Effect of road traffic noise on acoustic comfort of residential buildings: in the case of Adama city

Misiker Sisay Mola

A Thesis submitted to

The department of Architecture

School of civil engineering & Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Environmental Architecture

Office of Graduate Studies

Adama Science and Technology University

November 2022

Adama, Ethiopia

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Declaration

I declare that this Master' Thesis entitled "**Effect of road traffic noise on acoustic comfort of residential building: in the case of Adama city**" 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

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Misiker Sisay Mola ID PGR/21829/13 ________________________ ________________

Name of student Signature Date

Recommendation of Advisors

I, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of the thesis entitled "**Effect of road traffic noise on acoustic comfort of residential building: in the case of Adama city** "prepared under my/our guidance by **Misiker Sisay Mola ID No PGR/21829/13** submitted in partial fulfillment of the requirements for the degree of Master's of Science in Environmental Architecture. Therefore, I/we recommend the submission of the revised version of the thesis to the department following the applicable procedures.

Yared Girma(PHD)	______________________	_______________
Major Advisor/Supervisor	Signature	Date
_________________________	______________________	_______________
Co-advisor/Co-supervisor	Signature	Date

Approval Page for thesis

I/we, the advisors of the thesis entitled "**Effect of road traffic noise on acoustic comfort of residential building: in the case of Adama city**" and developed by Misiker **Sisay Mola ID No PGR/21829/13**, 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
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We, the undersigned, members of the Board of Examiners of the thesis by Misiker Sisay Mola ID No PGR/21829/13 have read and evaluated the thesis entitled "**Effect of road traffic noise on acoustic comfort of residential building: in the case of Adama city**" 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 **Environmental Architecture**.

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ABSTRACT

WHO recommends building healthy homes (homes that allow occupants to be in excellent physical, mental, and social condition), and mandates that noise in "healthy homes" is less than one decibel (dB). Over 55 dB of road traffic noise is exposed to around 40% of the world's population. The research was conducted in the city of Adama analysis Effect of road traffic noise on acoustic comfort of residential buildings. Adama is one of the Ethiopian cities established along the road that connects Addis Ababa to the port of Djibouti. People construct their homes near roads because of employment, they open shops in their houses for trade and business. This trend and the governmental officials planed residensial site along road expose to road traffic noise. The objective of the study analyzes the effects of road traffic noise on the acoustic comfort of residential buildings that are adjacent to a heavy traffic area. The research was conducted deeply relationship between subjective occupant survey and objective physical measurement as assessment methods of indoor environmental qualitys in buildings needs to be established to ascertain the degree of variation or equality in their measured variables. The objective analysis also measures the level of sound by measurement tools and compare the result with the standard limit of maximum threshold. The measurement is on selected site one (Adama Migira Bus Station, Karayu Street, Mamo Mazamir Street, Highway Street (To Ward Asela)) and Site Two (Peacock Bus Station, Abebe Bikila Street, Atlet Wami Biratu Street, Highway Street (To Ward Addis Abeba)) on thirty pieces of point on morning, afternoon and night time measure thirty minute. Subjective analysis the feeling of the 99 respondent on the current road traffic noise and internal acoustic comforts; informal interview, and site observation of material of building setback and other survey. The paper discussed finding from both methods that analyzed noise level and its physical and psychological effect on the residents. The respondents ensure that road traffic noise is the main source of external noise disturbance and affected the living condition and wellbeing of the residential dwellers, 71.72% of respondent agree with the disturbance of acoustic comfort of inhabitant. From this analysis the research recommend that the concerned body improve and create adoptive regulation to mitigate the effects.

Key word: acoustic comfort, healthy home. Indoor environmental quality, road traffic noise

ABBREVIATIONS

CAD Computer-aided design

dBA Noise level is thus described in decibels A

EEA European Environmental Agency

EPA Environmental Protection Authority

ESID Ecologically Sustainable Industrial Development

FHWA Federal Highway Administration

GIS Geographical Information System

ISO International Organization for Standardization

IEC Electro-Technical Commission

Leq- Equivalent Sound Pressure Level

L_{max} maximum sound pressure level

L_{den} Day-Evening-Night Average Level

L_{night} Night time Average Noise

LDP Land Development Plan

MS Microsoft

NOISE Noise Observation and Information Service for Europe

RTN Road Traffic Noise

SNM Strategic Noise Map

SLM Sound Level Meter

USA – United States of America

USDOT U.S. Department of Transportation

WHO World Health Organization

CHAPTER ONE

1. INTRODUCTION

The perception of sounds in day-to-day life is of major importance for human well-being. Communication through speech sounds from playing children, music, and natural sounds in parklands, parks, and gardens are all examples of sounds essential for satisfaction in everyday life. Conversely, in other forms, sounds are also uncomfortable for our ears and our body's activities these types of sounds are could noise. Noise is commonly known to have adverse health effects on residents in the urban living environment. Road traffic is the main source of noise in the urban environment. Urban noise pollution has been directly linked to increased traffic noise levels by the growing use of ground transportation as a result of city growth and everyday population needs. The frictional action between the road surface and tires, which creates a large detrimental impact on urban areas and the surrounding environment, is the primary cause of traffic noise. The dominance of traffic noise levels in the neighborhood interferes with people's ability to sleep, rest, study, and communicate, and combined with traffic noise irritation, these effects pose a long-term threat to people's health.

Although European & some developed countries are concerned about road traffic noise levels and the effects would receive high attention and detailed studies on the issues. however, all developing nations, including Ethiopia still do not focus on road traffic noise disturbance in residential buildings along the road, particularly, Adama city residents are exposed to road traffic noise, especially oldies streets that connect Adama city to Asela town and newly developed land use in Debella sub-city, both streets pass through the residential area of the city and access toward Adama Migira Bus Station and Peacock Bus Station consequently. As an environmentalist and a responsible citizen of the nation inspire to analyze the internal acoustic comfort and the level of road traffic noise as well as the consequence of the noise on the residential dwellers along the road in Adama city.

This chapter deals with the background of the study, statement of the problem, objectives of the study, research questions, scope of the study, the significance of the study, limitation of the Study, and description of the study area.

1.1 Background of The Study

Transportation has made a substantial contribution to the advancement of human civilization. Road transport accounts for the majority of activities (Jain, S.S.,et. al 2003). There has been a tenfold growth in the number of motorized vehicles in the last 40 years. If the current trend continues, the number of vehicles on the road will skyrocket, resulting in massive increases in traffic noise levels in the roadside environment (Johnson, D., & Saunders, E., 2006). Because of the predicted demographic boom, slower road mileage growth, and faster car growth in the market, traffic flow will increase. As a result, increased traffic volumes will utilize a major percentage of the road network, resulting in increased noise levels (Kudesia, V. & Tiwari, T., 2000). Based on previous patterns, it is plausible to predict that noise levels will rise in the future and that more individuals will be exposed to the bothersome noise (Li, B., et al, 2002). People living near highways will be subjected to more noise as traffic congestion increases, and this propagation will continue to hurt human health.

Recent research has projected that Road traffic noise is a severe pollutant that can cause both physiological and psychological health effects. The effects include annoyance (Ouis.D, 2001), hypertension(Barregard L. et al. 2009; Chang T-Y et al. 2011), sleep disturbance (Halperin D. 2014; Jakovljević B. et al. 2006), hearing mechanism dysfunction (Barrigón Morillas et al. 2002), myocardial infarction (Babisch W. et al. 2005; Paunovic and Belojević 2014; Selander J. et al. 2009), cardiovascular diseases(Begou P. et al. 2020; Davies and Van Kamp 2012; Munzel T. et al. 2014; Thomas Munzel et al. 2018), metabolic diseases like diabetes (Dzhambov AM. 2015; Mette S. et al. 2013), and psychotropic medication use (Okokon EO. et al. 2018). Based on the studies reported and growing evidence, the focus has shifted toward transportation-related noise pollution for its proper control and management.

With the rapid progress of urbanization, environmental noise has become an important factor that affects the health of residents (Skanberg and Ohrstrom, 2002). Numerous studies have shown that traffic noise has become a major environmental concern and a source of increased levels of discomfort, particularly in urban areas with significant levels of traffic congestion (Ali and Tamura, 2003; De Coensel et al., 2005; El-Fadel et al., 2002; Steele, 2001; Torija, 2010; Yang and Kang, 2005).

Since the mid-1960s, road traffic noise has been the biggest nuisance in highly industrialized urban spaces. According to research conducted by Szopińska (2017), and based on strategic noise map (SNM) data available on the Noise Observation and Information Service for Europe (NOISE) website, almost

16% of the population of the European Union in agglomerations exceeding 250,000 people is exposed to road traffic noise. The most favorable acoustic conditions (the smallest proportion of the population exposed to road traffic noise) were recorded in Italy, Estonia, France, Germany, and Portugal. In Poland, traffic noise affects about 40% of the population. Likewise in developing countries road traffic noise effects increase rapidly especially in Argentina because of the oldest car on the track with an average car age of 17 years (Gibbs, 2021).

The construction of building material is the most essential thing in an acoustic comfortable indoor environment for residential and other functions of the building. Construction materials are used to protect the air-born noise like road traffic noise and other environmental noises surrounding residential, not including the structural vibration, the research also aims to analyze the airborne noise of traffic noise. The building insulates the external sound by selecting material on the wall, ceiling, and floor, (Raymond D. et al., 2001) in addition to this install additional soundproofing material on the opening of the building. For all this road traffic noise is protected by a governmental body or road authority installed sound barrier and common buffer zone. (Pohl, 2009)

Whereas in the case of Ethiopia road traffic noise pollution is a critical problem for residents along high traffic roads. New residential development typically occurs near roadways because of the ease of traveling to work, school, and leisure and shopping activities. But as open space for new development becomes scarce, most people simply accept increases in highway traffic noise. (FHWA and Chris Corbisier, 2022) However, road traffic noise affects the health of the community that lives along the road.

In Adama city, there are difficult to predict where is the high influence of road traffic noise on the community because most of the residents are mixed with non-residential buildings. This is not only Adama city in all of the oldest cities of Ethiopia. (Golini, Aet al., 2001) from the observed area of the city, the bass station location and the settlement of residential buildings around the bus station is high dense transportation zone of the city. The road is the largest traffic movement area especially, the Addis Ababa highway lines the newly built road, and the land cover of the area is also new settlement residents. The second line Adama to asela was the oldest road and the settlements were existing possession. These residential buildings' Indoor environmental quality is affected by the annoying sound of road traffic noise;

this research aims to rectify the annoying sound of road traffic and analyze how to manage the noises for sustainable indoor environmental quality residential buildings.

1.2. Statement of the Problem

Nowadays traffic noise is considered a significant environmental predictor of physical inactivity and sleeping disorder. These types of pollution created by faulty design and construction of buildings nearby roads create physical and mental disturbance and other problems for residential dwellers. Sleep disturbances are being the very essential issue and are considered the main health burden concerning environmental noise exposure.

The nation of Ethiopia like other developing countries cities merged on the road adjacent. With the same of other Adama is one of the Ethiopian cities established along the road that connects Addis Ababa to the port of Djibouti. With this road the community settled along the road and People construct their homes near roads because of employment, they open shops in their houses for trade and business. The city municipality and the communities did not consider the road traffic noise affecting residents and damaging the buildings. It's due to Traffic, and thinning designing of the wall of a building, the reasons are; noise pollution, and, vibration. People feel uncomfortable. Medically, there are so many harmful impacts on human health. People become aggressive and non-cooperative in their attitude. The recognition of road traffic noise as one of the main sources of environmental pollution.

Some traffic noise pollution studies have been published in the past few years in various countries (Abo-Qudais and Alhiary, 2007; Agarwal and Swami, 2010; Al-Mutairi et al., 2011; Barros and Dieke, 2008; Doygun and Gurun, 2008; Jamrah et al. 2006; Ma et al., 2006; Phan et al. 2010). However, in our country of Ethiopia road traffic noise studies are not published on known journal sites. The only studies are on the impact of railway noise on the resident of the Adama cities (A. Hagos G/egziabher, 2021)

The country did not any regulations to mitigate road traffic noise. The only referring to the Environmental protection Authority guideline Ambient Environment Standards for Ethiopia. (EPA & ESID, 2003) Even though, the guideline has only illustrated the threshold of noise level for day and night time. Beyond that, not any other supportive regulations relate to road traffic noise.

The research focuses on the analyze the effects of road traffic noise on the acoustic comfort of residential buildings along the road and indicates a direction for the new settlement of residential site to be consider this research analysis

1.3. Objectives

1.3.1. General Objective

The general objectivity of the study is to analyze the effects of road traffic noise on the acoustic comfort of residential buildings that are adjacent to a heavy traffic area

1.3.1. Specific Objective

- To identify the noise level of the road traffic in the study area.
- To identify the impact of road traffic noise on the Acoustic comfort of residential buildings.
- To developed an adaptable directive or strategy for sustaining Road Traffic Noise and Indoor Environmental Quality Disturbance

1.4. Research Question

- How much is the road traffic noise level in the study area?
- What are the impacts of road traffic noise on the Acoustic comfort of residential buildings?
- What are the adaptable directives or strategies that help to create comfortable Road Traffic Noise in the internal space of domestic residential buildings?

1.5. Significance of the Study

The significance of this research mainly analyzing the effect of road traffic noise on residential inhabitants that are adjacent or near to roads in Adama city. Secondly, the research is used as the source for other research like researches work depends on the effects of noise on residential dwellers/inhabitants from road traffic and use an input for the policymaker, decision maker for maintaining noise pollution effects and. Thirdly as a reference for learners and other parts of the community to increase their awareness. In addition, the study is used as an analysis document for residential building designers, and structural analysis engineers.

1.6. Scope of the Study

1.6.1 Thematic Scope

The study analyses basic problems concerning road traffic noise to a residential building in the city of Adama. Road traffic noise level and its impact on acoustic comfort were analyzed.

1.6.2 Spatial Scope

The scope of this study is to analyze the effect of road traffic noise on residential inhabitants in the case of Adama city (Adama Migira Bus Station, Karayu Street, Mamo Mazamir Street, Highway Street (To Ward Asela)) and (Peacock Bus Station, Abebe Bikila Street, Atlet Wami Biratu Street, Highway Street (To Ward Addis Ababa)): to ensure acoustical comfort in the internal space domestic residential building along listed roads.

1.7. Limitation

The limitation of the study is the lack of documented information about the study area and the current situation of the country. As specified above the road traffic noise analysis depend on different existing factors specially LDP information on residential site and inclusive standard related to RTN Analysis.

1.8. Operational Definition

Noise Pollution is unwanted or annoying sounds that happen around you. Machinery, amplified music, noisy vehicles, and other things can cause it.

Acoustic Comfort is the perceived state of well-being and satisfaction with the acoustical conditions in an environment

Road Traffic Noise environmental noise generated from vehicles using roads and highways caused by rolling and propulsion

Hertz is the unit used to measure frequency

decibel is the unit used to measure intensity level

A residential building is a building containing separate residences where a person may live or regularly stay.

An apartment is “an individual dwelling unit, usually on a single level and often contained in a multi-unit building or development.”

A condominium is “a multiple-unit structure in which the units and pro-rata shares of the common areas are owned individually; a unit in a condominium property. Also, the absolute ownership of an apartment or unit, generally in a multi-unit building.”

1.9. organization of the paper

The papers are organized into five interdependent chapters. The first chapter, "General Introduction," outlines the research's background and the challenge that necessitates research efforts. This chapter also contains the research questions, Limitations, significant objectives, and scope. The second chapter "contains the literature review." The evaluation includes a diverse selection of previous works related to the research objective that supports the out came or guide for analysis methods. "Materials and methods" are the title of the third chapter. This chapter's first section covers the study's method, population, and sample, while the second section covers the tools and techniques used by the researcher to analyze and display the results. In general, the entire study plan is explained in detail in this chapter. The results and discussion of the data gathered are presented in Chapter 4. The study's final chapter, Chapter 5, summarizes the study's results, conclusions, and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

This paper reviews the literature on the role of sustainable indoor environmental quality in minimalizing annoying road traffic noise and built a way that mentions the Acoustic comfort of the residents. Generally, the reviews start with theoretical backgrounds, which include similar works at the global level, and then it comes to the theoretical background, reviewing according to the context of Ethiopia and the context of Adama city.

2.1. Theoretical Literature review

2.1.1. Acoustic comfort

Acoustic comfort is the perceived state of well-being and satisfaction with the acoustical conditions in an environment. Two primary forms of noise in buildings can influence it: (i) structure-borne (impact) noise, which is produced by a physical impact or vibration against a building component, and (ii) airborne noise, which is communicated via the air. One of the key acoustical elements that affect comfort is the sound pressure level. While airborne noise is normally predicted using the equivalent sound pressure level over a specific length of time (Leq), impact noise is typically predicted using the maximum sound pressure level (Lmax). The frequency, source, duration, and finality of the noise are further acoustical parameters that affect acoustic comfort. (Elie Azar, et.al. 2020)

acoustic comfort, which is defined as *"a state of contentment with acoustic conditions"*. Reducing potential factors that might cause occupants discomfort is the major objective of creating acoustic comfort conditions. The ultimate auditory environment conditions are determined using both quantitative and qualitative methods. The parameters that are taken into account during the quantitative evaluation include both structural and individual elements. The presence of sound insulation and the sound absorption coefficients of building and decorating materials are specifically taken into consideration, as they may significantly lower the noise levels from both the indoor and outdoor environment. Additionally, the shape and kind of space are very important since the reflection of sound waves on indoor surfaces can provide extremely uncomfortable circumstances for the inhabitants. (Panagiota Antoniadou, & Agis M. Papadopoulos,, 2017)

Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects on humans or other living organisms. According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is. Exposure for more than 8 hours to constant noise beyond 85dB may be hazardous. If you work for 8 hours daily close to a busy road or highway, you are very likely exposed to traffic noise pollution of around 85dB. Of different types of noise street traffic sounds from cars, buses, pedestrians, ambulances, etc. are one of the most common and continuous sources of the annoying sound. these noises affect human health. (World Health Organization, 1997)

2.1.2. Source of Noise

The most important noise sources of noise are road traffic, aircraft, railways, and industries, noise in the community from industrial and construction sites, and noise at home. Road traffic is by far the largest of these, and accounts for about 79 percent of noise annoyance.

Figure 1 shows the distribution of the different noise sources to which the general public is exposed. As other studies have already shown traffic is the major noise pollution source. The power/weight ratio of road vehicles has been continually increased to permit higher payloads, greater acceleration, and higher cruising speeds, resulting in more powerful engines which are usually noisier than lower-power ones(al horr et al., 2016)

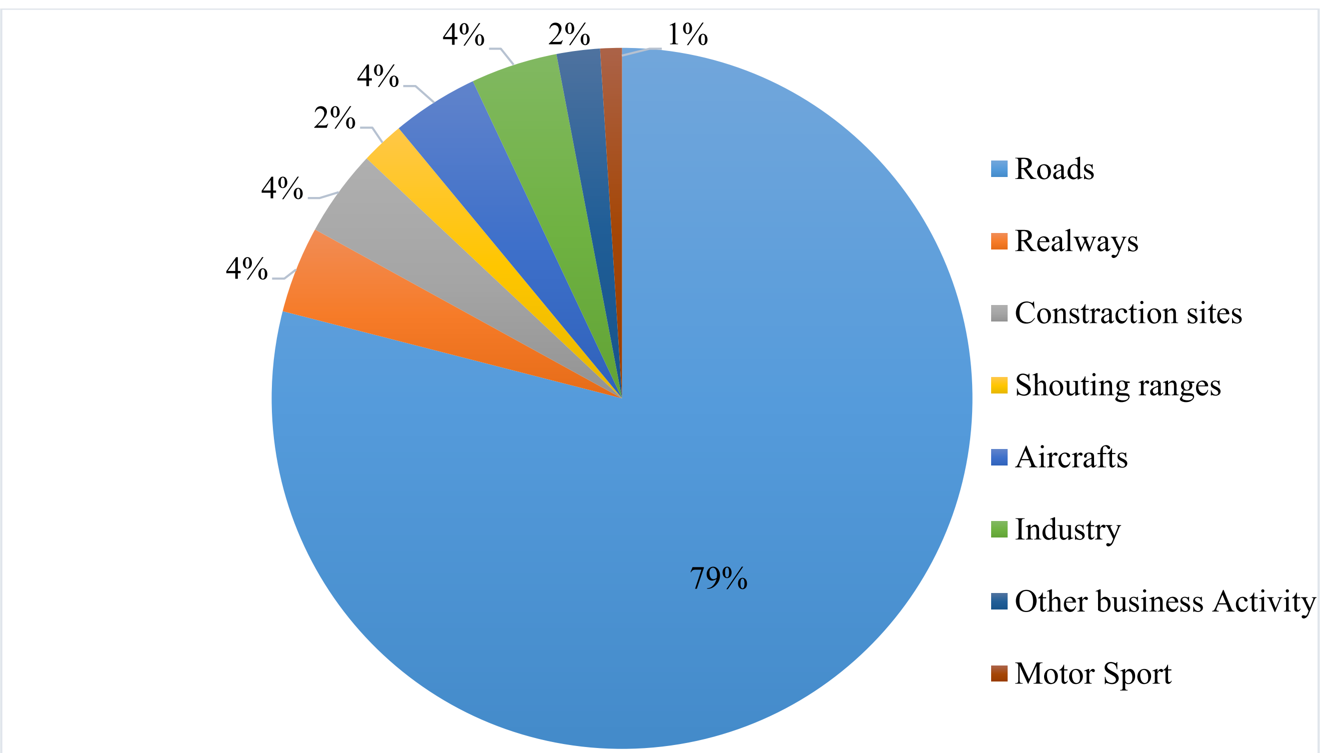


Figure 1 Distribution of human noise annoyance according to the type of noise source *(Helene A, Klæboe R., 2005)*

2.1.3. Road Traffic Noise

Environmental noise by road traffic. Typically, a combination of 'rolling noise' is caused by the interaction between the vehicle tire and the road surface tires on the road surface, and engine 'propulsion' noise. (GEMET, 2021) The level of highway traffic noise depends on three things: those are the volume of the traffic, The speed of the traffic, and The number of trucks in the flow of the traffic.

Generally, the loudness of traffic noise is increased by heavier traffic volumes, higher speeds, and greater numbers of trucks. Vehicle noise is a combination of the noises produced by the engine, exhaust, and tires. The loudness of traffic noise can also be increased by defective mufflers or other faulty equipment on vehicles. Any condition (such as a steep incline) that causes heavy laboring of motor vehicle engines will also increase traffic noise levels. In addition, other more complicated factors affect the loudness of traffic noise. For example, as a person moves away from a highway, traffic noise levels are reduced by distance, terrain, vegetation, and natural and manmade obstacles. Traffic noise is not usually a serious problem for people who live more than 150m from heavily traveled. (J. Jeffrey Peirce, & P Aarne Vesilind, 1998).

2.1.4. Source of noise on the vehicles

The noise radiating from a motor vehicle can come from several different sources whose contribution to the total noise can depend on the vehicle (see Figure 2). Table 1. shows the average, or rather the range of values. For the contribution to the total noise of the vehicle for each of those sources for both cars and heavy lorries. The amount of noise coming from each source depends very much on the types of vehicles involved and on the condition of the silencers. The noise due to the contact between the tires and the road surface becomes dominant at high speeds. There are considerable variations in the relative contributions of noise coming from the engines and exhaust systems in the case of two-wheeled vehicles.

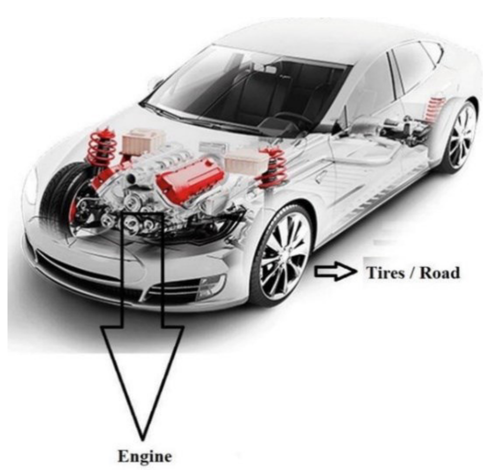


Figure 2 Sources of noise on a motor vehicle

Table 1 Percentage contributions from the different basic sources to the total amount of noise radiated by a well-maintained road vehicle (IRT-CERNE. 1979)

	Light Vehicles		Heavy Vehicles	
Source of noise	Town	Open road	Town	Open road
Air intake inlet	15 to 35	20 to 70		
Exhaust outlet	15 to 35	20 to 70	15 to 60	
Exhaust pipe assembly	15 to 30	20 to 70	--	
Engine block	15 to 30	20 to 70	--	40 to 80
Great box and transmission	20 to 30	20 to 70	30 to 80	
Cooling fan	--	20 to 70	10 to 50	
Tire-road surface contact	5 to 30	30 to 80	5	20 to 60

2.1.5. Effects of Traffic noise on health

Noise, defined as 'unwanted sound', is perceived as an environmental stressor and nuisance. Non-auditory effects of noise, as dealt with in this chapter, can be defined as 'all those effects on health and well-being which are caused by exposure to noise, with the exclusion of effects on the hearing organ and the effects which are due to the masking of auditory information (*i.e.,* communication problems).

Exposure to continuous noise of 85–90 dBA, particularly over a lifetime in industrial settings, can lead to a progressive loss of hearing, with an increase in the threshold of hearing sensitivity[2]. Hearing impairments due to noise are a direct consequence of the effects of sound energy on the inner ear. However, the levels of environmental noise, affect the physiology and psychology of the road adjacent communities.

