Thesis for the Degree of Master of Science in Environmental Science and Management

ASSESSMENT OF TRAFFIC NOISE: A STUDY OF WARD NUMBER 9 OF TOKHA MUNICIPALITY, KATHMANDU DISTRICT, NEPAL

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Pokhara University, Nepal

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Supervised by Praveen Kumar Regmi

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Environmental Management

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Dedication

This thesis work has been wholeheartedly dedicated to my beloved Parents **(Father Late Karna Bahadur Khadka and Mother Dammer Kumari Khadka)** and my wife **(Shristi KC)**, who have been my source of inspiration and gave me strength, who continually provided their moral, spiritual, emotional, and financial support. Your belief in me has served as a constant inspiration. I would like to express my gratitude to all of the contributors and participants for giving their time and knowledge to this study. May it enhance public knowledge and have a good effect. Lastly, I present this work with heartfelt gratitude and appreciation to everyone who believes in the power of knowledge and the pursuit of truth.

Laxman Khadka

Declaration

I hereby declare to School of Environmental Science and Management (SchEMS), affiliated to Pokhara University that this study entitled "**ASSESSMENT OF TRAFFIC NOISE: A STUDY OF WARD NUMBER 9 OF TOKHA MUNICIPALTY, KATHMANDU DISTRICT, NEPAL**" is based on my original research work. Related works on the topic by other researchers have been duly acknowledged. I owe all the liabilities relating to the accuracy and authenticity of the data and any other information included hereunder.

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Recommendation

This is to certify that this thesis entitled "**ASSESSMENT OF TRAFFIC NOISE: A STUDY OF WARD NUMBER 9 OF TOKHA MUNICIPALTY, KATHMANDU DISTRICT, NEPAL**" prepared and submitted by **Laxman Khadka**, in partial fulfilment of the requirements of the degree of Master of Science in Environmental Science and Management awarded by Pokhara University, has been completed under my guidance and supervision. I hereby recommend the same for acceptance by Pokhara University.

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Date: January, 2024

Certification

This thesis entitled "**ASSESSMENT OF TRAFFIC NOISE: A STUDY OF WARD NUMBER 9, TOKHA MUNICIPALTY, KATHMANDU DISTRICT, NEPAL**", prepared by **Laxman Khadka** has been examined by us and is accepted for the award of the degree of Master of Science (M.Sc.) in Environmental Science and Management by Pokhara University.

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This dissertation paper submitted by Mr. Laxman Khadka entitled "**ASSESSMENT OF TRAFFIC NOISE: A STUDY OF WARD NUMBER 9 OF TOKHA MUNICIPALTY, KATHMANDU DISTRICT, NEPAL**", has been accepted for the partial fulfillment of a Master of Science in Environmental Management from Pokhara University.

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Abbreviations and Acronyms

dBA	Decibel
E	East
GIS	Geographic Information System
GoN	Government of Nepal
GPS	Geographic Positioning System
Km	Kilometer
Leq	Equivalent Noise Level
Lmax	Maximum Noise Level
Lmin	Minimum Noise Level
L5	Noise level at five percentile of time
L10	Noise level at ten percentile of time
L50	Noise level at fifty percentile of time
L90	Noise level at ninty percentile of time
N	North
WHO	World Health Organization
dBA	Decibel
E	East
GIS	Geographic Information System
GoN	Government of Nepal

Abstract

The research was carried out in 15 different road junctions within ward number 9 of Tokha Municipality for the assessment of traffic noise through measurement and people's perception. The study was based on primary data collection of traffic noise with the help of sound level meter (TM 103) and people's perception with the help of questionnaire survey. The noise measurement was carried out during the peak traffic flow i.e. morning (9-11 AM) and evening (4-6 PM). Likewise, people's perception was also collected through a questionnaire survey. The results showed that equivalent noise level (Leq) during morning (9-11 AM) and evening (4-6 PM) at all measured road junctions exceeded the standard limit of 63 dBA as per the Nepal Rajpatra published on Kartik 13 for mixed residential areas in all measured road junctions. The road junctions that are connected with ring road (Buspark chowk, Kulaanta chowk, Shiva Mandir Chowk, Gongabu Chowk, Samakhusi chowk, Talimkendra chowk) had equivalent noise level above 75 dBA, which is harmul to human health and environment as per the WHO. Maximum equivalent noise level during morning and evening was observed in Gongabu Chowk as it is connected with ring road and has the higher probability of finding public transport for the residents of Tokha Municipality commute there for transportation purposes. The equivalent noise level of evening time (4-6 PM) was abit higher than morning time (9-11 AM) as more traffic congestion was seen in evening time due to shopping and purchases of daily household needs along with their daily office- home travel. In few of the noise measured junctions, the maximum noise level was above 100 dBA which was due to unnecessary pressure horn from vehicles. The data through the questionnaire survey underscores the pervasive awareness of and concern about traffic noise among the surveyed population. It also indicates a notable dissatisfaction with current noise control measures, suggesting a need for more effective interventions to address the impact of traffic noise on resident's daily lives. Noise hazard map of equivalent noise level during morning and evening was prepared with the help of GIS tool and showed how noise level distributed within the study area. This study helps to understand the distribution of noise and noise pollution in road junctions of ward number 9 of Tokha Municipality.

Keywords: *Traffic noise, Road junction, Equivalent noise level, People's perception*

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CHAPTER 1

INTRODUCTION

1.1 Background

The word "noise" comes from the Latin word "nausea," which means loud and unpleasant sounds. Noise is created by the people actions and mostly due to the growth and enhancement in the city area. Likewise, the movement of the vehicles and the growth in the industry are also the major reason for noise pollution [1]. Not only the urban area but the small region is also badly affected by the sound pollution, which is mostly alongside the pathways and the roads. Sound pollution has become universal, and even the developed countries are also the victim of it but in an unrecognizable way. Among other things; traffic due to the vehicle, airways, and railways; electrical instruments such as TV, radio etc. are some of the sources causing the sound pollution [2]. Likewise, the people are also the victim of the noise produce in the houses too. Even if nowadays noise has become liable to most of the people living in a noisy area for the longer area, but the noise has highly affected the health of the people in large volume. From rich to poor, everyone is affected by it. However, the most affected human beings are the one who is living beside the crowd roads.

Not all sound is considered as noise pollution. The World Health Organization (WHO) defines noise above 65 decibels (dBA) as noise pollution. To be precise, noise becomes harmful when it exceeds 75 decibels (dBA) and is painful above 120 dBA. As a consequence, it is recommended noise levels be kept below 65 dBA during the day and indicates that restful sleep is impossible with nighttime ambient noise levels in excess of 30 dBA.

Noise can be defined in different ways. People who study acoustics define noise as complex sound waves that are aperiodic, in other words, sound waves with irregular vibrations and no definite pitch. In engineering, noise is defined as a signal that interferes with the detection of or quality of another signal [3]. Basically, noise is unwanted sound. It is a pollutant and a hazard to human health and hearing. Noise in our environment affects physical health. Noise also has psychological and social implications and affects our wellbeing and quality of life. Frequent exposure to high level of noise hampers physical and mental peace and may cause damage to the health [4].

The noise pollution has become a major issue in the world, and one of them is due to traffic. The city areas where there is an abundant number of vehicles jammed in the narrow road, obviously the people living nearby will be affected by the noise coming out from thousands of the horns and vibration, mostly by the heavy vehicles [5]. This condition is similar in the Kathmandu valley and mostly around the ring road. It is not hidden that the ring road area consists of a huge number of the population because of which there is a tremendous increase in the number of the vehicle. Even if the width of the road has been conducted to reduce the traffic, but because of the increase in the number of vehicles, sound pollution is still occurring. The road, slope width, and surface structure distance to the road all raise noise levels as traffic density and communication between sellers of products and services related to the human population and traffic composition increases [6]. This applies to Kathmandu valley also. Traffic can be considered the major source of noise pollution in large cities.

1.1.1 Traffic Noise Pollution

Traffic noise which is steadily increasing is considered to be an important environmental health problem. Traffic noise is an increasing problem in modern society, and it is the dominating sources of noise in the urban environment [7]. In general, large and heavier vehicles emit more noise than smaller and lighter vehicles. Mostly heavy vehicles like truck, buses etc. are factors producing the noise [8]. Human beings experience the variable degree of the noise, which is centered upon their sound sensitivity capability. To eradicate the traffic noise, the town measures the mean degree of sound to examine the impact of the traffic noise on the public. Traffic noise is perhaps the most severe and persistent kind of sound pollution. Due to past insufficient urbanization plan, there is the implementation of the serious issues in the present days. Near the main road, the house, schools, medicals, companies and offices are constructed without barrier areas or sufficient noise proofing [9].

1.1.2 Effects of Traffic Noise Pollution

Sound pollution due to traffic on roads has become a serious problem for the health of the people. As it is a universal problem, the fast urbanization, and multiple degrees of increase in the traffic has generated the hazard. People living beside the roads are always affected by noise pollution which has now exceeded its level. The continuous contact in the sound pollutions leads to different negative influence in the health of the human being [9]. The noise coming from the traffic leads to a cardiovascular problem, stroke risk, diabetes, psychological problem, harangue, and deafness. It further reduced the labor performance of the people. It can be reduced with the implementation of the preventive methods.

It can be considered that the effects of sound pollution work based on introvert nature, mental illness, sound sensitivity; however, the outcomes are not similar in every problem. The tolerating capacity of the sound of the socializers and homebodies varies due to their different impetus threshold level. According to the survey, the extroverts have more resisting capacity than the introverts against sound pollution [10]. The working operation of the introvert people is extremely affected by the disturbance of the loud external sound from a different medium like music and sound pollution. In contrast to the introverts, the extroverts are quite better and swifter in their working activities in the existence of sound pollution. Likewise, according to the researcher the work type, time of contact and gender properties also the level of the sound in the exposed person to the sound pollution.

1.1.3 Demography of Study Area

Tokha is a municipality, which is located in Kathmandu district, Bagmati Province of Nepal. Tokha Municipality has total 11 wards, which are scattered across 17 square kilometers of geographical area. According to National Population and Housing Census, 2021, total population of Tokha Municipality is 1,33,755 (male: 66,532 and female: 67,223) with 37,025 number of households. In ward 9 of Tokha Municipality, total population is 13,760 (male: 6,948 and female: 6,812) which is 10.29 percent of municipality population while number of household is 3969 which is 10.72 percent of municipality household.

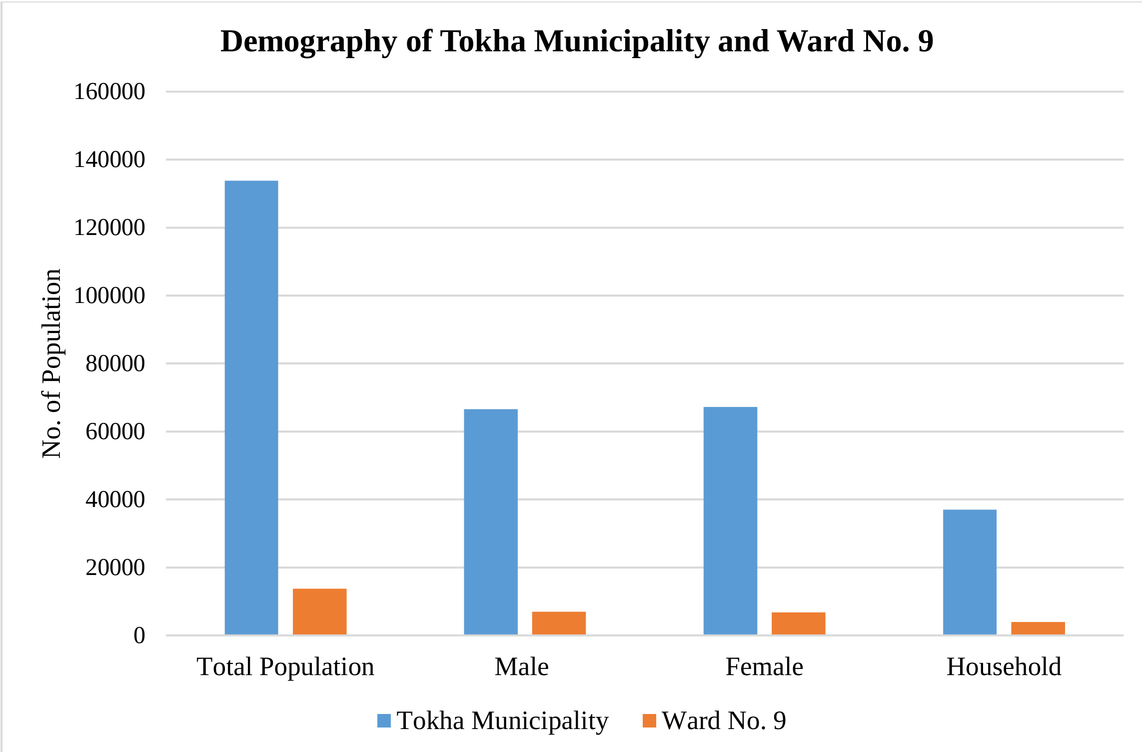

Figure 1.1: Demography of Tokha Municipality

(Source: National Population and Housing Census, 2021)

1.1.4 Hazard Mapping

A noise hazard mapping facilitates a better understanding of the road traffic noise problem, setting objectives and developing plans to address the issues. Sound level meter can be used to collect and compile the required noise information. The evaluation of scale of noise is effective for the mitigation measure for road traffic noise. A noise hazard map facilitates monitoring of environmental noise pollution in urban areas. It can raise citizen awareness of noise pollution level and aid in the development of mitigation strategies to cope with the adverse effect.

Tokha Municipality is relatively large city with high population i.e. The municipality has been experiencing continuously increase in population in all direction in the past few decades. Many significant changes have been experienced in terms of urbanization, industrialization, expansion of road network and infrastructure. The city has been subjected to persistent increase in road traffic due to overall increase in prosperity, fast development and expansion of economy.

Noise hazard mapping is used in the assessment of traffic noise to identify and visualize areas where noise levels exceed acceptable limits. It involves the creation of maps that illustrate the spatial distribution of noise hazards in a given area, often associated with road traffic. This mapping is essential for understanding the extent and intensity of noise pollution, which can have adverse effects on the health and well-being of individuals [11]. Additionally, measurement and estimation of traffic noise are significant tasks that lead to development of efficient methods of control [12].

