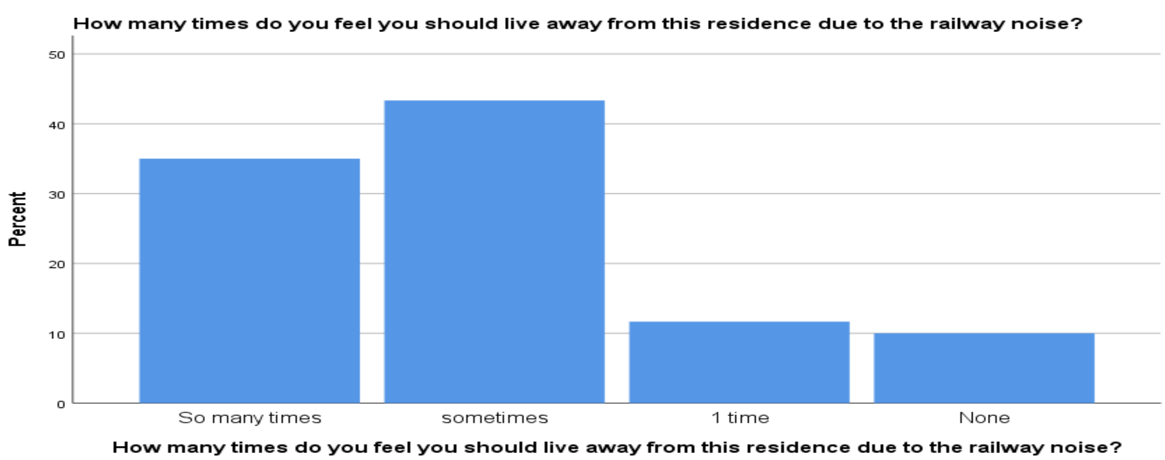

Figure 21. How often they thought live away from this residence due to the railway noise?

Table 28 shows below, from 60 respondents 53.3% of them missing the question and the remaining asked the question do they think noise has any role in their annoyance and 35% of them answer yes and the remaining 11.7% are responding no. Of a total of 28 valid respondents 75% agreed and 25 disagreed.

Table 28: Do you think railway noise has any role in your annoyance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	35.0	75.0	75.0
	No	7	11.7	25.0	100.0
	Total	28	46.7	100.0	
Missing	9999	32	53.3		
Total		60	100.0		

From 60 respondents asked if they have a superpower like a superman, do they demolish the railway station and 60% of them answers yes, and 40% of them answer no. Similarly, respondents asked about do they consider themselves an easily annoyed person and 32 of them respond no and 28 of them respond yes.

See table 29, from 60 respondents 39 of them missing this question about the role of the noise in their annoyance, and 52.4% of them answer very high; 28.6% of them answer high and the remaining 19.0 are responding low.

Table 29: Rate the role of the noise in your annoyance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very high	11	18.3	52.4	52.4
	High	6	10.0	28.6	81.0
	Low	4	6.7	19.0	100.0
	Total	21	35.0	100.0	
Missing	9999	39	65.0		
Total		60	100.0		

From 60 respondents asked about do they have a sleep problem and 71.7 of them respond yes and 28.3 of them respond no.

See table 30 below, 44 valid respondents participate from 60 respondents and asked the question do they think their family member has a sleeping problem, and 70.5% are answered yes and 29.5% respond no.

Table 30: Do you think your family member has a sleeping problem?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	31	51.7	70.5	70.5
	No	13	21.7	29.5	100.0
	Total	44	73.3	100.0	

Table 31 below, the question asked what they think the role of the railway noise on their sleep problem and 44 active responders 16 of them answer very high, 16 of them answer high, 9 of them answer low and the remains 3 are responding very low.

Table 31: What do you think is the role of the railway noise on your sleep problem?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very high	16	26.7	36.4	36.4
	High	16	26.7	36.4	72.7
	Low	9	15.0	20.5	93.2
	Very low	3	5.0	6.8	100.0
	Total	44	73.3	100.0	
Missing	9999	16	26.7		
Total		60	100.0		

See table 32 below, from a total of 48 valid samples questioned about the railway noise has a direct impact on their stress and 77.1% respond yes and 22.9 answers no.

Table 32: Do you think the railway noise has a direct impact on your stress?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	37	61.7	77.1	77.1
	No	11	18.3	22.9	100.0
	Total	48	80.0	100.0	
Missing	9999	12	20.0		
Total		60	100.0		

As shown in Table 33 below, the railway noise role on their stress. From a total of 60 samples, 23 of them missing, and from the total of 37 valid respondents 48.6% rate very high, 40.5% rates high, and 10.8% of them rates low.