2.1.6. RTNs exposure and psychological effects

Annoyance of Noise

The loudness of noise is objectively measurable with the appropriate equipment, but the annoyance to occupants cannot be measured directly. (Muller G, 2013) Noise exposure may be extremely disturbing when the noise masks auditory information required for the ongoing activity. The effect of noise exposure may also be influenced by behavioral responses related to predictability, controllability, informational content, attitudes, and individual differences. (Lundquist P, et al, 2000) When regular activities are in progress within a room, the acceptable level of background noise is set when noise from sources outside the room is not discernible. (A.Lawrence, 1970) There is a significant effect of background noise level ($p < 0.01$) on annoyance. (Phan HYT, 2010)

The relationship between loudness and annoyance of noises is widely studied, annoyance, as well as negative effects on performance, will increase with increasing sound level, the tonal character of the noise, and variability of the exposure. (Lundquist P, et al. 2000) Annoyance also depends upon the type of noise. (Lee PJ, et al, 2010) The most significant noise sources include road traffic noise. (Jakovljevic B, et al., 2009) tried to conduct tests on indoor multiple noise sources in residential buildings, but the difficulties in providing an accurate prediction for each source were caused by the effect of interaction among noise sources along with the non-acoustical aspects; e.g., occupants' sensitivity to noise. (Lee PJ, et al, 2010)

Annoyance refers to negative feelings like displeasure, disturbance, discontent, and uneasiness which finally manifests in the form of anxiety and stress. The levels of Annoyance are often used to reflect the somatic damage caused by traffic noise (Babisch.W, 2002)

Sleep Disturbance

A sufficiently loud noise will awaken a person; a less loud noise will usually stir a person from a deep sleep to a shallow sleep. People, on the other hand, adjust to noise during sleep, making it difficult to define a noise criterion for sleep disruption. (Halperin.D:, 2014), (Muzet.A, 2007)

Work performance

Noise has been studied for its impacts (if any) on job productivity, efficiency, concentration, errors and accidents, and so on, but results have been equivocal. Some researchers believe that noise has little or no effect on work performance after a time of acclimation, as long as it is not loud enough to interfere with voice communication, while others claim that noise can be a stressor even at low levels. (OECD, 1996)

2.1.7. Physiological responses to noise exposure

Noise exposure causes several predictable short-term physiological responses mediated through the autonomic nervous system. Exposure to noise causes physiological activation including an increase in heart rate and blood pressure, peripheral vasoconstriction, and thus increased peripheral vascular resistance. There is rapid habituation to brief noise exposure but habituation to prolonged noise is less certain. (Vallet M , et al, 1983)

Noise is an environmental stressor that activates the sympathetic nervous system and the hypothalamus–pituitary–adrenal axis, raising blood pressure, heart rate, and cortisol levels. Traffic noise has been linked to cardiovascular illness in the past, and the mechanisms of action proposed to explain this link suggest that noise may potentially raise diabetes risk. Long-term exposure to residential road traffic noise was linked to an elevated risk of diabetes in a Danish population, according to researchers. (Wendee Nicole, 2013) Cortisol and other glucocorticoid hormones limit insulin secretion and diminish insulin sensitivity in the liver, muscle, and adipose tissue. Low morning glucose levels, poor insulin sensitivity, and alterations in appetite management have all been linked to sleep problems in studies.

The researchers used information from the Danish Diet, Cancer, and Health cohort study, which included 57,053 people aged 50 to 64 and followed them by an average of 9.6 years. Any participants who had developed cancer or diabetes before to enrolment were excluded from the trial. There were 3,869 cases of incident diabetes available for study among the 50,187 eligible patients. Type 1 and type 2 diabetes were not differentiated by the researchers. Because type 1 diabetes usually develops in childhood, the majority of the cases in our study were most certainly type 2.

2.2. Empirical Literature Review

Traffic noise has become a recognized global problem. Now a day RTN is the primary source of noise in developed and developing countries especially in European countries are widely visible. As the report of the world health organization in European German, England, Sweden, and the largest urbanized countries shows that the roadside residential dwellers are a victim of RTN Couse of health problems.

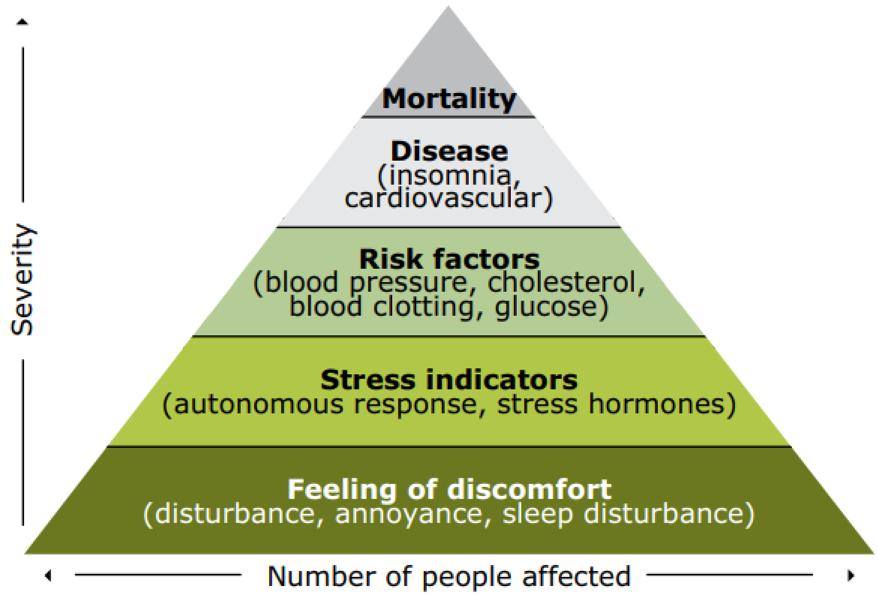


Figure 3 Pyramid of noise effects *(Babisch.W, 2002)*

2.2.1 Developed Country and Road Traffic Noise

Road traffic noise in Developed countries is a series issues because of rapid development of the cities and vehicle numbers on the road. although, parallelly increase the effects to the health of community's

Based upon current data, more than 41 million people are reported to be exposed above 55 dB L_{den} due to road traffic noise inside urban areas. Estimations show that the overall number of people exposed to road noise increases by more than twice the current figure, reaching nearly 90 million people exposed to road traffic noise inside urban areas in Europe. Adding to this figure, the estimated number of people exposed to major roads outside urban areas, the overall figure is around 24% of the total European population. i.e around 125 million people, are likely to be exposed to road traffic noise according to the END (Figure 4) (EEA, 2014)

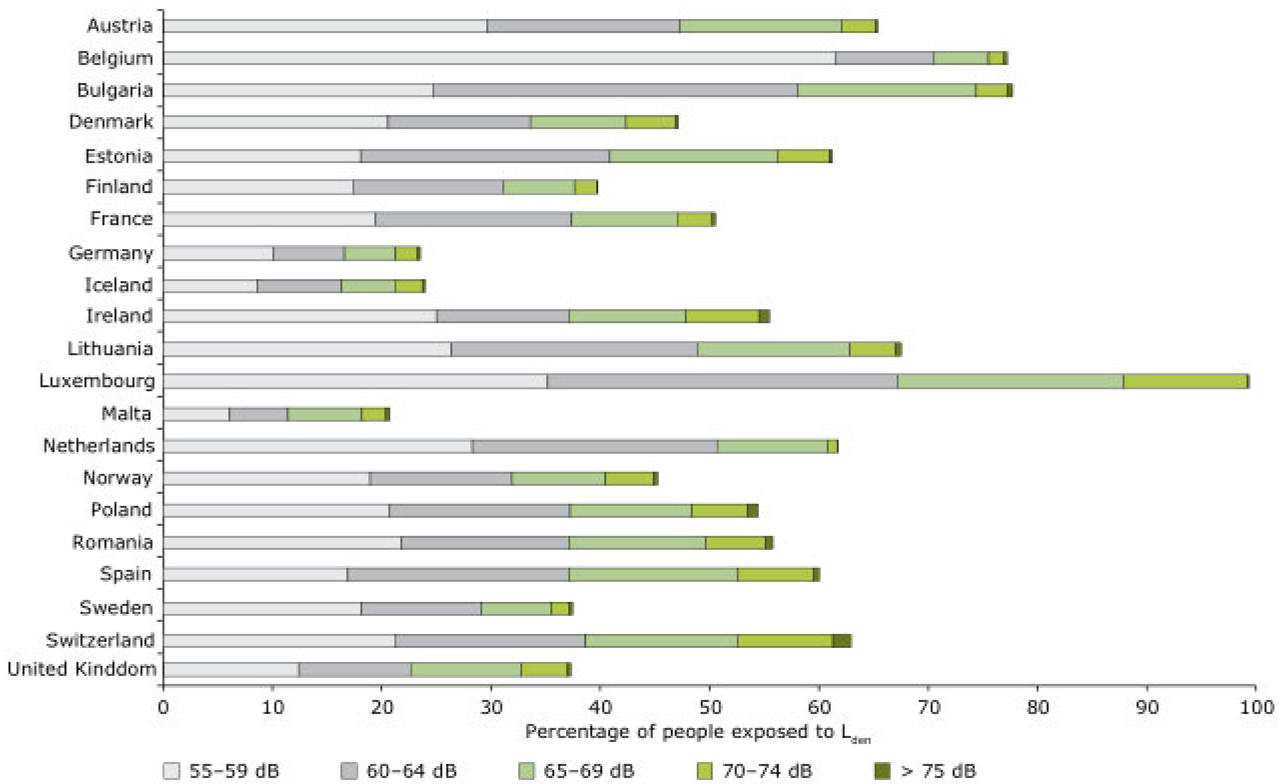


Figure 4 Percentage of population exposed to road noise, L_{den}, in 294 urban areas, EEA member countries (2012), *(EEA, 2014)*

2.2.2. Developing Country and Road Traffic Noise

Developing countries in Asia, such as China, India, and Vietnam, are dealing with serious traffic noise pollution in their cities. (Hayden.R.E, 2005) Malaysia is one of the developing countries included in this problem. . Star Online 2016 stated that 132 noise pollution complaints have been reported to the Department of Environment, Malaysia in 2015. (V C Segaran , et al., 2020)

Many emerging countries have allowed enormous volumes of traffic to travel at a constant speed in recent decades. The transportation sector in a rapidly urbanizing country like India is fast expanding, with the number of automobiles on Indian roadways increasing at a pace of more than 7% per year. Due to the constant development in the number of vehicles and the ever-expanding road network, the environmental quality of Indian cities is gradually deteriorating, increasing road traffic noise. Almost all Indian cities have traffic noise levels that surpass the regulatory bodies' permitted limits. (H.N. Rajakumara & R.M. Mahalinge Gowda, 2008)

The impact of noise on African countries According to the research, Nigeria, Egypt, and South Africa are experiencing rapid vehicle growth urbanization imbalances, which are causing RTN discomfort in roadside residential neighborhoods. (C A Wojuade, 2020) Ethiopia, like many other African countries, is a rapidly developing country, which means that traffic flow in the capital city of Addis Ababa is a major issue for the residential dweller who is near the roads. (Altaseb YE , 2018)

2.3. Definition and measurement:

Noise pollution refers to any unpleasant, damaging, or irritating noise that has the potential to harm people, wildlife, or the environment. The decibel (dB) is the main unit used to measure the intensity or loudness of sounds. A sound can also be measured by its pitch, which is the frequency of sound vibrations per second. For example, a low pitch produced by a deep voice makes fewer vibrations per second than a high voice. Sounds with a higher pitch, such as a cry or sound from a violin, have a high rate of vibrations. Sound is usually recorded with a microphone. However, in a sound level meter, a sound sensor is used. Sound sensors work like microphones but are much more accurate. (Altaseb YE , 2018)

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 (Janssen's, et.al, 2006).

2.4. Sound level meter

A Sound Level Meter (SLM) is an instrument (commonly hand-held) that is designed to measure sound levels in a standardized way. It responds to sound in approximately the same way as the human ear and gives objective, reproducible measurements of sound pressure levels.

Sound level meters are used to measure and manage noise from a variety of sources, including industrial plants, road and rail traffic, and construction work. With the addition of typical urban situations, such as concerts, leisure parks, and residential and commercial neighbors, the many different sources of sound and different characteristics, pose a variety of challenges for the professionals who assess them. (FHWA, 20018)

2.5. International Standards

International standards are important either because they are used directly or because they provide inspiration or reference for national standards. There are two main international bodies concerned with standardization. The International Organization for Standardization (ISO) deals primarily with a methodology to ensure that procedures are defined to enable the comparison of results. The International Electro-Technical Commission (IEC) deals with instrumentation to ensure that instruments are compatible and can be interchanged without major loss of accuracy or data. “IEC 61672 – Electro acoustics – Sound level meters” is the current international standard that sound level meters should meet to satisfy most modern regulations. It specifies “three kinds of sound measuring instruments” - the “conventional” sound level meter, the integrating-averaging sound level meter, and the integrating sound level meter. It defines the basic terminology including the central Rating Level parameter and describes best practices for assessing environmental noise.

2.6 Noise limit Standard for different countries

Many conflicts over noise pollution are handled by negotiation between the emitter and the receiver. Escalation procedures vary by country and may include action in conjunction with local authorities, in particular the police.

Table 2 Noise level standard selected countries (V C Segaran , et al, 2020)

Noise Level Limit	Noise level, Leq dBA	
	Day time	Night time
Malaysia (DOE Low Density)	55	50
Germany (Noise level guidelines)	45	35
Australia (Recommended outdoor background noise level)	45	35
Japan (Environmental quality standards)	45	35
Korea (Environmental quality goal)	50	45
Philippines (Environmental quality noise standards)	50	40
Iran		

(Residential area)	55	45
(Commercial area)	65	55
(Industrial area)	75	65

2.6.1. Guidelines for community noise

European Region of the World Health Organization the World Health Organization (WHO) European Region issued guidelines on community noise regulation in 1995. (Berglund, Birgitta; et al. 1999) Other versions of the guidelines were later produced by the WHO European Region, the most current of which was distributed in 2018. (WHO, 2018) The guidelines present the most recent evidence from research on non-occupational noise exposure and its relationship to physical and mental health outcomes undertaken in Europe and other areas of the world.

Table 3, 2018 WHO European Regional Environmental Noise Guideline *(WHO, 2018)*

Noise Source	Recommendation for Day-Evening-Night Average Level (Lden)	Recommendation for Night time Average Noise (Lnight)
Road traffic	53 dB(A)	45 dB(A)
Rail	54 dB(A)	44 dB(A)
Aircraft	45 dB(A)	40 dB(A)
Wind Turbine	45 dB(A)	No recommendation

2.6.2. Ethiopian noise Standard

The objective of these guidelines is to minimize the amount of noise to which people, living or working in sensitive locations, are exposed. Examples of such areas include domestic dwellings, hospitals, schools, places of worship, or areas of high amenities. The sensitivity to noise is usually greater at night-time than it is during the day, by about 10dB(A). Ideally, if the total noise level from all sources is taken into account, the noise level at sensitive locations should be kept within the following values:

Table 4 Ethiopian acceptable noise level in day and night time *(EPA & ESID, 2003)*

		Limits in dB (A) Leq	
Area Code	Category	Day Time *Note 1*	Night time *Note 2*
A	Industrial area	75	70

B	Commercial area	65	55
C	Residential area	55	45

Note-1 Day time reckoned in between 6.00 am to 9.00 pm

Note-2 Night time reckoned in between 9.00 pm to 6.00 am

2.7. Gap of the literature

Road traffic noise is the current problem in both developed and developing county the cases are not considering specified problem-solving design mainly on the indoor environmental quality.

A WHO report on European countries and a number of researchers prove that RTN is Avery adverse effect on human health and environmental acoustic sustainability, especially in the residential zone. As the review of the literature comparatively on developed and developing country, European and the other developing country are deeply work on the road traffic noise and its effect on the building users. On the constantly the issue is not given the necessary attention for the problem. The developing country scholars that study road traffic noise are in small size and not more focus. From the overall literature developing country like Ethiopia the road traffic noise concerning to adjacent residential acoustic comfort is no attention but the problem is largely affect the human health and day to day interaction of sociality. This perspective supports and potential to analyses Adama town road traffic noise impact on a highway

CHAPTER THREE

3. MATERIAL AND METHODS

This chapter describes the materials and procedures to be used in data for collection and measuring mechanisms as well as describes different types of methods that were used to analyze the existing problems. The analysis had four sections firstly visit the selected site and 50-meter radius (FHWA and Chris Corbisier, 2022) take the population quantity and observe the existing condition of the area secondly, analyze the filing of the community by informal interview thirdly, duplicate the prepared questionnaire weights as the response lastly, measure the sound level on a common interval.

The method of analysis used both qualitative and quantitative analysis methods. The areas are settled the building's common construction style both mud and HCB houses constantly. The mud houses are the same style of construction and form development and the same as mud houses, HCB houses also have the same form and style of construction.

3.1. Description of the study area

3.1.1. Geographical location

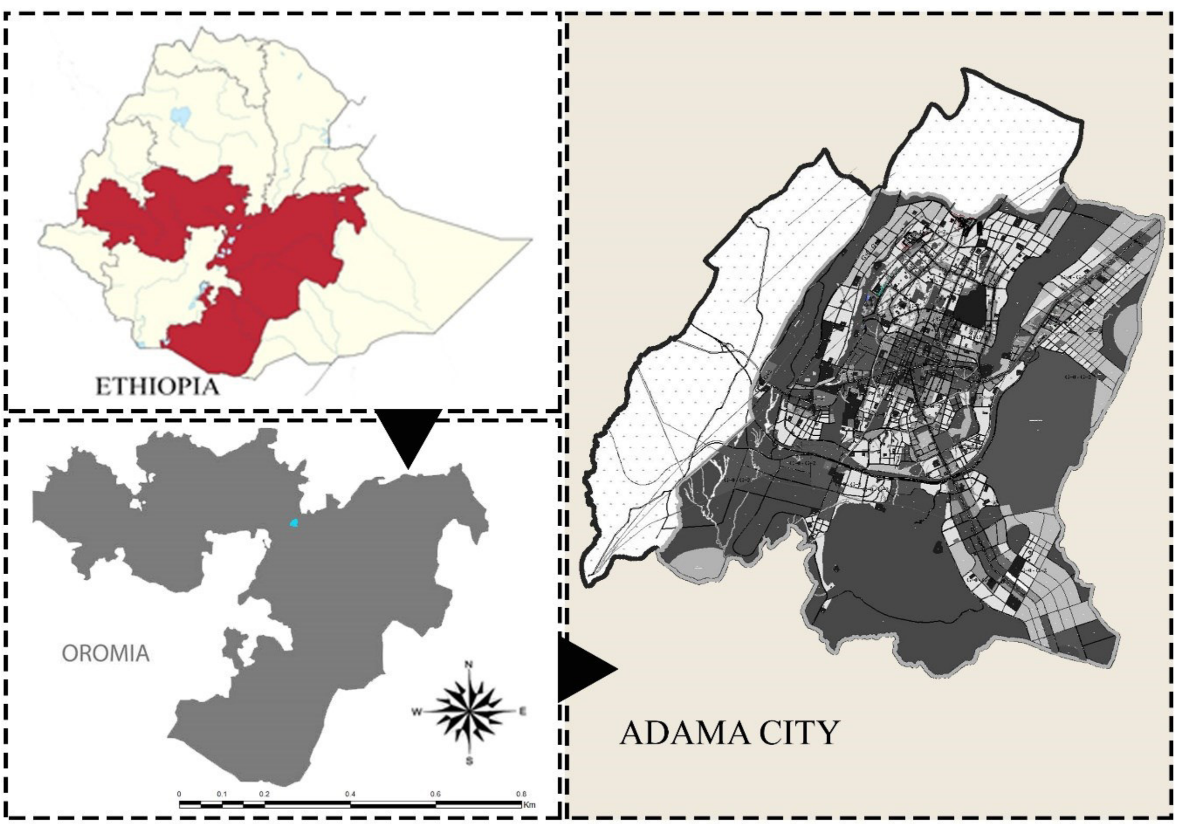


Figure 5 Adama city location map (Source: ethio-GIS and Adama Municipality)

Adama (Oromo: Adaamaa or Hadaamaa, Amharic: አዳማ), formerly Nazareth (Amharic: ናዝሬት), (Alain Gascon, 2003) is a city in central Oromia Region, Ethiopia. (Adama Administration, 2009), (C.I.Agency, 2009) Adama forms a Special Zone of Oromia and is surrounded by East Shewa Zone. It is located at 8.54°N 39.27°E at an elevation of 1712 meters, 99 km southeast of the Ethiopian capital, Addis Ababa. The city sits between the base of an escarpment to the west and the Great Rift Valley to the east.

3.1.2. Transportation and formulation of city

Adama is a busy transportation center. The city is situated along the road that connects Addis Ababa with Dire Dawa. A large number of trucks use this same route to travel to and from the seaports of Djibouti and Asseb (though the latter is not currently used by Ethiopia, following the Eritrean-Ethiopian War). Additionally, the new Addis Ababa-Djibouti Railway runs through Adama. (C.I.Agency, 2009), (Lindahl Bernhard, 2005)

Table 5. Depicts number and means of public transportation service in the city from 2007-2011

No	Type of vehicle	2007	2008	2009	2010	2011
1	Bajaj & minidoor	4200	3613	4416	5703	7200
2	Minibus	500	496	520	554	893
3	City Bus	4	4	4	14	14
4	Motor cycle	1222	290	310	1900	2512

As a transport hub with improved links of transportation and communication networks connecting the city with hinterlands, town and metropolitan which is the nerve-center of the country, a thriving city of Adama where exit points and main good paved roads radiate and branch off from it has been attracting passengers and freight from far and wide area. As noted unequivocally above, the city id located at the junction of major routes and highway connector to Addis Ababa, Wonji, Dire Dwa, Assela and Harar, and other areas of economic importance in providing urban services to its hinterlands in the country.

3.1.3. Average wind speed and Average Humidity

Average humidity in Adama

The city of Adama is closer to the great rift valley of Ethiopia form most of the sessions are shiny, because of this averagely the most humid months are August and the listed humid months are February. Compare to the highest and the list average annual percentage of humidity is 61.0%

Figure 6 The mean monthly relative humidity over the year in Adama, Ethiopia.(Average relative humidity in Adama, Ethiopia, 2022 weather and climate .com)

Average wind speed in Adama

Wind speed of Adama city is commonly observable strength compared with Addis abeba, averagely the most wind seen in November and the listed wind seen in August.

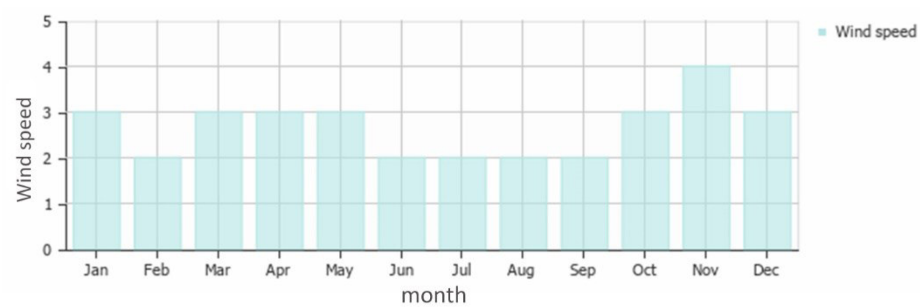


Figure 7 The mean monthly wind speed over the year in Adama, Ethiopia (Average wind speed in Adama, Ethiopia, 2022 weather and climate .com).

3.1.4. Socio-economic Analysis

The city's population increased from 220,212 in 2007 to 373, 661 in 2017. The influx of migrants from outside the state into the city is the primary factor in population. According to data gathered from the Ethiopian CSA, the urban expansion rate has reached 4.6%, while the current urban population growth rate of the city is estimated at 5.4% which is greater than the national and Oromia urban population growth rate. From this perspective, Adama city is the second most populous city in the country.

3.2. Research Design

This study is a mixed research design and uses both descriptive and explanatory research methods. A mixed approach which is both qualitative and quantitative data were used. Through quantitative (physical measurement) and qualitative (questionnaire, interview, and field survey). the research describes the existing phenomena relate to road traffic noise effects on residential buildings along the road and explain in detail the overcome methods. (Bailey Kenneth D., 2007)

3.3 Type and source of data

To fulfill the goal of this study, data have been collected from both primary and secondary sources. The secondary data sources presumed for this investigation are publications and journals in the study areas, reviews of literature and books, online archives, news magazines, other relevant documents, articles, statistics, and published and unpublished documents were reviewed. To this purpose, a survey of pertinent literature was conducted to examine international perspectives on the significance of and weight placed on interior acoustic comfort, as well as the impacts of traffic noise on both the indoor and outdoor acoustic comforts of residential buildings. While main data were gathered by asking respondents who had lived in loud areas of the city questions and conducting interviews. Additionally, the results of personal sound level measurements taken at various intervals are failing under

3.3. Sample size and Sampling Technique

The city's had two distinct bus stations namely peacock and migira bus stations. Those stations are erected among the residential space of the city and the out ways of the stations are through residential division roads as shown in figure 8. The road also the main gate of the Adama city on both side of the city neighborhood towns. Referring those locations of road side residential building samples point out in order to support the objective of the research. The sample are selected purposive sampling method, (Singh, Ajay S & Masuku, Micah B, 2014) depend on the following objectives or selection criteria

- The high traffic flow and continuous (road categorizes into highway, expressway and principal arterial roads; other are low traffic flow or the road showing highly intermittent noise
- Dense and longwise adjacent road domestic residential buildings
- The residential buildings nearby a bus station
- Vehicle types that pass through
- The character of traffic flow (continuous traffic flows especially Site two)

Compare to Adama city from the overall city the issues are adopted on two boldly screened. Site One or first location the vehicle from Adama Migira Bus Station go up Karayu Street and Mamo Mazamir Street, to Highway Street to Ward Asela town 3.72km distance from migira bus station to highway curve. The second location from Peacock Bus Station, go up Abebe Bikila Street and Atlet Wami Biratu Street to Highway Street to Ward Addis Abeba this is also 3.5km long.

