



ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Assessment of Road Safety Audits in Reducing Traffic Accidents: The Case of
Addis Ababa City**

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The project Submitted to the School of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Master of Science Degree in Civil Engineering, Specializing Road and Transport Engineering.

May 18, 2025
Addis Ababa
Ethiopia

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The undersigned have examined the thesis entitled (**Assessment of Road Safety Audits in Reducing Traffic Accidents: The Case of Addis Ababa City**) presented by **Addisu Getahun**, a candidate for the **Degree of Master of Science in Road and Transportation**.

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UNDERTAKING

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ABSTRACT

This audit evaluates road safety conditions across three major urban corridors in Addis Ababa: Leghar to Ayat via Megenagna and CMC, Shiromeda to Bole via 6 Kilo, and Megenagna to Kara. The assessment used a checklist of 78 items to review key infrastructure components including traffic signage, road markings, street lighting, pedestrian facilities, guardrails, landscaping, and other roadside safety features. The findings reveal widespread deficiencies, particularly in the areas of traffic signing, road markings, and pedestrian safety. While certain elements—such as street lighting coverage and landscaping were found to be partially compliant, critical features like clear zones, protective barriers, and accessibility infrastructure remain largely inadequate. These shortcomings pose serious safety risks to both motorists and pedestrians. Of particular concern is the Megenagna to Kara corridor, which is outdated and has not been upgraded due to ongoing corridor development. This route demands urgent attention and safety intervention. In contrast, newer corridors show relatively better performance but still require formal traffic safety audits and effective implementation of RSA findings. Overall, the audit highlights the demanding need for a wide-ranging infrastructure improvement plan and the systematic integration of Road Safety Audits (RSAs) into all current and future road development projects in Addis Ababa.

Key words: Traffic safety, Accident: Crash severity: Safety Audit,

ACKNOWLEDGMENTS

Firstly, I want to express my gratitude to the Almighty God for granting me success in this study.

Then, I extend my heartfelt thanks to my advisor, Dr. Yonas Minalu; I was very fortunate to have you.

Thirdly, I am grateful to the AAiT School of Civil and Environmental Engineering community and my friends for their moral support

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Acronyms

ADB	Asian Development Bank
DDP	Detailed Design Phase
DMC	Developing Member Countries
FSI	Fatal and Serious Injury
MoT	Ministry of Transport
NRSAP	National Road Safety Action Plan
PPD	Preliminary Design Phase
PPR	Pre-Opening Phase Review
PRS	Post-Opening Review Stage
RSA	Road Safety Audit
RTA	Road Traffic Accident
SA	Safety Audit
UK	United Kingdom

CHAPTER 1 INTRODUCTION

1.1 Background of the study

Urban road safety is a critical issue in growing cities where traffic congestion and increasing vehicle numbers contribute to frequent road accidents. Road safety audits (RSAs) have emerged as a proactive approach to identify and mitigate risks on road networks before accidents occur. Road traffic accidents resulting in deaths and injuries occur worldwide. It was estimated that over 1.2 million people died each year on the world roads as a result of road traffic accidents. According to a survey by WHO, more than 3,200 people get killed and over 130, 000 injured every day due traffic accidents across the world. Almost half of all occurred fatal accidents involve vulnerable road users, such as pedestrians, cyclists and power two wheelers. Road death varies based on the level of income of each nation across our globe. It can be observed from Figure 1.0 that more than 85% of accident fatalities occur in low- and middle-income countries, such as Ethiopia. Though road fatality rate in high income countries has been decreasing over the last decades, even in these countries road accidents remain one of the main causes of death, injury and disability(Ahmed et al., 2013).

1.2 What is Road Safety?

Road safety refers to the measures, actions, and practices aimed at preventing accidents and reducing the severity of injuries on roadways. It involves ensuring the safety of all road users, including drivers, pedestrians, cyclists, and passengers, through various strategies like road design, law enforcement, traffic management, and awareness campaigns. Road safety is a critical aspect of transportation planning and management, as it directly impacts public health, economic productivity, and social welfare. Governments and organizations worldwide work together to reduce traffic-related fatalities and injuries by implementing safety protocols and encouraging safe behavior on the roads(Gibbs et al., 2006).

A Road Safety Audit (RSA) is a formal safety performance examination of an existing or planned road or intersection. Conducted by a multidisciplinary team, an RSA evaluates potential road hazards, assesses the effectiveness of current road safety measures, and suggests improvements to enhance safety. The audit process includes a thorough review of road design, traffic signs, road markings, pedestrian facilities, and traffic flow to identify

safety concerns and vulnerabilities that might lead to accidents. RSAs can be carried out at various stages of road development, including the planning, design, construction, and operational stages, ensuring that road safety is prioritized throughout the life cycle of the infrastructure(Heaslip et al., 2010).

Road Safety Audits are essential tools for identifying road safety risks and preventing accidents before they occur. By involving professionals from diverse fields such as engineering, traffic management, and public health, an RSA helps in developing safer roadways for all users. Through detailed evaluations, RSAs ensure that roads are designed to minimize hazards, promote safe driving behaviors, and offer appropriate infrastructure for vulnerable users like pedestrians and cyclists. Ultimately, road safety audits contribute to the creation of safer, more efficient road networks, reducing the number of fatalities and injuries, and improving the overall quality of life for communities(Tumavičė et al., 2020).

1.3 Statement of the problem

Road safety initiatives in urban areas, traffic accidents remain a significant cause of injuries and fatalities. The effectiveness of RSAs in reducing these accidents, particularly in urban road networks, has not been extensively studied. Despite the implementation of road safety audits in urban areas, the rate of traffic accidents continues to rise, suggesting potential gaps in the effectiveness of these audits in addressing safety issues(Pietrantonio & Bornsztein, 2015). One key issue is the lack of consistent data on the direct impact of these audits, as there is limited empirical evidence to assess whether they lead to measurable reductions in accident rates. Moreover, challenges in implementing audit recommendations further weaken the effectiveness of these audits, as many identified hazards remain unaddressed. The success of road safety audits also varies across different types of urban roads, with some experiencing greater reductions in accidents than others, indicating that road-specific factors play a role in audit outcomes. Additionally, the current audit procedures may not be comprehensive enough, failing to address all potential hazards, which contributes to the persistence of traffic accidents. This study seeks to evaluate the existing road safety audit processes, assess their actual impact on accident reduction, and propose enhancements to improve their effectiveness in urban settings.

1.4 Research question

- What are the stages of RSA in Addis Ababa City?
- What is looks like Addis Ababa city road in terms of safety?
- What are the limitations of current RSA and recommendations from RSAs conducted in in Addis Ababa City?

1.5 Objective of the study

The main goal of this study is assessment of road safety audits in reducing traffic accidents.

1.5.1 Specific objectives

- To Assess the stages of the RSA process in Addis Ababa City.
- To analyze the current state of road safety in Addis Ababa City.
- To provide recommendations from RSAs conducted in Addis Ababa City.

1.6 Scope of the study

The scope of this study will cover two major roads: the Leghar to Ayat route and the Shiromeda to Bole route. These roads are existing corridors where development projects have already been completed.

1.7 Significance of the study

Traffic Safety Audit (TSA) study is crucial for identifying potential road hazards, improving infrastructure design, and enhancing overall traffic safety. It helps prevent accidents by detecting risks early, ensuring compliance with safety regulations, and promoting cost-effective road planning. By evaluating road conditions, driver behavior, and traffic flow, TSA studies support data-driven decision-making for policymakers and engineers. Additionally, they contribute to sustainable mobility by creating safer environments for pedestrians, cyclists, and motorists. Ultimately, a TSA study plays a vital role in reducing traffic-related injuries and fatalities while improving transportation efficiency.

1.8 Limitation of the study

During the preparation of this document, the writer encountered a few challenges. One major issue will be a financial constraint and reaching Traffic Police Officers will be difficult

because they will frequently be occupied with various duties and often away from their offices.

1.9 Structure of the work

The format of thesis is structured based on the type of research being done, the typical thesis structure of this study is as follow.