Table 33: How do you rate the role of the railway noise on your stress?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High	18	30.0	48.6	48.6
	High	15	25.0	40.5	89.2
	Low	4	6.7	10.8	100.0
	Total	37	61.7	100.0	

See table 34 and figure 22 below, from 15 valid responders rate the relation of railway noise with the hearing problem, 8 of them respond high; 5 of them answer low and the remaining 2 are responding very high. Generally, 53.3% rates high, 33.3% rates low, and 13.3% of rates very high.

Table 34: The role of the railway noise in hearing problem

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High	2	3.3	13.3	13.3
	High	8	13.3	53.3	66.7
	Low	5	8.3	33.3	100.0
	Total	15	25.0	100.0	

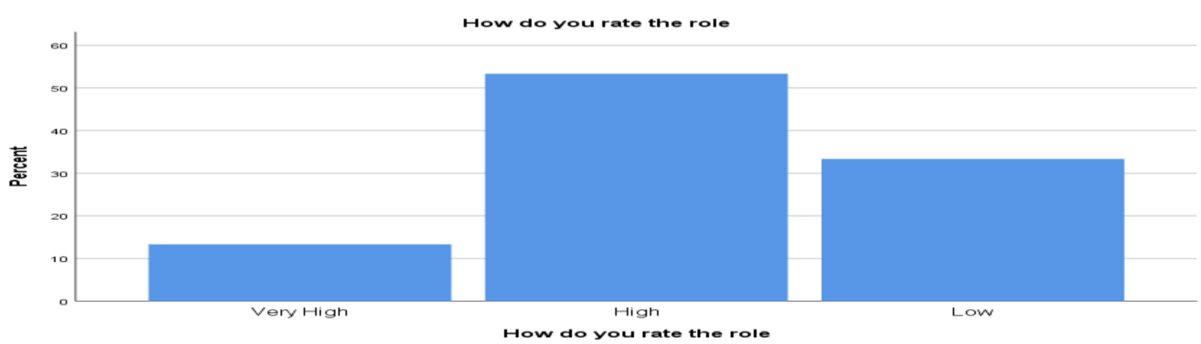

Figure 22. How do you rate the role of the railway noise hearing problem?

From 60 respondents asked about did any of their families have blood pressure and 34 of them respond no in percent 56.7 % and 26 of them respond yes in percent 43.3 %.

As shown in figure 23 below, annoyance and sleep problems are the most ranked.

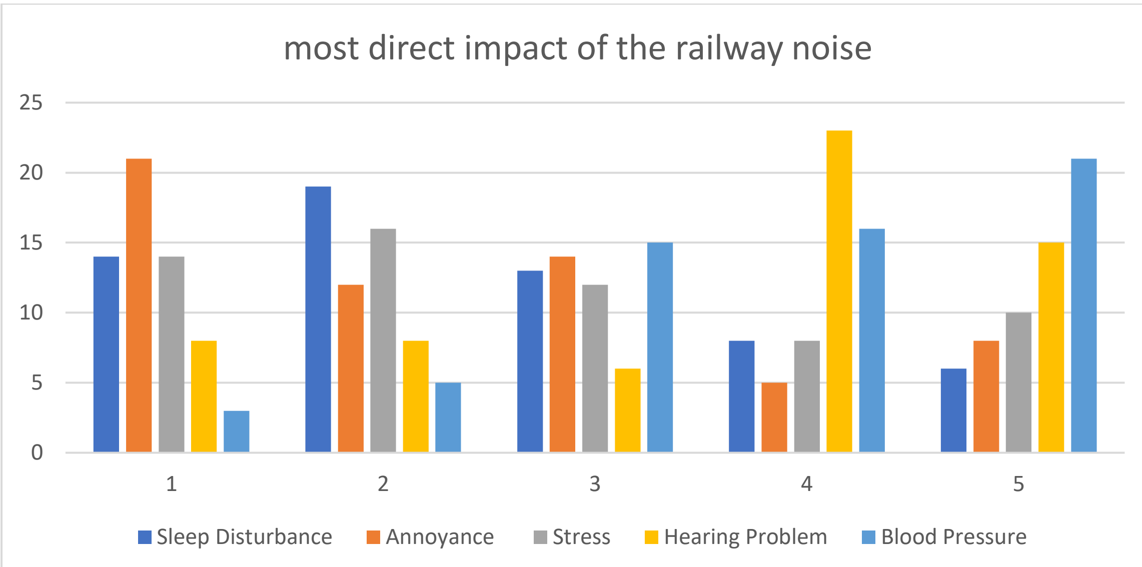

Figure 23. orders from 1 to 6 based on the most direct impact of the railway noise