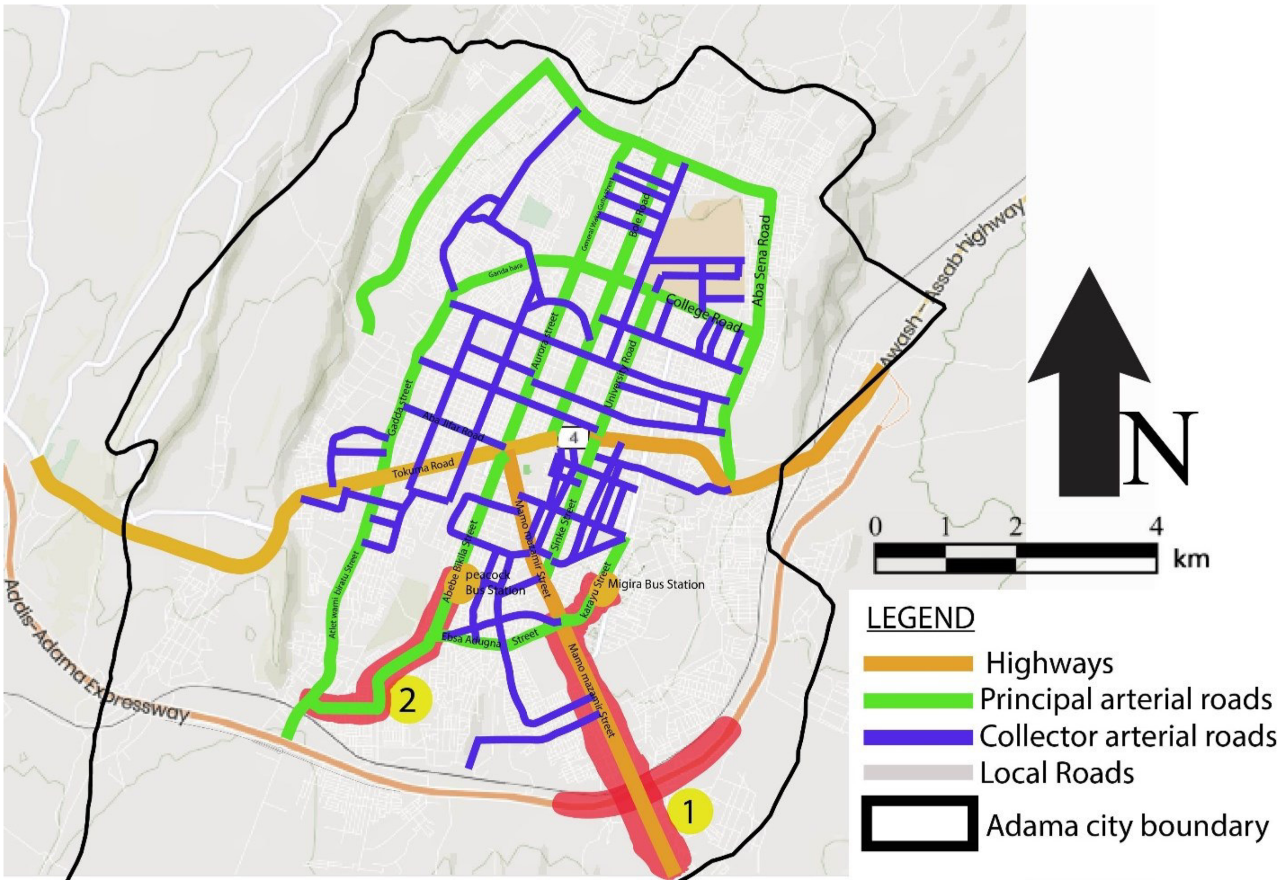


Figure 8 sampling location (prepared by authors)

To estimate the total population to study and for the site specification, it's used a 50m(the last dead spot of the Noisy sound) radius convention (USA Department of Transportation Federal Highway Administration, 2003) (FHWA and Chris Corbisier, 2022), (Standards Bureau of Indian, 2003) but the Adama city land use is showing the site arranged by block, one block includes two parcels the parcel or for a householder 20-meter length the width is different in place to place and it does not create variations on the analysis. On counting the population as the distance of building from roads edge. From this reference, the population size is counted by householder of the domestic residential building as illustrated on table 6 the first site has 1206 households the second site has 401 households. (Samy Tayie, 2005)

Table 6. a sampling of population size

No	Site Naming	Household
1	**Site One** (Adama Migira Bus Station, Karayu Street, Mamo Mazamir Street, Highway Street (To Ward Asela))	1206
2	**Site Two** (Peacock Bus Station, Abebe Bikila Street, Atlet Wami Biratu Street, Highway Street (To Ward Addis Abeba))	401
	Total	1607

on this collected data the researcher can't analyze all included households so to be sample re-arrange using random stratified sampling formulas (Bailey Kenneth D., 2007)

$$N_t = \frac{n}{1} + \frac{n}{N} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

N_t – Estimated household

n - the desired sample of household

N - total household

$$n = \frac{Z^2 * P * Q}{D^2} \text{------------------------------------}(2)$$

Where:

Z – Standard normal variable, Z = 1.96

P – population Estimate (targeted population), P = 0.5

D – Level of Statistical significance, D = 0.1

Q = 1-p

For the equation substitute number and calculate the estimated population size. First, calculate "n" values

$$n = \frac{Z^2 * P * Q}{D^2}, = \frac{(1.96)^2 * 0.5 * (1-0.5)}{(0.1)^2}$$

$$= 96$$

$$N_t = \frac{n}{1} + \frac{n}{N} = 96 + \frac{96}{1607} = 96.\ 0.0597386434$$

On counting the residential building on each site, it has uncertainty or desired marginal error for this (3/100) *96 result 2.88 approximately 3 sample size add on N_t value on the estimated population size. Finally, for two different location gate 99 households to analyses the comfort of indoor environmental quality but it separates for each sample units

Regarding the third equestion, we usually follow the method of proportional allocation under which the sizes of the samples from the different strata are kept proportional to the sizes of the strata. That is if P_i represents the proportion of population included in stratum i, and n represents the total sample size, the number of elements selected from stratum i is n * P_i. To illustrate it the calculated sample of size n = 99 is to be drawn from a population of size N = 1607 which is divided into two strata of size N_1 = 1207, and N_2 = 401. Adopting proportional allocation, we shall get the sample sizes as under for the different strata: For strata with N_1 = 1023, we have P 1 =1206/1607

and hence $n_1 = n * P_1 = 99\ (1206/1607) = 74$

Similarly, for strata with N_2 = 401, we have

$n_2 = n * P_2 = 99\ (316/1391) = 25$

Finally, on-site one analyzes 74 building households, on-site two analyze and communicate 25 households

3.3.1. Selection of sampling location point

From the selected two sites the physical measurement takes in the radius of 50m of the edge of the road (USDOT, 2018) and the interval of 10m of thirty points as shown on table 7, the located site the driving limis are 30kmh-80kmh. The analysis point position are selected based on the parcel distance from the edge of a road, buffer area coverage, noise barriers, building materials & the age of residential building those factors are the primary input for internal room road traffic noise disturbance. From this reference, the first location is the housing parcel arrangement is very close to the road only the walkways are there in between. The second site is most of the residential or oldies and large area parcels.

Table 7 Recommended Minimum Number of Samples *(USDOT, 2018)*

Speed Bin, mph (kmh)	Recommended Minimum Number of Samples
Idling or under 10 (16)	10
11–20 (18-32)	10
21–30 (34-48)	20
31–40 (50-64)	30
41–50 (66-80)	30
51–60 (82-97)	30
61–70 (98-113)	30
71 (114) and above	30

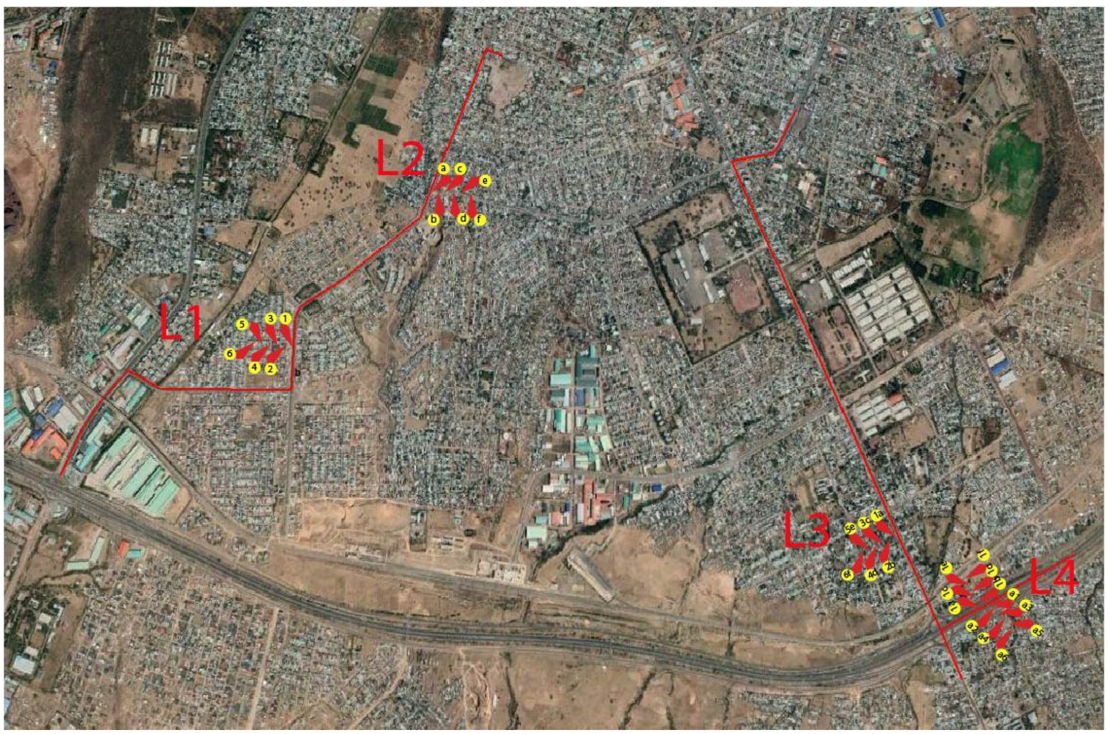


Figure 9 site location for physical measurement points

Location one(L1): select 6 points based on the closer parcel of residence to the road and HCB building material. On figure 10 show that the only four-point measure indoor space of residential building consequently the two points use to compare the noise redaction before and after the buildings.

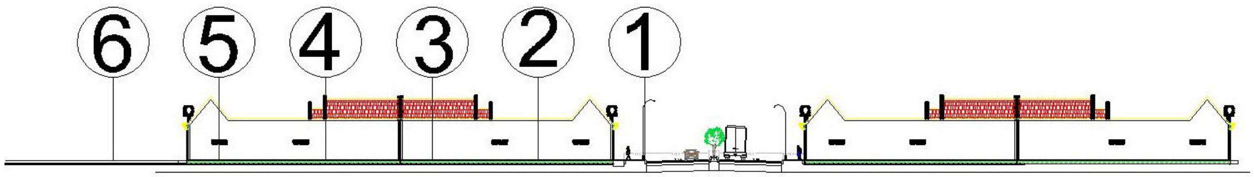


Figure 10 sectional view for Location one

Location Two(L2) selected 6 points this thing to help analyze the shop barriers to the internal space and mud as a building material on the location two to elaborate the front shop barrier for sound redaction and to analyses the intensity of road traffic noise. As shown on figure 11.

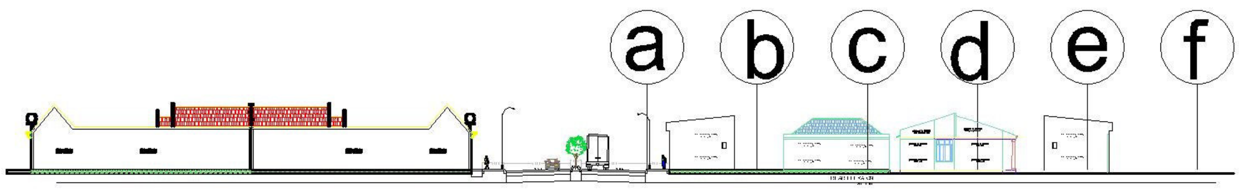


Figure 11 sectional view for Location two

Location Three(L3) selected 6 points those selections to analyze the use of vegetation and buffer zone, how match to barrier road traffic noise and mud property of construction material.

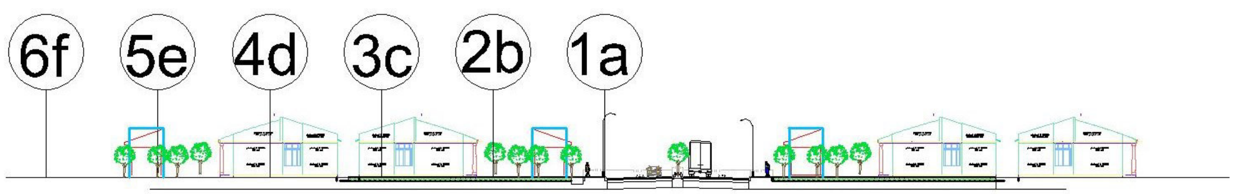


Figure 12 sectional view for Location three

Location Four(L4) selected 12 points because of both side's character of the landscape, road type & distance from the edge of the road to the residential. On this this location the left side is the residential buildings are closer to the road and equal level with road. However, the right side is from the road reference it have three meter and thirty-one centimeter level deference. The location four is the challenged locations compare with the rest of location As shown on figure 13

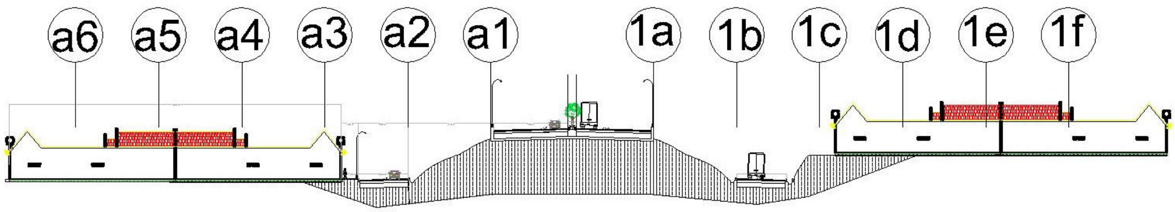


Figure 13 sectional view for Location Four

3.4. Data Collection

This study analyses the road traffic noise on the selected roadways of Adama city. The location is two different roads from migira bus station to asela line highway and peacock bus station to Addis Ababa line highway. Objective measurements and subjective assessments of the road traffic noise disturbance of domestic residential dwellers were on the selected points.

3.4.4. Material and sound level data collection

Measurements were taken under suitable climatic conditions i.e., no rain and no wind in the environment, using the digital sound level meter of type of Hti instruments, Model No.HT-80A; manual and carrying case, with a frequency range of 31.5Hz ~ 8k Hz and measuring level range between 30 dB ~130dB Accuracy of the instrument ±1.5 dB (under reference conditions) and display up data in 0.5 sec. All reading was taken on the 'A-weighting' frequency network, at a height of about 1.5 m from ground level, and on the 'Fast' range time weighting. The 'A' weighting characteristic and 'Fast' range is simulated as a 'human ear listening' response. The data collected from the field were recorded and analyzed in an MS excel worksheet. All noise values were expressed in dB (A) units.

Figure 14 Sound Level Meter

3.4.3. Observation time

Observation time was during working hours, it measures in the morning from 6:30 am- 8:30 am mid-day 12:00 pm-2:00 pm, and evening 6:00 pm-8:00 pm, and noise levels were taken for 15 minutes in 5-second intervals at each location point. To achieve higher accuracy, sampling was done on the random day strategy. So, at each sampling point, the data was collected with a minimum of two randomly selected working days in a week and six samples were taken from each site in 2022 from February to May.

3.5. Questionnaire

these types of methods are used for collecting data from an individual perspective and conceptual thinking of the listed question on the questionnaire. In an attempt to find out the existing situations of the selected urban living areas, identical and systematic questionnaires were developed and used in English and Amharic language in two survey sites. The questionnaires used in the three stages focused on people's perceptions of their living environment and the questionnaire for each stage is provided in the appendix. They were with many structured questions, including demographic data, evaluation,, and preference of road traffic noise sources, and perception of the general living environment. In general, the questionnaire surveys were divided into three parts the first part is general information about the person, the second is the perception of the respondent on road traffic noise and its effect on the health as well as the living environment. Based on the sampling number the questionnaire was distributed simple random method.

A five-level linear scale has been used generally in the questionnaires surveys to evaluate the comfort levels, significant levels, and preferable sounds. For example, on the question regarding the current living environment, five scales were supplied: 1, very good; 2, good; 3, average acceptable; 4, bad; and 5, very bad; while the questions concerning comfort levels of the sound environment in living areas and at home were asked with the five linear scales consisting of 1, very comfortable; 2, comfortable; 3, neither comfortable nor uncomfortable; 4, uncomfortable; and 5, very uncomfortable. It has also been used in ranking the most annoying noise sources when staying at home: 1, not very annoying; 2, occasionally; 3, medium; 4, annoying; 5, very annoying.

3.6. Filed survey

Survey the existing structure of housing arrangement, some noise barriers, different factors that affect the noise acceleration, traffic flow on the road, community understanding, and the grounded problem on the site. capture pictures and record video to support my objectives and existing physical condition as well as a community response

3.7. Informal Interview:

The interview is taking oral discussion with the house owner and the city communication bureau and transport authority on the flow of the traffic and related issues on the annoyance of sound.

3.9. Instrument Validity and Reliability:

To ensure the reliability of the data, questionnaires were translated from English to the local language and back again. The data were also centrally followed regularly until the data collection was completed. Instrument validity was ensured by resorting to pre-prepared standard question items for each of the indicators used.

3.10. Methods of Data Analysis:

Both qualitative and quantitative data from primary and secondary sources were, edited, organized, analyzed, summarized, and presented by employing qualitative and quantitative methods of data analysis. firstly, measure the using noise level meter and collect the data's and analysis the values on the road traffic noise effects and secondly collect the respondent questioner and prepare to analysis. Finally, the results were subsequently explained with the help of qualitative data to arrive at valid conclusions. To explain more quantitative data analysis use measuring instrument data encoding software Software's that use to analyze data use AutoCAD, ArcGIS, and MS Excel.

3.11. Data presentation

From all observed, collected, and analyzed data organized and documented using computer added way finally prepare graphically reach presentation, to short note, clear photo/image, presentational PowerPoint.

3.12. Ethical Consideration

For quality output the study has given prior concern on awareness creation on purpose and objectives of the study. Prior to the collection of data, each study participant gave their consent. Information has been protected from identity theft and divulging to third parties. For the use of materials, legal consent has been obtained from the department of architecture, the school of architecture, and civil engineering. Every source utilized during the study has been acknowledged. The data was examined by the researcher using the noise trishould standard.

CHAPTER FOUR

4. RESULT AND DISCUSSION

In this chapter analysis and results are reported to draw inferences from the study. Different types of information or data were gathered through different information or data gatherings techniques such as observation, informal interviews, Questionnaires and field surveys, using Sound Level Meter measured.

4.1. Background

4.1.1. Age of the respondent

The age group of the respondents as shown on figure 15 was ranged from 11 years old to over 65 years, from the total respondent n=99(100%) the most respondents were n=29 (29.29%) were aged from 25 to 34 years old, some respondents were n=26(26.26%) aged from 18 to 24, n=2(2.2%) were above 65 and few respondents are recorded. From this distribution traffic noise undermine the early age of the community and aware more.

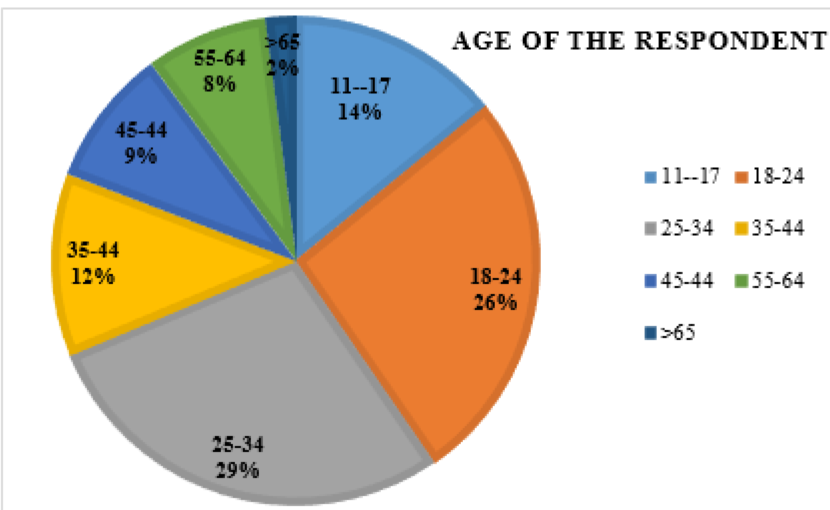


Figure 15 age of the respondent (field survey 2022)

4.1.2. gender diversity

The figure 16 shows the percentage of respondant on the qoestioneres servey data according to the data n=59,(59.60%) of respondant are male and the rest of n=40(40.40%) are females, in all types the male respondant are actively partcipated

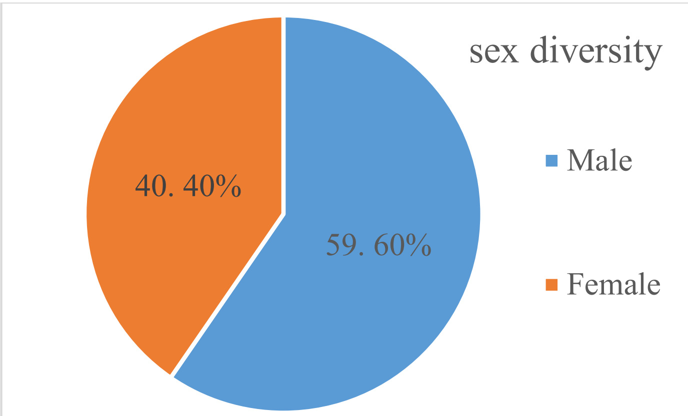


Figure 16 the respondent number of sex diversity

4.1.3. Educational background

Based on the survay qustionereies the respondant is skilled community n=34(34.34%), of the respondant is aBSc/BA educational background n=17(17.17%), were Ma/MSc and above and the listed educational background is n=3(3.03%) certaficate owners. The educational aknolegment of the respondant is incresae the respondant awerness and the question fill well.

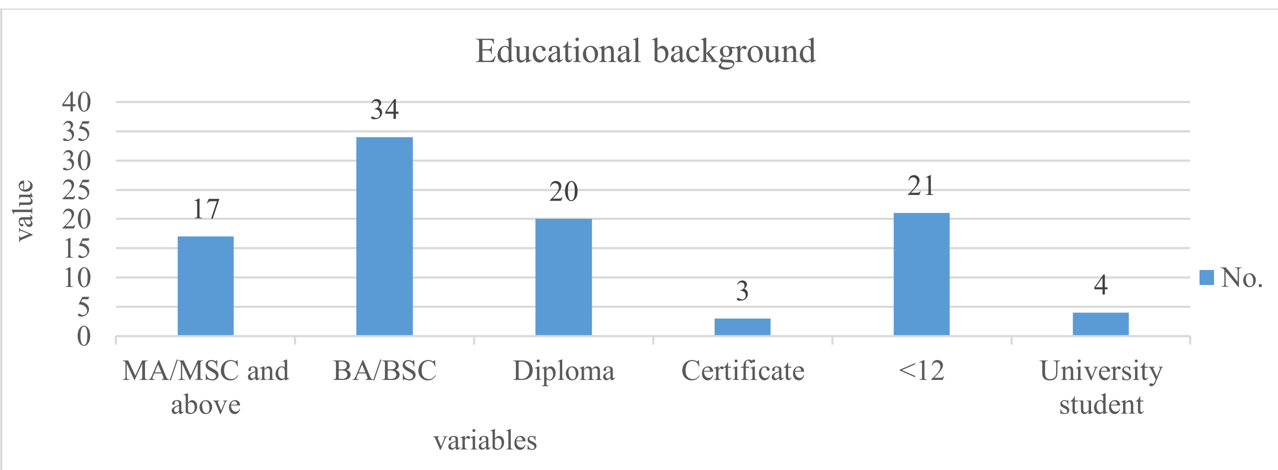


Figure 17 Educational background of the respondent:

4.1.4. Respondent ownership of the land parcel

from the total respondent n = 36(36.36%) are tenant or live rental house were n = 63(63.64%) of the respondent are live in its own house

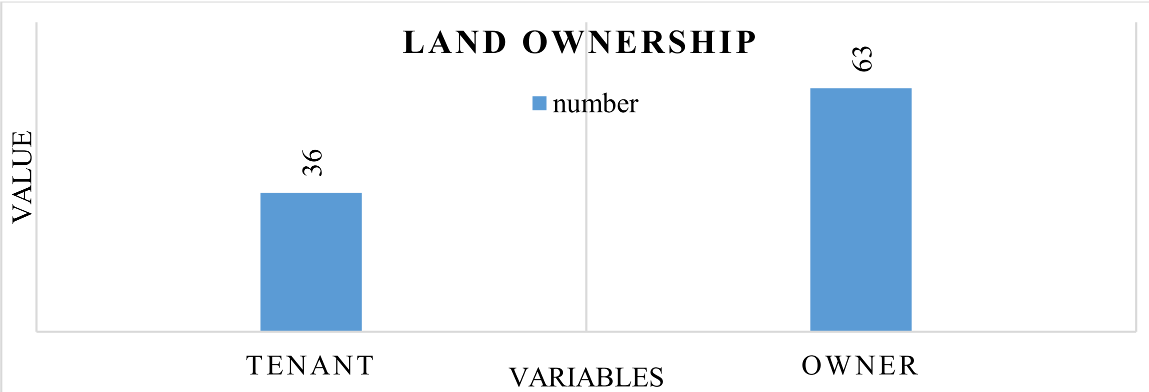


Figure 18 Respondent ownership of the land parcel

The total of 63 land owner n=48(76.19%) of the respondent answer also the land gate from government the rest of n = 15(23.81%) is by from the others. Relate to this opinion in n=64(64.65%) of the dwellers are long time inhabitants in the districts so it can't change the area at all.

4.1.5Choose of Living Environment

As mentioned above a five-level linear scale was used, from, do not mind, to, very important. The results in Adama city the selected sites are analyzed in Table 7, through the Independent Samples Test, it can be seen that there were generally significant influence factors are there in the listed issues. In terms of the order of importance of various factors, the respondent character for response is more similar. It is interesting to note that the factor 'quiet' was ranked as the 4th most important factor in cities, the sound environment was an important consideration compared to other factors. In addition to that from table 7 indicate that road traffic noise undermines by the respondent respond on quit zone for living environment is very important.