1.2 Statement of the Problem

The rapid growth of the unplanned urbanization in the valley region caused a very complex situation in the life of the people living over there [13]. Ward 9 of Tokha municipality falls under urban area with high density of population. Due to its dense population, the numbers of vehicles moving on the roads are also large. Narrow road with high traffic flow is a major problem of study area that creates noise pollution. Even if some of the roads are being extended by the government, but still due to the abundant number of vehicles, the people who are living here are facing noise pollution mainly due to traffic flow. Out of 27-kilometer length of ring road of Kathmandu valley, 1.6 kilometer falls under study area. People living near and within the ring road section of study area are mostly affected by noise pollution. Especially during office hour i.e. 9:30 AM to 5:30 PM, we can see huge traffic jam in major junction of study area that creates noise pollution. Ward no. 9 of Tokha Municipality lies in the borderland and is a gateway for entering the major areas of the Kathmandu city through ring road. This area is susceptible to abundant traffic during office and school hours, the peak traffic is mostly felt between 8:30 AM to 11:00 AM and 3:30 PM to 7:00 PM [14]. At the ward, fifteen sites were selected for the collection of traffic noise from 9:00 AM to 11:00 AM and 4:00 PM to 6:00 PM. Within the 100-meter periphery of the ward lies the Gongabu Buspark which also hosts huge traffic in the area. As per Lamichhane [15], the Gongabu Buspark records a maximum noise level of 106.1 dBA (A), which is comparatively high according to the prescribed limits of 70 dBA (A) which is noise and beyond the standards limit set by WHO and GON.

1.3 Research Questions

Traffic noise pollution level in the study area creates many questions. So my research questions are as follows;

- What are the current traffic noise levels at various junctions in ward number 9 of Tokha Municipality during morning (9-11 AM) and evening (4-6 PM)?
- How can the spatial distribution of traffic noise levels be effectively represented in a noise hazard map for ward number 9 of Tokha Municipality?
- What are the resident's perceptions and experiences of traffic noise in ward number 9 of Tokha Municipality?

1.4 Research Objectives

General objective is to access the traffic noise at different road junction of ward 9 of Tokha Municipality through measurement and people's perception.

Specific objectives:

- To measure the traffic noise level at different junctions of ward 9 of Tokha Municipality during morning (9-11 AM) and evening (4-6 PM)
- To prepare noise hazard map of ward 9 of Tokha Municipality
- To know the people's perception on traffic noise of ward 9 of Tokha Municipality

1.5 Rationale

The major reason behind the noise pollution in ward 9 of Tokha Municipality is the unplanned traffic movement. The number of vehicles moving on the roads is huge, and mostly during the working hour, it is uncontrollable. The study of traffic noise is not only important for human health issues but also for the effective management of traffic flow. Since, there are very few studies about noise pollution and its effects, this study was conceptualized to provide a gateway for studying and analyzing one of the busy ward of Tokha Municipality. The traffic flow is the major responsible factor for the noise pollution. This study aims to determine the noise level at different junction (chowk) of ward 9 as it is one of the busy wards of Tokha Municipality. This also helps to determine the noise level difference between morning (9-11 AM) and evening (4-6 PM). Nowadays noise exposure monitoring and its reduction are among the main concerns. Noise source is widely diffused especially in urban areas; their characterization is not simple and the quantification of a citizen's exposure to noise is a very difficult task. Moreover, the process requires different skills and experts from uncertainty evaluation and psychoacoustic approaches to maximize cost benefit and action plan adherence. The hazard map is required to know the current noise level, compares with the standards, and allocates the hazardous area. Thus, road traffic plays an important role in overall effects caused by noise to human health. This research work may be helpful for the collection of baseline information about present condition of noise levels for better traffic management and efficient policy making.

1.6 Limitation of the Study

The following are the limitations of the research study.

1. The study was carried out in certain time frame i.e., morning (9 to 11 AM) and evening (4 to 6 PM).
2. Externalities such as wind blow, people crowd, noise from restaurant, construction works etc. might affect the data value.

CHAPTER 2

LITERATURE REVIEW

2.1 Traffic Noise Pollution in International Scenario

Nejadkoorki et al. [16] undertook a comprehensive investigation into street traffic noise pollution in Yazd, Iran. Using the Bruel and Kjaer-2260 sound degree meter, the study meticulously measured noise levels across ten roads during morning working hours, systematically counting diverse vehicles. Employing Geographic Information System (GIS) tools, spatial information was created and managed, and sound degree charts were generated through interpolation. The research delved into specific vehicle types, including trucks, bikes, and buses, assessing their contributions to noise pollution. Data collection extended to various influencing factors such as altitude, geographical position, closest intersection distance, path geometry, and vehicle classification by class. The study aimed to offer a nuanced comprehension of the complex dynamics shaping street traffic noise pollution in Yazd, contributing valuable insights to environmental acoustics research.

Swift [17] conducted a literature review focused on exploring the potential health implications of aircraft noise. The study aimed to systematically survey the literature, concentrating on cardiovascular outcomes and analyzing potential strategies for mitigating cardiovascular issues resulting from airways sound pollution and associated health conditions. The findings diverged from previous reports, with crucial mechanisms not emphasized as initially intended or observed effects. The report discussed two primary directions, specifically the impact of noise-induced sleep disturbances and stress on cardiovascular health. These directions were chosen due to their perceived links to probable cardiovascular outcomes. The literature also examined the relationships between aircraft sound pollution and irritation, as well as the challenges posed by disrupted conversations and reading disturbances leading to delayed learning ability or memory issues. This research contributes to the ongoing exploration of the multifaceted effects of aircraft noise on health and well-being.

Schenker-Sprüngli [18] conducted a study addressing noise pollution, recognizing a prevailing lack of public initiative in addressing the practical challenges posed by extreme sound pollution. The effectiveness of combating sound pollution relies significantly on garnering public support and the successful implementation of regulations and corrective laws. The formulation of sound pollution laws plays a pivotal role in campaigns against noise pollution; however, the positive impact is contingent on proper implementation. The study emphasized the necessity for heightened public awareness and interest in countering sound pollution, noting a general indifference across education levels regarding the detrimental effects of excessive noise on human well-being. To catalyze awareness, the study proposed the imperative need for impactful public awareness campaigns, drawing on scientific insights accumulated over the past decade from national and international bodies, involving eminent experts. This research underscores the importance of proactive measures in addressing and mitigating the adverse effects of sound pollution.

Juang et al. [19] observed noise pollution and its effects on medical care workers and patients in hospitals. From the study, it was known that the objective of their project was to examine the several stages of sound pollution. The study was inspected in some of the hospitals of Taiwan to observe the sound pollution effects on the physical and mental expression of the medical employees, patients, and visitors in the hospitals based on the irritation they felt. Along with the questionnaire survey based on sound pollution, the instrument was also used to check the sound pollution in that region. From the observed result, it was found that every day means sound levels calculated are from the range of 52.6 to 64.6 decibels during the day. The observed data are higher than the previously calculated value of 50 decibels in Taiwan. According to the staffs and nurses, the main cause of the noise pollution was the conversation of the visitor among themselves and with the patients while the main cause for the noise outside the wards was due to the conversation of the patient's visitors as well as the sound produced by the children while playing. However, patients and visitors had different reasons. According to them, the main reason behind the sound pollution is the noise coming out from the opening and closing of the doors, along with the mourning sound created by the patients. Overall, the noise pollution is caused by the shouting of the nurse staffs, conversation of the visitors, footsteps, opening or closing of the door and recreation of the hospital's structure.

In the investigation of environmental noise measurements, Murphy and King [20] noted a distinct prominence of impulsive sounds over transient sounds as a primary source of irritation for individuals. This observation was made through the equal data produced by the Sound Level Meter, which was configured with the weighting of the "F" value. The study highlighted that the primary cause of human irritation was attributed to the surprising nature of impulsive sounds and the heightened sensitivity of the human ear, in contrast to the response characteristics of the Sound Level Meter's circuitry. Consequently, the Sound Level Meter recorded higher reading values before the decay of sound, emphasizing the significance of impulsive sounds in shaping the perceived environmental noise and its impact on human annoyance.

Kantharia et al. [21] delved into the realm of sound pollution issues and proposed mitigating measures. The study advocated for a comprehensive examination of the effects of sound pollution on factors such as the auditory capacities of adults and youths. The authors recommended conducting surveys to raise awareness among the general populace about the varying nature of harm caused by different types of sound pollution. Notably, they illustrated instances of sound pollution in construction zones and during the development of apartment or building projects to underscore the associated challenges. The study emphasized the need for proactive measures, suggesting that governmental bodies at the State or Federal level should take decisive actions to address and alleviate the impact of sound pollution on public health and well-being.

2.2 Traffic Noise Pollution in National Scenario

Murthy et al. [22] explained that sound pollution is an intrusive pollutant of air consisting of the aural and a mass of non-aural sound effects on the open people. In the absence of medicine for the treatment of the ear problem of losing the hearing capability to manifest contact is the next option. The day study files of the community sound pollution degree are rapidly examined during moderate urbanized Nepal parts. The sound pollution was examined by utilizing standardized sound pressure level meter based on the standard steps in several areas, which included the profitable and inhabited area of the Banepa town. It mostly examined the regions where more vehicles move creating traffic sound pollution. A trivial workout of sound pollution produced by several automobiles at the regular major streets was also done.

There are currently about 50,000 automobiles in Kathmandu valley has predicted that figure will double by the year 2010. With the increasing length of roads, more communities will be exposed to traffic noise. Ghimire et al. [23] illustrated that the vehicles are a significant foundation not just for air pollution but for the sound pollution too. The traffic police who are involved in regulating traffic, mostly to the dense traffic, has a chance of being the victims of the health problems of the air and sound pollution. The survey was done among seventy-eight police officers employed at

Dharan-Biratnagar corridor, to examine the quality of their ear hearing capacity and about the methods they have equipped to combat the effects of the sound pollution. Different questions are asked to the traffic police based on their calculation on the subjects: the capacity of hearing, previous and now contact to the noisy sound created by the vehicles and the individual controlling instruments.

2.3 Traffic Noise Pollution in the Kathmandu Valley

Recent research clearly demonstrate that road traffic has been the predominant source of annoyance; no other single noise has been of comparable importance. It is due to the large number of automotive vehicles in comparison with other machines. The mechanism of radiation of noise to outside from a vehicle has been different from the generation of noise inside the vehicle. The noise emitted depends on the relative levels, characteristics and the interaction of the directly radiated noises from the vehicles. The most important noise source of the vehicles is the power unit and its auxiliaries. Other important generators have been the transmission system, tires and braking system [24].

The noise level survey carried out by Chand et. Al [25] shows that the noise level varied from 65.1 dBA to 74.5 dBA in heavy traffic area and 63.2 dBA to 72.1 dBA in low traffic area of Kathmandu city. A study of sound pollution in Kathmandu Metropolitan City was conducted in 2019. The study spanned all 32 wards of KMC and was conducted during the months of November and December. The findings revealed an average equivalent noise level of 82.58 dBA in KMC, with Ward 24 registering the highest at 85.23 dBA and Ward 12 the lowest at 77.81 dBA. These results indicated that the recorded equivalent noise levels exceeded the established standards set by both the Government of Nepal and the World Health Organization for acceptable noise levels [26].

2.4 Sound Level Meter

The sound level meter is one of the simple and feasible instruments to measure the sound level to examine and to keep the record of the sound at a different degree. Besides calculating the average value of the sound level, the maximum and minimum value of the sound also should be calculated to know about its functions at a different level and period [27]. Alongside the long-term sound pollution, even the extreme pitch of the impulsive sound of the short period could make people deaf. Some of the levels of the sounds are set which should not exceed to keep the surrounding sound. The sound becomes dangerous to the health of human beings when its level exceeds 80dBA (A), and during such a situation, preventive measures should be implemented. During the eight hours working schedule of the employees, sound and peaceful environment needed to be created either by giving the employee ear defenders or by reducing the speed of the technologies during execution [28].

2.5 Noise Hazard Mapping

The systematic measuring, and visually displaying of the spatial distribution of noise levels of any studied location is denoted as noise mapping [29]. The sound level distribution of the selected field in an urban area is provided by noise mapping, it is an efficient means to understand the distribution of noise levels [30]. It can provide details of the noise level around the field site through a visual depiction of the noise level for specific area and a specific time [31]. This method is effective to understand and analyze the distribution of noise levels spatially over a period of time. It has been effectively used by development practitioners for understanding the ecological consequence of development.

An innovative system designed for the efficient production of noise maps through the simultaneous measurement of noise and GPS data is presented by Seong [32]. This comprehensive system is comprised of essential components, including a sound level meter, a GPS receiver, a database program for the systematic management of recorded data, and a program dedicated to noise map generation, incorporating a computer model specific to the targeted geographical area.

The integration of a GPS receiver with the sound level meter facilitates the concurrent measurement and storage of both noise levels and global positions at a given location. Following the data collection process, the database program is employed to directly import one or more sets of measured data stored in the sound level meter. Subsequently, the selected measurement results are exported to Arc GIS tools, where the generation of color-coded or noise contour line maps ensues. This utilization of measured data at user-defined locations enhances the precision and applicability of the produced noise maps.

2.6 Legal Provision

According to constitution of Nepal, Clause 30

Clause 30: Right to clean environment

(1) Every citizen shall have the right to live in a clean and healthy environment.

(2) The victim shall have the right to obtain compensation, in accordance with law, for any injury caused from environmental pollution.

Transportation Policy, 2001: Policy No. 12 pays special attention to improve 'the comfort, reliability, safety, frequency, availability, and affordability of public transport and to reducing harmful emission arising from public transport operations. The policy has the following provisions related to sound quality.

The Environment Protection Act, 2076: Section 7 deals with 'prevention and control of pollution' and restricts people from causing pollution that will have adverse effects on environment and public health. Section 15 has a provision to provide additional concessions and facilities to encourage any industry, enterprises, technology, or process that causes positive impacts on environment protection. Section 21 allows the ministry to develop any of its responsibilities to other governmental agencies. Section 23 empowers the GoN to frame and implement necessary guidelines under the Act for environmental protection. Section 24 empowers the GoN to frame necessary rules related to pollution control and standards.

Environment Protection Rules, 2077: Rule 15 prohibits emission of noise, heat, radioactive materials and waste from any mechanical means, industrial establishment, or any other place in contravention of standards prescribed by the Ministry. Rule 16 makes it mandatory for 55 different types of industry listed in Annex 7 of the Regulations to obtain Pollution Control Certificates. This has not yet been carried out because of some confusion about how it is to be done.

2.7 Regulation and Standard

WHO has prescribed the safe noise level for a city as 45 dBA. In United States the noise level of 65dBA at daytime and 55dBA at nighttime in streets is prescribed. Anyone crossing the limit is regarded as causing noise pollution. In Nepal also Government of Nepal has formulated noise level standard for different area for day and nighttime. Environment Department has been established under the Ministry of Science, Technology and Environment for monitoring the environmental condition. Government of Nepal has formulated noise level standard for different area for day and nighttime. Noise Level standard formulated by Government of Nepal is in table below.