As table 35 below, 60 respondents are asked the question who do they think should take responsibility and 25 of them think urban planners should take responsible; Fifteen of them think the government should take responsible; Thirteen of them agree all of them are responsible and the remains 7 of them believe their family is responsible for this problem. From a total of 60 valid respondents, 41.7% of them think the urban planner is responsible, 25.0% of them think the government is responsible; 21.7% of them think all are responsible and 11.7% of them believe their family is responsible for the noise problem.

Table 35: For this problem, who do you think should take responsibility?

	Frequency	Percent
Government	15	25.0
Family	7	11.7
Urban Planner	25	41.7
All	13	21.7
Total	60	100.0

4.2.1. ***Discussion.***

Most Abragodana residences feel happy than people living near a railway, this because of the many factors some of them believe the quietness of the place; others due to the accessibility to the main city center, and some responded, “don’t know I just like the way of living here”. But one of the key informants living in the near railway says “I am lucky most of my family don’t have their own house to live in, but at least I have.

Most of the Abragodan residence don’t experience any sleep disturbance and 80% of the residents who live near the railway believe they experience sleep disturbance. This shows the noise has a direct role in sleep disturbance. The reason for their sleep disturbance was asked for each respondent and most of them believe the noise of the traffic and the vibration of the rail. And the remains think due to their experience like drink coffee at night and so on. The noise pollution affects the people sleep time especially near to a railway the passenger vehicle moves only at 4 p.m. at a local time from Adama to Dire Dewa and from Dire Dewa to Adama arrive Adama at 8 a.m. local time.

The people who live in Abragodana have considered themselves as very cool people, comparatively most of the person lives near to railway consider themselves as easily annoyed people. The reason asked for the respondents and most them think due to the economic, environmental and genetic problem, one of the key informant, whose name is Alelegn, he in the middle of age living very close to the railway line responses, like this “I am annoyed every day because I am poor” and others key informant, whose name is Tesfa similarly living close to the railway respond like “how do you expect the people living here don’t be annoyed?” and the other key informant in the age of fiftieth similarly living in the near railway also responds, “I am easily annoyed people, may this came from genetic or not”.

Most of the respondents asked how many of their families are exposed to annoyance on average in every house there is 1 person exposed to this. As disused above the reason for this is the unsuitable environment or the economic problem or maybe the natural problem of the individual. In the comparative most of the living in the Abragodan believe they are not exposed to annoyance and most people who live near to a railway oppositely think they are exposed to annoyance; this may be related to the railway noise and vibration.

The different voice tone is used for communication, the more your hearing organ has some problem the louder the voice tone of your speech, but the other factor may also encounter for the loud voice tone. In this case, the respondents are asked about their voice tone and most Abragodana residence think their tone was being normal and 80% of the residents who live near a railway think their voice tone is loud. This may be directly related to the long-term effect of the railway noise. There are some dwellings livings for more than 6 years up to now, the long effect of the railway on deafness or hearing problems may cause; so, the problem of the noise comparatively expressed on more near a railway residence.

If you get enough sleep at night the less probability to sleep in the daytime. Most time the people who work most of their time at night encounter daytime sleep problems, but this is only not the problem children sleep in the daytime as well at night. The respondents were asked to answer if they sleep in the daytime, 70% of the Abragodana don't sleep in the daytime, and 55% of the residences who live near a railway sleep in the daytime. From the result above most of them sleep for 3–5 days/week. The dwelling living near to a railway may not get enough sleep at night due to the railway noise and they sleep at day time.

The residence asked about what they feel about living away from their home. Thirty-five percent of the dwellers who live in Abragodana feel sad and 35% feel normal and 25% of residence near the railway feel happy and 35% feel sad. The more you feel sad the more you like you're living environment. The more you get happy the more you hate your residence or the more the new place is very interesting. The Abragodana residences like their place compared with the residents who live near a railway. The residents living on the railway may don't get their house comfortable as it should be, one of the reasons may be the noise of the railway.