Table 8 Please give your evaluation for the following factors when choosing a living environment:(for buy and tenant persons)

Factor Rank	Do not Mind		rarely		Neutral		Important		Very important	
	No	%	No	%	No	%	No	%	No	%
Convenient for work	29	29.29	-	-	14	14.14	6	6.06	50	50.51
Convenient transportation	12	12.12	24	24.24	2	2.02	49	49.49	12	12.12
safety	-	-	7	7.07	-	-	39	39.39	53	53.53

Property price	-	-	13		21		20		45	45.45
Quiet	36	36.36	18	18.18	-	-	27	27.27	18	18.18
Views	39	39.39	23	23.23	-	-	35	35.35	2	2.02
Size of the house	74	74.74	9	9.09	16	16.16	-	-	-	-

4.1.6 Building Type You Live In

From over all survey of respondant n=97(98%) are live in domostic residensial villa, the only n=2(2%) of the respondant are live in condominium building.

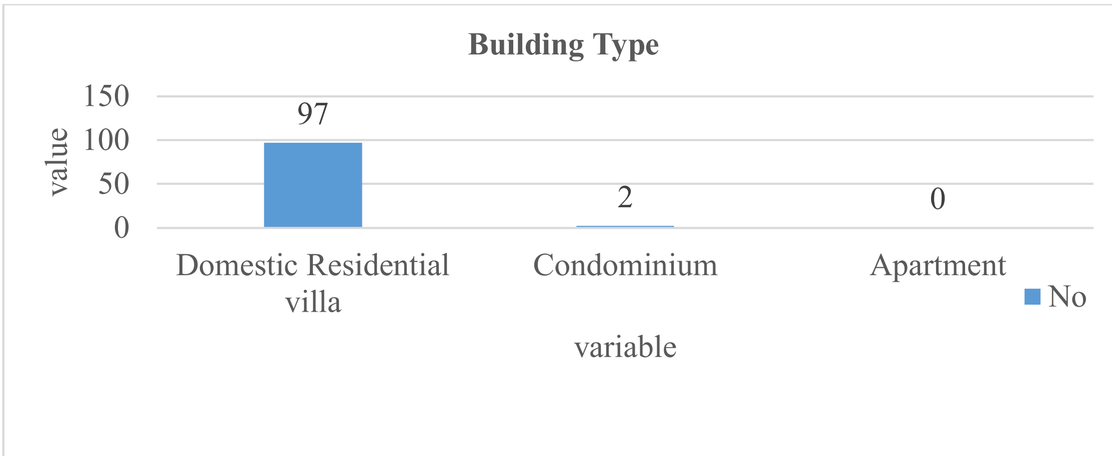


Figure 19 respondent building type that live in

4.1.7 Material that built your house

The respondent that combined material are mud with rendered cement screed and plastered stone wall

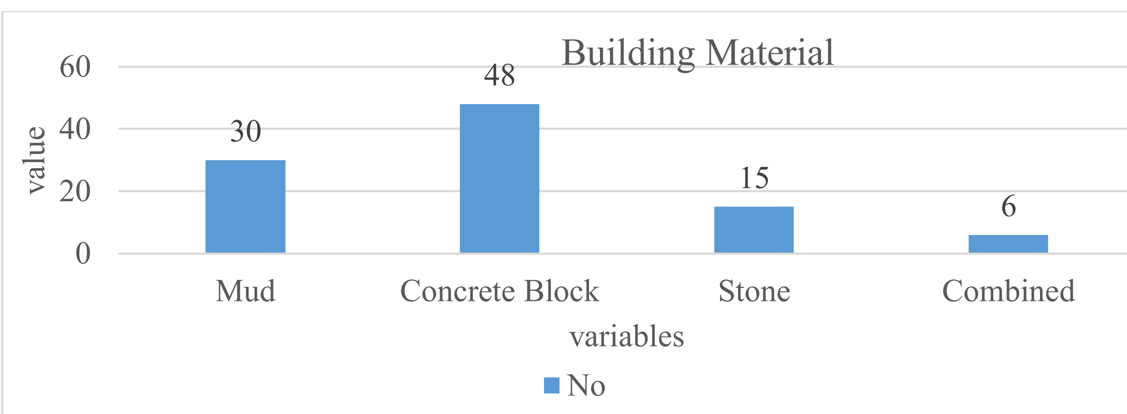


Figure 20 the respondents house building material types distribution

4.2. Site Analysis

From the field observation, Adama city on the located two sites road is busy traffic distribution from the early morning 6:00 am when the bus stations are open for service and heavy vehicle transit on the Addis Ababa – Adama highway road up to 6:00 pm the bus station is closed. The road host number of different vehicles continuously travelers to ward and out ward the city as well as commodity loaded heavy vehicles drive on the road especially, the road access to ward assela exit (Mamo Mazamir Street) is a high transit road of heavy vehicle. The vehicle also oldies brand of fabrication.

Compare with the city LDP and the existing residential arrangement adjacent to the road in figure 21 site one is the oldies existing housing and mixed residential areas and the second site is a new generated residential settlement area of the city. The setback of road from the residential is three meter on the first site but on the oldies site the residential set back is including walk way of the road three meter, Calvert width also one and half meter in addition to this the residential are built on the back of site; frontally built shop and other functional houses

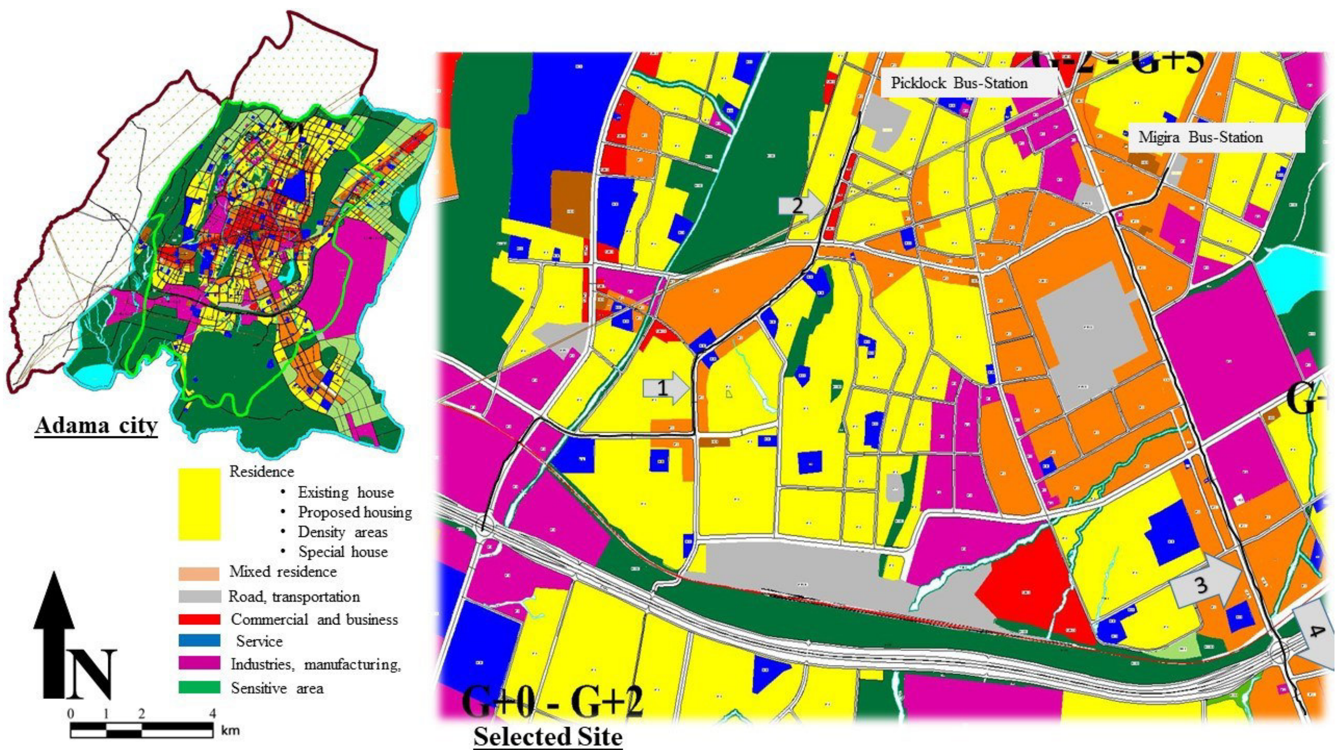


Figure 21 land use map of Adama city

On the figure 22 The building's closeness to the road is only varied on the adjacent to highway's left and right side in addition to that the topography difference also observed in the location but the rest of the site is closer to the road in between space from the parcel edge and the road is only walking way width.

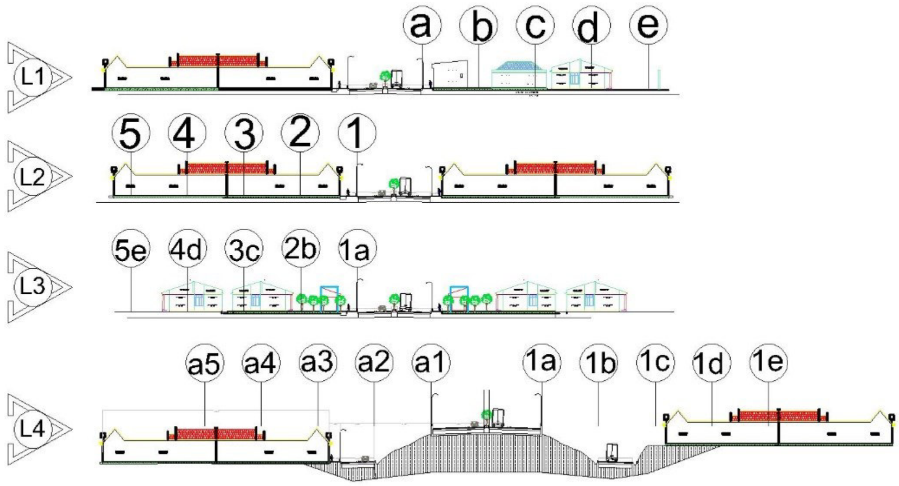


Figure 22 different location and road closeness sectional view

The topography of Adama as shown in the figure below almost flat character but when constricting the road there is cut and fill this create level deference

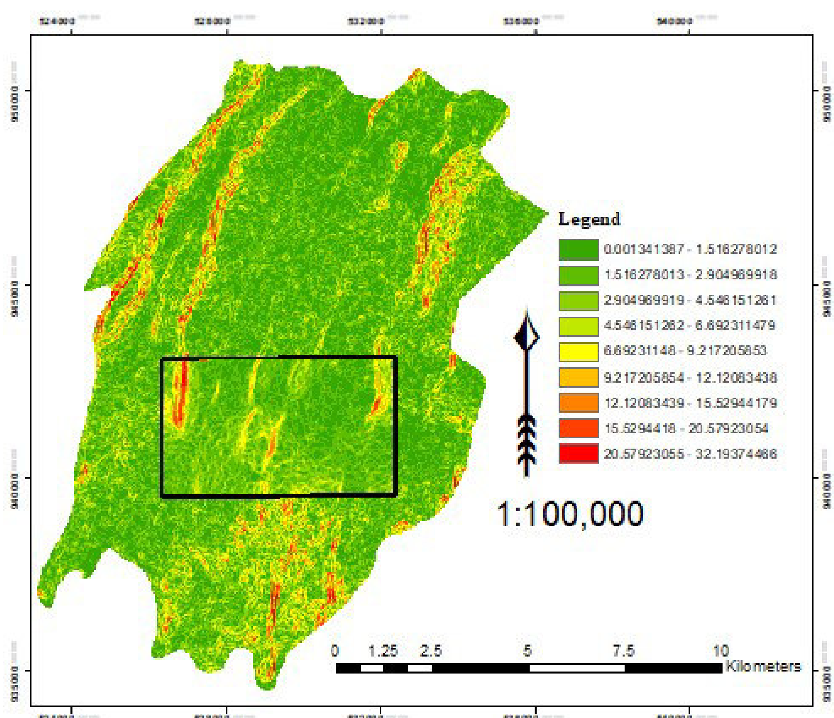


Figure 23 slope deference of the site (GIS analysis)

4.2.1 characterstics of building and road

According to the study the oldies site of location one the area merged from farming land the road also upgrades from rural arterial road in this case as shown on the figure 24 the building is constructed by mud wall and corrugated iron sheet, the same like the yard also constructed by corrugated iron sheet. The spacing with road only the dish(Calvert) widths

Figure 24 the site observed of building type and road closeness (field survay,2022)

The roads serve different type of cars like trackers, Bajaj, minibus, and the like, especially location two road and highways are host number of different car types those cars have emitted diversified sound.

Figure 25 car types dive on the road(field survay,2022)

4.3. Noise Level of the road traffic

The measured noise level were analyses and compared with World health organization noise limit regulation (World Health Organization, 1997) and guideline ambient environment standards of Ethiopia related to road traffic noise. (EPA & ESID, 2003) As well as the European environmental agency directive (EEA, 2014)

The measurement was conducted thirty points on four grouped categories on both sites. The category separate base on parcel distance from the road, building material of the residence, buffer zone on the external and in the compound of the residential parcel, adjacent topography, and sound barrier like shop Those factors are increasing the induced sound frequency. For the L1, L2, and L3 locations it has six points both side but for the L4 location it has twelve physical measurement points.

4.2.1 Location One(L1) On-Site Two Measurement Analysis

For this location, it has six points namely 1,2,3,4, 5, & 6 it has a 10-meter distance in between from the reference point of the road edge in fifty-meter radius

Location L1-1 at the edge of the road

The noise level measure at L1-1 point over various time intervals is shown in the figure 26. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 41.9 dB, while the afternoon noise level peaked at 100.8 dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

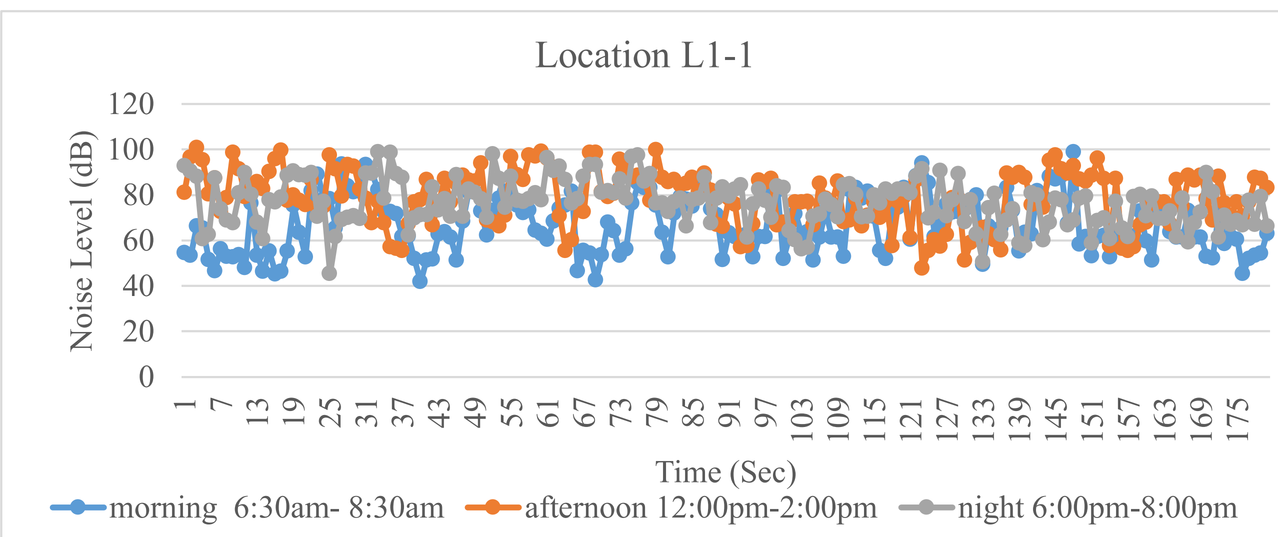


Figure 26 Location L1-1 at the edge of road graphical illustration

Location L1-2 (10m distance)

The noise level measure at L1-2 point over various time intervals is shown in the figure 27. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 39.8 dB, while the afternoon noise level peaked at 88.4 dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

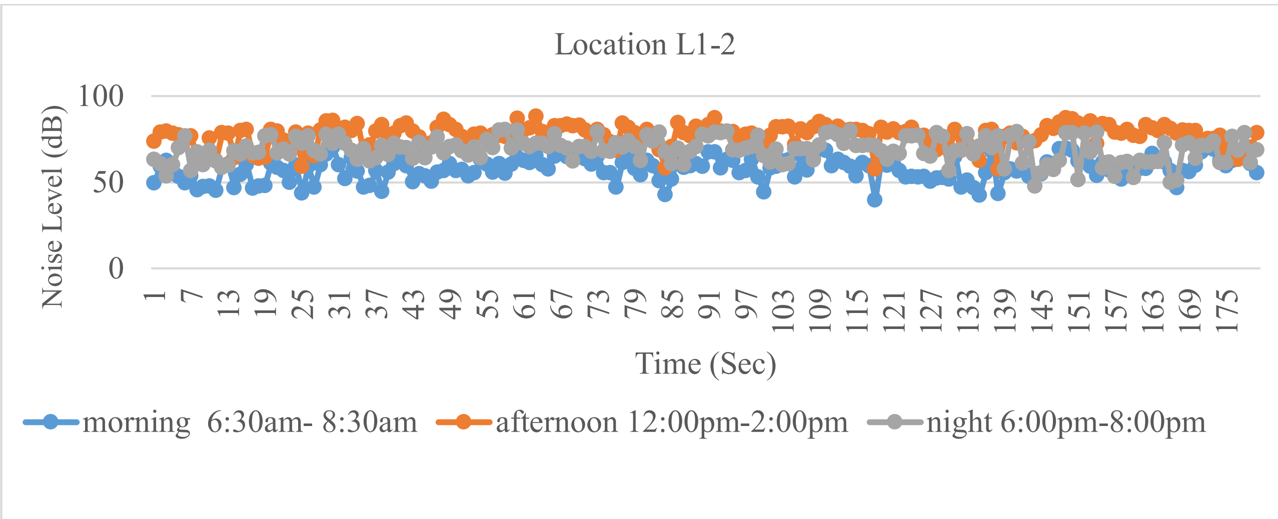


Figure 27 Location L1-2 (10m distance) graphical illustration

Location L1-3 (20m distance)

The noise level measure at L1-3 point over various time intervals is shown in the figure 28. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 34.8 dB, while the afternoon noise level peaked at 87.7 dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

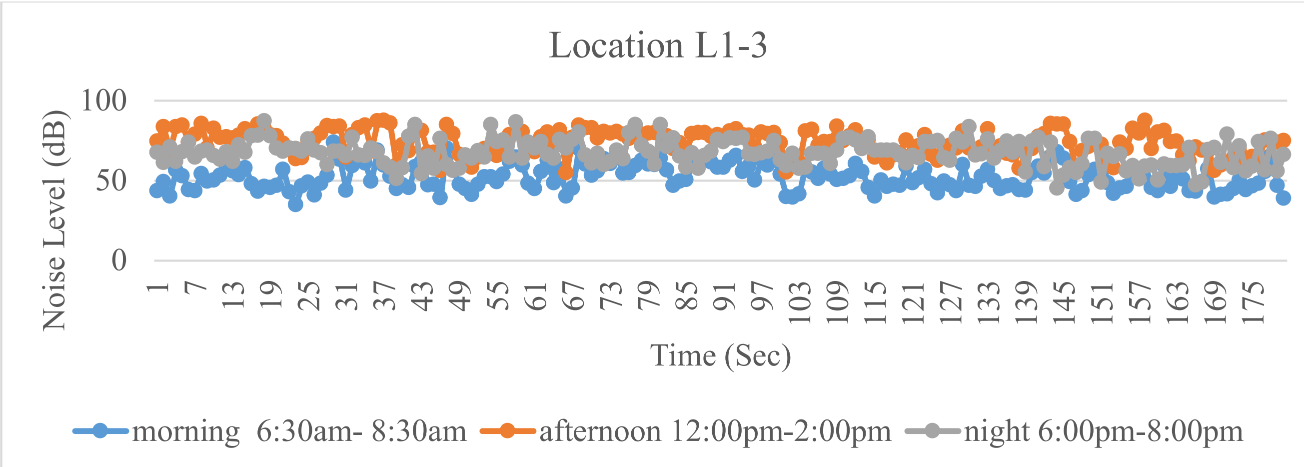


Figure 28 Location L1-3 (30m distance) graphical illustration

Location L1-4 (30m distance)

The noise level measure at L1-4 point over various time intervals is shown in the figure 29. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 30.6 dB, while the afternoon noise level peaked at 84.5 dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

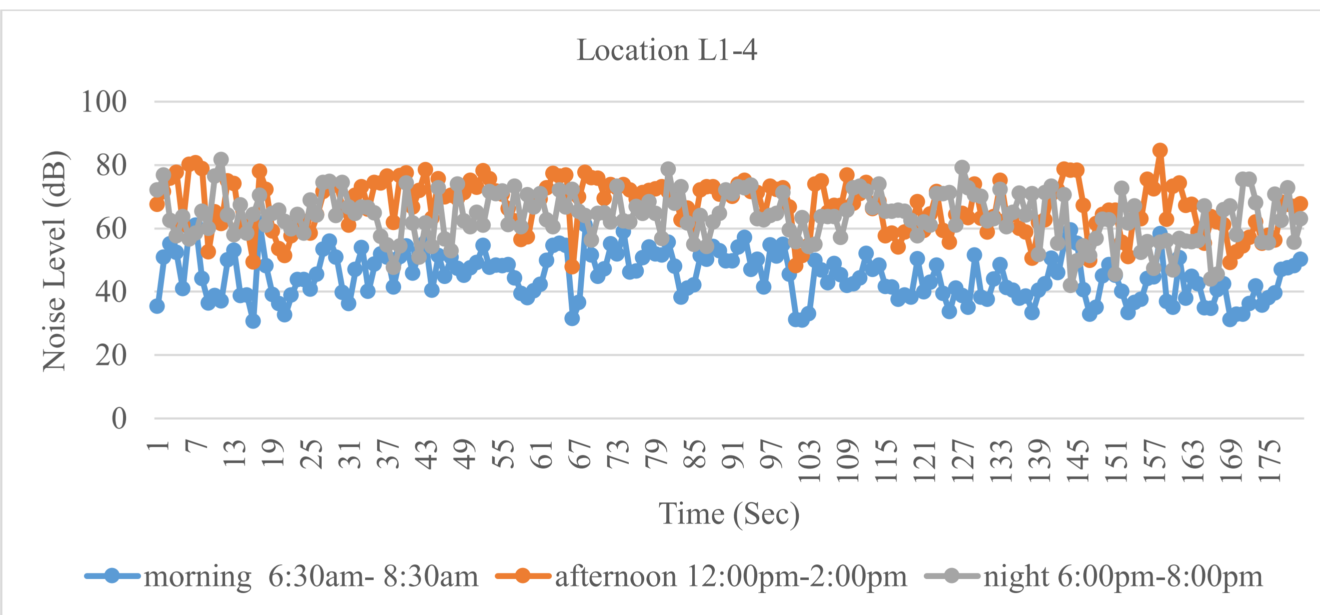


Figure 29 Location L1-4 (30m distance) graphical illustration

Location L1-5 (40m distance)

The noise level measure at L1-5 point over various time intervals is shown in the figure 30. The figure shows that the night time slightly the same noise level across time intervals, the morning and afternoon noise level is up and down across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 30.6 dB, while the afternoon noise level peaked at 84.5 dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

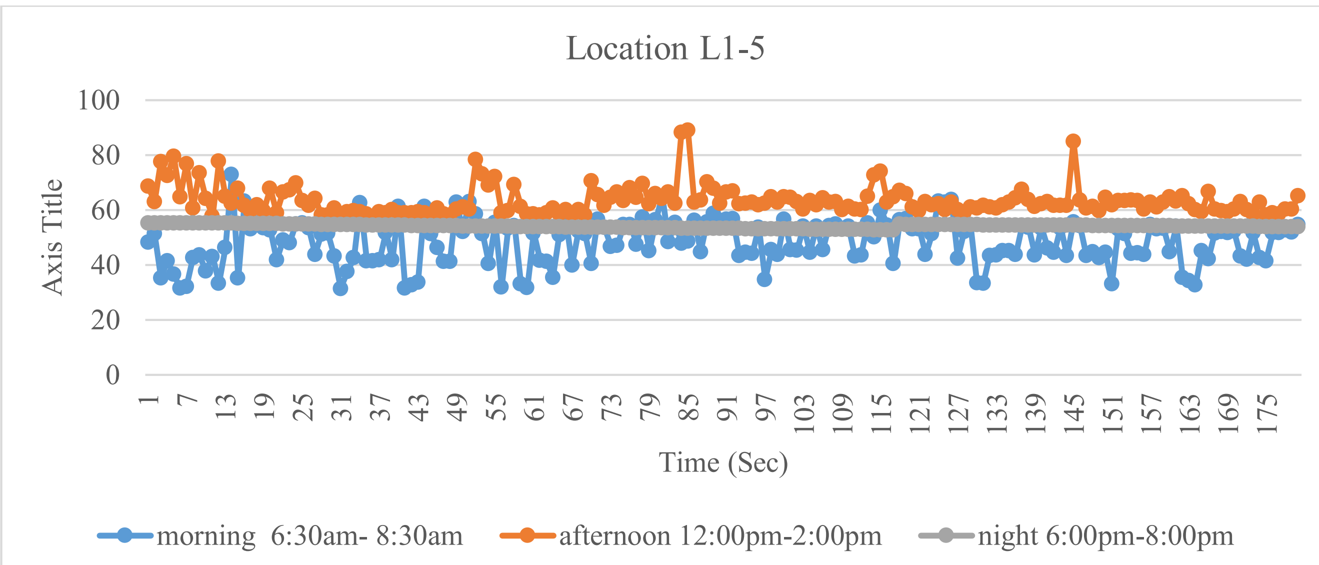


Figure 30 Location L1-5 (40m distance) graphical illustration

Location L1-6 (50m distance)

The noise level measure at L1-6 point over various time intervals is shown in the figure 31. The figure shows that the night time slightly the same noise level across time intervals, the morning and afternoon noise level is up and down across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 30.6 dB, while the afternoon noise level peaked at 67.4 dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

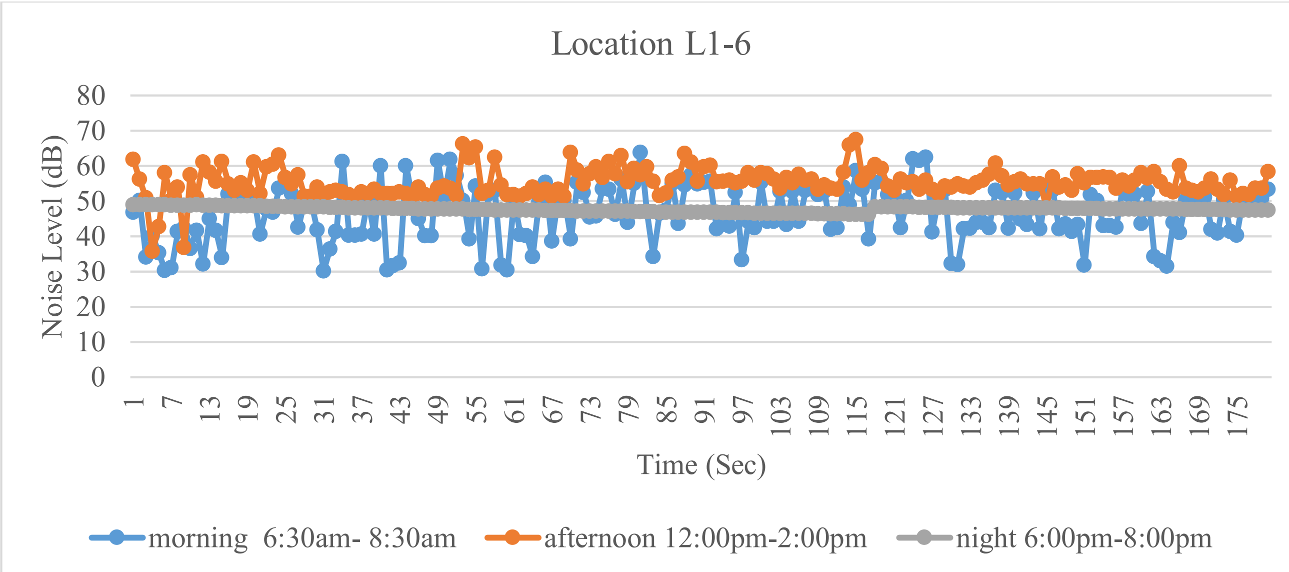


Figure 31 Location L1-6 (50m distance) graphical illustration

From the overall analysis of location one the noise decreases toward the edge to forty meters this indicates the noise induced by the building material of the house and the receiver far from the road traffic noise source. On table illustrate the all-in-one analysis

Refer from world health organization studies and Ethiopian acceptable noise level in day and night the location one average noise level is above the threshold of the standards especially in the afternoon time the noise is highly annoying. On residential building the annoying level is 55dB at day and 45dB at night, the recorded result on the location are greater than 45dB.