Table 2.1: Noise Level Standard of Nepal (2069)

S.N	**Area**	**Noise Level (Decibel)**	
		Day	**Night**
1	Silent Zone	50	40
2	Industrial Zone	75	70
3	Business Area	65	55
4	Rural Residential Area	45	40
5	Urban Residential Area	55	45
6	Mixed Residential Area	63	40

(Source: Nepal Raj Patra, Kartik 13, 2069)

The World Health Organization compendium of UN guidance on health and environment, provides an overview of the health implications posed by noise pollution. The chapter 11 dedicated for environmental pollution recommends the following sound pressure levels for the average noise exposure [33]:

- < 53 dBA L_{den} for road traffic noise
- < 54 dBA L_{den} for railway noise
- < 45 dBA L_{den} for aircraft noise
- < 45 dBA L_{den} for wind turbine noise

L_{den} : average sound pressure level over all days, evenings and nights in a year

2.8 People's Perception

Rapid and massive urbanization has transformed the ways of social organization, and with the access of roads, the lives of individuals have been affected in multiple ways. Since, the huge traffic in the research site, the localities receive high amount of noise. The process by which the brain interprets and organizes sensory information from the environment to produce a meaningful experience of the world is called perception. People's perception on noise pollution will help us understand how noise is understood at an urban setting with high vehicle frequency and narrow roads. Hede and Bullen [34] state that intense noise produces temporary loss of hearing in the short-term, and in the long term can cause irreparable damage to hear. The authors also depict a few effects of noise; distraction, sleep disturbance, and one's ability to perform tasks requiring mental concentration. Likewise, a high level of background noise also makes communication difficult by masking the speech sounds.

On the subjective rection towards noise, people usually feel annoyed with continuous exposure towards noise. The initial response towards noise is fear which can result from sudden noise from any source, in this case, mainly traffic noise [35]. Noise pollution harms the physiological and psychological well-being of humans and animals. For the perception of noise, the sources need to be identified, and people's reaction towards need to be identified. Excessive noise can cause 'annoyance, speech interference, sleep disruption, mental stress, headaches, and a lack of concentration, among other things.' Chand et al. [24] state that excessive noise can cause irritation, stress and hypertension; and in Kathmandu valley, it has a greater negative impact than female respondents. Amongst the rising proportion of the sample respondents in higher age groups acknowledges depression, sleeplessness, and a deafening effect.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Study area

Study was conducted in 15 different road junctions of ward number 9 of Tokha Municipality. This area was selected for the study of noise pollution as it is one of the highly traffic areas of Tokha Municipality with high density of population and narrow roads. 15 road junctions were selected based on major road junction with high flow of vehicles; these road junctions were identified within minimum of 100 meters distance, assuming that the junction with close proximity might have similar noise level. The observation includes the L_{eq} value, maximum value and minimum value at different latitude and longitudinal coordinates on the major road junction during morning and evening time. Total time duration for the data collection was 4 hours a day in which 2 hours (9-11 AM) in the morning and 2 hours (4-6 PM) in the evening. This time frame was selected for the measurement of noise level data as we can see huge traffic flow due to office hour, school hour, college hour etc. Data was noted in every 10 sec intervals with the help of TM-103 Sound Level Meter.

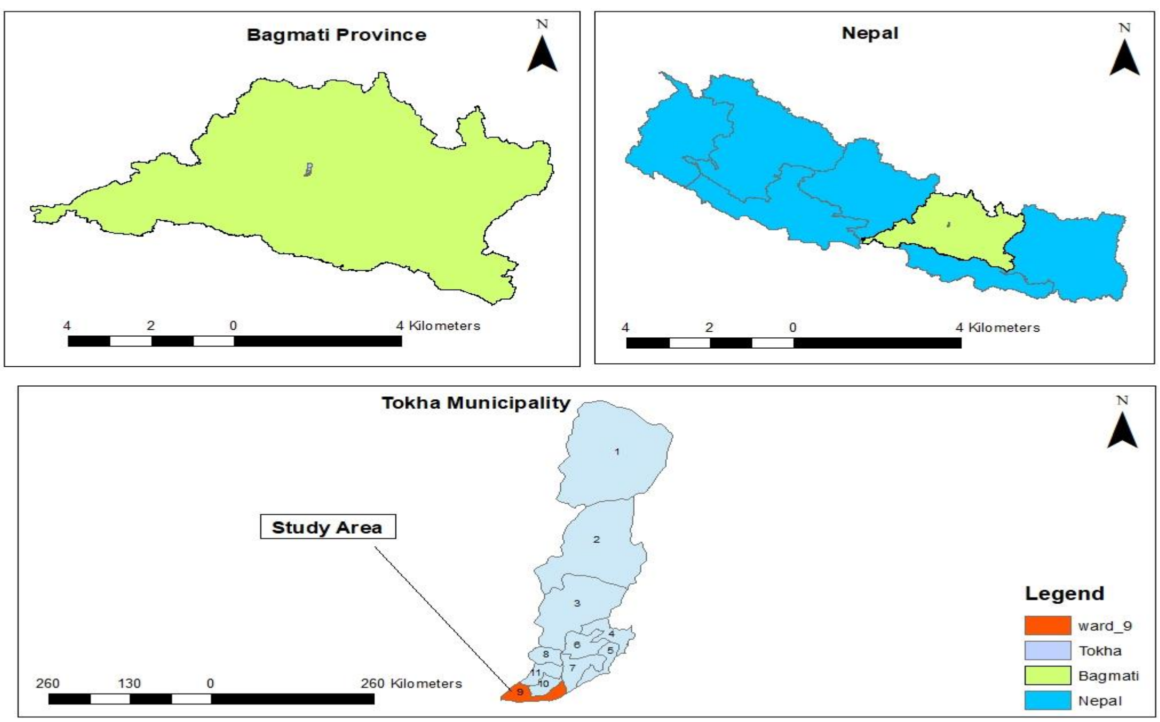

Figure 3.1: Map of Study Area

Table 3.1: Traffic Noise Measurement Junction along with Geographical Locations

Study Point	Geographical Coordinate	Location
J1	27^{0}44’22.12” N, 85^{0}18’40.68” E	Tokha Municipality-9, Jagaran Chowk
J2	27^{0}44’17.26” N, 85^{0}18’44.85” E	Tokha Municipality-9, Siddi Chowk
J3	27^{0}44’15.92” N, 85^{0}18’49.94” E	Tokha Municipality-9, Club Chowk
J4	27^{0}44’17.27” N, 85^{0}18’35.52” E	Tokha Municipality-9, Dipjyoti Chowk
J5	27^{0}44’11.94” N, 85^{0}18’35.25” E	Tokha Municipality-9, Myagdi Chowk
J6	27^{0}44’13.11” N, 85^{0}18’40.90” E	Tokha Municipality-9, Buddha Chowk
J7	27^{0}44’07.31” N, 85^{0}18’27.59” E	Tokha Municipality-9, Buspark Chowk
J8	27^{0}44’05.38” N, 85^{0}18’38.01” E	Tokha Municipality-9, Kulaanta Chowk
J9	27^{0}44’04.86” N, 85^{0}18’44.37” E	Tokha Municipality-9, Shivamandir Chowk
J10	27^{0}44’09.28” N, 85^{0}18’49.54” E	Tokha Municipality-9, Shanti Chowk
J11	27^{0}44’04.77” N, 85^{0}18’52.29” E	Tokha Municipality-9, Gongabu Chowk
J12	27^{0}44’05.66” N, 85^{0}18’05.06” E	Tokha Municipality-9, Samakhusi Chowk
J13	27^{0}44’10.71” N, 85^{0}18’19.93” E	Tokha Municipality-9, Talim Kendra Chowk
J14	27^{0}44’12.35” N, 85^{0}18’09.07” E	Tokha Municipality-9, Tokha Road Chowk
J15	27^{0}44’15.41” N, 85^{0}18’15.64” E	Tokha Municipality-9, Pargatinagar Chowk

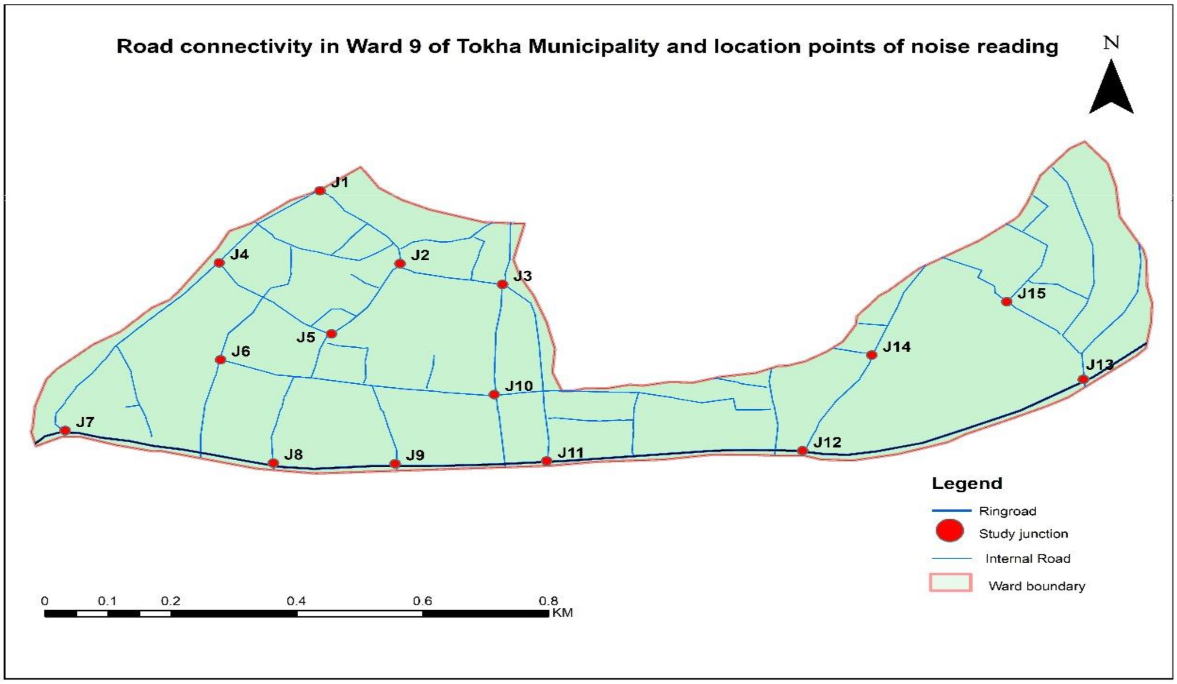

Figure 3.2: Noise measurement site within ward 9 of Tokha Municipality

3.1.1 Climate

The propagation of sound in the atmosphere is affected by humidity in air and wind, thus the study was chosen in spring season. Rainfall alongside mild climate condition with less air turbulence might affect the noise level thus the data collection was conducted in the spring season.

3.2 Research Plan and Design

The research design of the study followed mixed method; the quantitative aspect of the data was studied through equivalent sound level pressure whereas the qualitative aspect was analyzed through the perception of people via a questionnaire. The study was conducted with the aim of effective measurement of the traffic noise level at major road junctions and people's perception on traffic noise in ward 9 of Tokha Municipality due to traffic flow. Thus, measured noise level data and people's perception on noise was analyzed with the help of Microsoft excel. Based on measured noise data, noise hazard map of ward 9 was prepared.

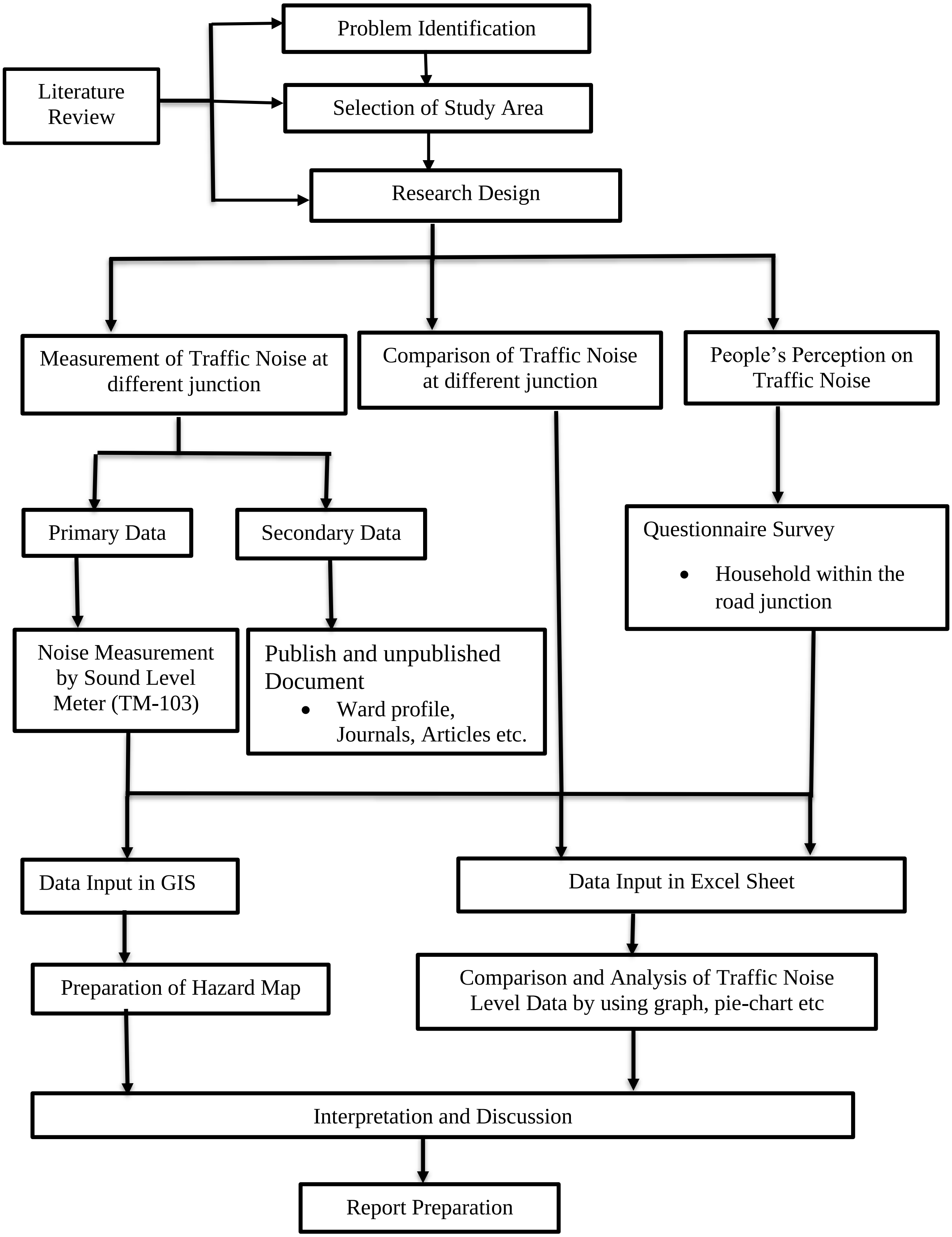

Figure 3.3: Methodological Framework

3.3 Selection of Sampling Sites

The collection of data was done in 15 selected road junctions where the normal traffic flow as high and very sensitive towards human exposure. The study was carried out during the autumn season at the road junctions. The instrument was kept in 1.5 meter above the ground level. Total time duration for the data collection was 4 hours a day in which 2 hours (9-11 AM) in the morning and 2 hours (4-6 PM) in the evening. This time frame was selected for the measurement of noise level data as we can see huge traffic flow due to office hour, school hour, college hour etc. The 15 selected road junctions were studied on a daily basis and based upon which the findings were presented. The junctions were selected based upon the traffic in the area, and with the assumption that within 100 meters proximity the noise levels were similar. The junctions are spatially distributed in ward 9 and form a connecting bridge between outside the ring road and the inner ring road.