From different scholars, it discusses that the noise results in a lot of diseases including blood pressure compares it asked the respondents about how many of their family members have blood pressure and it shows that; from two houses there is one family member is exposed to blood pressure, most of them answer none of their family members had blood pressure. Most of them informed from 1 to 2 years and 3–6 years in both places. The blood pressure victim family members asked if the railway noise has a role in the disease and 85% of them responded they don't think the blood pressure is caused by the railway noise.

4.2.2. ***<u>Specific Discussion on Railway Residence Survey</u>***

Almost all the respondent notices the railway noise. This shows the railway noise can't ignore. This implicates the noise is actively heard by almost all respondents either they're staying at home or living morning. And coming at night, either they're young or old or either they're male or females all are noticing the noises. Most of the respondents notice the noise at all times, not only singe day or afternoon or night this shows the problem is huge and it repeats every day.

Almost all the respondents negatively answer to what they do when they hear the noise of the railway. From the negative responses, one of the key informants, whose name is Belachew, respond like this "I feel frustrated and annoyed." And others also mention, "I feel sad" and from the positive response one of the key informants, whose name is Solomon said, "I almost adapted the noise!" This shows that most of the residence are negatively affected by the railway noises.

Most respondents responded the railway noise makes them wish to leave their house. Similarly, they also asked, "If they have a superpower like a superman, do they demolish the railway station?" And more than half of the answers will demolish the railway line. This shows that the residence believes their house isn't suitable for living. Most of the residents agreed they're living there because they have no other choice to live in because of the economic problem. They believe demolish the railway line will solve their problem.

Some of them are afraid of the railway due to the safety of their children and animal. Others hate it because of the health problem of the noise and vibration to their day-to-day life and the other separate their social life apart. Each of the respondents asked directly if they have anger management issues and 53.3% don't consider themselves as easily annoyed people and 46.7% of them think of themselves as easily annoyed people. And 46.7% of them asked, "Do they think railway noise has any role in their annoyance?"; two-third of the respondent think it has a direct relation and the remaining one-third of the respondent don't believe it has a direct relation. This shows the railway noise has a direct relation to the annoyance of the individual. The health issue is very critical to be studied for society's well-being. The railway noise affects the annoyance of each victim and more than half of the respondents rate the noise impact on their annoyance as very high. So, the results tell us that railway noise and vibration contribute to annoyance are very high.

Almost two-thirds of the sample show they have a sleep problem. And from those people similarly, almost two-thirds of them believe their family members have a sleep problem this indicates that more people are suffering from sleep problems. For understanding the degree of the noise problem, each respondent asked what they think is the role of the railway noise on their sleep problem. More than one-third of the respondent think it has very high roles. This shows that railway noise has a very strong relation with sleep problems.

More than two-thirds of the respondent has stress problems and the respondents asked if their stress was related to the railway noise and more than two-thirds of the respondent think it has a direct relation. This indicated that the railway has a direct impact on the stress of the dwellings. For understanding the degree of the railway noise to the residence's stress. They were asked how they rate the role of the railway noise on their stress and almost half of them believe it has a very high role in this stress. And this indicated that the railway noise has a strong relationship with the stress of the dwellings.

More than half of the respondents don't encounter hearing problems. The remains, for those who think they have encountered hearing problems asked about "did they think the railway noise has a direct role on the hearing problem?" And more than half of them think it doesn't have any role for their hearing problem, this indicates that the railway noise has some relation, but not that much direct relation with the hearing problem.

More than half of the respondents think railway noise hasn't any role in causing blood pressure. This indicates that the railway noise has some relation, but not that much direct relation with the blood pressure disease.

Annoyance is ranked first with 35% of the respondent, second-ranked both sleep disturbance and stress both by 23.33%, fourth-ranked are hearing problems and the last ranked is the blood pressure. This indicated that the railway noise has a direct impact on the health of the residents living near the railway.

Almost half of the respondents think the urban planner has a huge role in his problem. The city should be suitable for all. This indicates that the urban planner has a greater role for the community well-being and influence the government to guarantee the safety of the peoples.

CONCLUSION AND RECOMMENDATION

5. CONCLUSION

Generally, according to the study, three kinds of analysis are used for identifying the noise level and the impact of the noise on the residents. Most of the sites and the houses located in the site are characteristic as similarity, which is very advantageous by excluding unnecessary variables to the measurement noise level. For measurement of the noise level, it assigned 6 study areas grouped and named each alphabetically from “A” up to “F.” The noise level of the site is in the range between 44.2 dB up to 79.1 dB. Based on the Swiss federal office standard the noise level of spots A, B, C, D, E, and F are above the permissible noise level. All recorded data are more than the allowed standard, this means the site is not suitable for the residence zone. Similarly based on the World Health Organization (WHO) studies the result found in the location “A,’ “B,’ “C,’ ‘D,’ “E” causes annoyance and hypertension. In addition to this, the result found in the Adama railway line within a different range of location “A” at day time and afternoon can cause hearing loss, but not causing deafness.