Table 9 L1-(1-6) measured noise level summary

Point	At morning			At afternoon			At Night		
	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)
L1-1	41.9	98.9	66.84	47.8	100.8	78.76	45.4	98.9	76.60
L1-2	39.8	71.6	57.73	57.6	88.4	77.20944	47.8	80.6	68.97
L1-3	34.8	73.8	52.23	54.9	87.7	74.00	45.4	87.4	67.31

L1-4	30.6	61.6	45.0466 7	47.8	84.5	67.0216 7	41.9	81.6	63.7983 3
L1-5	31.5	73	48.20	57.3	89.1	63.46	52.8	55.4	54.19
L1-6	30.2	63.8	46.57	35.7	67.4	55.27	46.3	48.9	47.69

NB: - remained the Sound level meter reserve all the surrounding noise

4.2.2 Location Two(L2) On-Site Two Measurement Analysis

Location L2-a, at the edge of the road

The noise level measure at L2-a point over various time intervals is shown in the figure 32. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 43.2 dB, while the afternoon noise level peaked at 103.8dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

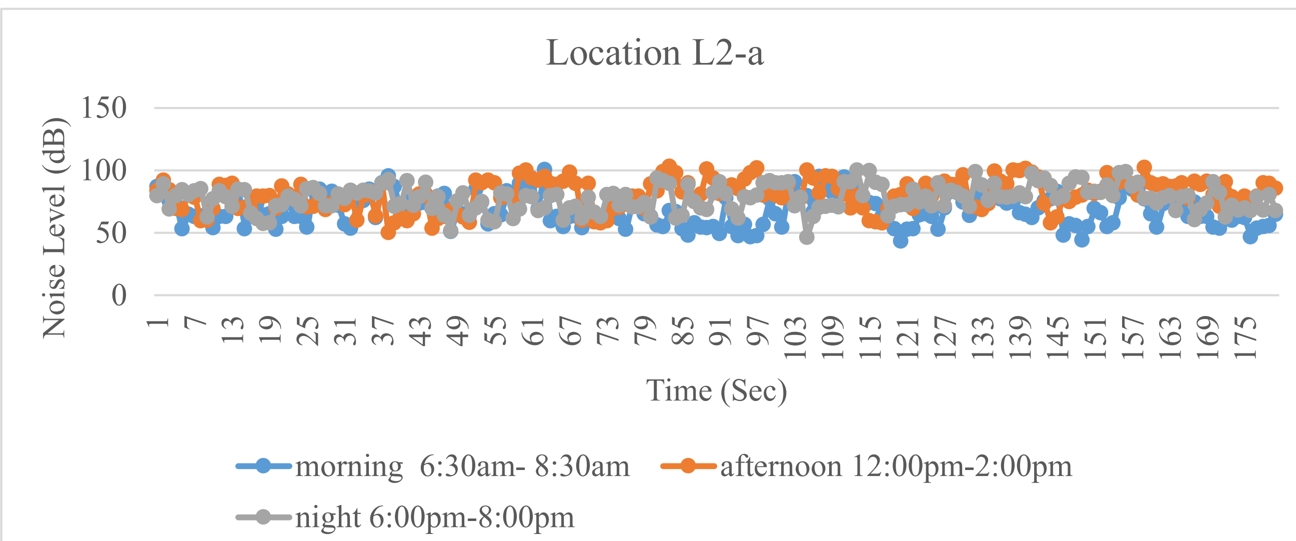


Figure 32 Location L2-a at the edge of road graphical illustration

Location L2-b (10m distance)

The noise level measure at L2-b point over various time intervals is shown in the figure 33. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest.

The morning noise level was 60.39dB, while the afternoon noise level peaked at 89.7dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

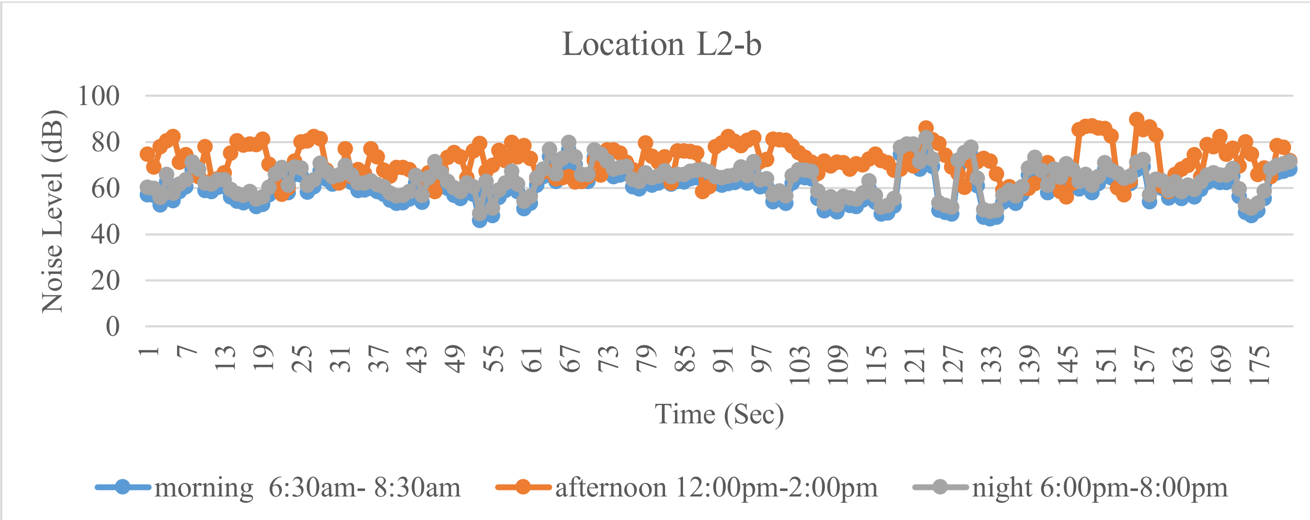


Figure 33 Location L2-b (10m distance) graphical illustration

Location L2-c (20m distance)

The noise level measure at L2-c point over various time intervals is shown in the figure 34. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 39.2dB, while the afternoon noise level peaked at 87.7dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

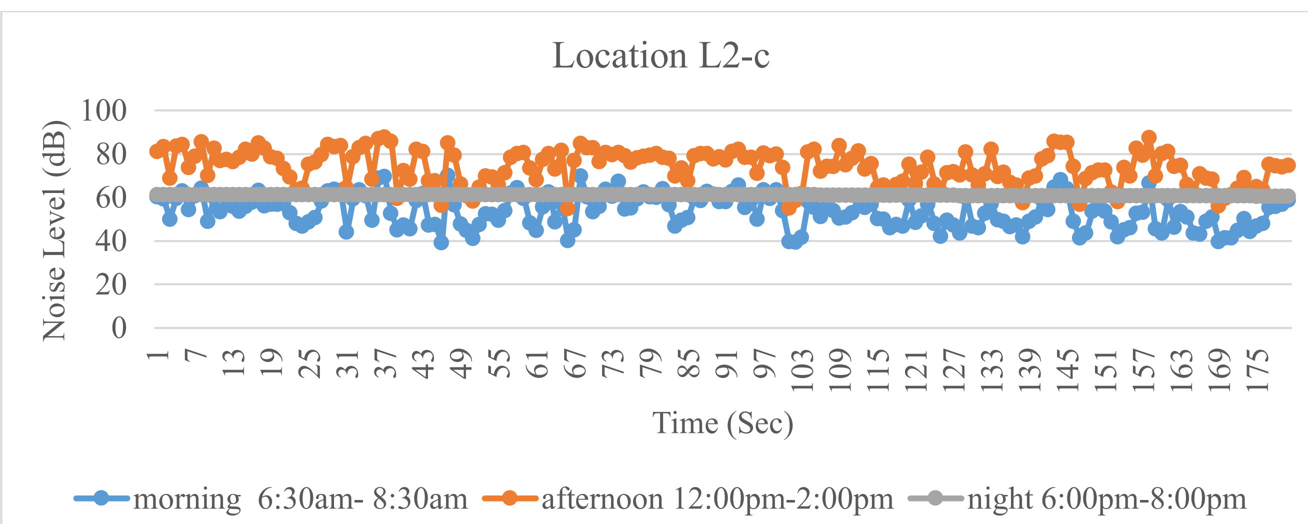


Figure 34 Location L2-c (30m distance) graphical illustration

Location L2-d (30m distance)

The noise level measure at L2-d point over various time intervals is shown in the figure 35. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 30.0dB, while the afternoon noise level peaked at 84.6dB. This information indicates that road noise is highest in the late afternoon and slightly in the night.

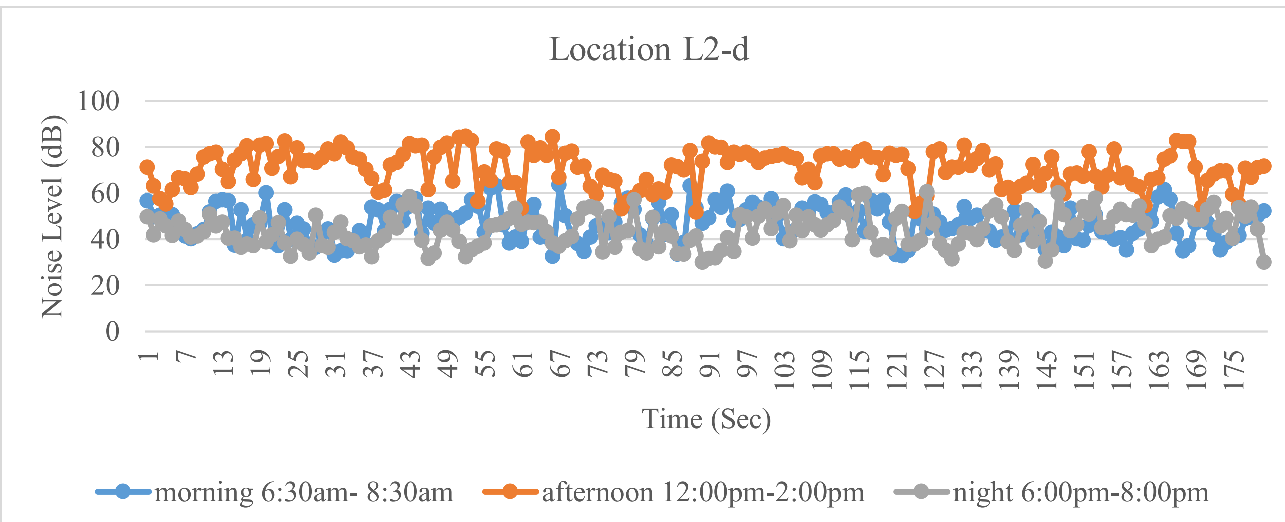


Figure 35 Location L2-d (30m distance) graphical illustration

Location L2-e (40m distance)

The noise level measure at L2-e point over various time intervals is shown in the figure 36. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 30.5dB, while the afternoon noise level peaked at 71.7dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

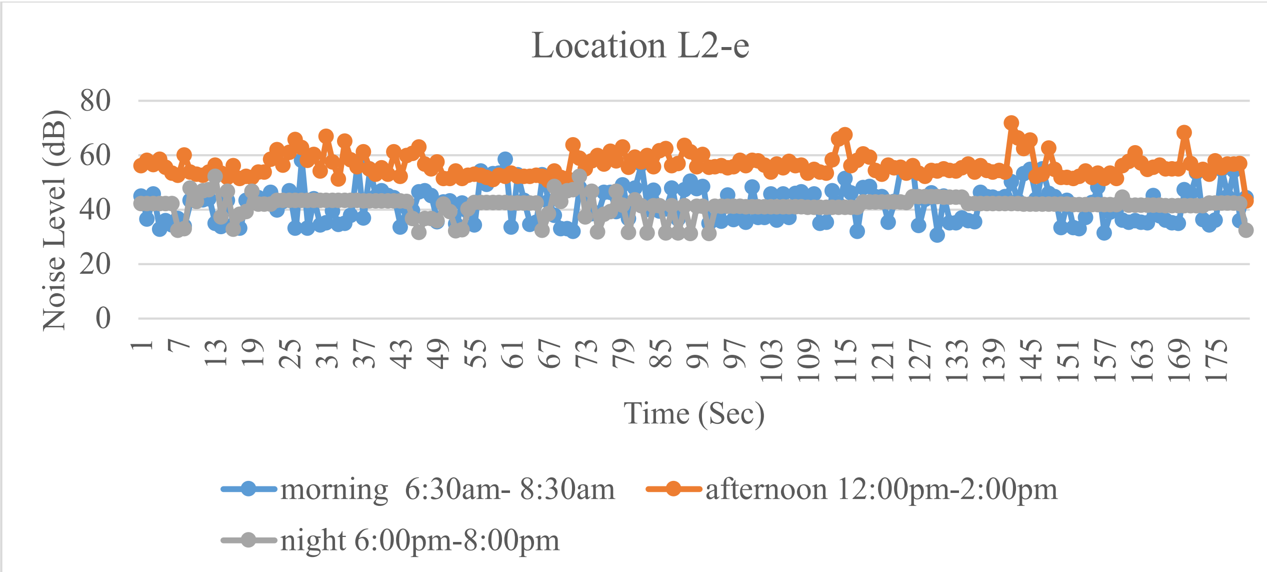


Figure 36 Location L2-e (40m distance) graphical illustration

Location L2-f (50m distance)

The noise level measure at L2-f point over various time intervals is shown in the figure 37. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 30.0dB, while the afternoon noise level peaked at 63.7dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

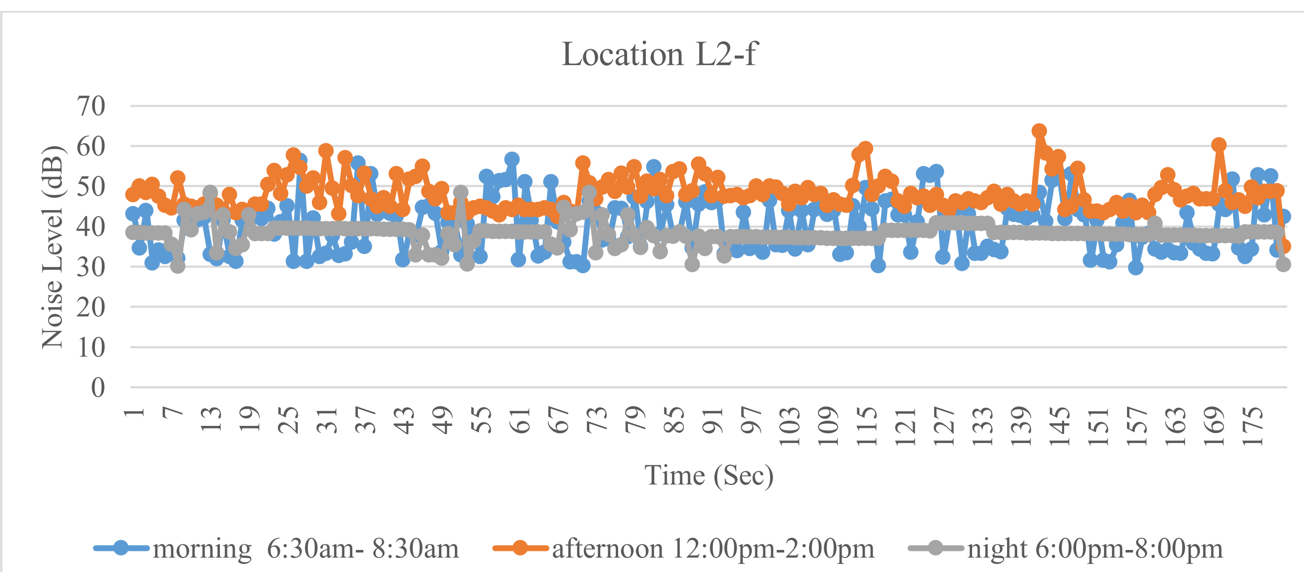


Figure 37 Location L2-f (50m distance) graphical illustration

From the overall analysis of location one the noise decreases toward the edge to forty meters this indicates the noise induced by the building material of the house and the receiver far from the road traffic noise source. On table illustrate the all-in-one analysis.

According to research by the World Health Organization, Ethiopian and different country allowed noise levels throughout the day and at night, the noise at this site is generally too loud, especially in the afternoon. The limit level on a residential building is 55 dB during the day and 45 dB at night; nevertheless, the results that were recorded there are higher than 45 dB.

Table 10 L2-(a-f) measured noise level summary

Point	At morning			At Afternoon			At Night		
	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)
L2-a	43.2	100.2	68.14	50	103	80.71	46.3	99.8	77.50
L2-b	45.8	78.5	60.39	56.1	89.7	71.68	49	81.7	63.59
L2-c	39.2	70.2	53.64	54.9	87.7	74.04	60.6	61.4	61.09
L2-d	32.6	63.6	47.04	51.8	84.6	70.90	30	60.5	42.28
L2-e	30.5	58.4	41.93	43	71.7	56.08	31.2	52.2	41.40
L2-f	30	56.7	40.24	35	63.7	48.08	30.1	48.5	38.30

NB: - remained the Sound level meter reserve all the surrounding noise

4.2.3 Location Three(L3) On-Site One Measurement Analysis

Location L3-1a at the edge of the road

The noise level measure at L3-1a point over various time intervals is shown in the figure 38. The figure shows that there is much closer values in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 66.50dB, while the afternoon noise level peaked at 100.8dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

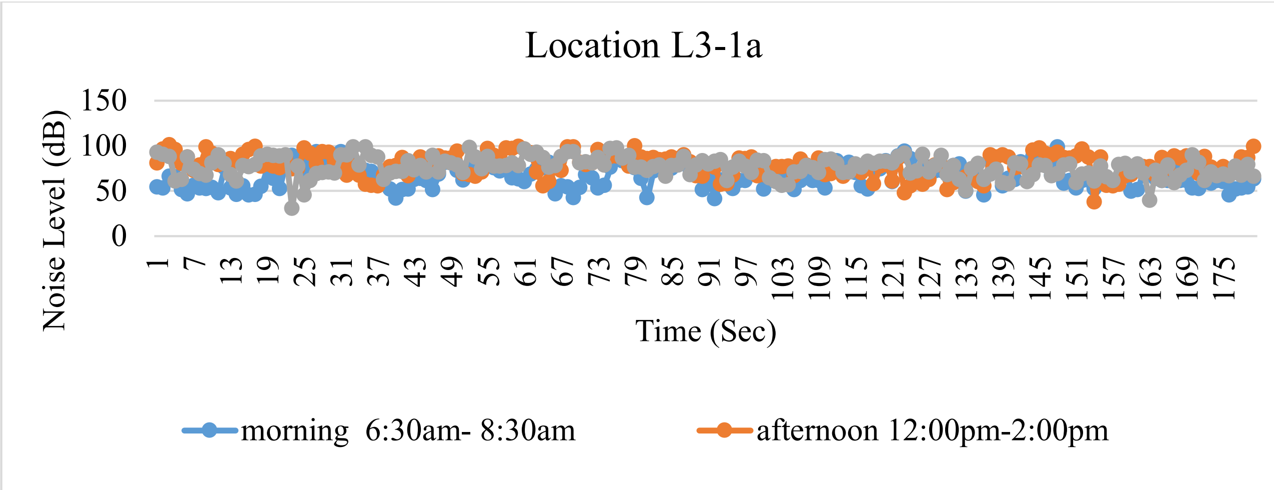


Figure 38 Location L3-1a at the edge of road graphical illustration

Location L3-2b (10m distance)

The noise level measure at L3-2b point over various time intervals is shown in the figure 39. The figure shows that there is much closer values in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 53.44dB, while the afternoon noise level peaked at 90.3dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

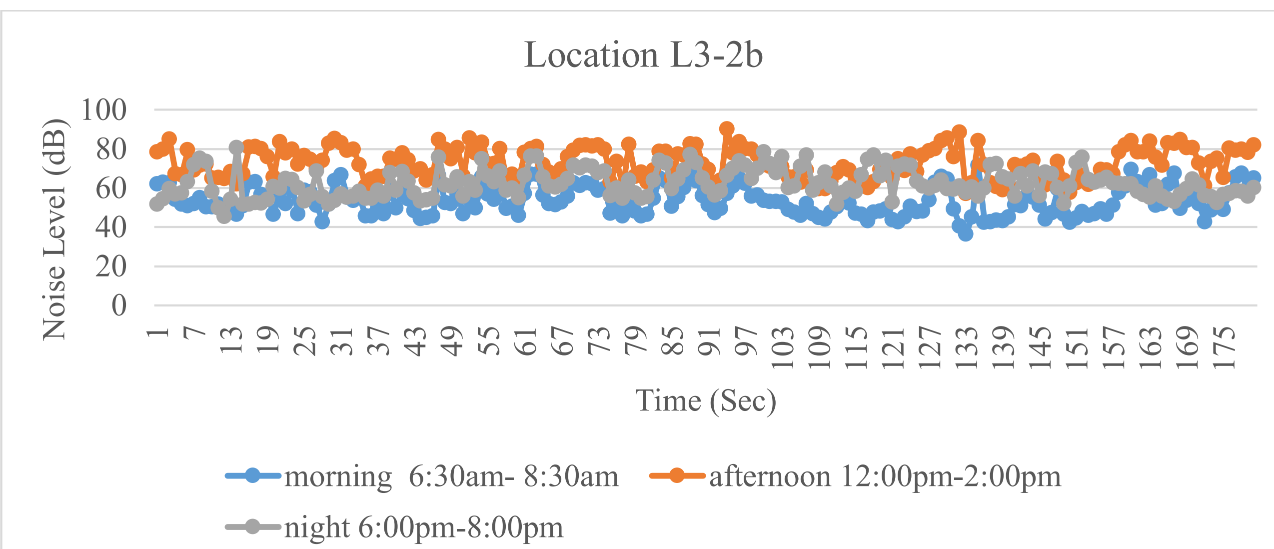


Figure 39 Location L3-2b (10m distance) graphical illustration

Location L2-3c (20m distance)

The noise level measure at L3-3a point over various time intervals is shown in the figure 40. The figure shows that there are much closer values at night and afternoon in noise levels across time intervals, the afternoon time score higher yet, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 36.7dB, while the afternoon noise level peaked at 90.0dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

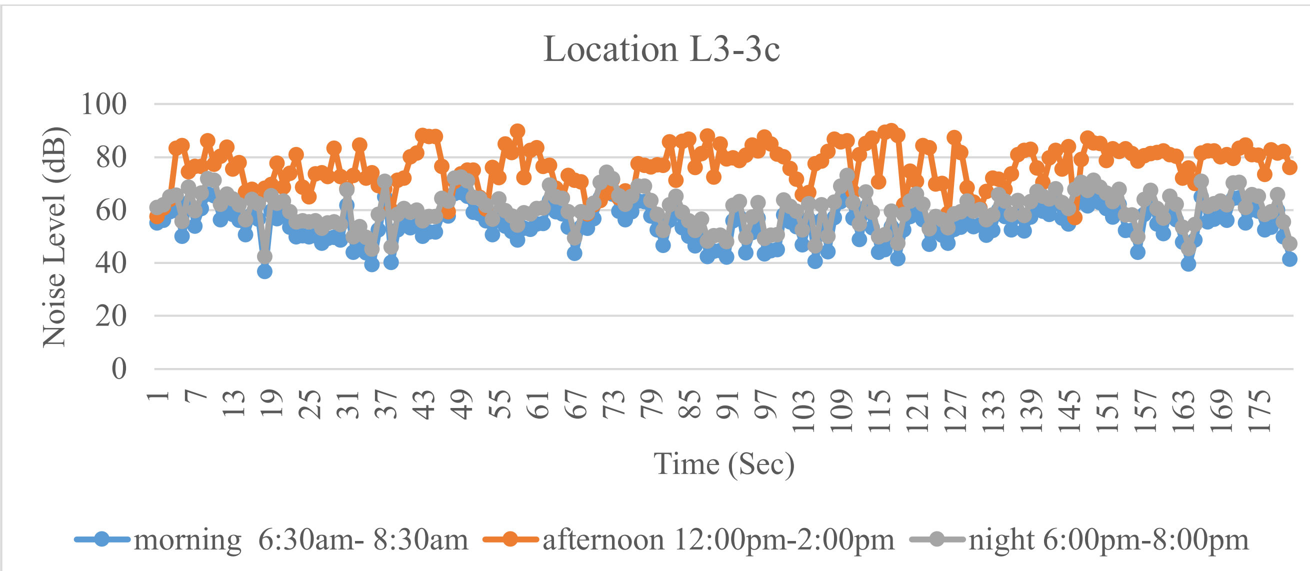


Figure 40 Location L3-3c (30m distance) graphical illustration

Location L3-4d (30m distance)