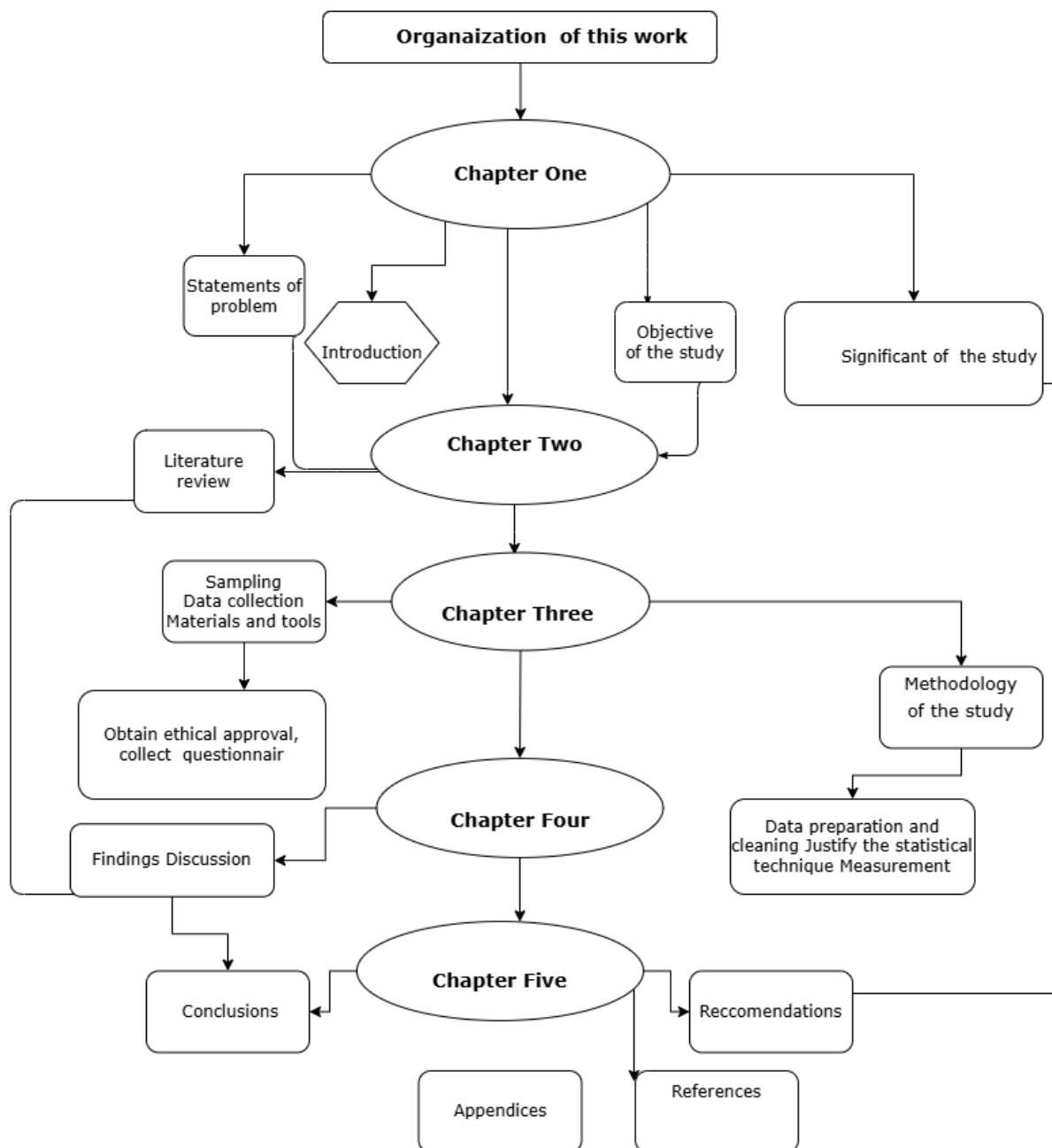


Figure 1 Structure of the work

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This literature review aims to provide a comprehensive summary of studies relevant to the proposed research title, focusing on various aspects of the Road Safety Audit (RSA) process. It examines methodologies used in previous studies, identifies factors influencing network hierarchy, explores different modeling techniques, and analyzes insights from case studies. The RSA process consists of four key aspects: the institutional framework, which establishes policies and responsible organizations; audit implementation arrangements, which define roles, responsibilities, and coordination; audit stages, which encompass planning, reporting, and follow-up actions; and the audit process, which follows a step-by-step methodology to identify and assess road safety issues. Additionally, this review highlights research gaps, establishing a strong foundation for the study and clarifying its contribution to existing knowledge. Road Safety Audits (RSA) are proactive safety management tools used to evaluate road infrastructure at different stages of planning, design, construction, and operation. They help identify potential hazards and recommend safety improvements to minimize road accidents. Unlike reactive safety measures that address issues after accidents occur, RSA takes a preventive approach, ensuring that road designs and traffic systems prioritize safety from the outset. The effectiveness of RSA lies in its multidisciplinary approach, involving engineers, planners, and traffic safety experts to create safer road environments for all users, including pedestrians, cyclists, and motorists.

2.2 Definition and purpose of Road Safety Audits

2.2.1 What Is a Road Safety Audit?

A Road Safety Audit (RSA) is a systematic process that integrates traffic safety expertise into road planning and design to help prevent crashes. It involves a formal assessment of a road or road project, conducted by an independent, qualified auditor or a team of auditors. These experts evaluate potential risks to road users and recommend safety improvements. Auditors may be in-house safety specialists within the road authority or external consultants with expertise in road safety (Ahmed et al., 2013).

Road Safety Audit (RSA) is a formal and systematic evaluation of a road project conducted by an independent team of qualified professionals to identify potential safety concerns. It is carried out at various stages of a road's design, construction, and operation to ensure that safety risks are minimized. The main goal of an RSA is to enhance road safety by proactively identifying and addressing hazards before they contribute to accidents and fatalities. The purpose of a Road Safety Audit is to improve the overall safety of road infrastructure for all users, including motorists, pedestrians, and cyclists. Unlike traditional safety inspections, RSAs focus on preventing accidents before they occur rather than merely analyzing past crash data. This proactive approach helps road designers and engineers implement changes that reduce potential risks and enhance the overall safety of the transportation network(Huvarinen et al., 2017).

Road Safety Audits also contribute to cost-effective road improvements by identifying safety issues early in the planning and design phases, thereby reducing the need for expensive modifications after construction. By addressing safety concerns at the design stage, RSAs help governments and transportation agencies avoid future costs related to accidents, medical expenses, and infrastructure repairs. This makes RSAs an essential tool in sustainable road development(Kumar & Mathur, 2022)

Another key purpose of RSAs is to ensure that road infrastructure is designed with all road users in mind. Many road networks primarily focus on vehicular traffic, often overlooking the needs of pedestrians, cyclists, and persons with disabilities. An effective RSA ensures that roads are inclusive and accommodate all users safely, promoting equitable and accessible transportation systems. Ultimately, Road Safety Audits play a crucial role in reducing traffic accidents, fatalities, and injuries. By integrating safety assessments into road planning and development, RSAs help create safer roads, improve traffic efficiency, and support economic growth by ensuring secure and reliable transportation systems. Countries that implement regular RSAs see significant improvements in road safety and reduced accident rates, contributing to overall public well-being. A Road Safety Audit (RSA) is a structured and systematic evaluation of a planned or existing road project conducted by an independent, qualified, and multidisciplinary team. The audit identifies potential crash risks and provides recommendations for safety improvements. Originally developed in the United Kingdom in the 1980s, RSAs are now widely recognized as one of the most cost-effective methods for enhancing road safety and reducing crash risks. They can be conducted at any stage of a road project's life cycle through an eight-step process(Heaslip et al., 2010).

RSAs align with the Safe Systems Approach to road safety management, which aims to ensure that human errors do not result in fatalities or severe injuries. The issue of road safety is widely acknowledged as a multidisciplinary and multisectoral challenge. The Asian Development Bank (ADB) has developed comprehensive guidelines to assist its Developing Member Countries (DMCs) in formulating and implementing effective road safety policies. According to these guidelines, the most effective approach to improving road safety involves collaboration among key agencies within each country. Each agency should implement coordinated action plans within its respective area of responsibility (Tumavičė et al., 2020).

To ensure effective coordination, a road safety council comprising representatives from all key stakeholders or a multisectoral committee led by a designated ministry should oversee these efforts. The guidelines outline potential institutional arrangements and priority actions for various sectors. In terms of specific road safety measures, agencies may engage in location improvement programs aimed at reducing traffic crashes. Additionally, they may conduct traffic crash prevention initiatives by performing Road Safety Audits (RSAs). These audits can be conducted either by the agencies themselves or through subcontracting qualified domestic consultants. Regardless of the approach, agencies are generally responsible for developing, updating, and managing RSA procedures on behalf of the roads department (Bala & Adamu, 2017).