Alongside, the instrumental measurement it was also required that the people's perception towards noise be understood. The people's perception would help us to understand what people mean by noise and how it has affected in their daily livelihood. For understanding the people's perception, the respondents were selected through purposive sampling where 4 people representing their households were selected from each junction. Since, the effect of noise is high in these junctions, people residing in the junction were considered as the primary respondents for understanding the case. The representative sample consisted of businessman, women, individuals, and locals residing in the area.

3.4 Method of data collection

The study was based on primary and secondary data as described below:

3.3.1 Primary Data

1. Direct Measurement

Traffic noise was measured in 15 different junctions within ward 9 of Tokha Municipality. The TM-103 sound level meter instrument was used for the measurement of noise levels. This instrument was portable precise digital sound level meter. The instrument was set at 10 second interval to record the data. Thus, the raw data was obtained. This raw was used for the calculation of Equivalent A-weighted sound pressure level (LA_{eq}), maximum sound pressure level (L_{max}), minimum sound pressure level (L_{min}), L_5, L_{10}, L_{50} and L_{90}.

Equivalent A-weighted sound pressure level (LA_{eq}) was calculated by using the following formula:

1. $LA_{eq}= 10\log \{1/T(10^{L_1/10}+10^{L_2/10}+10^{L_3/10}+\ldots\ldots\ldots+10^{L_n/10})\}$

where LA_{eq}: Equivalent A-weighted sound pressure level in decibel (dBA)

T: Total or Actual time period

L: Noise level in decibel

N: Number of events

2. $i= (P/100)*n$

where i=Position of P^{th} percentile

P=Percentile of time

n=Number of values appear in ascending order

As Noise level at five percentile of time is calculated by using formula like;

$L_5= (5/100) *n$

Similarly, other values at different percentile of time were calculated by using above equation.

Figure 3.4: TM-103 Sound Level Meter

2. **Questionnaire Survey**

Questionnaire survey was performed to know the people's perception on traffic noise. The people's perception would help us understand what people mean by noise and how it has affected in their daily livelihood. For understanding the people's perception, the respondents were selected through purposive sampling where 4 people representing their households were selected from each junction. Since, the effect of noise is high in these junctions, people residing in the junction were considered as the primary respondents for understanding the case. The representative sample consisted of business-owners, women, individuals and locals residing in the area.

3.4.2 Secondary Data

Several journal articles, books, library search and government reports based on noise pollution and its effects was collected and analyzed. Demographic data was collected from National Population and Housing Census, 2021. Alongside, research focusing on policy intervention were understood through daily gazettes, Constitution of Nepal, and policy briefs from the concerned ministries. The secondary data collection was done through desk research.

3.5 Data Analysis and Interpretation

The obtained sound level pressure data was tabulated and calculated by using Microsoft Excel software. Values like LA_{eq}, L_{max}, L_{min}, L_5, L_{10}, L_{50} and L_{90} was calculated using formulas to compare and analyze the data quantitatively by using bar diagram, line diagram etc. Also, Noise hazard map of study area was prepared by Arc GIS and analyze in qualitatively way.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Results

4.1.1 Measurement of Sound Level at Different Road Junctions

In the morning, the equivalent continuous noise level (L_{eq}) at Jagaran chowk was recorded at 75 dBA (A), with a maximum noise level (L_{max}) of 93.7 dBA and a minimum noise level (L_{min}) of 56.7 dBA. The 5th percentile (L_5) was 60.1 dBA, the 10th percentile (L_{10}) was 61.8 dBA (A), the median or 50th percentile (L_{50}) was 67.7 dBA, and the 90th percentile (L_{90}) was 73.6 dBA. In the evening, the Leq at Jagaran chowk increased to 77 dBA, with an elevated L_{max} of 99.4 dBA and L_{min} of 60.7 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 62.3 dBA, 63.3 dBA, 66.8 dBA, and 73.6 dBA, respectively. These results suggest that the evening period experiences higher overall noise levels, with notable increases in maximum and minimum noise levels. The percentiles indicate a generally elevated noise distribution during the evening. This information is crucial for understanding the noise dynamics at Jagaran Chowk and provides a basis for further investigations and potential noise mitigation strategies in the area.

Table 4.1: Noise Level Data of Jagaran Chowk

Location: Jagaran Chowk					**Date: 2023/09/12**			
S.N.	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	75	93.7	56.7	60.1	61.8	67.7	73.6
2	Evening	77	99.4	60.7	62.3	63.3	66.8	73.6

2. Junction 2 (Siddi Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Siddi chowk was 72.9 dBA, with a maximum noise level (L_{max}) of 90 dBA and a minimum noise level (L_{min}) of 57.4 dBA. The 5th percentile (L_5) was 61.2 dBA, the 10th percentile (L_{10}) was 63.6 dBA, the median or 50th percentile (L50) was 69.5 dBA, and the 90th percentile (L_{90}) was 75.1 dBA. During the evening, the L_{eq} at Siddi chowk slightly increased to 73.4 dBA, with an elevated L_{max} of 98.8 dBA and a reduced L10 of 51.1 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 54.1 dBA, 54.8 dBA, 56.6

dBA, and 63.1 dBA, respectively. These findings indicate that noise levels are slightly higher in the evening, with notable differences in maximum and minimum noise levels. The percentiles reveal a shift in noise distribution during the evening. Understanding these patterns is crucial for assessing and addressing noise concerns in Siddi Chowk, providing a basis for potential noise management strategies.

Table 4.2: Noise Level Data of Siddi Chowk

Location: Siddi Chowk					**Date: 2023/10/01**			
S.N.	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	72.9	90	57.4	61.2	63.6	69.5	75.1
2	Evening	73.4	98.8	51.1	54.1	54.8	56.6	63.1

3. Junction 3 (Club Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Club chowk was 73.3 dBA, with a maximum noise level (L_{max}) of 96.5 dBA and a minimum noise level (L_{min}) of 52.1 dBA. The 5th percentile (L_5) was 54.9 dBA, the 10th percentile (L_{10}) was 56.2 dBA, the median or 50th percentile (L_{50}) was 62.5 dBA, and the 90th percentile (L_{90}) was 70.6 dBA. During the evening, the L_{eq} at Club chowk slightly increased to 74.9 dBA, with a decreased L_{max} of 94.4 dBA and a raised L_{min} of 54 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 59.7 dBA, 61.6 dBA, 67.6 dBA, and 73.7 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. This understanding is critical for evaluating and addressing noise issues in Club Chowk, providing insights for potential noise management strategies.

Table 4.3: Noise Level Data of Club Chowk

Location: Club Chowk					**Date: 2023/10/02**			
S.N.	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	73.3	96.5	52.1	54.9	56.2	62.5	70.6
2	Evening	74.9	94.4	54	59.7	61.6	67.6	73.7

4. Junction 4 (Dipjyoti Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Dipjyoti chowk was 74.1 dBA, with a maximum noise level (L_{max}) of 92.1 dBA and a minimum noise level (L_{min}) of 56.4 dBA. The 5_{th} percentile (L_5) was 60.8 dBA, the 10^{th} percentile (L_{10}) was 62 dBA, the median or 50^{th} percentile (L_{50}) was 65.7 dBA, and the 90_{th} percentile (L_{90}) was 71.6 dBA. During the evening, the L_{eq} Dipjyoti chowk increased to 75.6 dBA, with an elevated L_{max} of 98.2 dBA and a slightly lower L_{min} of 56.3 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 61.8 dBA, 63.7 dBA, 70 dBA, and 76 dBA, respectively. These findings suggest that noise levels are marginally higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Dipjyoti Chowk, offering insights for potential noise management strategies.

Table 4.4: Noise Level Data of Dipjyoti Chowk

Location: Dipjyoti Chowk					**Date: Date: 2023/10/03**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	74.1	92.1	56.4	60.8	62	65.7	71.6
2	Evening	75.6	98.2	56.3	61.8	63.7	70	76

5. Junction 5 (Buddha Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Buddha chowk was 75 dBA, with a maximum noise level (L_{max}) of 96.5 dBA and a minimum noise level (L_{min}) of 60.8 dBA. The 5th percentile (L_5) was 65.8 dBA, the 10th percentile (L_{10}) was 67 dBA, the median or 50th percentile (L_{50}) was 70.8 dBA, and the 90^{th} percentile (L_{90}) was 72.6 dBA. During the evening, the L_{eq} at Buddha chowk increased to 76.8 dBA, with an elevated L_{max} of 99.8 dBA and a slightly higher L_{min} of 62.6 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 66 dBA, 67.4 dBA, 71.6 dBA, and 76.1 dBA, respectively. These findings suggest that noise levels are higher in the evening, with notable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Myagdi Chowk, providing insights for potential noise management strategies.

Table 4.5: Noise Level Data of Myagdi Chowk

Location: Myagdi Chowk					**Date: Date: 2023/10/04**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	75	96.5	60.8	65.8	67	70.8	72.6
2	Evening	76.8	99.8	62.6	66	67.4	71.6	76.1

6. Junction 6 (Buddha Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Buddha Chowk was 71.5 dBA, with a maximum noise level (L_{max}) of 88.8 dBA and a minimum noise level (L_{min}) of 56.9 dBA. The 5th percentile (L_5) was 60.4 dBA, the 10th percentile (L_{10}) was 61.2 dBA, the median or 50th percentile (L_{50}) was 64.7 dBA, and the 90th percentile (L90) was 71 dBA. During the evening, the L_{eq} at Buddha Chowk increased to 72.7 dBA, with an elevated L_{max} of 94.2 dBA and a slightly lower L_{min} of 54.3 dBA. The L_5, L_{10}, L_{50}, and L90 percentiles for the evening were 59.2 dBA, 60.4 dBA, 66.6 dBA, and 74.3 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Buddha Chowk, providing insights for potential noise management strategies.

Table 4.6: Noise Level Data of Buddha Chowk

Location: Buddha Chowk					**Date: Date: 2023/10/05**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	71.5	88.8	56.9	60.4	61.2	64.7	71
2	Evening	72.7	94.2	54.3	59.2	60.4	66.6	74.3

7. Junction 7 (Buspark Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Buspark Chowk was 76.7 dBA, with a maximum noise level (L_{max}) of 99.6 dBA and a minimum noise level (L_{min}) of 53.6 dBA. The 5th percentile (L_5) was 60.7 dBA, the 10th percentile (L_{10}) was 62.7 dBA, the median or 50th percentile (L_{50}) was 68.6 dBA, and the 90th percentile (L_{90}) was 76.2 dBA. During the evening, the L_{eq} at

Buspark Chowk increased to 77.6 dBA, with an elevated L_{max} of 97.5 dBA and a slightly higher L_{min} of 56.7 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 62.5 dBA, 64 dBA, 68.2 dBA, and 76.7 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Buspark Chowk, providing insights for potential noise management strategies.

Table 4.7: Noise Level Data of Buspark Chowk

Location: Buspark Chowk					**Date: Date: 2023/10/06**			
S.N.	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	76.7	99.6	53.6	60.7	62.7	68.6	76.2
2	Evening	77.6	97.5	56.7	62.5	64	68.2	76.7

8. Junction 8 (Kulaanta Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Kulaanta Chowk was 75.6 dBA, with a maximum noise level (L_{max}) of 97.7 dBA and a minimum noise level (L_{min}) of 63 dBA. The 5th percentile (L_5) was 67.1 dBA, the 10th percentile (L_{10}) was 68.1 dBA, the median or 50th percentile (L_{50}) was 72 dBA, and the 90th percentile (L_{90}) was 76.6 dBA. During the evening, the L_{eq} at Kulaanta Chowk increased to 77 dBA, with an elevated L_{max} of 96.7 dBA and a slightly lower L_{min} of 56.5 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 63.4 dBA, 64.9 dBA, 69.6 dBA, and 77.5 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Kulaanta Chowk, providing insights for potential noise management strategies.

Table 4.8: Noise Level Data of Kulaanta Chowk

Location: Kulaanta Chowk					Date: Date: 2023/10/08			
S.N.	Time Period	L_{eq} (dBA)	L_{max} (dBA)	L_{min} (dBA)	L_5	L_{10}	L_{50}	L_{90}
1	Morning	75.6	97.7	63	67.1	68.1	72	76.6
2	Evening	77	96.7	56.5	63.4	64.9	69.6	77.5

9. Junction 9 (Shivamandir Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Shivamandir Chowk was 76.4 dBA, with a maximum noise level (L_{max}) of 101.3 dBA and a minimum noise level (L_{min}) of 56.2 dBA. The 5th percentile (L_5) was 62.6 dBA, the 10th percentile (L_{10}) was 63.6 dBA, the median or 50th percentile (L_{50}) was 67.5 dBA, and the 90th percentile (L_{90}) was 74.8 dBA. During the evening, the L_{eq} at Shivamandir Chowk increased to 76.9 dBA, with an elevated L_{max} of 99.3 dBA and a slightly higher L_{min} of 61.7 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 66.7 dBA, 67.9 dBA, 71.5 dBA, and 76.5 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Shivamandir Chowk, providing insights for potential noise management strategies.