The noise level measure at L3-4d point over various time intervals is shown in the figure 41. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 37.1dB, while the afternoon noise level peaked at 83.4dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

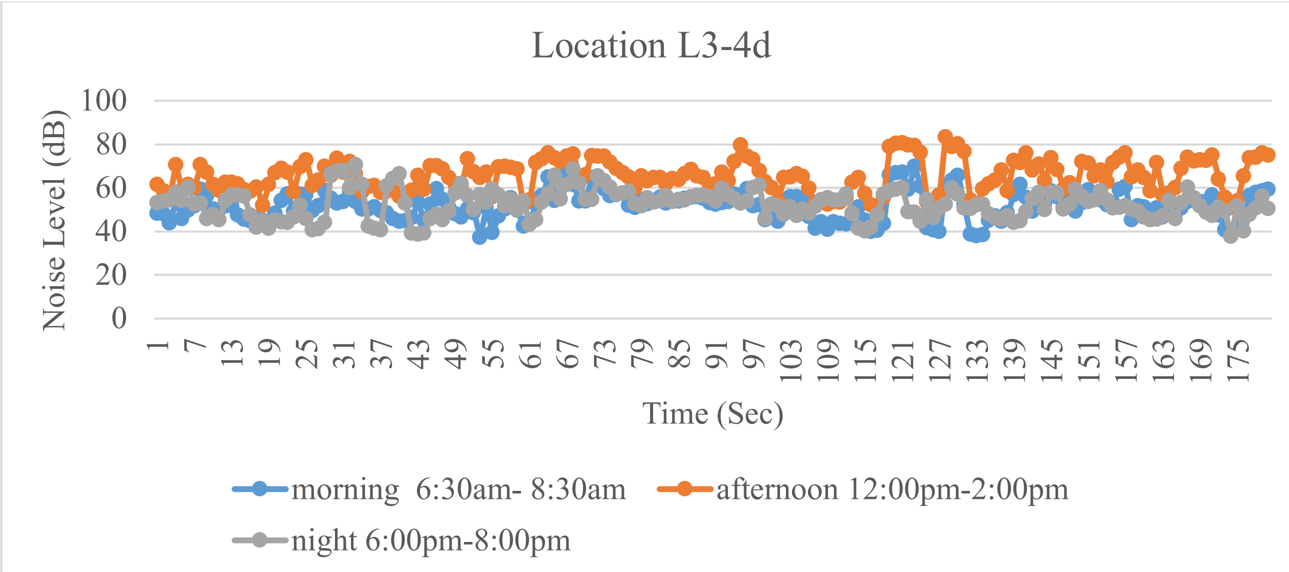


Figure 41 Location L3-4d (30m distance) graphical illustration

Location L3-5e (40m distance)

The noise level measure at L3-5e point over various time intervals is shown in the figure 42. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 30.0dB, while the afternoon noise level peaked at 75.2dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

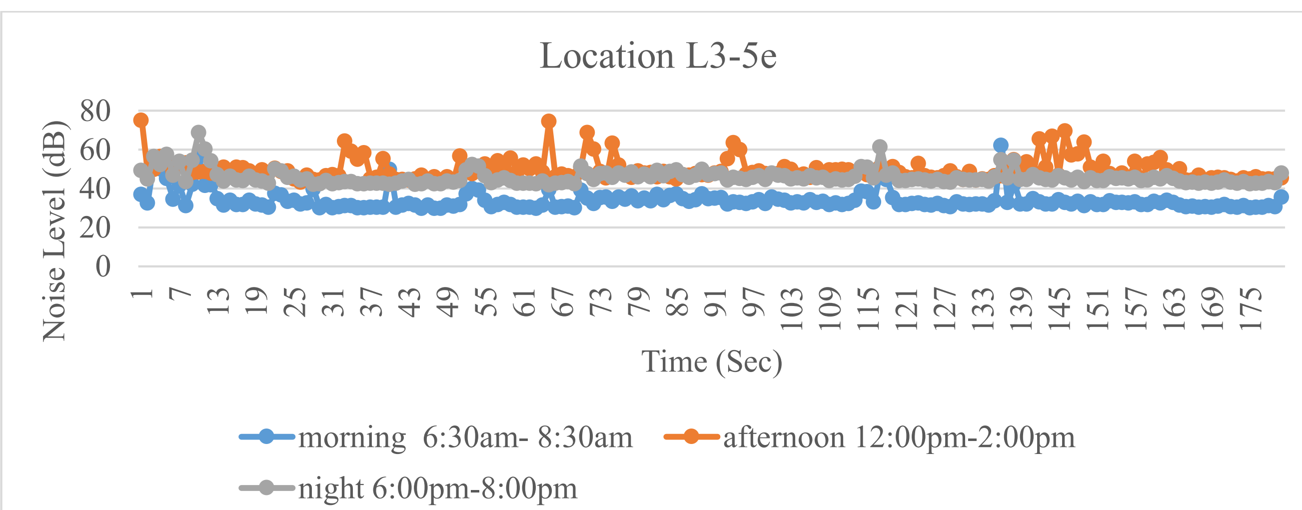


Figure 42 Location L3-5e (40m distance) graphical illustration

Location L3-6f (50m distance)

The noise level measure at L3-6f point over various time intervals is shown in the figure 43. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 30.0dB, while the afternoon noise level peaked at 68.1dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

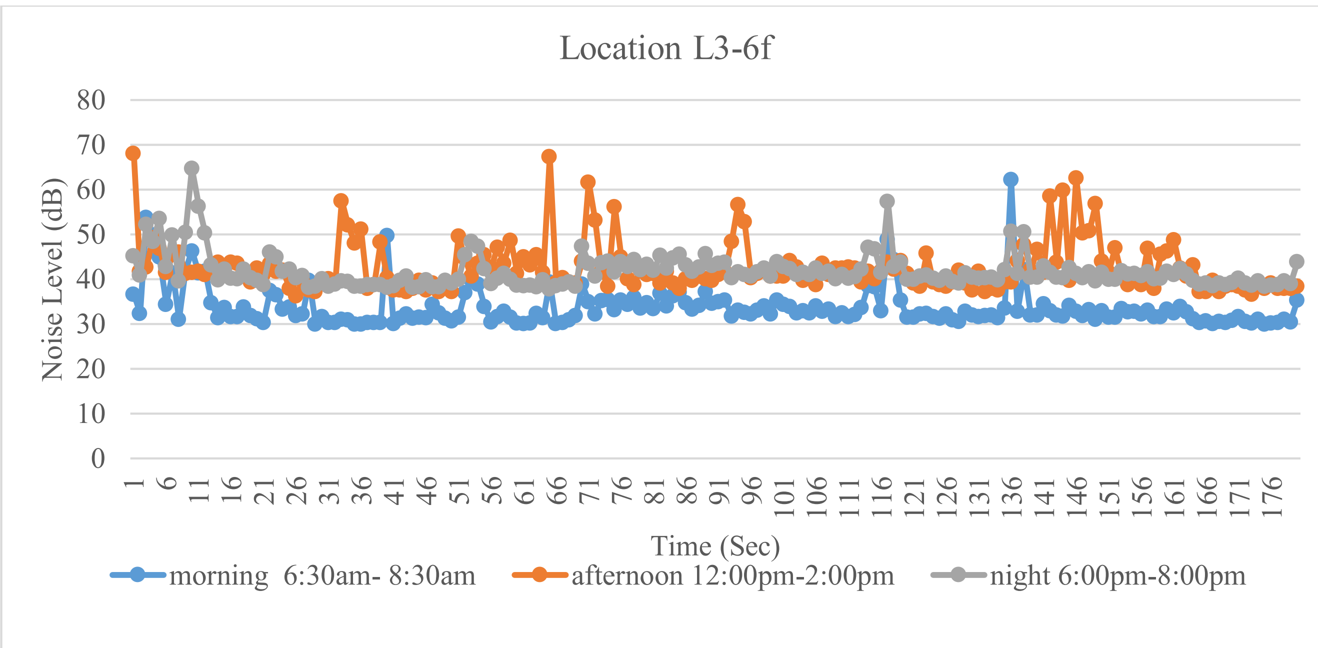


Figure 43 Location L3-6f (50m distance) graphical illustration

From the overall analysis of location one the noise decreases toward the edge to forty meters this indicates the noise induced by the building material of the house and the receiver far from the road traffic noise source. On table illustrate the all-in-one analysis.

The noise at this location is typically excessively high, especially in the afternoon, according to studies by the World Health Organization (WHO, 2018), which found that Ethiopian and other countries were permitted noise levels during the day and at night. The maximum sound pressure level for a residential building is 55 dB during the day and 45 dB at night; nevertheless, the measurements made there indicate that the maximum level is greater than 45 dB.

Table 11 L3-(1a-6f) measured noise level summary

Point	At morning			At Afternoon			At Night		
	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)
L3-1a	41.5	98.9	66.50	37.6	100.8	78.73	30.6	98.9	76.21
L3-2b	36.5	71.7	53.44	57.2	90.3	72.92	51.9	78.6	66.90
L3-3c	36.7	68.5	54.63	57.2	90	76.30	42.5	74.3	60.43
L3-4d	37.1	69.8	51.69	49.8	83.4	65.38	38.6	70.5	53.15
L3-5e	30	62.4	33.96	43.4	75.2		42	68.9	45.89
L3-6f	30	62.2	33.78	36.3	68.1	42.65	37.9	64.8	41.79

NB: - remained the Sound level meter reserve all the surrounding noise

4.2.4 Location Three(L4) On-Site One Measurement Analysis

Location L4-a1 at the edge of the road

The noise level measure at L4-a1 point over various time intervals is shown in the figure 44. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 58.5dB, while the afternoon noise level peaked at 103.8dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

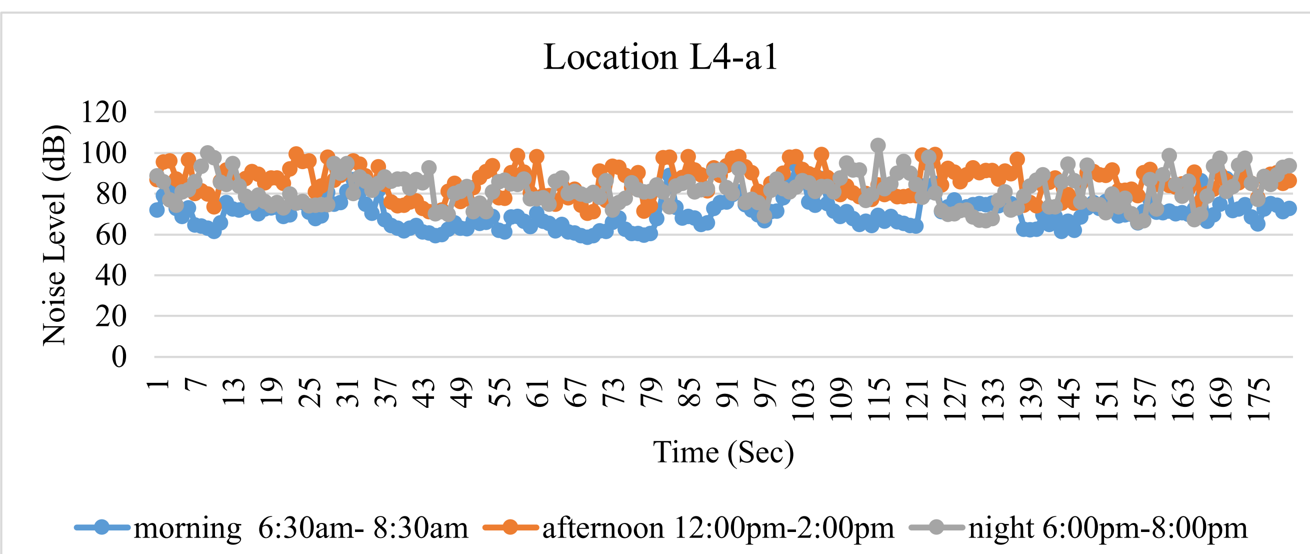


Figure 44 Location L4-a1 at the edge of road graphical illustration

Location L4-a2 (10m distance)

The noise level measure at L4-a2 point over various time intervals is shown in the figure 45. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 38.2dB, while the afternoon noise level peaked at 95.7dB. This information indicates that road noise is highest in the late afternoon and slightly in the night.

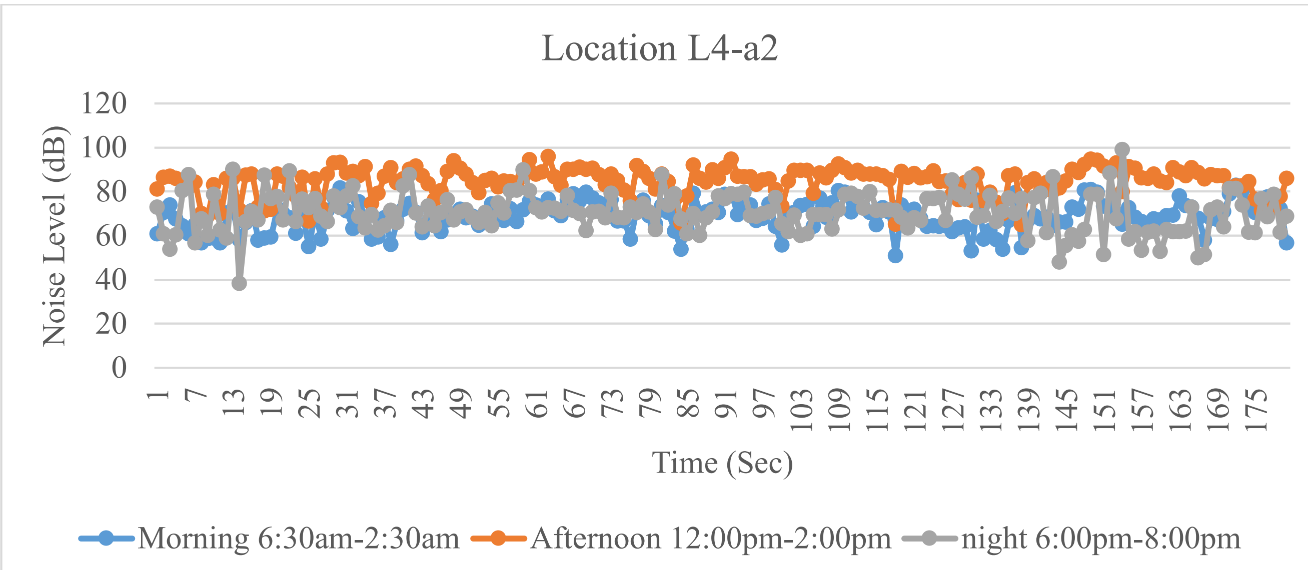


Figure 45 Location L4-a2 (10m distance) graphical illustration

Location L4-a3 (20m distance)

The noise level measure at L4-a3 point over various time intervals is shown in the figure 46. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 39.2dB, while the afternoon noise level peaked at 93.8dB. This information indicates that road noise is highest in the late afternoon and slightly in the night.

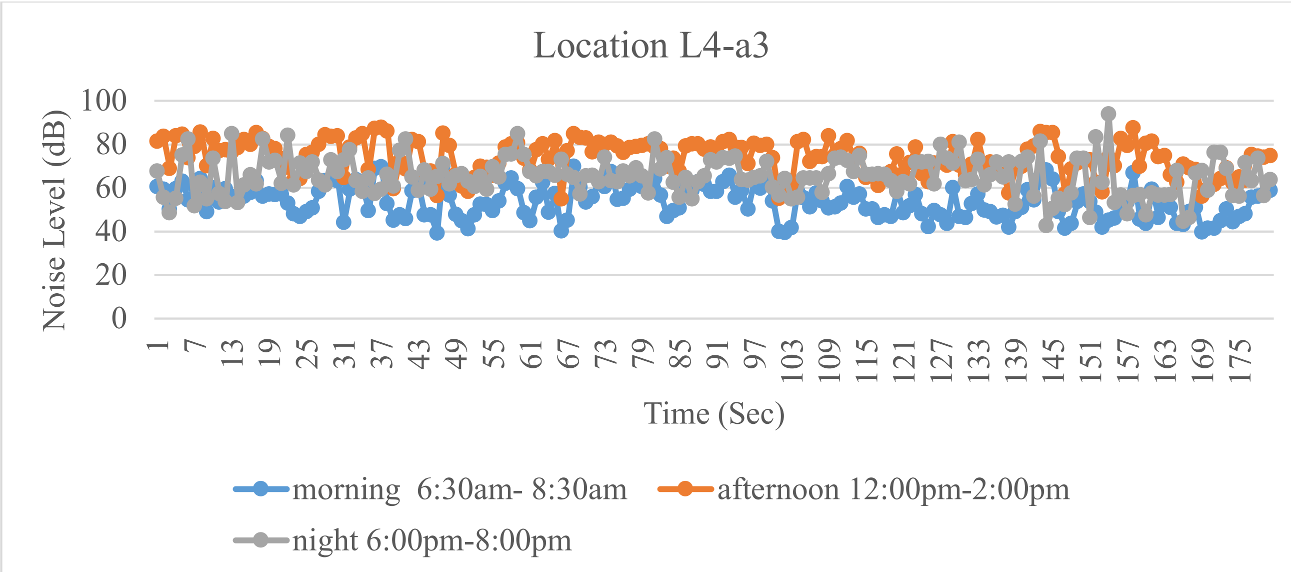


Figure 46 Location L4-a3 (30m distance) graphical illustration

Location L4-a4 (30m distance)

The noise level measure at L4-a3 point over various time intervals is shown in the figure 47. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 30.5dB, while the afternoon noise level peaked at 73.2dB. This information indicates that road noise is highest in the late afternoon and slightly in the night.

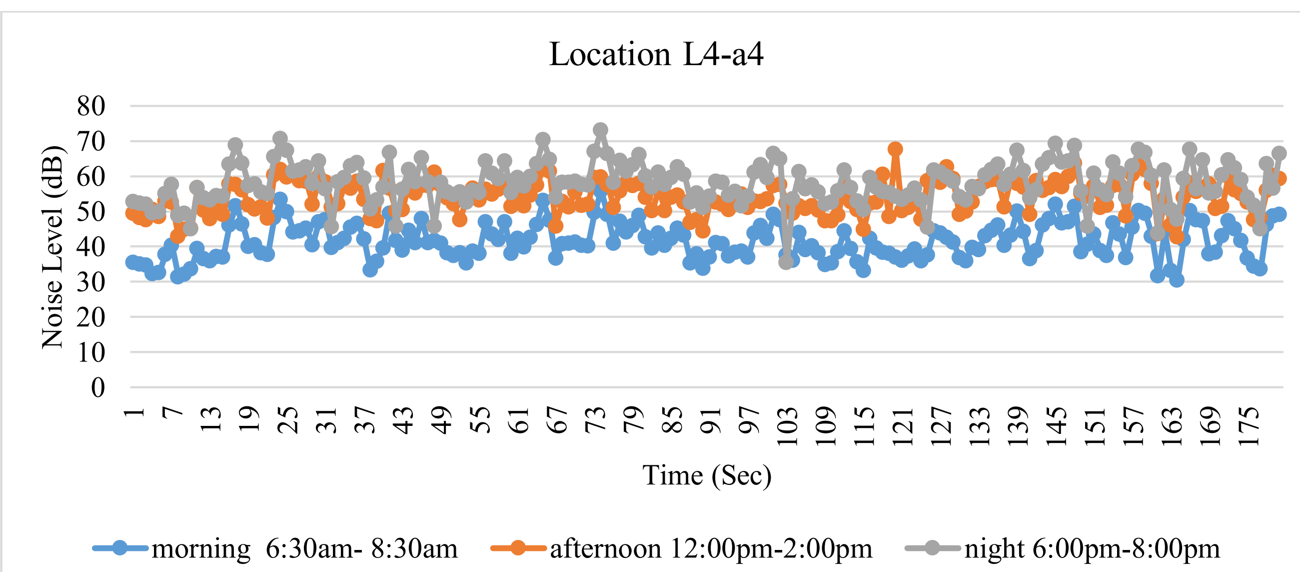


Figure 47 Location L4-a4 (30m distance) graphical illustration

Location L4-a5 (40m distance)

The noise level measure at L4-a5 point over various time intervals is shown in the figure 48. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 37.0dB, while the afternoon noise level peaked at 106.3dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

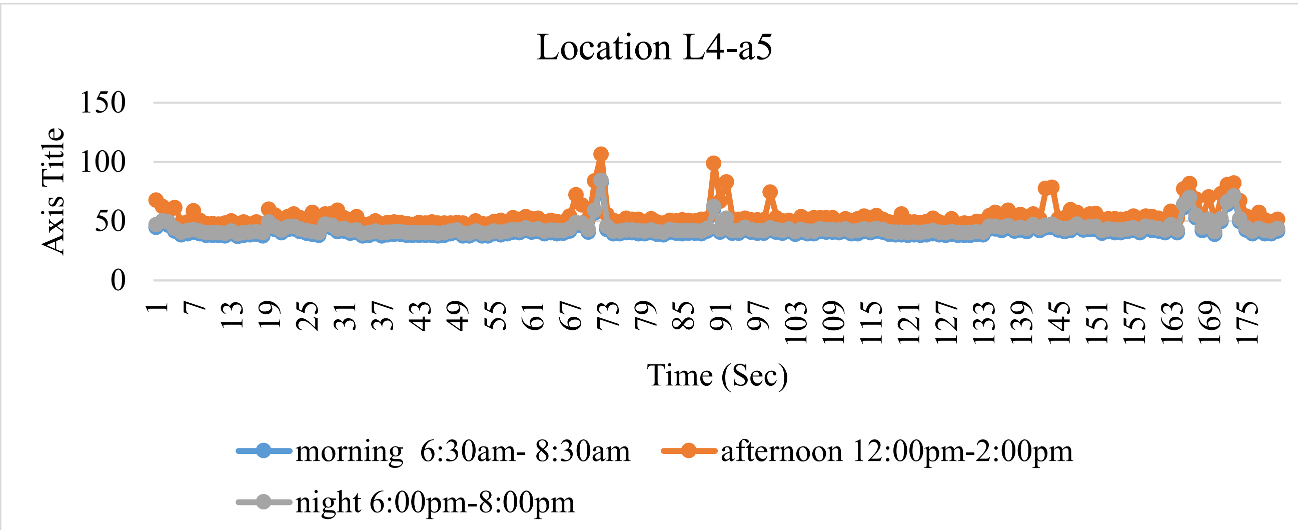


Figure 48 Location L4-a5 (40m distance) graphical illustration

Location L4-a6 (50m distance)

The noise level measure at L4-a6 point over various time intervals is shown in the figure 49. The figure shows that there is much closer values in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 34.3dB, while the afternoon noise level peaked at 69.3dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

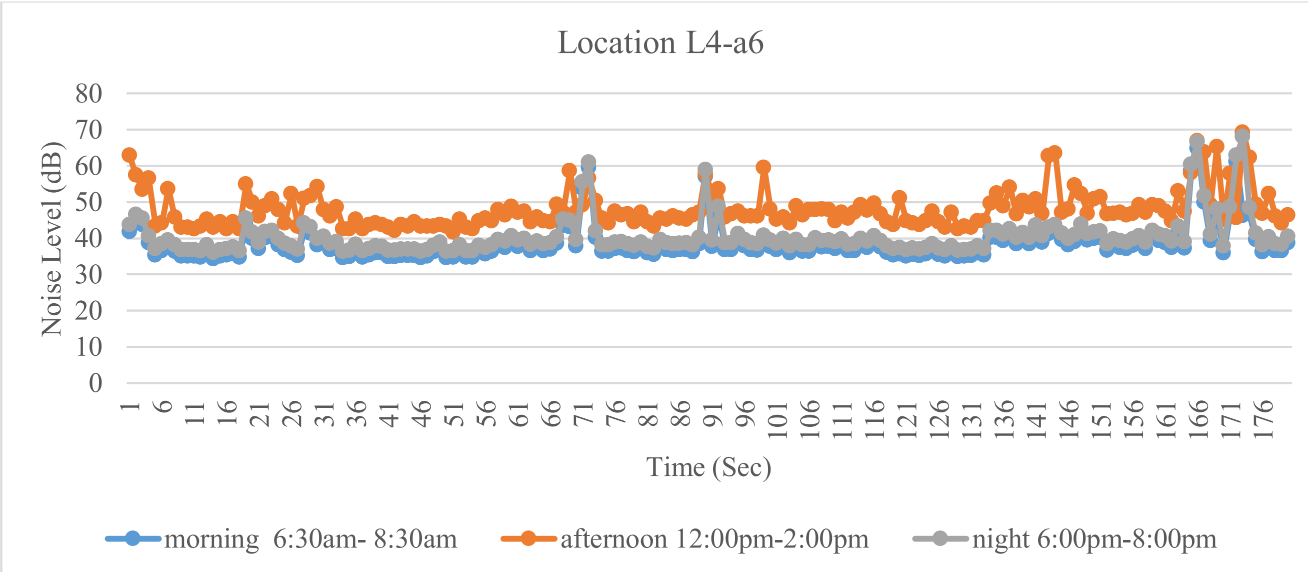


Figure 49 Location L4-a6 (50m distance) graphical illustration

From the ovel all analysis of location one the noise decreases toward the edge to forty meter this indicate the noise induced by the building material of the house and the receiver far from the road traffic noise source. On table illustrate the all-in-one analysis.