2.2.2 Global Adoption of Road Safety Audits

The RSA concept was first introduced in the United Kingdom (UK) in 1989. Recognizing its effectiveness, many countries, including Australia, Denmark, New Zealand, and the UK, have since adopted similar safety assessment systems. Other developed nations are also increasingly incorporating RSA principles into their road safety management strategies.

It is important to note that RSAs focus on crash prevention rather than crash reduction. While RSAs help identify and mitigate risks before accidents occur, they do not specifically address existing crash-prone areas. To create safer road networks, both crash prevention (through RSAs) and crash reduction (through hazardous location improvement programs) must be implemented together. While RSAs alone cannot eliminate all safety risks, they play a critical role in preventing conditions that may lead to road accidents (Gibbs et al., 2006).

2.3 Theoretical Framework of Road Safety Audits

2.3.1 Principles of Road Safety Audit (RSA)

The fundamental principle of a Road Safety Audit (RSA) is to proactively identify and mitigate potential safety risks before they lead to crashes. RSAs follow a preventive approach rather than a reactive one, ensuring that road designs and existing roads are evaluated with safety as the top priority. This process adheres to the Safe Systems Approach, which recognizes human error and aims to reduce the severity of crashes. Additionally, RSAs are conducted by an independent and multidisciplinary team, ensuring an unbiased and comprehensive assessment of road safety risks.

2.3.2 Methodologies of Road Safety Audit

The RSA methodology involves a structured and systematic process that applies to all stages of a road project from planning and design to construction and operation. It typically follows an eight-step process, which includes defining the audit scope, gathering relevant data, conducting field inspections, identifying safety issues, and providing recommendations. Auditors rely on a combination of site observations, crash data analysis, and engineering judgment to assess road conditions and user behavior. The audit team then prepares a detailed report with recommended improvements to enhance road safety.

2.3.3 Application and Effectiveness of RSA

RSAs are widely used as an effective tool for crash prevention in many countries. By identifying risks early in the project lifecycle, RSAs help reduce long-term costs associated with road crashes and subsequent modifications. The methodology promotes a collaborative approach, encouraging road authorities, designers, and policymakers to work together in implementing safety measures. While RSAs alone cannot eliminate all risks, they are a proactive and cost-effective strategy that contributes significantly to the creation of safer road networks.

2.3.4 Principles in Network-Level Road Safety Management Strategies

Road safety practitioners emphasize the importance of deliberate planning to enhance road safety. Traditionally, they have aimed to address all types and severities of crashes minor, serious, and fatal through a combination of reactive and proactive/predictive approaches:

Reactive Policies and Activities: These focus on analyzing past crashes to prevent similar incidents from recurring at the same location. Common activities include crash investigation,

identification of high-risk locations, and targeted interventions to mitigate known crash patterns (Austroads, 2015a).

Proactive Policies and Activities: These involve identifying and predicting risks at specific locations before crashes occur. The goal is to mitigate risks—either by eliminating or reducing them to prevent foreseeable fatal and serious injury (FSI) crashes. Road Safety Audits (RSA) for design plans or operational locations fall under this category. Additionally, mass action treatment programs for homogeneous road segments are considered proactive measures.

2.3.5 Road Safety Audit Process and Stages

The **Road Safety Audit (RSA)** process is a critical element of proactive road safety management. It involves a systematic evaluation of road infrastructure projects at different stages to identify potential safety risks. The key stages of the RSA process include:

1. **Feasibility Stage:** Identifies high-level safety concerns before project planning begins. At this stage, the scope and characteristics of the scheme are evaluated, and the initial parameters for the design are established. These include route alternatives, applicable design standards, integration with the existing road network, the number and types of intersections, and whether the proposed road will be accessible to all types of traffic.
2. **Preliminary Design Stage:** Evaluates the road design concept to ensure safety principles are embedded. General layouts for horizontal and vertical alignments, as well as junction configurations, are defined at this stage. By the end of this phase, the design should be sufficiently developed to support any required decisions regarding land acquisition
3. **Detailed Design Stage:** Reviews finalized design plans for any potential hazards before construction. The layout, signage, road markings, lighting, roadside equipment, and landscaping are all finalized during this phase.
4. **Pre-Opening Stage:** Assesses the completed infrastructure before it is opened to traffic. Just before opening, the new or modified road should be tested by driving, cycling, and walking under various conditions, including at night and in adverse weather.
5. **Post-Opening Stage:** Examines safety performance after the road is in use to identify any emerging risks. After a new or upgraded road has been in use for several months,

its performance can be evaluated to determine if it functions as intended and whether any design modifications are needed based on actual user behavior.

Table 1 Road Safety Audit Process and Stages

RSA Stage	Description
Feasibility Stage	Identifies high-level safety concerns before project planning begins. Evaluates scheme scope, route alternatives, design standards, network integration, intersection types, and road accessibility.
Preliminary Design Stage	Assesses design concepts to embed safety principles. Defines layouts for horizontal/vertical alignments and junctions. Supports decisions such as land acquisition based on preliminary plans.
Detailed Design Stage	Reviews finalized design plans for hazards prior to construction. Focuses on layout, signage, markings, lighting, roadside equipment, and landscaping to ensure safety compliance.
Pre-Opening Stage	Evaluates infrastructure readiness just before opening. Involves physical testing (driving, cycling, walking) under various conditions (e.g., nighttime, bad weather) to detect safety issues.
Post-Opening Stage	Monitors road performance after use begins to identify any emerging risks. Informs decisions on design adjustments based on real-world user behavior and crash data analysis.

A well-structured RSA process requires clearly defined roles and responsibilities among key stakeholders. Participants in an RSA generally fall into two groups:

- **Client Team:** Represents the organization commissioning the road project, typically a state or local transport authority. In large projects funded by public agencies or development banks, an externally appointed project manager may oversee the process.
- **Audit Team:** Consists of at least two qualified professionals with expertise in road safety engineering, crash investigation, and road design. The audit team leader is responsible for conducting the audit, liaising with the client team, and ensuring compliance with RSA policies.

2.3.5.1 Ensuring RSA Independence

Maintaining the independence of the RSA process is critical to ensuring unbiased and credible evaluations. If auditors are not independent, several risks may arise, including:

- Failure to identify and address hazards effectively.
- Ethical concerns, such as conflicts of interest and malpractice.
- Pressure to modify findings or provide undeserved positive feedback.

2.3.6 Key Responsibilities in the RSA Process

The project manager plays a crucial role in facilitating the RSA process by:

- ✓ Drafting and issuing the RSA brief.
- ✓ Appointing an independent audit team.
- ✓ Coordinating between the project designer and audit team.
- ✓ Seeking specialist input from planners, traffic engineers, and safety experts.
- ✓ Responding to audit findings and implementing agreed safety measures.

2.3.7 Road Accident Recording Systems in Ethiopia

In Ethiopia, the regional traffic police departments are responsible for recording all traffic accidents within their respective jurisdictions. At the national level, the Federal Police Commission oversees the compilation and processing of accident data. In each woreda police station, accident data are reported manually using standardized forms. These forms capture various details, including the classification of the accident, date, time, day of the week, driver's age, sex, education level, vehicle ownership, and service type. The collected data are first submitted through monthly reports to the respective Regional Police Commissions, which then compile and forward quarterly reports to the Federal Police Commission for generating national accident statistics.

The primary purpose of accident data collection in Ethiopia is to support law enforcement and legal proceedings. However, some of the recorded information, while not directly useful for police operations, is critical for other organizations, such as transport authorities, urban planners, and road safety agencies. Unfortunately, the accident recording system remains outdated and inefficient, particularly at the woreda and zonal levels. Data collection is largely manual, leading to inconsistencies and missing records.

Field experiences indicate significant gaps and challenges in accident data recording. For instance, during data collection efforts in the Gurage Zone, Yem Special Woreda (SNNPR), and Jimma Zone Police Commission offices, it was observed that accident records will be incomplete or entirely missing for periods exceeding four years. Additionally, key details such as accident causes, exact locations, and contributing factors will often not be documented.

properly. A comprehensive and modernized accident recording system is essential to improve road safety analysis and policy-making in Ethiopia.