Table 4.9: Noise Level Data of Shivamandir Chowk

Location: Shivamandir Chowk					Date: Date: 2023/10/09			
S.N.	Time Period	L_{eq} (dBA)	L_{max} (dBA)	L_{min} (dBA)	L_5	L_{10}	L_{50}	L_{90}
1	Morning	76.4	101.3	56.2	62.6	63.6	67.5	74.8
2	Evening	76.9	99.3	61.7	66.7	67.9	71.5	76.5

10. Junction 10 (Shanti Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Shanti Chowk was 72.8 dBA, with a maximum noise level (L_{max}) of 95.3 dBA and a minimum noise level (L_{min}) of 52.6 dBA. The 5th percentile (L_5) was 56 dBA, the 10th percentile (L_{10}) was 57.9 dBA, the median or 50th percentile (L_{50}) was 63.9 dBA, and the 90th percentile (L_{90}) was 72.2 dBA. During the evening, the L_{eq} at Shanti Chowk increased to 74.8 dBA, with an elevated L_{max} of 100.6 dBA and a slightly higher L_{min} of 59.7 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 63 dBA, 64.1 dBA, 67.8 dBA, and 72.8 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Shanti Chowk, providing insights for potential noise management strategies.

Table 4.10: Noise Level Data of Shanti Chowk

Location: Shanti Chowk					**Date: Date: 2023/10/10**			
S.N.	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	72.8	95.3	52.6	56	57.9	63.9	72.2
2	Evening	74.8	100.6	59.7	63	64.1	67.8	72.8

11. Junction 11 (Gongabu Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Gongabu Chowk was 77.6 dBA, with a maximum noise level (L_{max}) of 97.9 dBA and a minimum noise level (L_{min}) of 56.4 dBA. The 5th percentile (L_5) was 61.6 dBA, the 10th percentile (L_{10}) was 63.7 dBA, the median or 50th percentile (L_{50}) was 68.4 dBA, and the 90th percentile (L_{90}) was 75.1 dBA. During the evening, the L_{eq} at Gongabu Chowk increased to 78.2 dBA, with an elevated L_{max} of 98.4 dBA and a slightly lower L_{min} of 52.6 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 56.6 dBA, 58.4 dBA, 65.5 dBA, and 75.3 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Gongabu Chowk, providing insights for potential noise management strategies.

Table 4.11: Noise Level Data of Gongabu Chowk

Location: Gongabu Chowk					**Date: Date: 2023/10/11**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	77.6	97.9	56.4	61.6	63.7	68.4	75.1
2	Evening	78.2	98.4	52.6	56.6	58.4	65.5	75.3

12. Junction 12 (Samakhusi Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Samakhusi Chowk was 76.6 dBA, with a maximum noise level (L_{max}) of 94.7 dBA and a minimum noise level (L_{min}) of 54.3 dBA. The 5th percentile (L_5) was 62.2 dBA, the 10th percentile (L_{10}) was 64.3 dBA, the median or 50th percentile (L_{50}) was 68.7 dBA, and the 90th percentile (L_{90}) was 76.5 dBA. During the evening, the L_{eq} at Samakhusi Chowk increased to 77.1 dBA, with an elevated L_{max} of 101.4 dBA and a slightly lower L_{min} of 52.8 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 57.7 dBA, 59.2 dBA, 64.7 dBA, and 72.4 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Samakhusi Chowk, providing insights for potential noise management strategies.

Table 4.12: Noise Level Data of Samakhusi Chowk

Location: Samakhusi Chowk					**Date: Date: 2023/10/12**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	76.6	94.7	54.3	62.2	64.3	68.7	76.5
2	Evening	77.1	101.4	52.8	57.7	59.2	64.7	72.4

13. Junction 13 (Talimkendra Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Talimkendra Chowk was 75 dBA, with a maximum noise level (L_{max}) of 93.4 dBA and a minimum noise level (L_{min}) of 60.5 dBA. The 5th percentile (L_5) was 63.2 dBA, the 10th percentile (L_{10}) was 64.9 dBA, the median or 50th percentile (L_{50}) was 69 dBA, and the 90th percentile (L_{90}) was 75.6 dBA. During the evening, the

L_{eq} at Talimkendra Chowk increased to 76.9 dBA, with an elevated L_{max} of 96.7 dBA and a slightly lower L_{min} of 54.7 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 63.4 dBA, 64.9 dBA, 69.6 dBA, and 77.5 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Talimkendra Chowk, providing insights for potential noise management strategies.

Table 4.13: Noise Level Data of Talimkendra Chowk

Location: Talimkendra Chowk					**Date: Date: 2023/10/13**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	75	93.4	60.5	63.2	64.9	69	75.6
2	Evening	76.9	96.7	54.7	63.4	64.9	69.6	77.5

14. Junction 14 (Tokha Road Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Tokha Road Chowk was 73.8 dBA, with a maximum noise level (L_{max}) of 96.3 dBA and a minimum noise level (L_{min}) of 51.9 dBA. The 5th percentile (L_5) was 59.2 dBA, the 10th percentile (L_{10}) was 61.5 dBA, the median or 50th percentile (L_{50}) was 66.7 dBA, and the 90th percentile (L_{90}) was 72.8 dBA. During the evening, the L_{eq} at Tokha Road Chowk increased to 76 dBA, with an elevated L_{max} of 96.6 dBA and a slightly lower L_{min} of 54.7 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 61.6 dBA, 63.6 dBA, 68.5 dBA, and 75.3 dBA, respectively. These findings suggest that noise levels are higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Tokha Road Chowk, providing insights for potential noise management strategies.

Table 4.14: Noise Level Data of Tokha Road Chowk

Location: Tokha Road Chowk					**Date: Date: 2023/10/16**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	73.8	96.3	51.9	59.2	61.5	66.7	72.8
2	Evening	76	96.6	54.7	61.6	63.6	68.5	75.3

15. Junction 15 (Pargatinagar Chowk)

In the morning, the equivalent continuous noise level (L_{eq}) at Pargatinagar Chowk was 73.3 dBA, with a maximum noise level (L_{max}) of 97.7 dBA and a minimum noise level (L_{min}) of 59.2 dBA. The 5th percentile (L_5) was 62.3 dBA, the 10th percentile (L_{10}) was 63.3 dBA, the median or 50th percentile (L_{50}) was 66.8 dBA, and the 90th percentile (L_{90}) was 73.2 dBA. During the evening, the L_{eq} at Pargatinagar Chowk increased to 74.1 dBA, with an elevated L_{max} of 92.4 dBA and a slightly higher L_{min} of 60.5 dBA. The L_5, L_{10}, L_{50}, and L_{90} percentiles for the evening were 63.2 dBA, 64.9 dBA, 69 dBA, and 75.6 dBA, respectively. These findings suggest that noise levels are slightly higher in the evening, with noticeable changes in maximum and minimum noise levels. The percentiles indicate a shift in noise distribution during the evening. Understanding these patterns is crucial for evaluating and addressing noise concerns at Pargatinagar Chowk, providing insights for potential noise management strategies.

Table 4.15: Noise Level Data of Pargatinagar Chowk

Location: Pargatinagar Chowk					**Date: Date: 2023/10/17**			
S.N	**Time Period**	**L_{eq} (dBA)**	**L_{max} (dBA)**	**L_{min} (dBA)**	**L_5**	**L_{10}**	**L_{50}**	**L_{90}**
1	Morning	73.3	97.7	59.2	62.3	63.3	66.8	73.2
2	Evening	74.1	92.4	60.5	63.2	64.9	69	75.6

4.1.2 Comparison of noise level at different junctions

4.1.2.1 Comparison of L_{eq} noise level at different junctions

a. L_{eq} in the morning

During the day the standard noise level of Nepal for mixed residential areas according to the Nepal Rajpatra published on Kartik 13, 2069 is 63 dBA. The below graph presents a comparison of equivalent continuous sound pressure level or L_{eq} of the different locations of study area during the morning time. The assessment of traffic noise across various junctions within ward number 9 of Tokha Municipality, Nepal, reveals a range of equivalent noise levels (L_{eq}) values. The data indicates differences in the acoustic environments at these locations. Gongabu Chowk stands out with the highest morning L_{eq} of 77.6 dBA, suggesting elevated traffic noise levels, closely followed by Buspark Chowk at 76.7 dBA and Shivamandir Chowk at 76.4 dBA. Conversely, Buddha Chowk exhibits the lowest morning L_{eq} at 71.5 dBA, indicating a relatively quieter environment. These variations highlight the diverse noise profiles in the morning across different junctions.

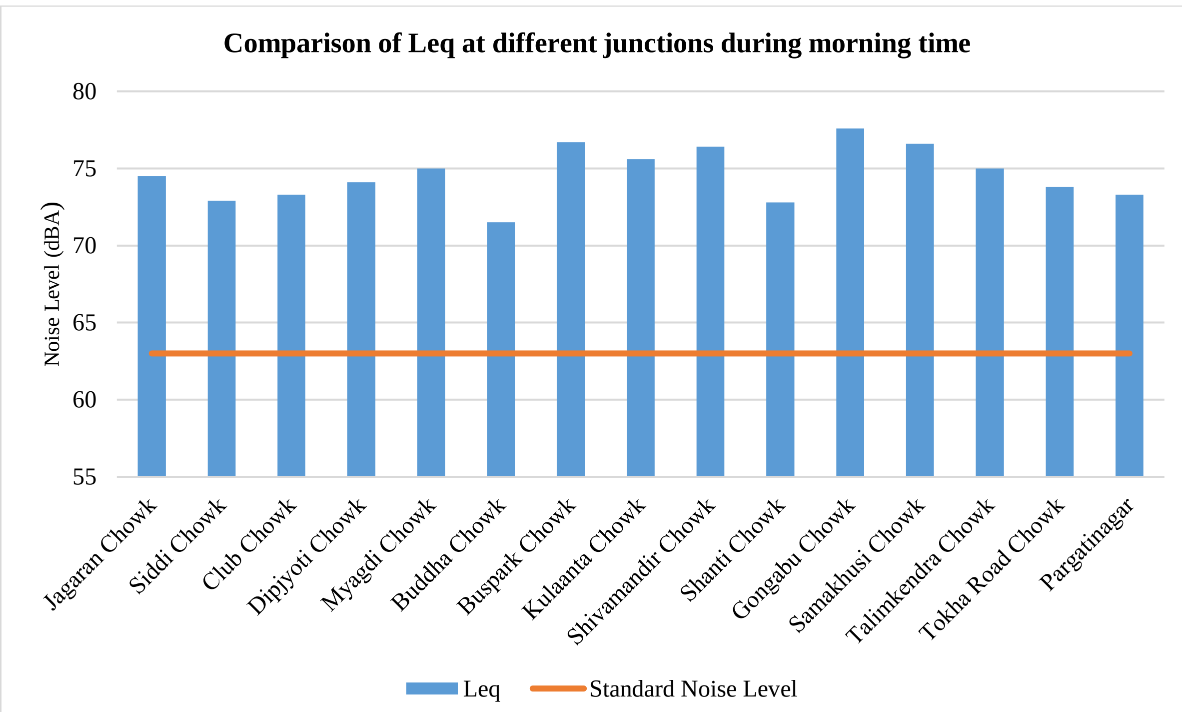

Figure 4.1: Comparison of L_{eq} at different junctions during morning time

b. L_{eq} in the evening

During the day the standard noise level of Nepal for mixed residential areas according to the Nepal Rajpatra published on Kartik 13, 2069 is 63 dBA. The below graph presents a comparison of equivalent continuous sound pressure level or L_{eq} of the different locations of study area during the evening time. The assessment of traffic noise in various junctions within ward number 9 of Tokha Municipality, Nepal, reveals a range of noise levels. Gongabu Chowk stands out with the highest L_{eq} of 78.2 dBA, indicating elevated overall noise levels, closely followed by Buspark Chowk at 77.6 dBA. Conversely, Buddha Chowk exhibits the lowest L_{eq} at 72.7 dBA, suggesting comparatively quieter conditions. These variations highlight the diversity in acoustic environments across different locations in evening time.

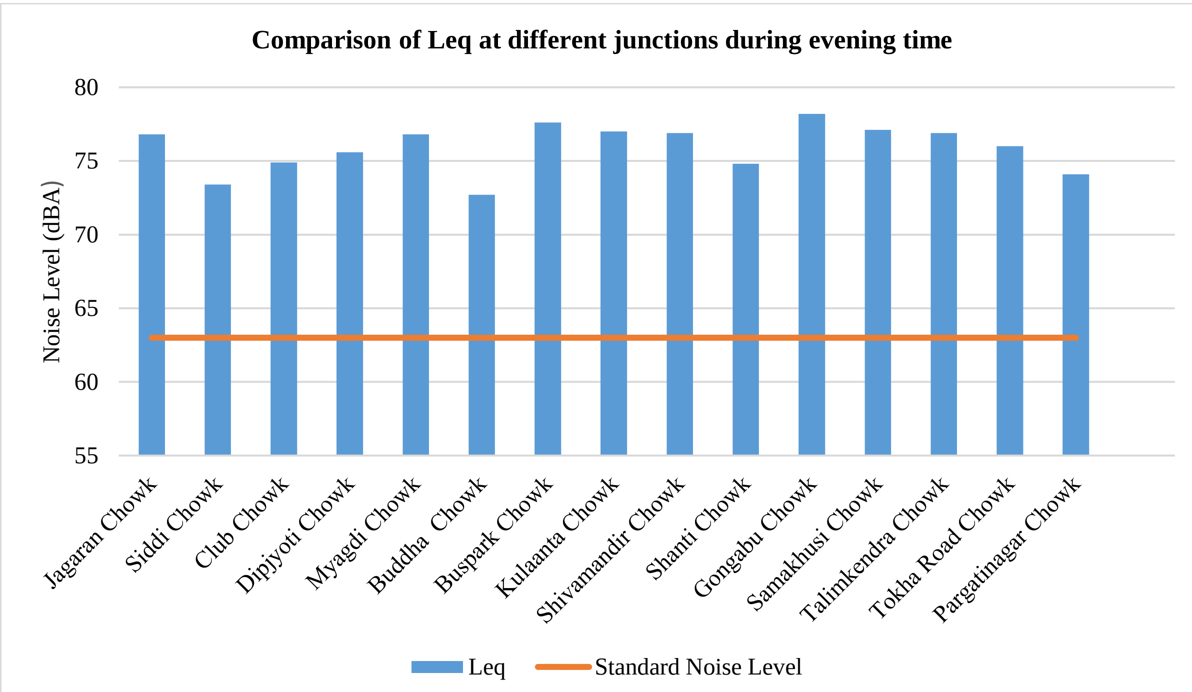

Figure 4.2: Comparison of L_{eq} at different junctions during evening time

4.1.2.2 Comparison of L_{max} noise levels at different junctions

a. L_{max} in the morning

L_{max} is the maximum level of noise source or the environment where peak is the maximum level of the noise source. The assessment of traffic noise in various 15 junctions within ward number 9 of Tokha Municipality, Nepal, reveals a spectrum of maximum noise levels (L_{max}) across junctions during morning time (9 AM- 11AM). Notably, Shivamandir Chowk stands out with the highest L_{max} at 101.3 dBA, indicating instances of peak noise events due to pressure horn of vehicles. But Buddha Chowk registers the lowest L_{max} at 88.8 dBA, suggesting a relatively quieter setting in terms of maximum noise levels.