Studies by the World Health Organization indicated that Ethiopian and other nations were allowed noise levels throughout the day and at night, but that the noise at this site is often unacceptably high, especially in the afternoon. A residential building's allowable sound pressure level is 55 dB during the day and 45 dB at night, although tests taken there show that the maximum level is higher than 45 dB.

Table 12 L4-(a1-a6) measured noise level summery

Point	At morning			At afternoon			At Night		
	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)
L4-a1	58.5	93.8	69.45	70.3	99.3	85.48	66	103.6	81.69
L4-a2	50.9	82.7	68.71	64.9	95.7	84.50	38.2	98.9	70.41
L4-a3	39.2	70.2	53.64	54.9	87.7	74.04	42.7	93.8	65.42
L4-a4	30.5	55.9	41.54	42.8	67.7	54.12	35.5	73.2	58.14
L4-a5	37	82	41.63	46.3	106.3	54.40	39.3	84.3	43.93
L4-a6	34.3	64.8	38.49	41.7	69.3	47.93	36.1	68.1	40.4

NB: - remained the Sound level meter reserve all the surrounding noise

Location L4-1a at the edge of road

The noise level measure at L4-1a point over various time intervals is shown in the figure 50. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 58.8dB, while the afternoon noise level peaked at 102.1dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

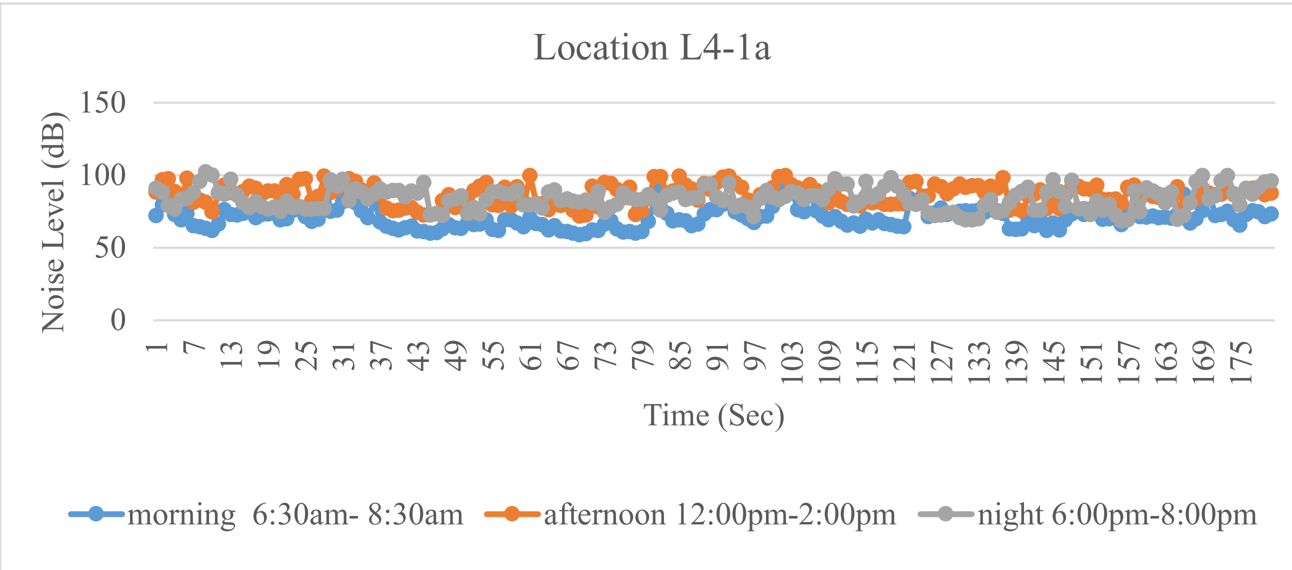


Figure 50 Location L4-1a at the edge of road graphical illustration

Location L4-1b (10m distance)

The noise level measure at L4-1b point over various time intervals is shown in the figure 51. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 51.3dB, while the afternoon noise level peaked at 100.4dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

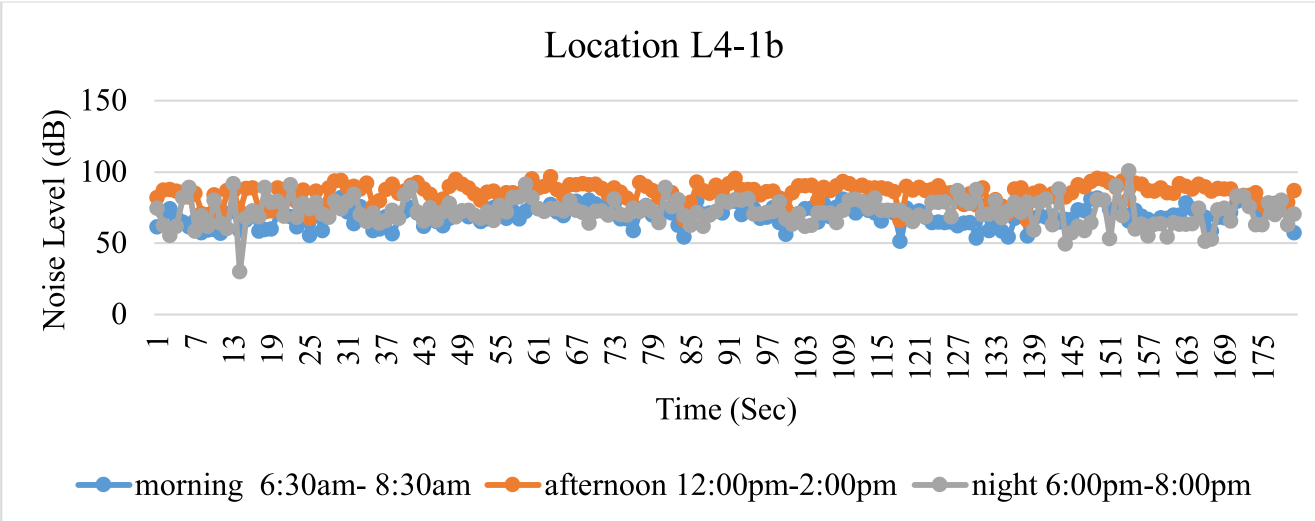


Figure 51 Location L4-1b (10m distance) graphical illustration

Location L4-a3 (20m distance)

The noise level measure at L4-a3 point over various time intervals is shown in the figure 52. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 38.2dB, while the afternoon noise level peaked at 101.1dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

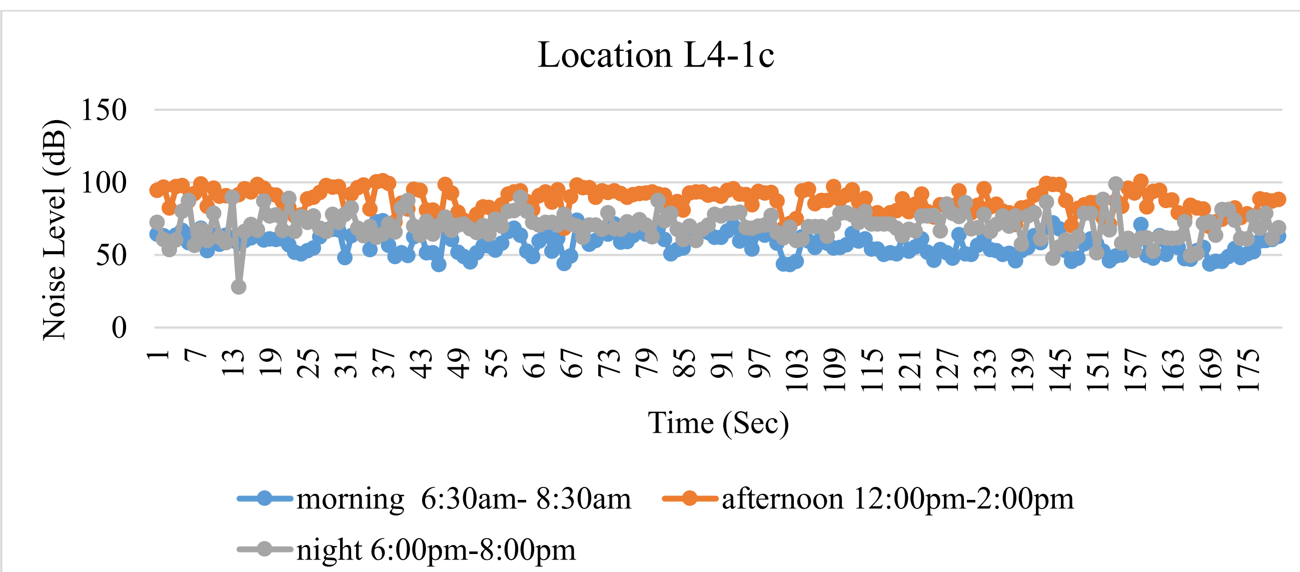


Figure 52 Location L4-1c (30m distance) graphical illustration

Location L4-1d (30m distance)

The noise level measure at L4-a3 point over various time intervals is shown in the figure 53. The figure shows that there is not much variation in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the night (6:00pm-8:00pm) having the lowest. The morning noise level was 30.9dB, while the afternoon noise level peaked at 68.9dB. This information indicates that road noise is highest in the late afternoon and slightly in the night.

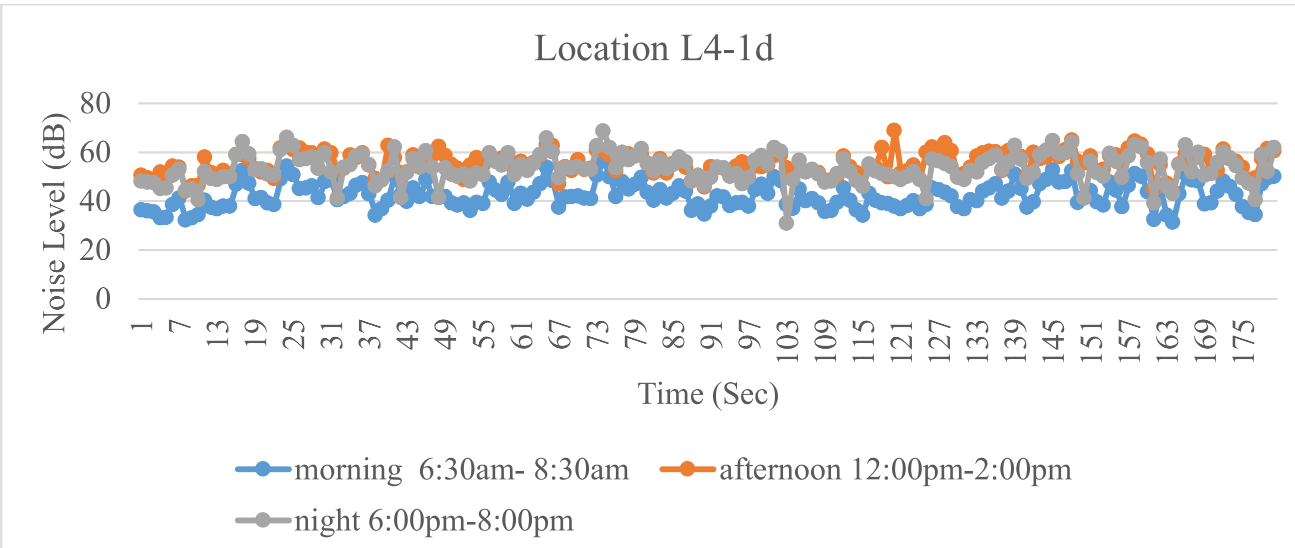


Figure 53 Location L4-1d (30m distance) graphical illustration

Location L4-1e (40m distance)

The noise level measure at L4-1e point over various time intervals is shown in the figure 54. The figure shows that there is much closer values in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 35.3dB, while the afternoon noise level peaked at 92.1dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

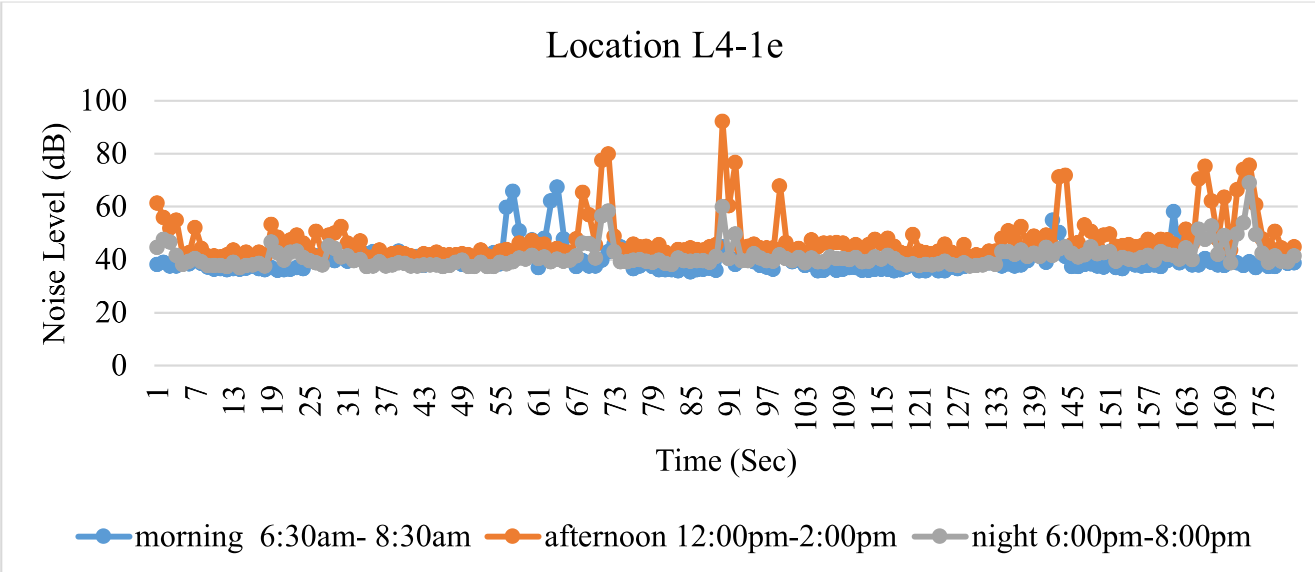


Figure 54 Location L4-1e (40m distance) graphical illustration

Location L4-1f (50m distance)

The noise level measure at L4-1f point over various time intervals is shown in the figure 55. The figure shows that there is much closer values in noise levels across time intervals, with the afternoon (12:00 pm-2:00 pm) having the highest average sound level and the morning (6:30 am-2:30 am) having the lowest. The morning noise level was 30.5dB, while the afternoon noise level peaked at 65.1dB. This information indicates that road noise is highest in the late afternoon and slightly in the morning.

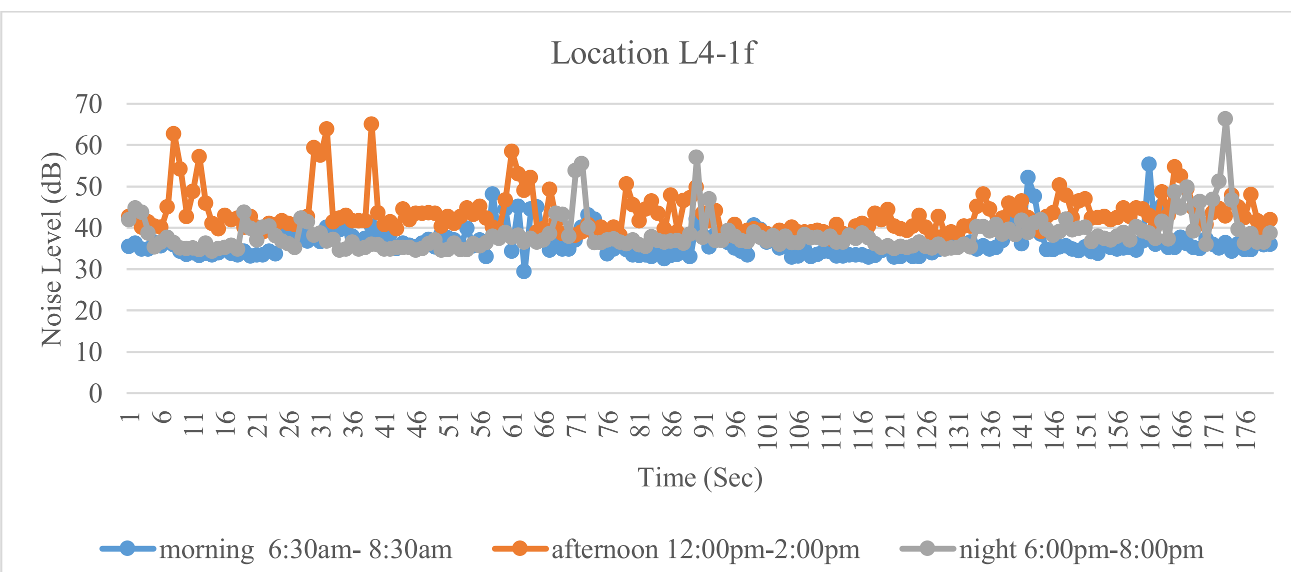


Figure 55 Location L4-1e (40m distance) graphical illustration

From the overall analysis of location one the noise decreases toward the edge to forty meter this indicate the noise induced by the building material of the house and the receiver far from the road traffic noise source. On table illustrate the all-in-one analysis.

Studies by the World Health Organization indicated that Ethiopian and other nations were allowed noise levels throughout the day and at night, but that the noise at this site is often unacceptably high, especially in the afternoon. A residential building's allowable sound pressure level is 55 dB during the day and 45 dB at night, although tests taken there show that the maximum level is higher than 45 dB.

Table 13 L4-(1a-1f) measured noise level summery

Point	At morning			At afternoon			At Night		
	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)	Min(dB)	Max(dB)	Avg(dB)
L4-1a	58.8	94.1	70.64	71.6	99.5	86.67	68.2	102.1	83.74
L4-1b	51.3	83.1	69.11	65.6	96.4	85.20	39.7	100.4	71.85
L4-1c	43.3	74.3	57.74	68.3	101.1	87.44	38.2	98.9	70.35
L4-1d	31.3	56.7	42.34	44	68.9	55.32	30.9	68.6	53.54
L4-1e	35.3	67.3	39.54	40	92.1	47.61	37	69	41.05
L4-1f	30.5	55.4	36.28	37.3	65.1	43.22	34.3	66.3	38.35

NB: - remained the Sound level meter reserve all the surrounding noise

4.4. Impact of road traffic noise in the IAQ of residential Buildings

Indoor environmental quality (IEQ) is the term used to describe how well a building's environment supports the health of its residents. IEQ is influenced by a variety of variables, such as lighting, air quality, and acoustic comfort and dampness level. Acoustic comfort is not the indoor sound also the external environment sound is the very essential for indoor comfort. Road traffic noise is one of the most pollutant of noise in the globe on this research show the road traffic noise effect on residential building occupant internal comfort.

4.4.1. General Living Environment

Table 14,15, compares the perception of interviewees and respondent of questioners in the city of Adama on specified location evaluate their indoor environmental quality, sound quality of their living area, and sound quality at home, where a five-level linear scale was again used, from comfortable, to very uncomfortable and very well to very bad. the perception of sound quality on living area of respondent is depend on his own level of annoyance and environmental noise disturbance in this fact n=36(36.36%) of the respondent is uncomfortable condition on the environmental sound quality; however, relate to home sound quality evaluation n=77(77.78) of the respondent uncomfortable condition.

Table 14 Evaluations of living environment and sound quality

Alternatives	Very comfortable	comfortable	Neither comfortable nor uncomfortable	uncomfortable	Very uncomfortable
Sound quality of their living area	-	17	19	36	12
sound quality at home	-	-	6	77	6

With relate to sound quality of environment the indoor environmental quality is also influenced by road traffic noise and other source of environmental noises the evaluation also includes the personal evaluation of indoor environmental quality's level as seen on table 14. Based on the perception of respondent n=37(37%) is perceiving its bad on IEQ of your home.

Table 15 Evaluation of indoor environmental quality

Alternatives	**NO of respondents**	**Percent**
Very well	-	
well	15	15. 15%
Neither well nor bad	17	17.17%
bad	37	37.38%
Very bad	30	30.30%

4.4.2. Traffic noise and indoor environmental quality

Road Traffic noise the major source the environmental noise pollution for external and internal space of residential building environment. The evaluations measure the effect of road traffic noise the quality Indoor environmental quality and living quality

Table 16 road traffic noise and indoor environmental quality perception of the community

do you think the road traffic noise is affect Indoor Environmental Quality?		
Alternatives	**NO of respondents**	**Percent**
Yes	71	71.72%
No	28	28.28%
Total	99	100%

Table 16 show that the traffic noise affects the indoor environmental quality n = 71(71.72%) of the total population is confirm that road traffic noise is the disturbance sound source of the area. This illustrate the RTNs annoyed the IEQ and health effect of the occupant.

Table 17 road traffic noise and living quality

Are there road traffic noise pollution affect your living quality?		
Alternatives	**No of respondents**	**Percent**
Yes	81	81.82%
No	18	18.18%
Total	99	100%

Traffic noise is may affect the working efficiency, comfortable sound quality and rate of listening those all issues are affected living quality, on Table 17 illustrated that n= 81(81.82%) of the population is disturbed their living quality. The magnitude of the effect is illustrated on table 16 the effect measure on three basic component comfort, work efficiency, and price of house. from these 81 total respondents 51(62.96%) is significantly affected your comfort, 59(72.83%) medium influence on work. On the other side the road traffic noise the price of house is not more significantly effect. On the living quality points also survey the out came of the effect on human health; the health problem by high range of noise is physiological or psychological disease, however, from the listed disease and respondent filling by road traffic noise. in general, 47(47.47%) of the respondent affected by sleep disturbance, 35(35.35%) also by annoyance and 23(23.23%) of the respondents are hypertension psychological diseases. from this analysis the magnitude of the effect is not reach on physiological effects.

Table 18 magnitude of traffic noise effect on living environment

Situation	Comfort					work					Price of house				
Scale	None	Rarely	Medium	Significant	Very Significant	Not disturbed	Occasional	Medium	Disturbed	Very disturbed	Not	Occasional	Medium	Affected	Very affected
Traffic noise	-	11	17	51	2	6	5	59	6	5	30	46	-	5	-

Relative issue on table 19 the family member affected by traffic noise deficiency diseases are 86(86.87%) of the respondent are not affected. From the result of 15 respondents the disease is hypertension and sleeping disturbance effects

Table 19 disease caused by road traffic and relative environmental noise the respondent family members

Alternatives	**NO of respondents**
Annoyance	-
Hypertension	2
Sleeping Disturbance	6
Hearing Mechanism disinfection	-
Myocardial infarction	-
Cardiovascular diseases	-
Metabolic disease like diabetes	-

4.4.3. Main Activities at home

Since noise may be more disturbing for certain activities, such as oral communication, listening to radio and intellectual tasks, than for other activities, The main activities of the respondents when they stay at home were asked about and the results are shown in Table 19. It can be seen that there was a high percentage of. activities which could potentially be disturbed by noise.

Table 20 Reasons not to stay at home

What are the main activities when you stay at home?		
Alternatives	**NO of respondents**	**Percent**
Reading	30	30.30%

Tv	52	52.53%
Music	17	17.17%
Other	-	-

The activities of the dwellers in your home are different in the character of occupant, on table 20 show that most of the people seen Tv programs n = 52(52.53%) in addition to the activities there is also trend that sleep on day time figure 48A shows that 56(56.56%) of the respondent sleep on day time, the analysis also focuses on the range of time that sleep on day time on figure 48B.

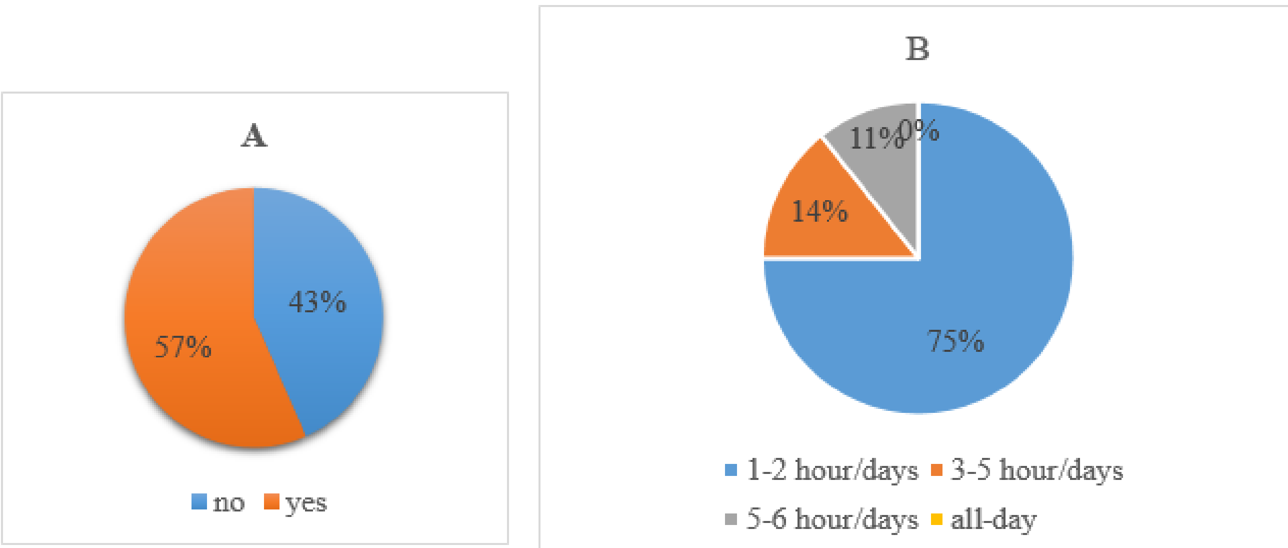


Figure 56 A) Those who like to sleep during the day B) Time Interval for those who like to sleep during the day

From the above graph data's, the road traffic noise indicates that influences your stay at home on day time n = 65 (65.66%) is respond that stay at home is challenged. Table 21 shows the most of the inhabitants not welling for stay home at day time.