Casualties from Road Traffic Accidents have been a serious concern of researchers in traffic safety. Models have also been used to study injuries and deaths due to Road Traffic Accidents. For instance, (Gibbs et al., 2006) applied structural time series method to the monthly data series of the numbers killed and seriously injured in Great Britain from January 1969 to December 1984. The results demonstrated the effectiveness of the introduction of seat belt legislation.

(Jacobs, 1986) carried out an analysis of road traffic accident fatalities in 20 developing countries for different years using linear regression and established significant relationships between fatality rates and level of vehicle ownership.

2.4 Gaps in literature review

Despite the extensive literature on Road Safety Audits (RSA) covering their purpose, methodology, global application, and theoretical foundations, several critical research gaps remain, particularly in the context of developing countries like Ethiopia. These gaps include a lack of localized empirical studies, insufficient attention to institutional and implementation challenges, outdated and inefficient accident data systems, and limited integration of RSA findings into broader safety strategies. Moreover, existing studies often overlook vulnerable road users and rarely apply RSA at the network level. Additionally, the use of advanced tools such as GIS mapping and predictive analytics remains minimal, limiting the effectiveness and precision of RSA processes in resource-constrained settings.

CHAPTER 3 METHODOLOGY

3.1 Basic concepts of methodology

This section of the paper discusses about the methodology employed during the whole research execution by commencing the way how the study area selected, certain criteria used, how the data for this study extracted, sorted, and organized, and finally how the analysis conducted.

3.2 Study Area

The study area for this road safety audit project three routes were selected. This were Megenagna–Kotebe/Kara/Leghar to Ayat route and the Shiromeda Via 6kilo to Bole routes. These routes represent a mix of high-traffic arterial roads, signalized and unsignalized intersections, roundabouts, and areas with intense pedestrian and vehicular interaction. The Megenagna-Ayat corridor includes critical segments such as Leghar, Megenagna, CMC, and Ayat, which are characterized by public transport congestion, inadequate pedestrian facilities, and roadside commercial activity. Similarly, the Shiromeda–Bole corridor passes through Shiromeda, Arat Killo, Meskel Square, and Bole, areas with high pedestrian volumes, major institutional and commercial zones, and complex traffic conditions. This safety audit aims to assess existing road infrastructure, identify safety risks for all road users especially pedestrians and vulnerable groups and provide recommendations for improving safety performance along these key urban corridors.

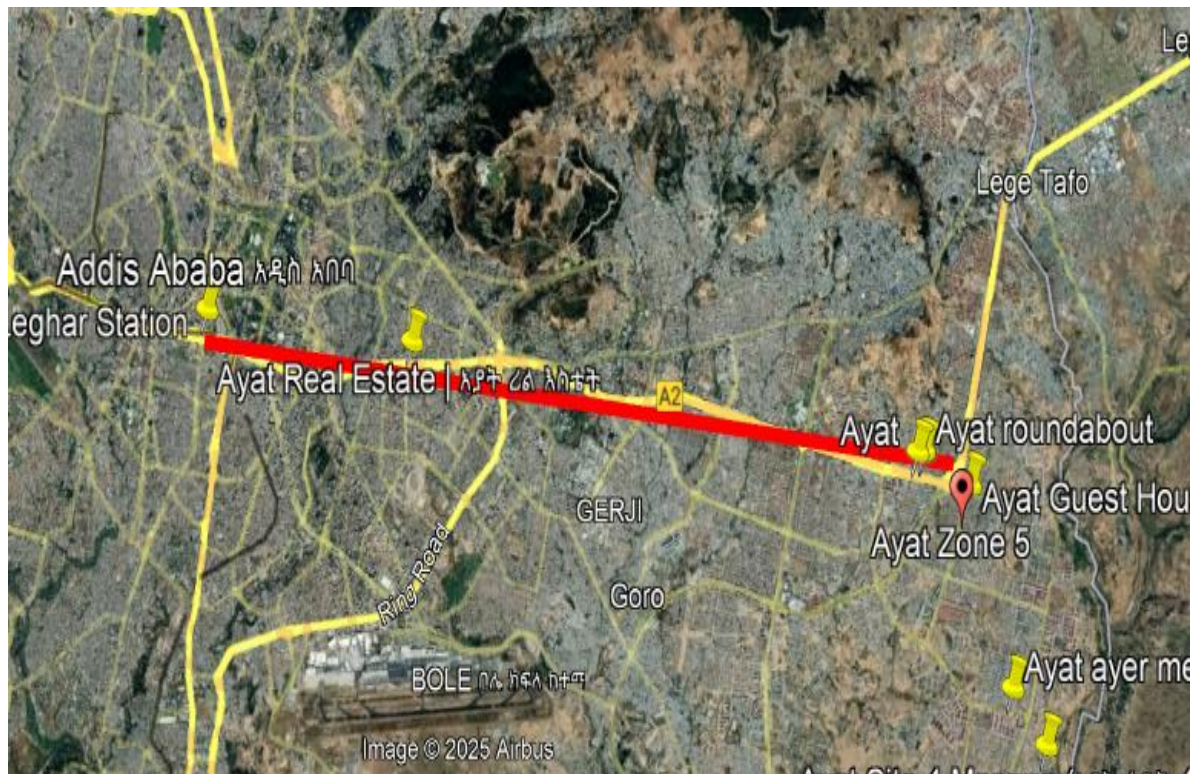


Figure 2 Leghar to Ayat route

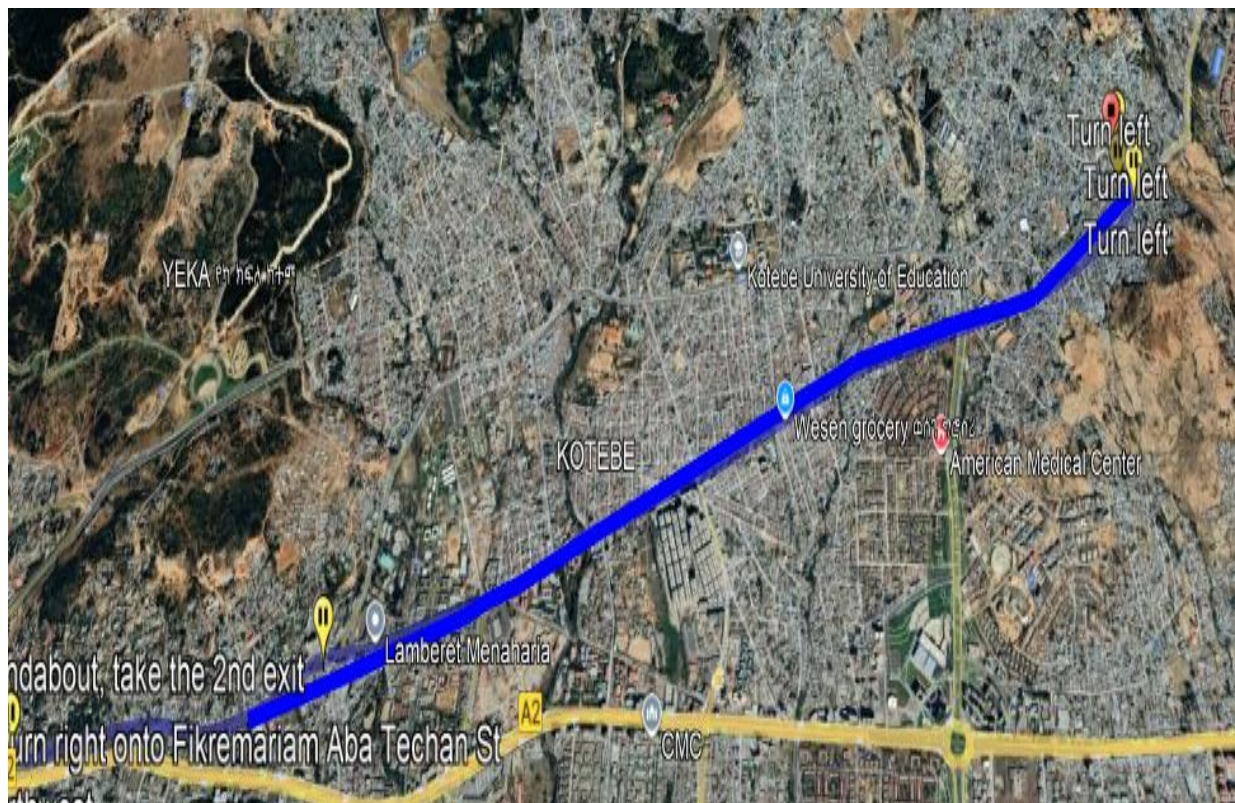


Figure 3 Megenagna to Kara



Figure 4 Shiro meda to Bole

3.3 Data Collection

To achieve the objectives of the road safety audit, two types of data were collected from the selected routes: road type data and traffic accident data. Prior to data collection, a thorough review of previous research studies had been conducted to provide a broad understanding of road safety issues and the challenges faced by researchers in similar contexts. This literature review was instrumental in developing a reliable, efficient, and effective approach to the study. In preparation for the fieldwork, three persons were trained to ensure they were well-equipped with the necessary knowledge to gather accurate and reliable data.