The research compares two places based on their degree on the noisiness and the residence living in the abragodan, which is much quietest, are happier; sleep well, less annoyed, normal voice tone, healthier than the residences live near a railway. The resident who lives in the near railway is more unsatisfied on their living environment than the dwelling in Abragodana.

Almost all respondents, who live the near railway line, notice the railway noise and they negatively responded to it. More than half of the respondents notice health impacts on their family members due to the railway noise. Similarly, they believe their house isn’t suitable for living, it exposed them to different kinds of diseases and it has a direct relation with the railway noise. The results tell us that railway noise and vibration contribute to annoyance are very high. Almost two-third the sample show, they have a sleep problem, more than two-thirds of the respondent has stress problems; this shows that the railway noise has a very strong relation with sleep problems and stress. From the research annoyance is ranked first with 35% of the respondent, second-ranked both sleep disturbance and stress both by 23.33%, fourth-ranked are hearing problems and the last ranked is the blood pressure. Almost half of the respondents think the urban planner should take responsibility.

6. RECOMMENDATIONS

1. Ethiopia as a country doesn't have any kind of proclamation and standard for the noise emission, for all zone such as residences zone, mixed-used zone, industry zone, school and health institutions. To achieve this the national institution should motivate the researcher to study the noise as general and make standards at the national level for control the issue and it should also publish the proclamation.
2. Understanding the environmental impact of the project should study by different organizations for avoiding any kind of ambiguous results for the benefit of the contractor. The people who live nearby to the project or the society should actively participate.
3. For an already constructed railway, different cost-effective mitigation methods should use based on the purpose of the site and the degree of the noise impact to the society. There are different methods including afforestation, building buffer for reflection noise, using building material on each house, and so on. Afforestation is one of the most recommended not only for noise minimizing but also for environmental, visual, and also economical. The best practice of this method is to allocate the residence area then with 10–15 m from the railway line cover by environmentally suitable trees. In our case due to economic problems planting trees within 2–10 from the railway line minimized the noise level and noise pressure, which affect the residents living nearby.
4. For the new construction of the railway, it should pass through the buffer zone with at least a 60 m radius from the residence zone. Sleep disturbance is generally dominating by road traffic in situations where the L_{night} for the railway, the noise is 55 dB or less. Therefore, a reduction of railway noise is only effective until a certain limit. To benefit from low noise limits for railway noise, additional measures against urban road traffic noise should be taking first.
5. There are many variables not studying in this study; such as the vibration impact, impact on the mixed uses and other zones, and how the impact is different from different demographic groups. Besides the noise many other problems came with the railway line, such as segregation of cities, visual discontinuities, safety issues, and others should also study very well before any kind of expansion project started at the national level. This all-unknown variable should study by the other scholars in a different context of the country, before preparing any kind of standards and proclamations.

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APPENDIX

Appendix A- Field observation checklist

Train Type	Period	Trains Per Period	Car Per Train	Source-Receptor Distance (m)	Description
Freight					
Passenger					
Freight					
Passenger					

Appendix B- Field Measurement Table 1

Time	Train Type	No of Locomotives	No of Cars	Idling Duration	Weather Conditions	Description

Appendix C- Field Measurement Table 2

Time	Train Type	No of Locomotives	No of Cars	Idling Duration	Weather Conditions	Description

Appendix D – Sound character adjustments

The table below describes adjustments from ISO 1996-1:2003 (CSA 2005). The adjustments may be applied to measurements or predictions of Day-Night sound levels at the noise receptor.

Specification	Adjustment to add to Day-Night sound level (dB)
Regular Impulsive	+ 5
Highly Impulsive	+ 12
Prominent Tones	+ 3 to + 6

Appendix E - Questionary One

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE

DEPARTMENT OF URBAN PLANNING AND DESIGN

MSC PROGRAM

Dear respondent, thank you in advance for your time.

This questionnaire is designed to gather data for research purposes to the fulfillment of MSc in the field of Urban Planning and Design Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the open-ended and closed questions.

Gender A) Male B) Female

Location A) Abragodana B) near a railway

Age A) below 18 B) 18-50 C) above 50

Number of household members -------------------------------------

1. When did you move to this place (Residence)?

A) 1-2 year ago B) 3-6 year ago C) more than 6 years ago

2. how did you feel about your current living place?