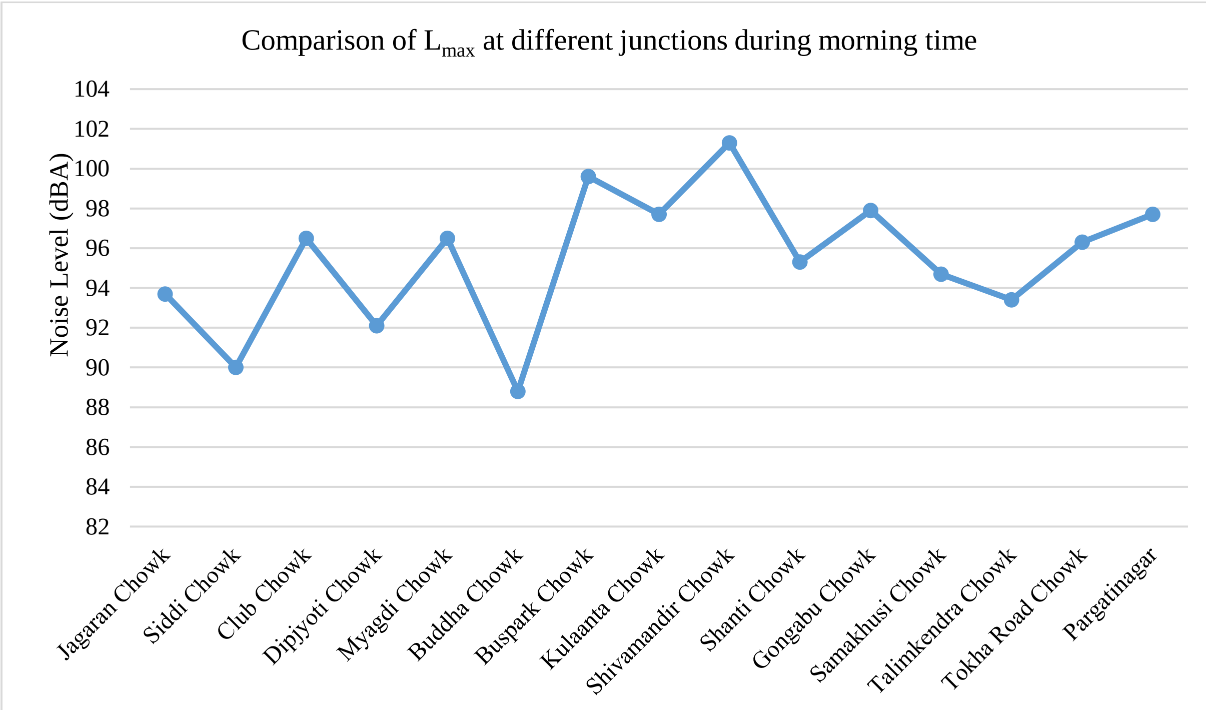

Figure 4.3: Comparison of L_{max} at different junctions during morning time

b. L_{max} in the Evening

L_{max} is the maximum level of noise source or the environment where peak is the maximum level of the noise source. The assessment of traffic noise in various 15 junctions within ward number 9 of Tokha Municipality, Nepal, reveals a spectrum of maximum noise levels (L_{max}) across junctions during evening time (4 PM -6 PM). Samakhusi Chowk stands out with the highest L_{max} at 101.4 dBA, indicating a significant occurrence of peak noise influenced by pressure horn of vehicles. But Pargatinagar Chowk registers the lowest L_{max} at 92.4 dBA, suggesting a relatively quieter environment in terms of maximum noise levels.

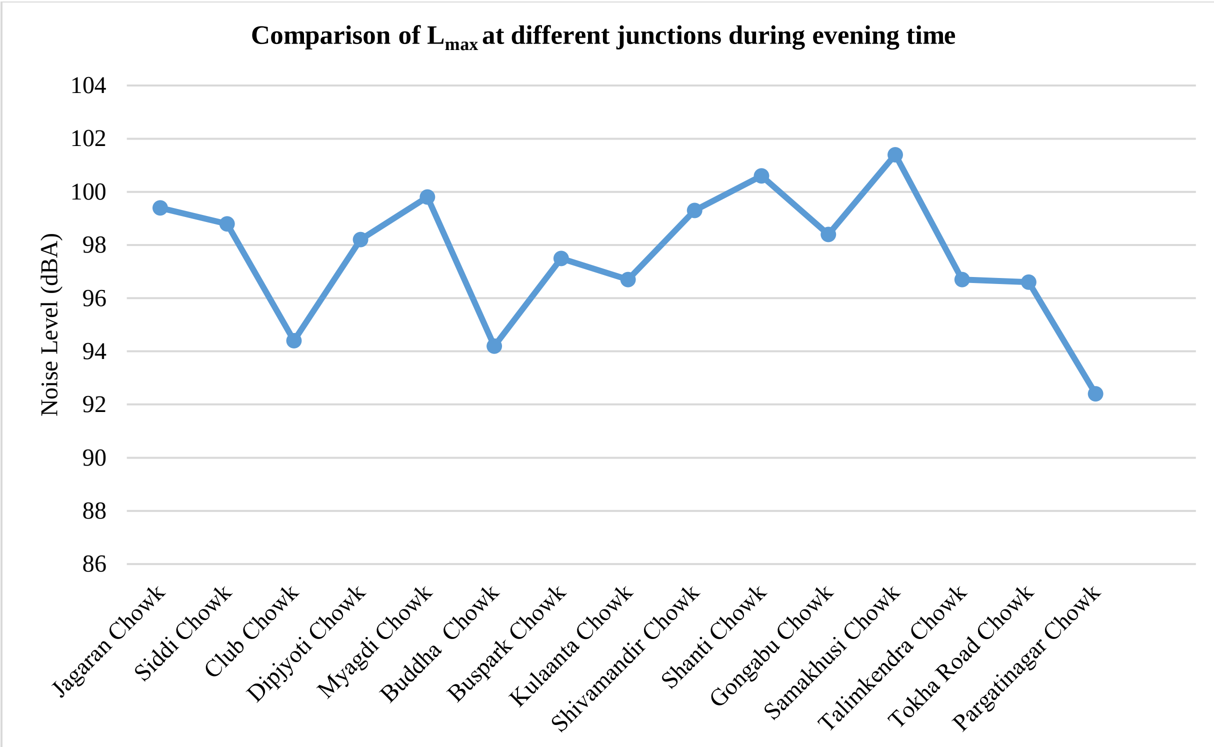

Figure 4.4: Comparison of L_{max} at different junctions during evening time

4.1.2.3 Comparison of Lmin noise levels at different junctions

a. L_{min} in Morning

Examining the minimum noise levels (L_{min}) in the morning time (9 AM- 11 AM) at various junctions within ward number 9 of Tokha Municipality, Nepal, sheds light on the quieter aspects of the acoustic environment. Tokha Road Chowk has the lowest L_{min} at 51.9 dBA, suggesting a relatively peaceful environment in terms of minimum noise levels. Club Chowk follows closely with an L_{min} of 52.1 dBA, indicating a similar trend of lower noise in the morning. Conversely, Kulaanta Chowk exhibits the highest L_{min} at 63 dBA, indicating a somewhat elevated minimum noise level due to background noise from construction work other than traffic noise.

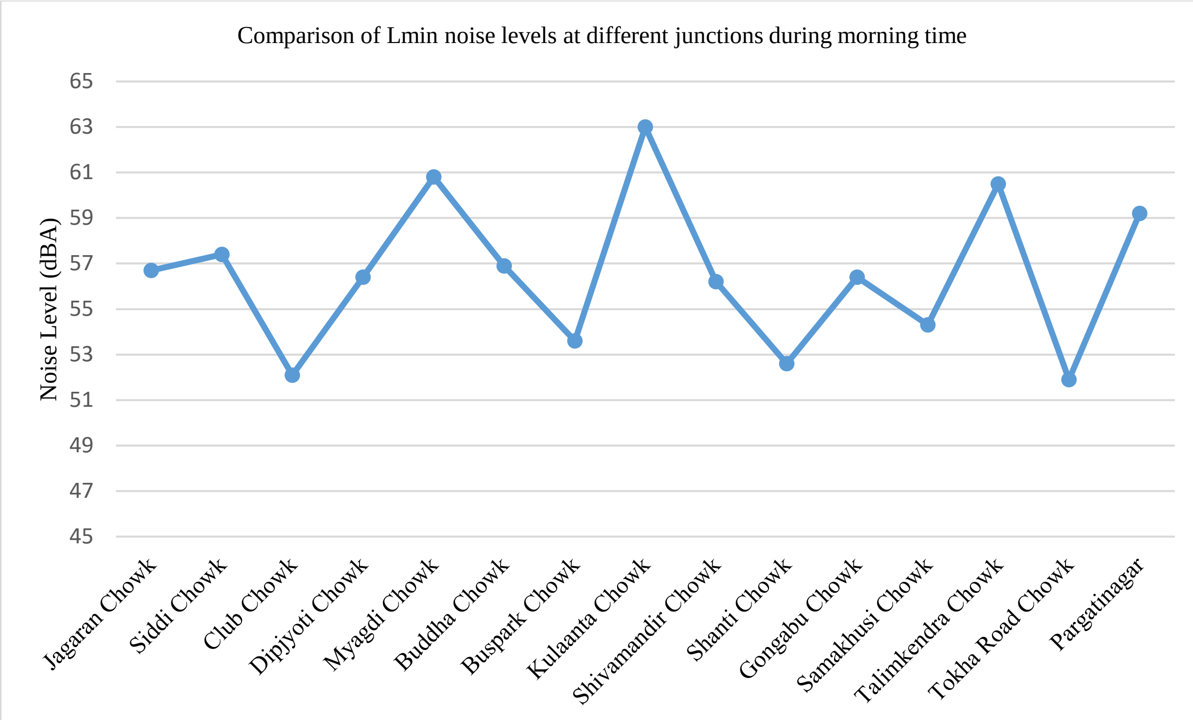

Figure 4.5: Comparison of L_{min} noise levels at different junctions during morning time

b. L_{min} in Evening

Examining the evening time (4 PM- 6PM) minimum noise levels (L_{min}) at various junctions within ward number 9 of Tokha Municipality, Nepal, provides insights into the quieter aspects of the acoustic environment. Siddi Chowk has the lowest L_{min} at 51.1 dBA, suggesting a relatively quiter environment with minimal noise during the morning hours. Samakhusi Chowk follows closely with an L_{min} of 52.8 dBA, indicating a similar trend of lower noise levels in the morning. Conversely, Myagdi Chowk exhibits the highest L_{min} at 62.6 dBA, indicating a somewhat elevated minimum noise level influenced by background noise of people and hotel other than traffic noise to that junction.

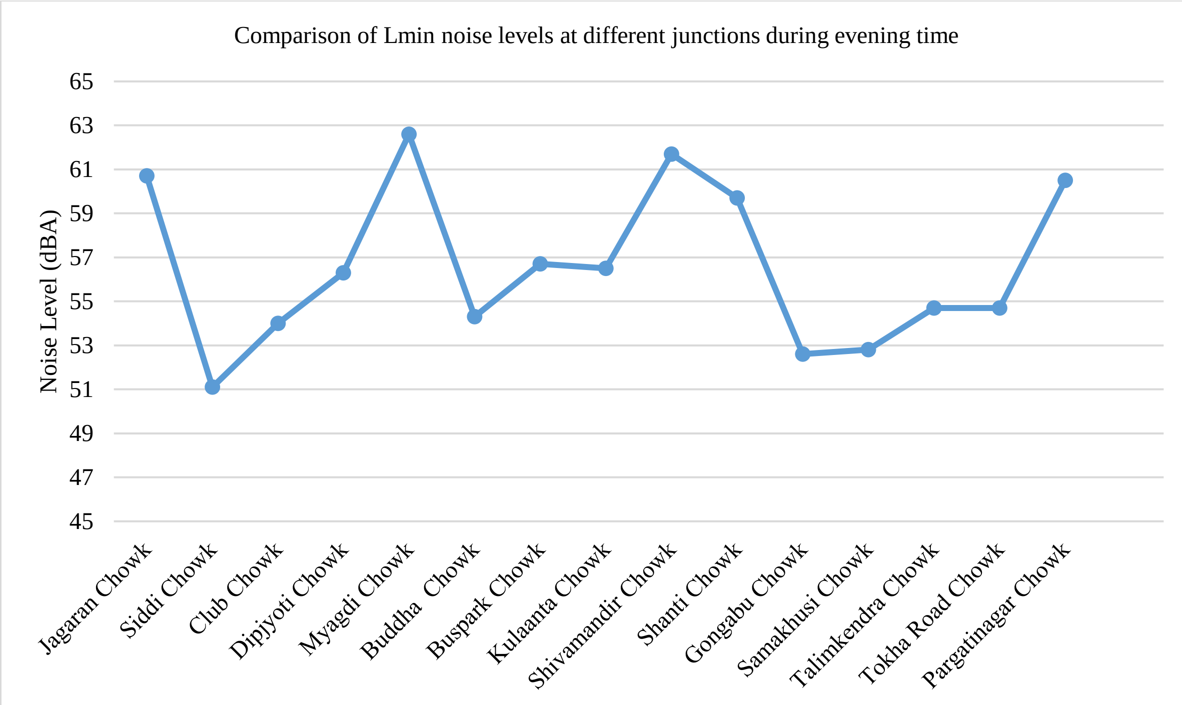

Figure 4.6: Comparison of L_{min} noise levels at different junctions during evening time

4.1.3 Noise Hazard Map

a. Morning Time

The noise hazard map of equivalent noise during morning of the study area was prepared with the help of Arc GIS tool. The noise hazard map was plotted from the equivalent noise level and the map was colored with different colors on the basis of intervals. This color combination was selected only for distinct notice of differ in equivalent noise level from one junction to another. Equivalent noise level measured in 15 different road junctions within ward 9 of Tokha Municipality shows the indication by red color (76.5- 77.6 dBA), orange color (75.3-76.4 dBA), yellow color (74-75.2 dBA), light green color (72.8- 73.9 dBA) and dark green colour (71.5- 72.7 dBA). Higher noise level indicated by red color was seen in J_7 (Buspark Chowk), J_{11}(Gongabu Chowk) and J_{12} (Samakhusi Chowk) as these chowks are connected with ring road and most busy chowks with heavy traffic flow was seen in this area. The lowest equivalent noise level noise was indicated by dark green color that was seen in J_6 (Buddha Chowk) due to quitter environment with low flow of vehicles in comparison to other noise measured junctions.