3.4 Population and Sample Size

The population for this study consisted of pre-selected road junctions along three routes: from Leghar to Ayat, from Shiromeda to Bole, and from Megenagna to Kara. These routes were chosen because they are long and had recently been constructed as part of the Addis Ababa road corridor development except for the Megenagna to Kara route, which had not yet been constructed under the corridor development project.

1.1.1 Process for data collection

Three data collectors, forming the road safety audit team, were organized, with one designated as the team leader. The team leader obtained a consent letter from AAiT and prepared for a preliminary safety audit meeting. During this meeting, the team outlined the key aspects of the data collection process, including who would be involved, what tasks would be performed, and when each task would take place. Each team member was assigned specific responsibilities to ensure efficiency and accuracy. Mobile phones were used to divide the total route length into three sections, with each data collector responsible for one section.

1.1.2 Method of Analysis

Each set of collected data, accompanied by relevant photographs, was meticulously documented to ensure accuracy and reliability. The documentation process included detailed notes on site conditions, road geometry, signage, pavement quality, pedestrian facilities, and traffic control measures. These data sets provided a comprehensive understanding of the traffic environment at the time of assessment. Following the documentation, the data were systematically analyzed and compared against the established Ethiopian traffic safety audit standards. This comparative analysis helped identify gaps, non-compliances, and potential risk factors within the existing infrastructure. Based on the audit results, practical and evidence-based recommendations were developed to enhance road safety, improve infrastructure design, and align the observed conditions with national traffic safety objectives.

3.4.1 Ethical Approval

All data collection was conducted in accordance with ethical approval and research ethics guidelines. The recorded videos used exclusively for academic purposes.

CHAPTER 4 ANALYSIS AND DISCUSSION

4.1 Introduction

In this section, the author analyzes the data collected from the three segments of the study area routes in relation to the assessment of Road Safety Audits in reducing traffic accidents. This includes the stages of the safety audit, comprehensive data analysis, and relevant suggestions using Road Safety Performance Review Ethiopia and National Road Safety Strategy.

4.2 Data analysis

4.2.1 Preparation and planning

Prior to the fieldwork, the safety audit team carefully planned the data collection by identifying key road segments to be assessed, including both existing and newly constructed roads within the study area. Background information on ongoing construction projects and road development plans was reviewed to ensure that the audit would cover relevant sections and accommodate any limitations caused by construction activities.

4.2.2 Site inspection and data collection

The data collection phase was conducted over three days, using a mobile phone camera to capture detailed images of the road conditions. On the first day, the audit focused on the older road segment stretching from Megenagna to Kara. The second and third days targeted newly developed corridors under the road development project, specifically the Legehar to Ayat and Shiromeda to Bole routes. This hands-on inspection provided a comprehensive visual record of the current state of these routes.

4.2.3 Identification of safety Issues

During the site visits, the team identified several constraints that impacted the inspection process. Notably, the Yetebaberut to Ayat segment had not yet been constructed, and the Shiromeda to 6 Killo section was still under construction, preventing a full safety assessment of these areas. Such limitations highlighted the challenges posed by ongoing development projects to the auditing process.

4.2.4 Development of recommendations

Due to the inability to inspect certain sections, the audit team adapted their approach by redirecting their data collection efforts to alternative road segments. These included the 6 Killo to Bole route, accessible via the Shiromeda to Bole corridor, and the Legehar to Yetebaberut section, which is part of the planned Legehar–Ayat corridor. This flexibility ensured that the audit still covered critical areas where safety interventions could be proposed.

4.2.5 Reporting

The comprehensive data collected through these inspections served as the foundation for a detailed traffic safety audit report. This report analyzed existing road conditions, identified potential hazards, and provided actionable recommendations to improve traffic safety along the assessed corridors. The analysis also considered physical constraints and alternative segments reviewed during the audit process. Data collection for the safety audit was conducted over a period of three days, using a mobile phone camera to visually document road conditions. The study encompassed both existing roads and newly constructed corridors. On the first day, the assessment focused on the older road segment extending from Megenagna to Kara. The second and third days were devoted to evaluating newly developed corridors under the ongoing road development initiative specifically, the Legehar to Ayat route and the Shiromeda to Bole corridor. However, due to ongoing construction activities, some sections could not be fully inspected. These included the Yetebaberut to Ayat segment, which has not yet been constructed, and the Shiromeda to 6 Kilo section, which remains under construction. Consequently, the team redirected their efforts to assess alternative routes. These included the 6 Kilo to Bole segment (via the Shiromeda to Bole corridor) and the Legehar to Yetebaberut section, both of which form part of the planned Legehar–Ayat corridor.

4.3 New road Safety Audit



Figure 5 Absence of Correct type of longitudinal line markings

The image shows a significant road safety concern: the absence of lane markings on a section of the roadway. Unpainted lanes pose serious risks to drivers, cyclists, and pedestrians by reducing visibility and guidance, particularly during low-light or adverse weather conditions. Clear lane separations are essential for maintaining proper vehicle alignment, facilitating safe overtaking, and minimizing the risk of side-swipe or head-on collisions. The lack of markings may also contribute to driver confusion and erratic lane behavior, especially in urban areas with high traffic volumes or near construction zones like the one shown in the image. This issue should be prioritized in audit recommendations to enhance road safety and ensure compliance with road design standards.

4.3.1 Proposed Solution

To address the absence of lane markings and enhance road safety, it is recommended that proper lane demarcation be applied using high-visibility thermoplastic road paint, which is durable and resistant to wear. Reflective paint or embedded road studs (cat's eyes) should be incorporated to improve visibility at night or during adverse weather conditions. The lane painting should follow standard road width guidelines and be applied uniformly across the entire stretch of the road.



Figure 6 Discontinuities in “through” lanes and unsafe “trap” lanes are identified

The image illustrates critical issues related to discontinuities in “through” lanes and the potential for unsafe “trap” lanes. The shoulder, measuring less than 2 meters, is heavily eroded and encroached upon, disrupting the seamless flow of traffic and forcing vehicles to swerve into adjacent lanes to avoid obstacles or pedestrians. The sidewalk is in disrepair and lacks a continuous, safe path, leading pedestrians to walk dangerously close to moving vehicles. Although not visibly marked, the degraded shoulder can be misinterpreted as a drivable lane by drivers, creating a “trap” lane scenario where sudden re-entry into traffic may cause accidents or erratic maneuvers. To address these issues, it is proposed to reconstruct the sidewalk to a minimum standard width of 1.5–2 meters with durable pavement, clearly define and separate the shoulder from the vehicle lane using curbs or road markings, and install appropriate signage to warn drivers of any lane changes or shoulder

conditions. These measures will enhance pedestrian safety and ensure uninterrupted vehicle movement.



Figure 7 Obstructing the vehicle path.

As it shown above figure 7 above the median is not properly aligned with the longitudinal center of the lane, and a large stone is obstructing the vehicle path. This misalignment and obstruction significantly increase the risk of severe crashes, especially when a driver attempts to change lanes at high speed. The vehicle may strike the stone or improperly aligned median, causing damage particularly on the right side—and potentially leading to loss of control or secondary collisions.

To enhance road safety, a proper clear zone should be provided—free of fixed and non-frangible obstacles to allow errant vehicles a recovery area without causing severe damage. Additionally, all roadside furniture and structures within this zone should be made of frangible (breakaway) materials to minimize impact forces in the event of a crash. Realigning

the median correctly with the lane's longitudinal axis and removing or replacing fixed hazards like the stone with safer, energy-absorbing alternatives will significantly reduce the potential for vehicle damage and injury.