A) Very sad B) Sad C) Normal D) Happy E) Very Happy

3. did you experience sleep disturbance? A) Yes B) No

if yes how do you rate your sleep disturbance

A) Very high B) high C) Normal D) comparatively low E) almost none

Note: If your answer to the first question is ***No*** that means you are sleeping very well!

4. if you answer the above question ***Yes***, then what do you think is the cause or reason for your sleep disturbance?

----

5. Did you consider yourself an over warmed or easily annoyed person?

A) Yes B) No

If it is yes, what do you think is the reason for your annoyance?

How many of your family members are exposed for annoyance? ------------------------------

6. how most people express your voice tone/level

A) Quite B) Normal C) Loud

7. How often do you demand to repeat their word, while communicating?

A) Almost none B) sometimes C) most times D) I don't notice

8. Did you sleep in the daytime? A) Yes B) No

If yes How often

A) 1-2 days /week B) 3-5 days/week C) 5-6 days /week D) all-day

9. How many of your family members have blood pressure diseases ---------------------?

If there is one or more, when did the doctor inform the patient?

A) 1–2-year B) 3–6-year C) up to 10-year D) more than 10 years

10 what did you feel when you spent 1 or more days away from your home or residence?

A) Very Sad B) Sad C) Normal D) Happy E) Very Happy

The reason ---

Appendix F - Questionary Two

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

SCHOOL OF CIVIL ENGINEERING AND ARCHITECTURE

DEPARTMENT OF URBAN PLANNING AND DESIGN

MSC PROGRAM

Dear respondent, thank you in advance for your time.

This questionnaire is designed to gather data for research purposes to the fulfillment of MSc in the field of Urban Planning and Design Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the open-ended and closed questions.

Gender A) Male B) Female

Age A) below 18 B) 18-50 C) above 50

Number of household members --------------------------------------

1. Did you notice the railway noise A) Yes B) No

If **yes,** when did you notice the most time?

A) only Morning B) only afternoon C) only at Night D) All time

2. What did you feel when you heard the noise of the railway?

----

3. Did you Notice Any Health Impact due to the Railway noise in your Family members?

A) Yes B) No

If **yes ,** what kind of health impact ---

----

4. What do you think about the importance of studying the impact of noise?

A) Unnecessary B) less Necessary C) very necessary D) extremely necessary

5. How many times do you feel you should live away from this residence due to the railway noise?

A) So many times, B) sometimes C) 1 time D) None

6. If you have a superpower like superman do you demolish the railway station?

A) Yes B) No

7. Do you consider yourself an easily annoyed person? A) Yes B) No

If **yes**, did you think railway noise has any role in your annoyance? A) Yes B) No

Again, if **yes**, rate the role of the noise in your annoyance

A) Very high B) High C) Low D) Very Low

8. Do you have a sleep problem? A) Yes B) No

If **Yes**, do you think your family member has a sleeping problem? A) Yes B) No

If **Yes**, what do you think is the role of the railway noise on your sleep problem?

A) Very high B) High C) Low D) Very low

9. Did you ever stress? A) Yes B) No

If **Yes**, do you think the railway noise has a direct impact on your stress? A) Yes B) No

If ***Yes***, how do you rate the role of the railway noise on your stress?

A) Very High B) High C) Low D) Very Low

10. Did you encounter any hearing problems? A) Yes B) No

If **yes,** did you think the railway noise has a direct role? A) Yes B) No

If **yes,** again how do you rate the role?

A) Very High B) High C) low D) very low

11. Did any of your families have blood pressure? A) Yes B) No

If **yes,** do you think the railway noise has a direct impact? A) Yes B) No

If **yes** again, your reason, please

----

12. Please make an order from 1- 5 based on the most direct impact of the railway noise.

Sleep Disturbance --------------

Annoyance ---------------

Stress--------------------

Hearing Problem ---------------

Blood Pressure -----------------

13. What are the methods you used to minimize the effect of the railway noise?

----

14. For this problem, who do you think should take responsibility?

A) Government B) Family C) Urban Planner D) All

15. What will be the solution to improve it? Based on your experience

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Appendix G - Planning Documents Reviewed and Analyzed in this Research

No	Planning Documents	year
1	Ethiopia Railway Corporation	2001
2	Urban Plan Proclamation	2005
3	Growth and Transformation Plan 2	2016
4	Adama Structure Plan Revision Project City Wide Study Report	2017