Table 21 factors for home stay

. Do you think that road traffic noise influences your stay at home on day time		
Alternatives	**NO of respondents**	**Percent**
Yes	65	65.66%
No	34	34.34%

The Source of noise vehicle capacity also the factor for the disturbance and annoying on staying home for day time. Based on Table 22 the source of noise from heavy vehicles are is the main source of effect for annoyance and sleep disturbance n=78(78.78%) of inhabitant annoyed and n=87(87.88%) is sleep disturbance effects.

Table 22 evaluation of vehicle type and noise effect

Situation		Source effect					Annoyance					Sleep disturbance				
Scale		None	Rarely	medium	Significant	Very Significant	Not annoyed	Occasional	Medium	annoyed	Very annoyed	Not disturbed	Occasional	Medium	Disturbed	Very disturbed
Traffic noise	Light Vehicle	41	14	39	5	0	37	5	27	18	12	58	22	16	3	0
	Medium heavy vehicles	4	8	31	35	17	0	19	10	42	28	0	8	6	14	71
	heavy vehicles	0	0	23	32	43	0	1	2	18	78	0	0	0	12	87
	Two Wheelers	49	2	16	2	0	36	23	38	1	1	36	25	16	22	0

4.4.2. Road traffic noise and disturbance range in the room

Most of residential building on the study area are the same internal room arrangement and functional distribution among each other. The most disturbed room is closer room to the road; from this reference based on table 23 the most disturbed room is master bed room and it's about n = 44(44.44%). And also, less disturbed room is child bed room

Table 23 traffic noise disturbance of room

	Most disturbed	Less disturbed
Kitchen	24	-
Living & dining room	31	20
Master bed room	44	9
Child bed room1	-	31
Child bed room2	-	38

4.5. DISCUSSION

4.5.1. Noise level of traffic noise

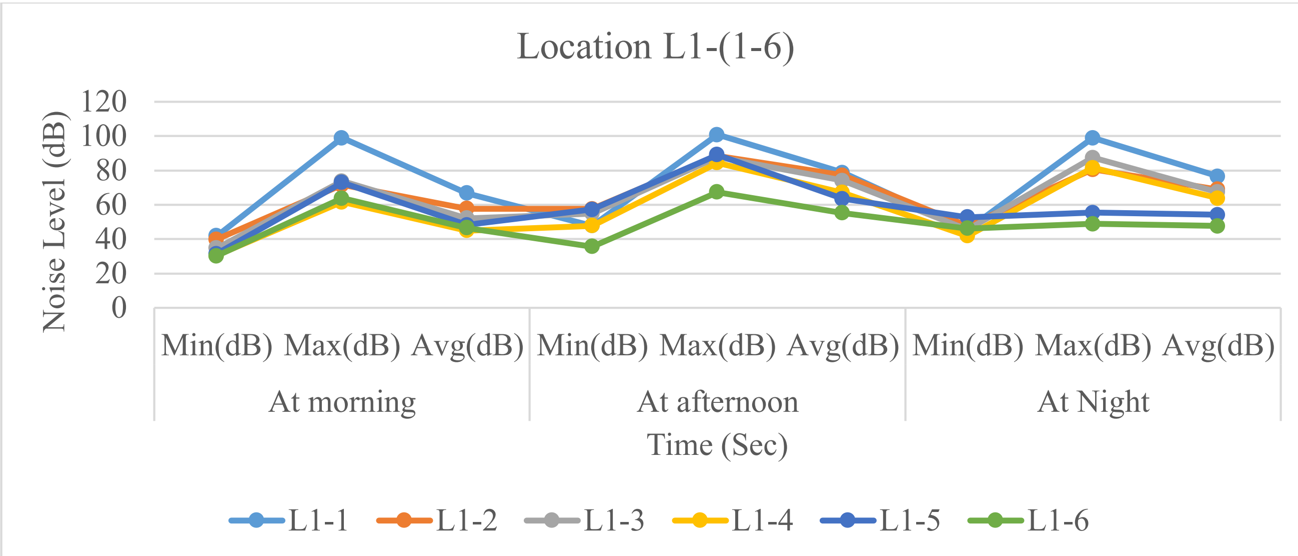
The recorded results of the site observations of both site one (Adama Migira Bus Station, Karayu Street, Mamo Mazamir Street, Highway Street (To Ward Asela)) and Site Two (Peacock Bus Station, Abebe Bikila Street, Atlet Wami Biratu Street, Highway Street (To Ward Addis Abeba)) are shown on the figure 57 the noise vary from the list of 30.2 dB on L1-6 to the height noise record on L4-a1 are included.

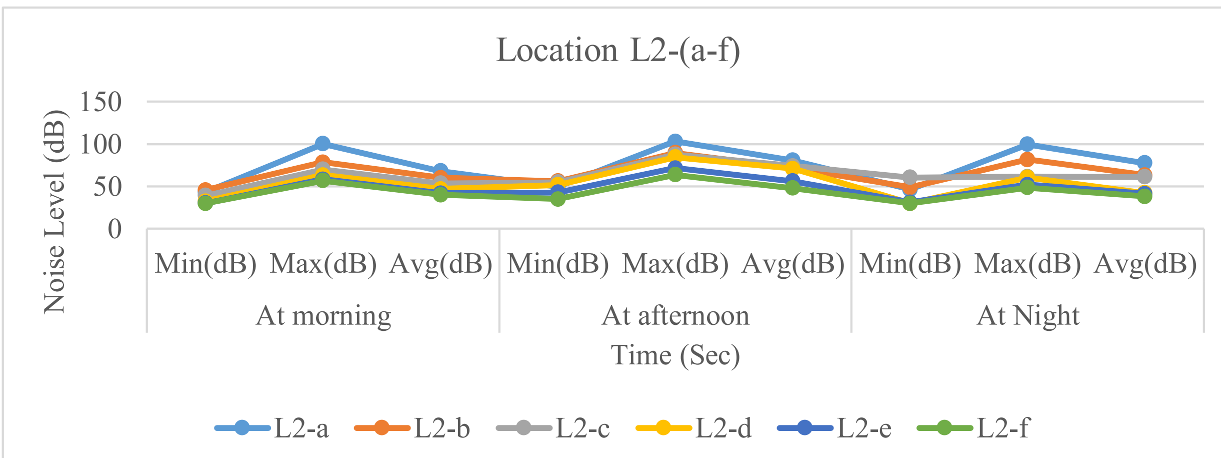
In general, the noise level measurement of Adama city analyze based on the world health organization (WHO, 2018), US federal highway authority European environmental agency (EEA, 2014), and DIRECTIVE 2002/49/EC of European parliament amended on environmental noise and guideline ambient environment standards for Ethiopia (EPA & ESID, 2003). From all those standards the premises are listed on literature review part of the research.

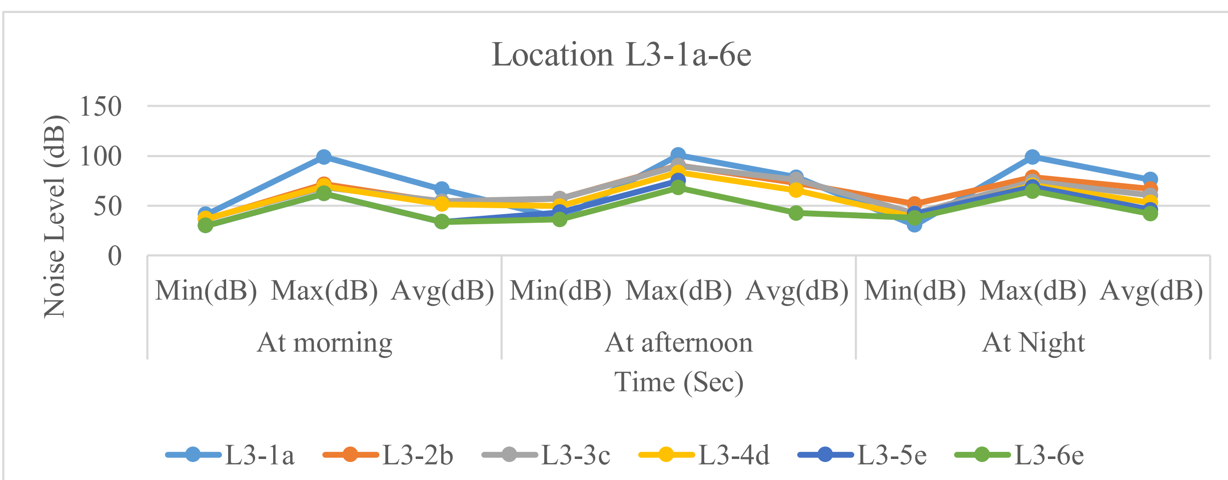
Studies conducted by the World Health Organization (WHO) have established with adequate evidence that noise levels over 53 dB (A) and 45 dB (A), respectively, in day and night. This limit is for residential area of newly developed or existing urban indoor acoustic environment. The organization also indicate the direction for all building types in the urban environment but the limit standard is varying with respected function.

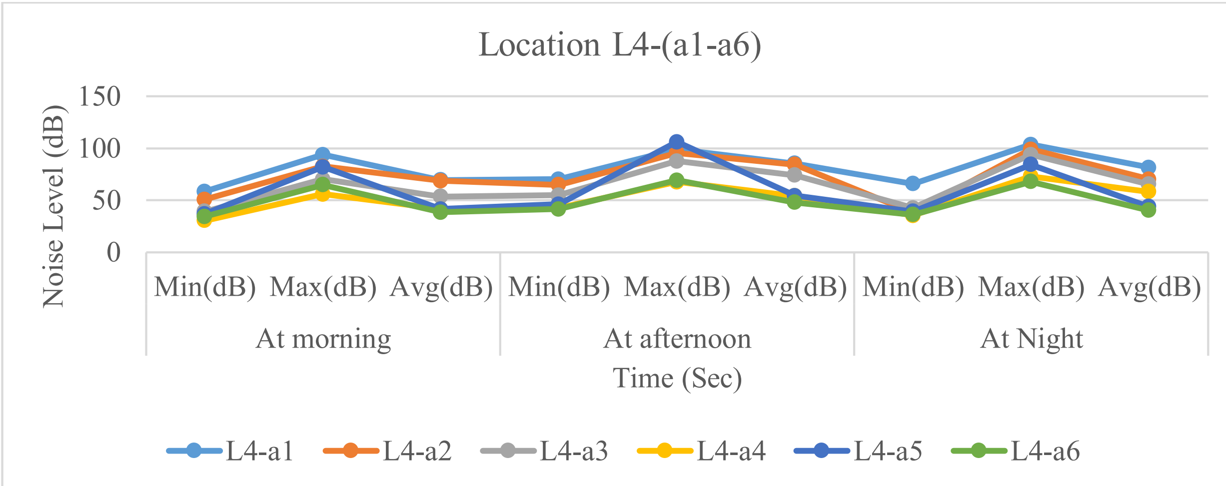
Based on the US federal highway authority and European environmental agency the limit is not match vary with the other organization but the guide line no more description. Even thought, the guide lines put maximum limit on road traffic noise standard for residential area of urban environment. On the day 55 dB and night time is 45 dB.

Based on different standards the points that locate on the edge of road (L1-1, L2-a, L3-1a, L4-a1, L4-1a) are the peak noise record and above annoying levels are that 100.8dB ,100.3 dB, 100.8 dB, 103. 6 dB, and 102.4 dB consequently, recorded on afternoon and night time intervals. In fact, the noise level decrease when the points far away from the road and protective barrier hang over the sounds


Location L1-(1-6)
Noise Level (dB)
120
100
80
60
40
20
0
Min(dB) Max(dB) Avg(dB) Min(dB) Max(dB) Avg(dB) Min(dB) Max(dB) Avg(dB)
At morning
At afternoon
At Night
Time (Sec)
L1-1 L1-2 L1-3 L1-4 L1-5 L1-6


Location L2-(a-f)
Noise Level (dB)
150
100
50
0
Min(dB) Max(dB) Avg(dB) Min(dB) Max(dB) Avg(dB) Min(dB) Max(dB) Avg(dB)
At morning
At afternoon
At Night
Time (Sec)
L2-a L2-b L2-c L2-d L2-e L2-f


Location L3-1a-6e
Noise Level (dB)
150
100
50
0
Min(dB) Max(dB) Avg(dB) Min(dB) Max(dB) Avg(dB) Min(dB) Max(dB) Avg(dB)
At morning
At afternoon
At Night
Time (Sec)
L3-1a L3-2b L3-3c L3-4d L3-5e L3-6e



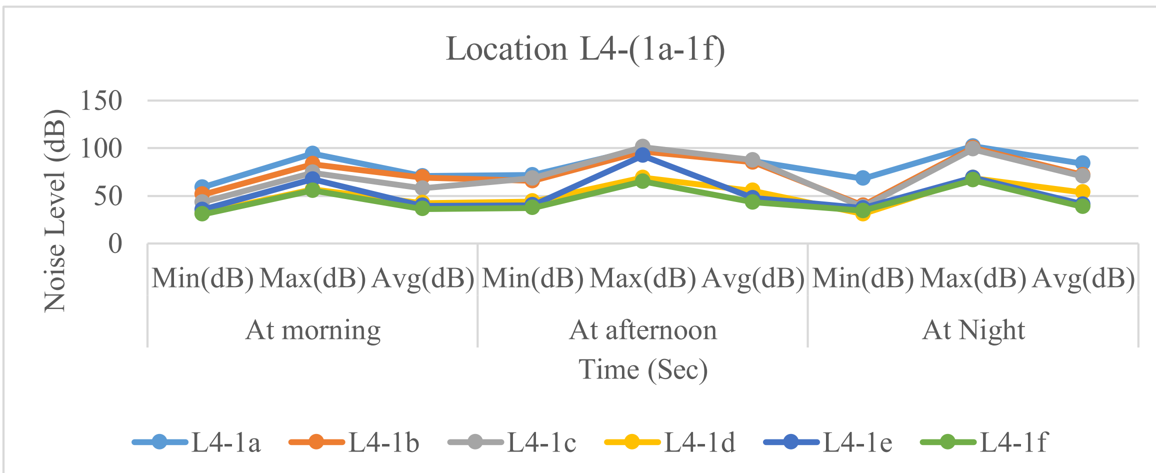


Figure 57 summarized graph of the objective analysis on the min(dB), max(dB) and Avg(dB)

The above graph shows the detail noise record on 5,400 second of pick time

According to the guideline ambient environment standards of Ethiopia and world health organization the range of sound is disturbing for the range of hearing scale of the community. For instance, the average range of noise is up to 106.3dB noise on L4-a5 living room internal spaces. However, the noise level meter is recording all environmental noise.

4.5.2 impacts of road traffic noise in the acoustic comfort of residential buildings

Residential building is a mostly personal spaces for rest, this space more comfortable acoustic comfort is one of the essential criteria to be sustainable indoor environment. However, indoor and outdoor unwanted sound affect the living condition of environment of community.

Urban residential environment mostly acoustic comfort affected by road traffic noise like Adama city. Most of the road adjacent residential dwellers affect by RTNs rather than houses away from the road. From the observation, informal interview and questioner respondent survey the study area of Adama city inhabitants on both site one (Adama Migira Bus Station, Karayu Street, Mamo Mazamir Street, Highway Street (To Ward Asela)) and Site Two (Peacock Bus Station, Abebe Bikila Street, Atlet Wami Biratu Street, Highway Street (To Ward Addis Abeba)) road traffic noise is a challenged to stay home and sleeping early evening; the Couse is the road traffic source of noise is created communication disturbance and loudness effect in the internal room of the area. The community personal behavior is changed they speak loudly with equal loudness of the surrounding noise level.

Based on table 12 the sound quality of the house above 77.78% are uncomfortable and disgust by the neighborhood road traffic noise. Compare with other area the location dwellers are affected more and not lackey because most of inhabitant influenced by government to take the land for residential construction.

The less likely you are to sleep during the day if you get adequate sleep at night. People who work mostly at night frequently experience issues with daytime sleep, but this is rarely a problem for children, who sleep both during the day and at night. The respondent wont that sleep at day time with the same thing also need to goes away because of noise disturbance 65.66 % of the respondents influenced by road traffic noise the dwellers that stay home on day time.

According to WHO published report on European city's road traffic noise affect the occupant health and wellbeing's; especially younger and oldest part of community. In the city of Adama the effect is not match more disease like diabetes and myocardial infection but the analysis indicate 47.47 present residents affected day and night sleeping disturbed annoyance and hypertension. Even if the hearing mechanism disinfections by road traffic noise. The acceleration of noise pollution Couse by road traffic threatening stage.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

In this chapter concluded the research analysis as the objective value and the result or the observed fact on road traffic noise purposively selected site on Adama city residential suit and put recommendation optional problem-solving mechanism take by city administration and community. In addition to this regulate adaptable directive for future land use formulations.

5.1 CONCLUSION

Based on the study road traffic noise levels is greater in residential building that are Adjacent to road. The research take measurement on two sites on four different locations with six sub points on location one up to three, for location four use twelve points based on the US federal highway authority. The points are starts from the edge of the road (L1-1, L2-a, L3-1a, L4-a1, L4-1a) it is high noise level it is exciding the ear capacity. However, noise induced by building material, vegetation, internal activities the noise decrease far from the road and the list of noise record are fifty meter away from the road (L1-6, L2-f, L3-6f, L4-a6, L4-1f). despite this the noise level is almost on the limit level of noise.

With reference to WHO European Regional Environmental Noise Guideline the level of noise on each point on residential site is disturbed by the noise source from the road specially in the afternoon time the lowest noise level is 63.7dB on point L2-f, fifty meter far from the reference road. The road traffic noise in the Adama city residential site affect the living condition of the society and social interactions.

In the other hand the analysis also observes, interviewed and collect the formal questioner from community; most of the respondent are felling unhappy and abused the system of communal background of society by the road traffic noise. Because the noise not allowed to communicate each other likewise, the researcher Can’t speak as the community loudness. The research questioner respondents are almost who live on the near to the road. The respondents live in the area above half of the respondent un comfortable in your house. As illustrate above most of the community health impact by the road traffic noise, especially, the community affected by Annoyance, hypertension and sleep disturbance. For these overall problem the respondent force to solve the problem by concerned governmental bodies.

5.2. RECOMMENDATION

The acoustic environment of residential building is sensitive area to protect those locations of urban from road traffic noise the listed ways of resolving method are illustrated as follow

A. For already settled residential site along roads like the analyzed location of Adama city the residential owner installs internally sound proofing materials externally the government and/or concerned body manage the existed setback by create buffer zone, vegetation's and mainly built the traffic noise barrier for roads those material contract glass, aluminum and still frame
B. The government body create inclusive directives like DIRECTIVE 2002/49/EC of European parliament and adaptive regulation to mitigate the existing problem and prepare amendment for environmental impact analysis developer where they lead for sustainable acoustic environment based on acoustic environment
C. Non-governmental body architect, urban planner and designer construction operator, and communities cooperatively study for comfortable acoustic residential environment. Basically, this issues are mainly analyzed by environmentalist that know the problem more than other stockholders.
D. For all there is structural vibration noise didn't cover by the research. The aim of the research analyses the air born noise and its consequences and indicate how it resolve. But this area also the main problem on the area the road designer and authorial also obligatory for newly developing area and existed one.

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APPENDIX 1 RESEARCH QUESTIONERS

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First of all, thanks for voluntariness to accepting my research fulfilment questionnaires'. I would like to ask strongly Please help me by giving the correct answer for each question and play your role in my research paper. The following questions are designed to look in to the creation of ***Effect of road traffic noise on acoustic comfort of residential building: in the case of Adama city***. All information is you give will be used only for the purpose of the study to support my research feasibility. So, you are kindly requested to answer.

Direction;

- ☐ You are requested to put mark in the box provided in front of each question.
- ☐ For questions you are required additional answers, write only on space provided.

Part one: personal information

Age .11-17 ☐ .18-24 ☐ .25-34 ☐ .35-34 ☐ .45-44 ☐ .55-64 ☐ .>65 ☐

Sex Male ☐ Female ☐

Educational background: MA/MSC and above ☐ BA/BSC ☐

Diploma ☐ certificate ☐

< Grade12 ☐ university student ☐

Part two: General information for the person.

1. Are you a tenant ☐ owner ☐

2. Are you a local inhabitant? Yes, ☐ (please specify how many years) No, ☐ (Your previous living place)

3. Which area do you live, please specify post code ______, floor of your home. ________________ and approximate distance between main opening (such as door, window) of your house and road _____

4. For the first question your answer is owner how you get the land

government ☐ buy ☐

- if your answer is government The concerned body that give a chance to change a place what is your decision. Yes, I want to change ☐ No, I didn't change ☐

5. Please give your evaluation for the following factors when choosing a living environment:(for buy and tenant persons)

Factor Rank	Do not Mind	rarely	Neutral	Important	Very important
Convenient for work					
Convenient transportation					
safety					
Property price					
Quiet					
Views					
Size of the house					

6. Did you undermine the road traffic noise (related to question No 5) Yes ☐ No ☐

7. what type of building you live in

Domestic residential villa ☐ Apartment ☐ Condominium ☐

8. Material that built your house

Mud ☐ Concrete Block ☐ Stone ☐ Combined ☐ (please specify the combined material)

Part Three: Living Environment and road traffic Noise

1. How do you think your Indoor Environmental Quality?

Very well ☐ Well ☐ Neither well nor bad ☐ Bad ☐ Very bad ☐

2. Personal evaluation for sound quality of your living area.

Very comfortable ☐ Comfortable ☐ Neither comfortable nor uncomfortable ☐

Uncomfortable ☐ Very uncomfortable ☐

3. do you think the road traffic noise is affect Indoor Environmental Quality?

Yes ☐ No ☐

4. In your house which room is more disturbed by road traffic noise? Kitchen ☐

living & dining Rm. ☐ Master bed Rm ☐ child bed Rm1 ☐ child bed Rm2 ☐

5. In your house which room is less disturbed by road traffic noise? Kitchen ☐

living & dining Rm. ☐ Master bed Rm ☐ child bed Rm1 ☐ child bed Rm2 ☐

6. What are the main activities when you stay at home?

Reading ☐ TV ☐ Music ☐ other ☐ (specify____________)

7. Personal evaluation for sound quality of your home.

Very comfortable ☐ Comfortable ☐ Neither comfortable nor un comfortable ☐

Uncomfortable ☐ Very uncomfortable ☐

8. Are there road traffic noise pollution affect your living quality? Yes, ☐ No, ☐

- If your answer is yes, Specify the magnitude of the effects

Situation	Comfort					work					Price of house				
Scale	None	Rarely	Medium	Significant	Very Significant	Not disturbed	Occasional	Medium	Disturbed	Very disturbed	Not	Occasional	Medium	Affected	Very affected
Traffic noise															

Again, if your answer is yes, mark on the listed caused disease

Annoyance ☐ hypertension ☐ sleep disturbance, ☐

hearing mechanism disfunction ☐ myocardial infarction, ☐

cardiovascular diseases, ☐ metabolic diseases like diabetes, ☐

9. is there a family member affected by traffic noise deficiency diseases Yes, ☐ No, ☐

- If your answer is yes which diseases affected

Annoyance ☐ hypertension ☐ sleep disturbance, ☐

hearing mechanism disfunction ☐

10. what you fill when the high noise vehicle is pass

____

____

____

11. Did you sleep in the daytime? Yes ☐ No ☐

If yes How often

1-2 hour/days ☐ 3-5 hour/days ☐ 5-6 hours/days ☐ all-day ☐

12. Do you think that road traffic noise influences your stay at home on day time

Yes, ☐ No, ☐

If your answer is yes how/why_________________________

13. Personal evaluation for noise sources disturbs when stay at home?

Situation		Source effect					Annoyance					Sleep disturbance				
Scale		None	Rarely	medium	Significant	Very	Not annoyed	Occasional	Medium	annoyed	Very annoyed	Not disturbed	Occasional	Medium	Disturbed	Very disturbed
	Light Vehicle															

Traffic noise	Medium heavy vehicles															
	heavy vehicles															
	Two Wheelers															
	Others__________															

Part four: solving way option of road traffic Noise

1.Are there any noise insulation measures in your house such as double glazing or sound absorption louvers? Yes, ☐ (Please Specify)____________________ No, ☐

2. Do you think it is necessary to add such noise insulation in your house?

Yes, if it is change ☐ No, it is not necessary ☐

3. Are there any noise insulation measures outside your house, such as noise barriers?

Yes, ☐ (Please Specify)____________________ No ☐

4. Do you think it is necessary to add such noise insulation outside your house?

Yes, if it is change ☐ No, it is not necessary ☐

5. What are the methods you used to minimize the effect of road traffic noise?

____

____

____

6. For this problem who take responsible

Community concerned governmental body ☐ family ☐ researcher ☐

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

____

____

____

APPENDIX 2 Absorption coefficient

Absorption coefficient - α - for some common materials can be found in the table below:

Material	Sound Absorption coefficient [1)] - α -
Wood wool cement on battens, 25 mm	0.6 - 0.07
Snow	0.75
Slag wool or glass silk, 50 mm	0.8 - 0.9
Rubber sheet, 6 mm porous	0.1 - 0.2
Polyurethane foam, flexible	0.95
Polystyrene, expanded rigid backing	0.15
Polystyrene, expanded on 50mm battens	0.35
Plywood panel, 3 mm	0.01 - 0.02
Plaster walls	0.01 - 0.03
Persons, each	0.2 - 0.5
Mineral wool, 100 mm	0.65
Hardwood	0.3
Gypsum board, 12 mm	0.04 - 0.07
Glass, ordinary windows	0.1 - 0.2
Glass, large panes heavy plate	0.03 - 0.05
Floor, wood	0.06 - 0.1
Floor, linoleum, asphalt, rubber or cork tiles on concrete	0.03
Floor, concrete or terrazzo	0.02
Fiberboard on battens, 12 mm	0.3 - 0.4
Cork sheet, 6 mm	0.1 - 0.2
Concrete block, painted	0.05 - 0.07
Concrete block, coarse	0.3 - 0.4
Carpet, heavy on concrete	0.3 - 0.6
Carpe, heavy on foam rubber	0.5 - 0.7
Brickwork, unpainted	0.02 - 0.05
Brickwork, painted	0.01 - 0.02
Asbestos, sprayed 25 mm	0.6 - 0.7
Acoustic tiles	0.4 - 0.8
Acoustic belt, 12 mm	0.5