Figure 8 Road side infrastructure

As shown in the figure above, the roadside infrastructure presents several safety and functional issues due to poor planning and maintenance. There is no clearly designated vehicle lane or pedestrian walkway, which creates confusion and increases the risk of accidents for both drivers and pedestrians. Additionally, the drainage ditch is blocked, which could lead to water accumulation on the road, further deteriorating driving conditions and potentially damaging the road surface. Trees are growing haphazardly within the space that should be allocated for pedestrian and bicycle use, obstructing movement and forcing vulnerable road users into unsafe positions closer to vehicle paths. The lack of organized road elements and the intrusion of natural growth into human-use areas highlight a failure in urban

road design standards. To ensure safety and usability, the area needs to be restructured with clear demarcations for vehicle lanes, pedestrian paths, and bicycle tracks, proper landscaping control, and effective drainage solutions to support both mobility and environmental resilience. To address the safety and functional issues identified in the roadside infrastructure, a comprehensive redesign and rehabilitation plan should be implemented. First, clear and properly marked lanes for vehicles, pedestrians, and cyclists must be established using durable road markings and signage that meet urban planning and traffic safety standards. The blocked drainage ditch should be cleaned, repaired, and regularly maintained to ensure proper water flow and prevent flooding or road damage. Additionally, trees and vegetation encroaching on pedestrian and bicycle paths should be pruned or relocated as part of a structured landscaping plan that balances greenery with safety. Installing curbs or protective barriers can help separate different traffic types and enhance overall organization. Urban planners should also ensure ongoing maintenance, including monitoring vegetation growth, repainting road markings, and maintaining drainage infrastructure. By implementing these solutions, the road can become safer, more accessible, and more sustainable for all users(Jain et al., 2017).



Figure 9 Site obstruction

The current line of route presents a significant visibility issue, particularly at the right turn, due to the presence of an overgrown or obstructive tree. Additionally, the roadside ditch is not properly constructed or maintained, creating a hazardous condition. These factors pose a heightened risk for elderly individuals, persons with disabilities, and pedestrians or drivers traveling at night, increasing the likelihood of accidents or injuries.(Jain et al., 2017; Miller et al., 1969; Morris, 1981)

Suggested Solutions:

1. Tree Trimming or Removal:

The obstructive tree should be trimmed or, if necessary, removed to improve visibility at the right turn. This will enhance safety for all road users, particularly during low-light conditions.

2. Proper Ditch Construction:

Redesign and reconstruct the ditch to ensure it is level, well-drained, and securely covered or fenced where necessary. This will prevent accidental falls or vehicle-related incidents.

3. Enhanced Lighting:

Install adequate street lighting around the turn and near the ditch to improve visibility at night for pedestrians and drivers.

4. Warning Signage and Road Markings:

Place clear signage ahead of the turn to warn of the visibility limitation and potential ditch hazard. Reflective road markings can also help guide traffic more safely.



Figure 10 Road side tree

The species and size of the trees currently planted within the roadside clear zone present a major visibility obstruction for both drivers and pedestrians. These trees have grown horizontally into the line of sight, limiting visibility of oncoming traffic, road signs, and pedestrians walking along the roadside. This is especially dangerous at night or in poor weather conditions. As shown in the referenced image, the side branches of the trees have extended horizontally, instead of growing vertically. This improper growth pattern not only blocks visibility but may also force pedestrians closer to traffic, increasing the risk of accidents.

Suggested Solutions:

1. Cut and Reshape Existing Trees:

- The trees should be properly cut to remove branches that grow horizontally into the road or pedestrian path.
- Cutting should focus on shaping the trees to encourage vertical growth, improving visibility and clearance.
- Work with professional arborists to ensure safe and healthy cutting techniques.

2. Replace Inappropriate Tree Species:

- If the current trees are naturally wide-spreading species, consider removing and replacing them with upright, columnar species better suited for roadside planting.
- Choose smaller trees with vertical growth habits that do not obstruct the clear zone.

3. Maintain the Clear Zone:

- Ensure that the area within the roadside clear zone is kept free of large trees or obstructions.
- Follow local regulations and road safety standards regarding vegetation near roads.

4. Ongoing Maintenance Plan:

- Implement a regular tree maintenance schedule to monitor and cut any branches that may become obstructive over time.
- Periodic trimming will prevent future safety issues and maintain a clear line of sight.



Figure 11 Median size and length of pedestrian crossing

As shown in the image above, the width of the median is not proportional to the total carriageway width. The road is a two-way, four-lane carriageway (two lanes in each direction), but the existing median is too narrow to accommodate pedestrians safely.

When pedestrians attempt to cross the road, they are required to cross two lanes in one direction before reaching the median. However, due to the narrow design of the median, there is no sufficient space for them to stand safely while waiting to cross the remaining two lanes. As a result, pedestrians are often forced to stand within or near the live traffic lanes, posing a serious safety hazard. This situation is particularly dangerous during peak traffic hours or at night when visibility is low.

The absence of a properly designed pedestrian refuge area in the median increases the likelihood of traffic accidents, as pedestrians may unintentionally block the flow of vehicles or drivers may not anticipate their presence in the middle of the road (Austroads, 2021).

Suggested Solutions:

1. Widen the Median for Pedestrian Refuge:

- Redesign and reconstruct the median to include a safe pedestrian refuge zone wide enough to accommodate at least 2–3 people.
- This refuge should include curb ramps for accessibility, especially for the elderly and people with disabilities.

2. Install Designated Pedestrian Crossings:

- Mark safe, signal-controlled pedestrian crossings at regular intervals.
- Add zebra crossings and pedestrian lights to improve visibility and regulate crossing movements.

3. Add Raised Islands or Pedestrian Shelters:

- Consider building raised pedestrian islands or shelters within the median for extra protection and visibility.
- These can act as safe waiting areas for people crossing in stages.

4. Improve Signage and Road Markings:

- Install clear warning signs for drivers alerting them to pedestrian crossing zones ahead.
- Use reflective paint and signage to increase visibility at night.

5. Implement Traffic Calming Measures:

- Introduce speed-reducing features (e.g., speed bumps or rumble strips) before pedestrian crossing points to encourage vehicles to slow down.
- Narrow lanes slightly (if feasible) to reduce vehicle speeds near pedestrian-heavy areas.

6. Community and Authority Coordination:

- Engage local authorities, traffic engineers, and urban planners to redesign the median and crossings based on traffic and pedestrian flow data.
- Involve community members to identify the most commonly used crossing points and ensure new infrastructure meets their needs.



Figure 12 Improper parking dedicated for buses

In many areas, taxis are parking in lanes that are specifically dedicated for buses. This is a serious issue because it leads to traffic congestion. When taxis block these dedicated bus lanes, buses are forced to change lanes or slow down, causing delays not just for bus passengers but for all other road users as well. The situation becomes worse during peak hours when public transportation is most needed to reduce road traffic (Hoonsiri et al., 2021; Tsitsokas et al., 2021) (Russo et al., 2022).

1. **Lack of enforcement** – Taxi drivers often park in bus lanes because there is no consistent penalty or monitoring.
2. **Insufficient parking options** – In some places, taxis have no dedicated stopping areas to pick up or drop off passengers.
3. **Driver negligence or urgency** – Some taxi drivers prioritize quick passenger access over traffic rules.

Suggested Solutions:

1. **Increase Enforcement:**

Authorities should regularly monitor bus lanes using cameras or traffic officers. Fines or penalties should be strictly applied to violators who park in bus-only lanes.

2. Designated Taxi Zones:

Create clearly marked taxi pick-up and drop-off zones that are separate from bus lanes but still conveniently located for passengers.

3. Public Awareness Campaigns:

Educate both drivers and passengers about the importance of keeping bus lanes clear and the negative effects of illegal parking.

4. Physical Barriers:

Where possible, install barriers or curbs that separate bus lanes from general traffic to prevent unauthorized vehicles from entering or parking there.

5. Time-Based Access Rules:

In some areas, allow taxis to use certain lanes during non-peak hours but keep them strictly bus-only during rush hours.



Figure 13 Shoulder cleanness and barrier for road users

As observed on-site, the shoulder area of the road is currently blocked due to the placement of metal works. Additionally, the ditch cover along the roadside has been poorly constructed or remains incomplete. This condition creates a physical barrier for pedestrians who attempt to use the roadside for walking. As a result, pedestrians are being forced to walk along the edge of the main traffic lane particularly on the right-side corner of the route where space is already limited. This encroachment onto the carriageway increases the risk of accidents and disrupts the smooth flow of vehicular traffic. Their impact are (Quezon & Kumala, 2018).