By analyzing the spatial distribution, residents and urban planners can identify areas prone to higher noise exposure, aiding in targeted mitigation strategies such as sound barriers or traffic management. This information is crucial for understanding the impact of noise on the community and guiding future urban development plans to minimize noise-related health concerns and enhance the overall quality of life in Tokha Municipality's Ward 9.

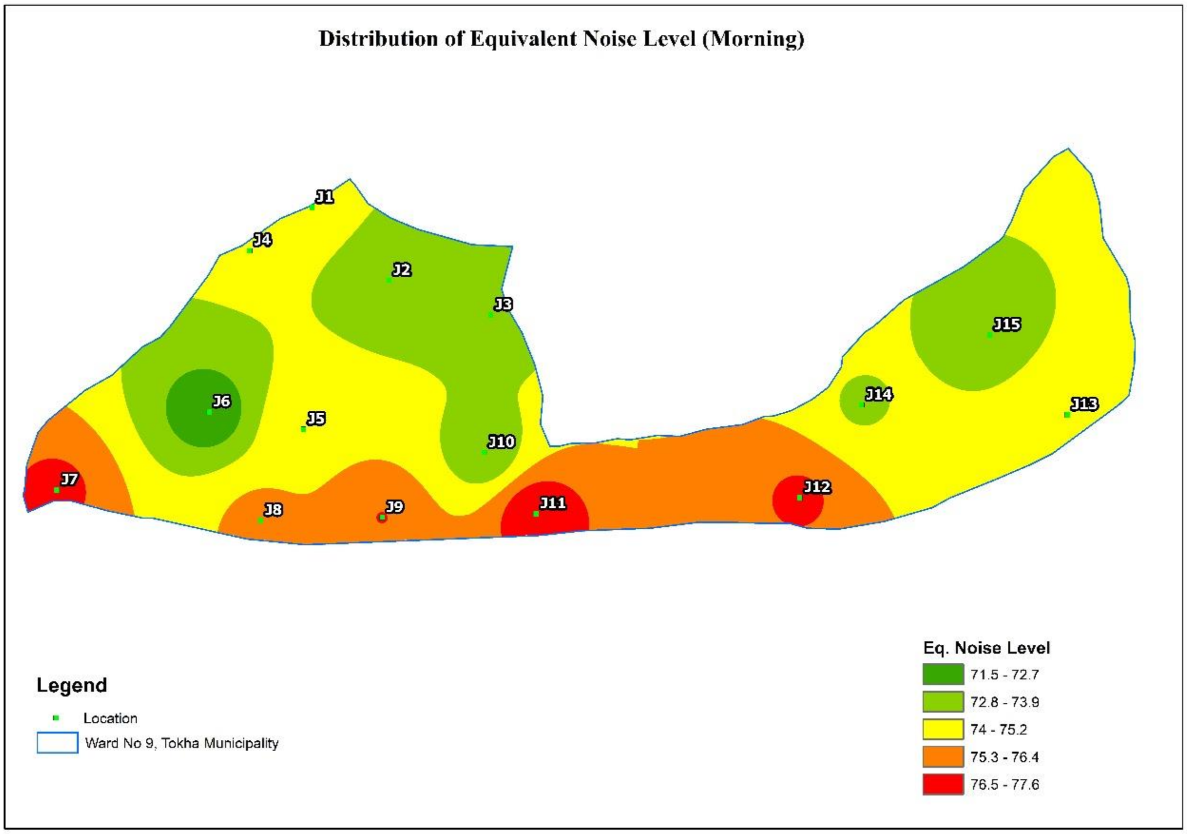

Figure 4.7: Noise hazard map of study area during morning time

b. Evening Time

The noise hazard map of equivalent noise during evening time (4 PM – 6 PM) of the study area was prepared with the help of Arc GIS tool. The noise hazard map was plotted from the equivalent noise level and the map was colored with different colors on the basis of intervals. This color combination was selected only for distinct notice of differ in equivalent noise level from one junction to another. Equivalent noise level measured in 15 different road junctions during evening time within ward 9 of Tokha Municipality shows the indication by red color (77.2-78.2 dBA), orange color (76.1-77.1 dBA), yellow color (75-76 dBA), light green color (73.9-74.9 dBA) and dark green color (72.7-73.8 dBA). During evening time higher noise level indicated by red color was seen in J_7 (Buspark Chowk) and J_{11}(Gongabu Chowk) as these chowks are connected with ring road and most busy chowks with heavy traffic flow was seen in this area. The lowest equivalent noise level noise was indicated by dark green color that was seen in J_6 (Buddha Chowk) and J_2 (Siddi Chowk) due to quitter environment with low flow of vehicles in comparison to other noise measured junctions.

By analyzing the spatial distribution, residents and urban planners can identify areas prone to higher noise exposure, aiding in targeted mitigation strategies such as sound barriers or traffic management. This information is crucial for understanding the impact of noise on the community and guiding future urban development plans to minimize noise-related health concerns and enhance the overall quality of life in Tokha Municipality's Ward 9.

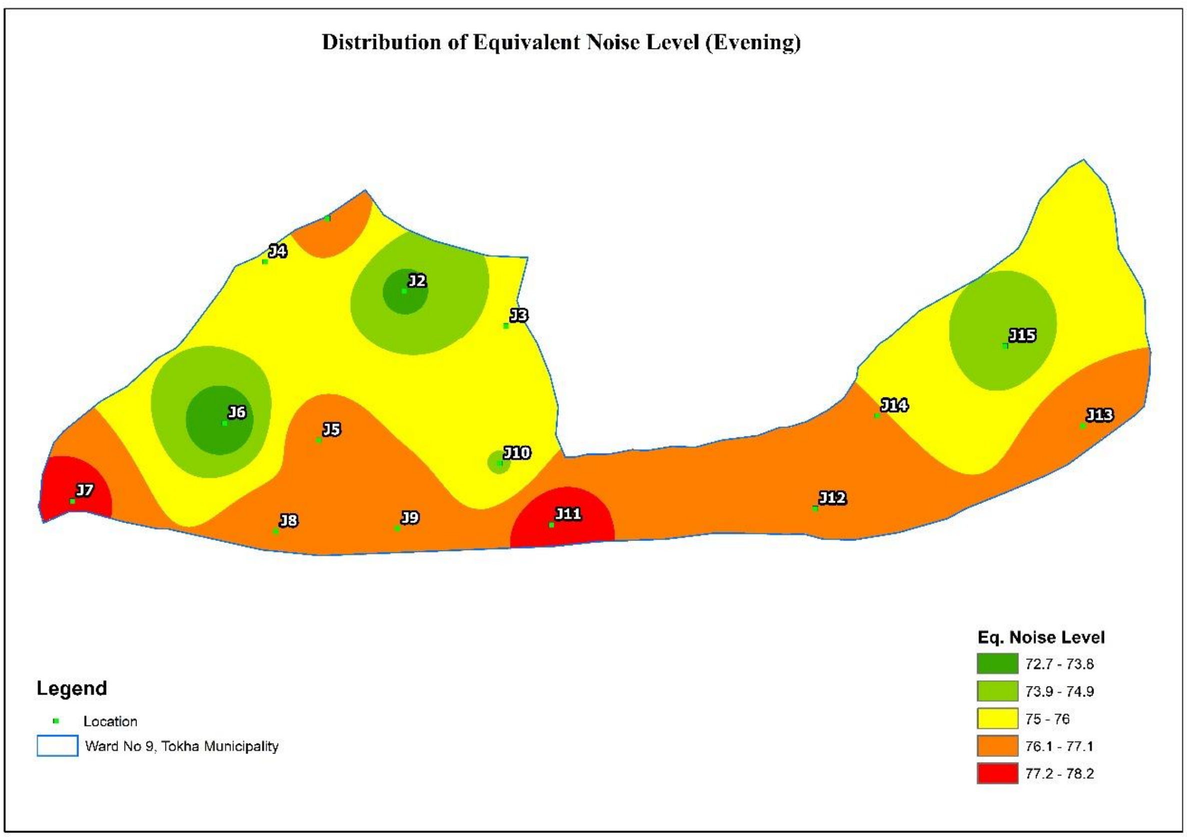

Figure 4.8: Noize hazard map of study area during evening time

4.1.4 People's Perception on Traffic Noise

Questionnaire survey on people's perception on traffic noise was conducted among 60 people within this study area. This includes businessman, medical assistant, women, local people etc.

The survey data on people's perception of traffic noise provides valuable insights into the awareness, impact, and opinions of the surveyed population. All 60 respondents indicate awareness of traffic noise, highlighting a universal recognition of this environmental concern. The major sources of traffic sound were identified, with 100% citing cars/taxis, 62% buses/micros, 100% bikes, and 40% mentioning other vehicles, such as delivery vehicles and ambulances, demonstrating a comprehensive understanding of the diverse sources contributing to traffic noise.

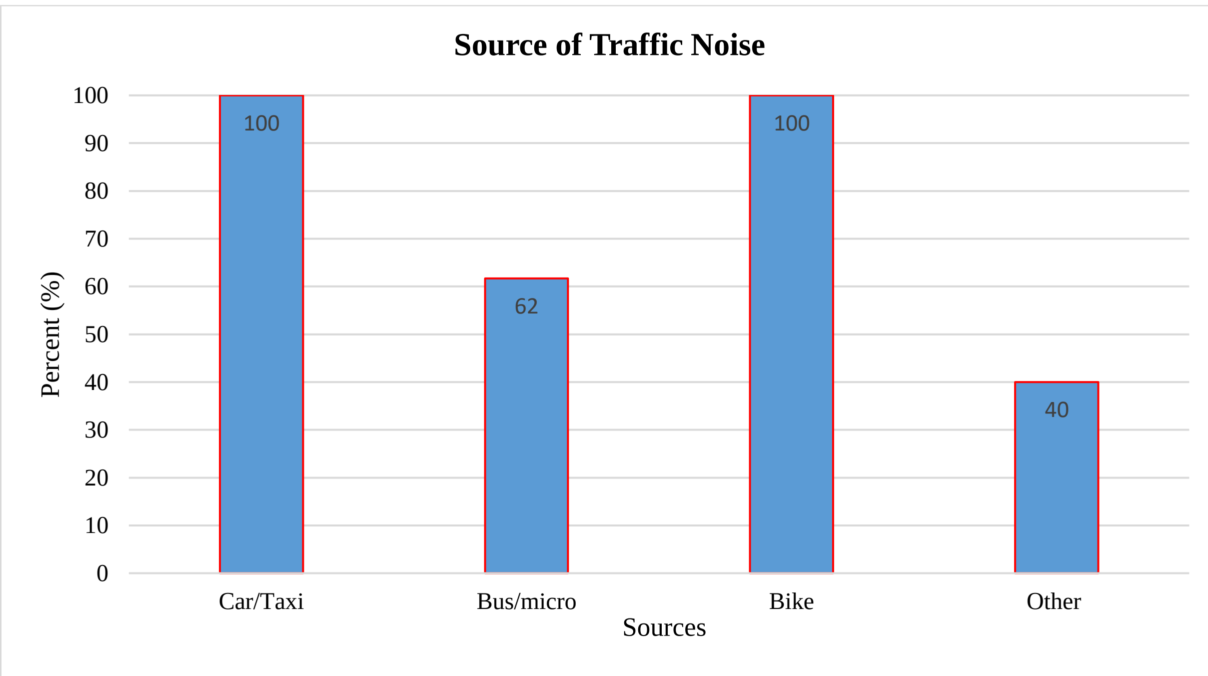

Figure 4.9: Sources of traffic noise in study area

Concerning the timing of loud traffic noise in their locality, a substantial number of respondents identify the morning (90%) and evening (95%) as the most common periods, emphasizing the impact of traffic noise on resident's daily routines.

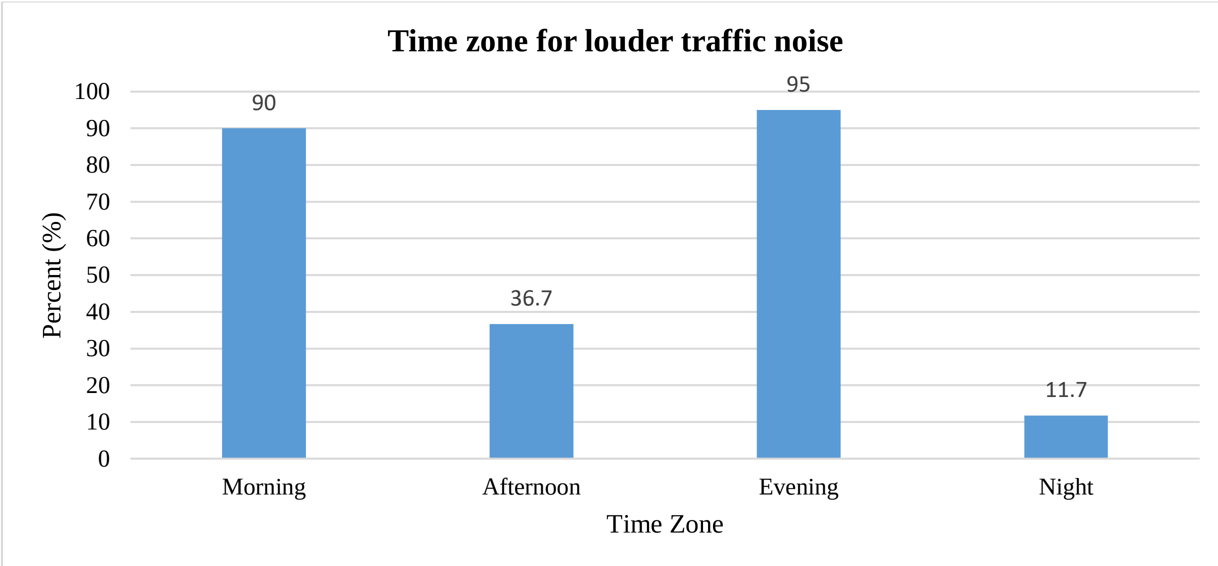

Figure 4.10: Time zone for louder traffic noise

While a majority of respondents (61.7%) claim that traffic noise rarely impacts their ability to concentrate on their daily routine, a notable portion (31.7%) acknowledges occasional impacts, suggesting a potential influence on their daily lives.

The awareness of potential health impacts due to traffic noise is high, with 85% of respondents acknowledging these effects. However, only a small fraction (3.3%) claims to have experienced physical symptoms, such as stress, irritability, and headaches, due to exposure to traffic noise, indicating that while awareness is prevalent, direct personal experiences of health impacts are limited among the surveyed population.

None of the respondents have taken preventive measures to mitigate the impact of traffic noise at home, such as installing soundproof windows or using white noise machines, suggesting a potential area for intervention or awareness campaigns. Moreover, a significant majority (78.3%) perceives that authorities have not taken adequate incentives to reduce traffic noise in their living environment.

Respondents suggest various effective measures to reduce traffic noise, including declaring no horn zones (18.3%), promoting public transportation usage (56.7%), enforcing lower speed limits in residential areas (31.7%), encouraging the use of electric vehicles (46.7%), and imposing fines for unnecessary horn usage (78.3%). These suggestions highlight a multifaceted approach to addressing traffic noise, combining regulatory measures, infrastructure development, and behavioral interventions.

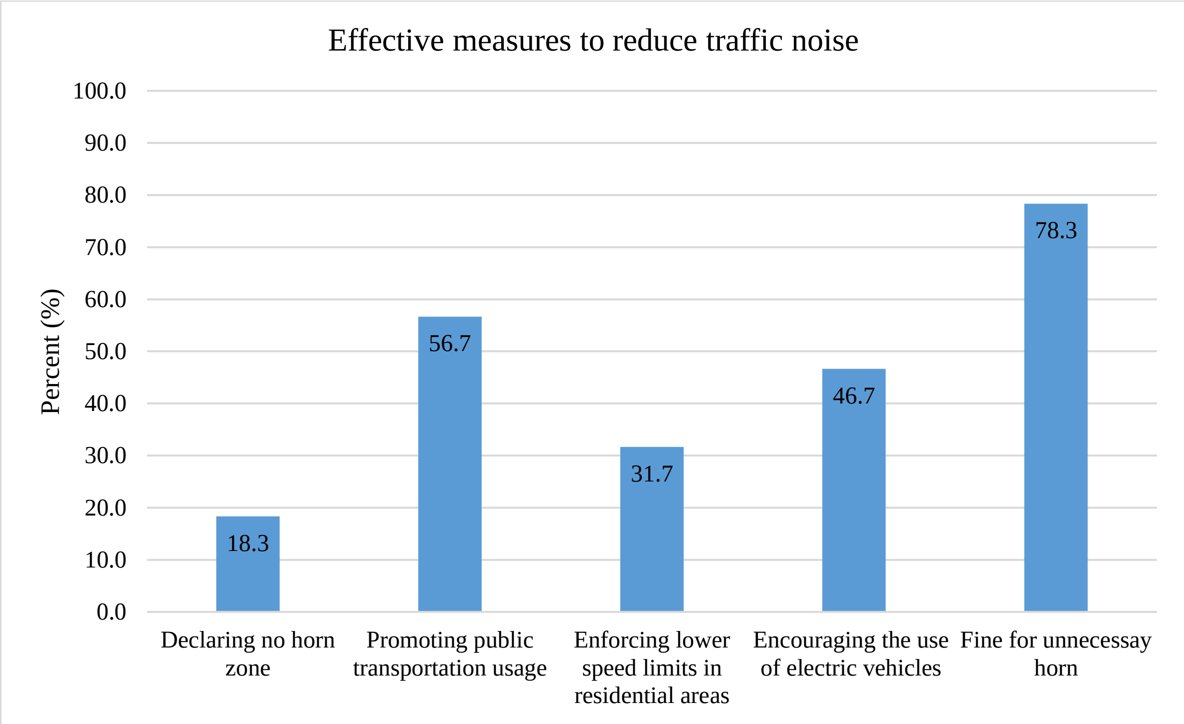

Figure 4.11: Effective measures to reduce traffic noise

In terms of agreement with the statement "A reduction in traffic noise is essential for a safe and healthy ecosystem," the majority (61.7%) either agree or strongly agree, underlining a shared belief in the significance of noise reduction for overall well-being. These findings collectively indicate a nuanced understanding of traffic noise issues among the surveyed population, along with suggestions for comprehensive solutions and a willingness to support noise reduction initiatives for a healthier ecosystem. In summary, the data underscores the pervasive awareness of and concern about traffic noise among the surveyed population. It also indicates a notable dissatisfaction with current noise control measures, suggesting a need for more effective interventions to address the impact of traffic noise on residents' daily lives.

4.2 Discussion

The equivalent traffic noise of study area was ranges from 71.5 dBA to 77.6 dBA in the morning time (9-11 AM) and 72.7 dBA to 78.2 dBA in the evening time (4-6 PM). However, these values exceed the standard limit of 63 dBA as per the Nepal Rajpatra published on Kartik 13 for mixed residential areas. This means that these noise levels have greater impact on human health as well as environment. Highest equivalent noise levels both morning and evening time was seen at Gongabu Chowk (77.6 dBA in morning and 78.2 dBA in evening) as it is connected with ring road and has the higher probability of finding public transport the residents of Tokha municipality commute there for transportation purposes. This value is also higher than the result derived by Singh et.al [36] at same chowk in which L_{eq} ranges from 71.5 dBA in morning to 77.6 dBA and in the evening. The L_{eq} of evening time was seen abit higher than that of morning time as residents of ward number 9 of Tokha Municipality additionally commute for evening shopping and purchases of daily household needs along with their daily office- home travel. The road junctions that are connected with ring road (Buspark chowk, Kulaanta chowk, Shiva Mandir Chowk, Gongabu Chowk, Samakhusi chowk, Talimkendra chowk) had equivalent noise level above 75 dBA, which is harmul to human health and environment as per the WHO.

Likewise, Praveen et al [26] conducts a research in the Kathmandu Metropolitian City, which lies adjacent to the Tokha municipality. In my field location, Ward no. 26 of KMC lies right beneath Ward no. 9 of Tokha municipality, locating at Gongabu. The findings from the research showcase that the equivalent sound level of Ward no. 26 Gongabu of KMC is 83.11 dBA whereas in my measurement location Gongabu scores at 77.6 dBA in the morning and 78.2 dBA in the evening. This exhibits that the noise level during the daytime elevates and Ward no. 9 Gongabu of Tokha municipality becomes one important gateway of heavy traffic noise in the Kathmandu Metropolitian City.

These variations underscore the importance of considering peak noise events alongside average noise levels for a comprehensive assessment. Further investigation into the sources contributing to elevated noise peaks, their potential impacts on the local community, and compliance with noise standards will be crucial for devising effective noise management strategies and urban planning in the region. The maximum noise during morning and evening were varies from 88.8 dBA to 101.4 dBA which was higher than the result at Siddharthanagar Municipality, Rupandehi [37]. The minimum noise during morning and evening time was varies from 51.1dBA to 62.6 dBA which was due to background noise other than vehicles. The maximum and minimum noise level were 101.4 dBA and 51.1 dBA which is lower than the results shown at Banepa, Kavre [22].

The hazard map generated from the comparison of equivalent noise levels highlights persistent elevated noise levels at various junctions, emphasizing the need for effective noise management strategies in ward number 9 of Tokha Municipality. Potential measures include traffic management, sound barriers, and public awareness campaigns. Specific attention is recommended for investigating noise sources contributing to peak events, allowing for targeted interventions. The study underscores the importance of compliance with established noise standards and guidelines, such as those set by the World Health Organization (WHO), to guide the development and implementation of noise reduction strategies.

The survey results indicate that all 60 respondents are aware of traffic noise, with unanimous recognition of car/taxi, bus/micro, bikes, and other vehicles as major sources. The majority of respondents note that traffic noise is loudest in the morning and evening, aligning with the observed diurnal pattern in the acoustic environment. Additionally, a considerable number of respondents acknowledge the potential health impacts of traffic noise, with two individuals reporting stress, two reporting irritability, and one reporting headaches due to exposure. The survey sheds light on the public's coping mechanisms, revealing that none of the respondents have taken measures like installing soundproof windows or using white noise machines to mitigate the impact of traffic noise at home. Furthermore, the majority of respondents (47 out of 60) believe that authorities have not taken sufficient incentives to reduce traffic noise in their living environment. Interestingly, the community provides valuable insights into effective measures to reduce traffic noise, with a notable emphasis on promoting public transportation usage, enforcing lower speed limits in residential areas, encouraging electric vehicle use, declaring no horn zones, and imposing fines for unnecessary horn usage.

In urban residency of India, noise pollution at the road is mainly seen due to the improper use of traffic horns and extensive use of loudspeaker [38]. However, in my findings, the major causing of road traffic noise is due to bikes and taxis/car. This opens up an avenue that excessive noise level can be because of improper use of horns. Regular usage of loudspeakers for public purpose has been restricted by the municipality in that location. There are detrimental effects on health as a result of noise pollution, some of these conditions are stress, high blood pressure, cardiovascular diseases, peptic ulcers, and headaches induced by migraine. The effects of noise pollution traverse different dimensions and impacts such as physical, physiological, psychological, and communication-related diseases.

Through this research, we can further recommendations by the monitoring of sound levels and excessive horns at the municipal scale in urban and semi-urban settings. Noise descriptors at different points were identified through the noise hazard mapping, and for the reduction of direct or indirect noise pollution Nungate and Alam [39] recommend the following measures development of pedestrian and cycling lanes, increasing the use of more greenery and sound-absorbing materials in the road side, restricting the use or pressure and multi-tone horns, checking the vehicle’s condition, and effecting enforcement of noise pollution control and regulation as per the standard.

Considering these perceptions alongside the quantitative data on noise levels, it becomes evident that community engagement is crucial for developing effective noise management strategies. The public's awareness of the issue, their understanding of potential health impacts, and their suggestions for mitigation measures should be integrated into the decision-making process. This collaborative approach, combining technical data with community insights, is essential for creating a holistic and sustainable noise reduction strategy in ward number 9 of Tokha Municipality.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

In conclusion, this comprehensive study sheds light on the intricate soundscape of Tokha Municipality, with a specific focus on 15 road junctions in Ward 9. The empirical examination, coupled with hazard mapping and community perceptions, reveals a notable concern—the persistent elevation of noise levels, particularly during the evening hours, exposing residents to potential health and environmental risks. The Hazard Map, an outcome of the comparative analysis, vividly highlights noise hotspots, with Gongabu Chowk emerging as a focal point, recording the highest levels of 77.6 dBA in the morning and 78.2 dBA in the evening. These values surpass the thresholds set by the World Health Organization for irritation and noise pollution, indicating a critical soundscape imbalance. The revelation that noise levels remain consistently above 70 dBA during the morning and evening across all study areas underscores the urgency for targeted interventions.

Specifically, the acknowledgement of traffic as a major contributor to elevated noise, exemplified by Gongabu Chowk, aligns with both empirical measurements and community perceptions. The disparity in noise levels, ranging from the highest at Gongabu Chowk to the lowest at Buddha Chowk, underscores the direct correlation between traffic volume and noise pollution. As this study concludes, the identified effective measures proposed by the community, such as promoting public transportation and enforcing speed limits, should guide future noise reduction strategies. Gongabu Chowk, with its exceptionally high noise levels, stands as a stark reminder of the pressing need for intervention, perhaps through traffic management and infrastructure improvements.

Moving forward, bridging the gap between empirical findings and community insights remains crucial. Deeper investigations into the specific sources contributing to noise peaks, along with continued community engagement, will refine noise management strategies. In doing so, this study not only contributes valuable data but advocates for an integrated, holistic approach that prioritizes the well-being and quality of life for the residents of ward number 9 of Tokha Municipality.

5.2. Recommendation

- It is recommended to conduct further studies on noise pollution in extensive way which include day and night separation if there is a device that can deliver equivalent noise levels for 12 hours, as enforced by the Government of Nepal
- Further research can be done on the effects of noise pollution on health of people living within ward 9 of Tokha Municipality.
- Several strategies such as provision of fines for unnecessary horn, promotion of electric vehicles, promotion of public transport etc can be implemented by concern authorities inorder to control traffic noise pollution.

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APPENDICES

Appendix-1: Questionnaire for the People's Perception on Traffic Noise

Name of respondent:
Age:
Gender:
Occupation:

1. Do you know about traffic noise?

a. Yes b. No

If yes then,

2. What are the major sources of traffic sound?

a. Car/tax b. bus/micro c. bike d. other such as delivery vehicles, ambulance etc

3. When is the traffic noise loud in your locality?

a. Morning b. Afternoon c. Evening d. Night

4. How much does traffic noise impact your ability to concentrate on your daily routine?

a. Never b. Rarely c. Occasionally d. Frequently e. Very frequently

5. Are you aware of potential health impacts due to traffic noise?

a. Yes b. No

6. Have you experienced any physical symptoms due to exposure to traffic noise?

a. Yes b. No

5.1 if yes, what are the symptoms:

a. Anxiety
b. Stress
c. Nervousness
d. Irritability
e. Headache
f. Hearing loss
g. Other

7. Have you taken any measures to reduce the impact of traffic noise in your home, such as installing soundproof windows or using white noise machines?

a. Yes b. No

8. Do you think the authorities taken any incentives in reducing traffic noise in your living environment?

a. Yes b. No

9. What do you think the effective measures to reduce traffic noise?

a. Declaring no horn zone

b. Promoting public transportation usage
c. Enforcing lower speed limits in residential areas
d. Encouraging the use of electric vehicles
e. Fine for unnecessary horn

10. To what extent do you agree with the following statement: "A reduction in traffic noise is essential for a safe and healthy ecosystem"?

a. Strongly Disagree   b. Disagree   c. Neutral   d. Agree   e. Strongly Agree

Appendix-2: Photographs

Photo Plate-1: Noise measurement at Jagaran Chowk during evening time

Photo Plate-2: Noise measurement at Buspark Chowk during morning time

Photo Plate-3: Noise measurement at Club Chowk during morning time

Photo Plate-4: Noise measurement at Gongabu chowk during evening time

Photo Plate-5: Noise measurement at Kulaanta Chowk during morning time

Photo Plate -6: Noise measurement at Samakhusi Chowk during evening time

Photo Plate-7: Noise measurement at Shivamandir Chowk during morning time

Photo Plate-8 Noise measurement at Siddi Chowk during evening time

Photo Plate-9: Noise measurement at Talimkendra Chowk during morning time

Photo Plate-10: Noise measurement at Myagdi Chowk during evening time

Photo Plate-11: Traffic jam at Gongabu Chowk during evening time

Photo Plate-12: Traffic jam at Samakhusi Chowk during evening time

Photo Plate-13: Questionnaire survey with businessman

Photo Plate-14: Questionnaire survey with businessman

Photo Plate- 15: Questionnaire survey with medical assistant

Photo Plate-16: Questionnaire survey with women in study area