- **Pedestrian Safety Risk:** With the sidewalk blocked and ditch covers not in place, pedestrians are left with no safe walking space, exposing them to moving vehicles.
- **Traffic Congestion:** The displacement of pedestrians into the main lane causes partial blockage, leading to congestion especially during peak hours.
- **Increased Enforcement Burden:** The current setup increases the need for continuous traffic management and law enforcement to ensure safety.
- **Reduced Accessibility:** The obstruction particularly affects vulnerable groups such as children, the elderly, and people with disabilities.

Suggested Solutions:

1. **Immediate Clearance of Metal Works:** Remove or relocate any construction materials or metal works currently obstructing the shoulder.
2. **Proper Construction of Ditch Covers:** Ensure the ditch covers are well designed, safely constructed, and level with the road surface to allow safe pedestrian use.
3. **Provision of Temporary Pedestrian Pathways:** Until permanent work is completed, install temporary barriers or markings to guide and protect pedestrian movement.
4. **Install Signage and Warnings:** Erect appropriate signage to alert both pedestrians and drivers about the ongoing hazards.



Figure 14 Extremely dangerous man hole

A dangerously exposed or damaged manhole has been identified along the pedestrian path. This condition presents a severe safety risk to all road users, especially:

- Persons with disabilities,
- Elderly individuals, and

- Anyone traveling at night when visibility is reduced.

The absence of a proper cover or warning around the manhole increases the likelihood of serious injuries or fatalities. It can cause pedestrians to trip, fall, or suffer impact-related harm. In nighttime conditions, when lighting is limited or absent, the danger becomes even more critical.

Potential Risks:

- **Injury or Fatality:** A fall into an open or unstable manhole could lead to severe injury or death, particularly for children, elders, and visually impaired individuals.
- **Legal and Liability Issues:** Failure to address the hazard could expose responsible agencies or contractors to legal consequences.
- **Public Distrust and Frustration:** Visible hazards that go unresolved diminish public trust in infrastructure management.

Suggested Solutions:

1. **Immediate Securing of the Manhole:** Cover the manhole securely with a durable, high-visibility lid or barrier.
2. **Temporary Protection Measures:** Until permanent repairs are made, cordon off the area with reflective tape, cones, or barricades to prevent access.
3. **Repair or Replace Damaged Infrastructure:** If the manhole cover is missing, cracked, or loose, it should be replaced immediately with a standard-compliant and tamper-resistant cover.
4. **Install Warning Signs and Lighting:** Install visible signage and, if possible, solar-powered warning lights around the area to alert pedestrians and drivers.



Figure 15 Missing or faded median and lane division lines

It has been observed that the median markings and lane division lines on this section of the road are either missing, faded, or not clearly visible to drivers. This lack of clear road markings creates confusion among motorists, particularly during night-time or poor weather conditions.

Impact and Risks:

- **Increased Risk of Conflict and Collisions:** Without clear lane guidance, drivers may unintentionally drift into adjacent lanes or cross into oncoming traffic, increasing the likelihood of side-swipe crashes and head-on collisions.
- **Reduced Road Discipline:** The absence of clear lane divisions encourages unsafe overtaking, lane weaving, and unpredictable driving behavior.
- **Poor Night Visibility:** The lack of reflective or visible paint lines makes it especially dangerous at night or in low-visibility situations (rain, fog, etc.).
- **Challenges for New or Visiting Drivers:** Drivers unfamiliar with the road layout may become disoriented, leading to unsafe decisions.

Proposed Solutions:

1. **Repaint Median and Lane Division Lines:** Apply high-quality, reflective paint for all lane markings and the center median. Use thermoplastic or durable paint for longer service life.
2. **Install Reflective Road Studs (Cat's Eyes):** For added night-time visibility and guidance, especially along curves or medians.

3. **Periodic Maintenance Schedule:** Establish a regular road marking maintenance program to ensure that lines remain visible and intact.
4. **Use Standard Lane Widths and Marking Colors:** Ensure all markings comply with national or international road safety standards (e.g., yellow for medians, white for lane divisions).
5. **Public Awareness and Enforcement:** Combine marking improvements with education and traffic enforcement campaigns to improve compliance and safety.

4.4 Shiro Meda via 6 kilos to Bole route

The Shiro Meda to Bole route via 6 Kilo was constructed as part of the corridor development plan in Addis Ababa. This route connects the northern area of Shiro Meda to the central and southern parts of the city, passing through the key 6 Kilo area. It features modern infrastructure that stands out in comparison to older routes in the city. The road includes enhanced lighting systems that improve visibility and safety, as well as a dedicated bicycle lane that promotes alternative, eco-friendly transportation. Additionally, the incorporation of green areas adds aesthetic value and contributes to environmental sustainability. Overall, the route aims to improve urban mobility and support the city's long-term sustainable development goals (Girma & Mulatu, 2025).

Despite its modern design and improved infrastructure, the Shiro Meda to Bole route via 6 Kilo presents several safety concerns for both passengers and drivers. While the inclusion of dedicated bicycle lanes, better lighting, and green spaces marks a significant upgrade from older routes, there are still challenges. Pedestrian crossings are often poorly marked or not prioritized, which increases the risk of accidents. Some intersections lack clear traffic signals or signs, leading to confusion among drivers. In addition, the protection barriers between the bicycle lanes and vehicle traffic are minimal or absent in certain areas, putting cyclists at risk. These issues highlight the need for further improvements to ensure the route is not only modern but also safe and user-friendly for everyone.



Figure 17 Street lighting is blocked or obscured by tree branches



Figure 16 Uncompacted and lacks proper traffic control measures

The intersection in question presents multiple critical road safety and operational issues:

1. **Uncompacted Surface:**

- An uncompacted intersection surface leads to poor traction, especially during adverse weather conditions, increasing the risk of vehicle skidding and accidents.

- Loose or uneven surfaces can cause vehicle damage, particularly for two-wheelers and non-motorized users.

2. **Lack of Traffic Control Measures:**

- The absence of stop signs, yield signs, traffic signals, or roundabouts means drivers approach the intersection without clear right-of-way rules.
- This leads to confusion, aggressive driving behavior, and a higher potential for collisions.

3. **Long Lanes at the Cross Intersection:**

- Long approach lanes without proper lane markings or guidance allow uncontrolled vehicle merging and lane changes.
- Without visual cues, drivers may misjudge distances and speeds, further escalating crash risks.

4. **No Channelization:**

- Channelization structures such as medians, islands, or guide markings are essential for directing vehicle flow and separating conflicting movements.
- Without channelization, the intersection becomes disorganized, and turning movements (especially left turns or U-turns) are poorly defined.

5. **Absence of a Central Island:**

- A central island is crucial in large intersections to organize traffic and reduce the speed of turning vehicles.
- Without it, there is no physical or visual separation of conflicting movements, increasing crash potential.

4.5 **Proposed Solutions:**

1. **Surface Improvement:**

- **Compaction and Paving:** The intersection surface should be compacted and paved with suitable materials (e.g., asphalt or concrete) to provide durability, grip, and evenness.
- **Drainage Enhancements:** Ensure proper drainage to prevent water accumulation that could weaken the roadbed or create hydroplaning risks.

2. **Implement Traffic Control Devices:**

- **Signage:** Install appropriate signs (e.g., STOP, YIELD, and intersection ahead warnings) at all approaches.



- **Traffic Signals or Roundabout:** Based on traffic volume analysis, install signals or construct a roundabout to manage vehicle movements.
- **Markings:** Add clear lane markings, stop lines, and directional arrows.

3. Lane Channelization and Central Island Installation:

- **Painted or Raised Islands:** Introduce painted or raised islands to separate turning lanes and guide traffic into correct paths.
- **Central Median/Island:** Construct a central island to control turning movements and reduce conflict points. It also provides refuge for pedestrians crossing the road.

4. Intersection Redesign:

- **Geometric Redesign:** Modify the layout to include turning lanes, appropriate curb radii, and pedestrian crossings.
- **Chicanes or Tapers:** Introduce road narrowing or tapers to reduce vehicle speeds at the approach to the intersection.

5. Pedestrian and Vulnerable Road User Considerations:

- Include crosswalks, pedestrian islands, and signage.
- Install speed humps or rumble strips to calm traffic near the intersection.

6. Traffic Study and Monitoring:

- Conduct a traffic impact assessment to understand flow patterns, volume, and peak-hour behaviors.
- Implement a short-term monitoring plan to evaluate the effectiveness of the interventions and refine them as necessary.



Figure 18 Tree-lined urban street

The image shows a tree-lined urban street with the following characteristics during observation in the filed survey.

- **Well-maintained sidewalk:** A wide pedestrian pathway is present on the left side, providing comfortable walking space and shaded by large overhanging trees.
- **Curved roadway:** The street gently curves to the left, which may reduce visibility for drivers and pedestrians alike.
- **No visible traffic control:** There are no visible traffic signs, signals, or speed-calming devices in the image.
- **Lighting concern:** The tree canopy is dense and may obstruct street lighting, especially at night, reducing visibility and potentially creating unsafe conditions.
- **Mixed-use road:** Vehicles, including a small van, use the street, and a pedestrian is also visible, indicating shared use but no distinct crossing or safety infrastructure (like pedestrian crossings or warning signs).

4.5.1 Key safety observations

- **Lighting obstruction:** The tree branches obscure the light poles, which may render lighting ineffective at night.
- **No pedestrian crossings:** No zebra crossings or pedestrian priority markings are visible, which poses risks in mixed traffic.
- **Lack of signage:** There is an absence of traffic calming or warning signs, particularly around the curve.

4.5.2 Suggested solution

1. **Trim tree branches** around streetlights to improve nighttime visibility.
2. **Install pedestrian crossings** (zebra stripes) at regular intervals, especially near entrances/exits.
3. **Add signage** indicating pedestrian presence, speed limits, and upcoming curves.
4. **Evaluate lighting effectiveness** at night and enhance where necessary.
5. **Install speed-calming measures** like speed humps or rumble strips if speeding is an issue.

4.6 Leghar to CMC-Ayat

The Leghar–CMC to Ayat routes were developed as part of a larger corridor development project. However, this particular study focuses only on the section from Leghar–CMC, as the stretch from CMC to Ayat has not yet been completed and is currently still under construction. The study specifically emphasizes safety concerns, particularly near intersections, and also considers provisions for bicycle infrastructure in the completed areas.

4.7 Traffic signal and road marking

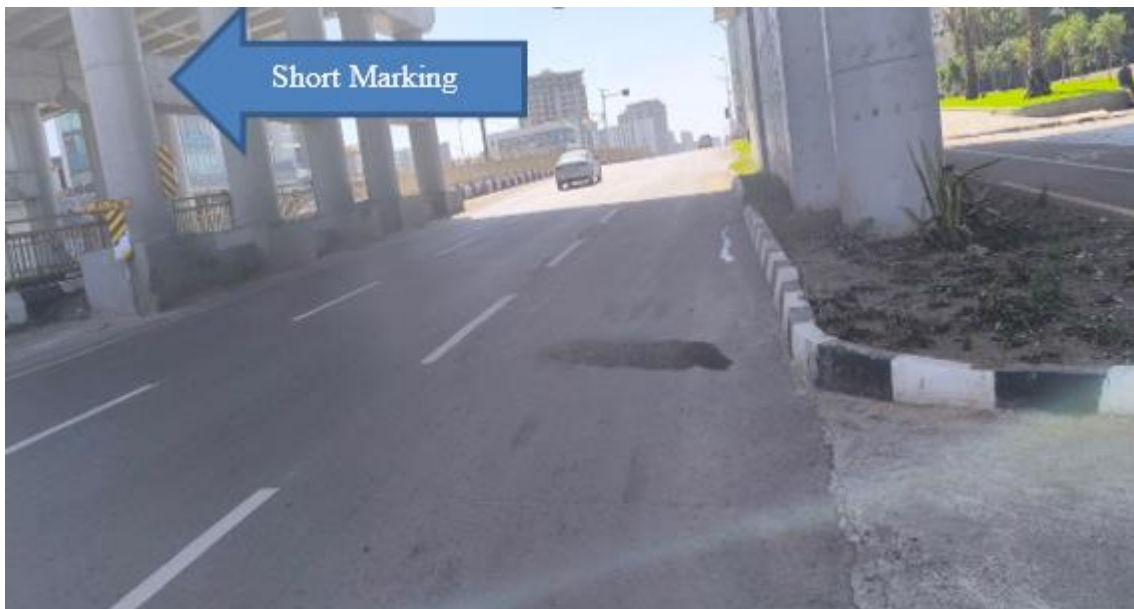


Figure 19 Marking and lane change

As shown in the figure above, the number of lanes suddenly changes from four to three, which creates a serious hazard. This abrupt lane reduction leads vehicles to swerve unexpectedly, often resulting in severe crashes, particularly into the overpass column located

in the area. One major issue is that the lane markings are not clearly visible from a distance they only become noticeable when the vehicle is already very close to the pole, roughly one car length away. This makes the location extremely dangerous, a concern that has also been raised by traffic police officers. And, the pole is positioned just two meters away from the railway lane and very close to the main traffic lane, increasing the risk of right-side or frontal collisions. To improve safety in this area, it is recommended that reflective warning signs or reflectors be installed in a visible location so that drivers can recognize the hazard from a greater distance. Furthermore, the overpass column should be shielded using energy-absorbing materials, such as crash cushions or guardrails, which can reduce the impact force and help prevent fatal accidents(Espadaler-Clapés et al., 2023; Sun & Elefteriadou, 2014).



Figure 20 Pedestrian safety and cycle lane discontinuity

As shown in the figure above, the bicycle lane is discontinuous, and the drainage ditch (ditch line) is not properly installed or aligned. These design flaws pose significant safety hazards, particularly for cyclists and individuals with disabilities. The lack of a continuous and clearly marked bicycle lane forces cyclists to merge into the main traffic lane unexpectedly, increasing the risk of collisions with motor vehicles. Furthermore, improperly constructed or exposed ditch lines can cause cyclists to lose control or trip, leading to injuries or damage to bicycles. These issues are especially dangerous for people with mobility challenges, such as wheelchair users or those with visual impairments, who rely on smooth and predictable

pathways. To address these problems, the bicycle lane should be made continuous throughout the corridor, with clear and durable markings to guide riders safely. Additionally, the drainage ditches should be properly designed and covered or relocated to prevent hazards along the cycling and pedestrian paths. Using smooth, slip-resistant materials and ensuring level transitions between lanes and adjacent surfaces will further improve safety and accessibility for all users (Chen & Xie, 2009; Phillips et al., 2011; Vasic & Ruskin, 2013).

4.8 Summary of the three route assessment from the check list

4.9 Leghar to via Megenagna to CMC- Ayat

Based on the audit findings, several safety aspects of the traffic environment were evaluated, including traffic signs, road markings, street lighting, roadside safety, pedestrian provisions, landscaping, and other road safety features. These components are critical for ensuring safe and efficient traffic flow, minimizing hazards, and improving overall roadway usability for all users is shown in appendix A.

4.9.1 Traffic Signing and Road Marking

The audit of traffic signing highlights both strengths and weaknesses in the current provisions. Positive elements such as the inclusion of regulatory signs and proper guide signage for unfamiliar drivers were part of the review. However, several shortcomings were identified. The signs were often not providing positive, actionable guidance, and in some cases, unnecessary warning signs were still present, creating potential confusion. Sign positioning, especially at intersections and curves, was also problematic, sometimes obstructing sight lines or posing physical hazards. Moreover, reflectorizing and lighting for visibility during low-light conditions were not adequately provided, which compromises nighttime safety.

On the road marking side, the situation is similar. While longitudinal lines and hazard approach markings were mostly included, discontinuities in through lanes and trap lane designs were flagged as concerns. Additionally, barrier lines were missing at overtaking hazard locations, and stop lines and pedestrian crossings were not always correctly positioned. Critically, retro-reflective pavement markers, which are essential for night driving, were absent, further reducing night-time visibility.

4.9.2 Street Lighting and Roadside Safety

In the audit of street lighting, there is a partial success. While lighting standards and distribution were generally acceptable, lighting transitions where lighting ends and darkness begins were found lacking, which can create sudden changes in visibility for drivers. Positively, lighting poles themselves were not considered hazards and did not obstruct driver sight lines.

For roadside safety provisions, the audit showed more significant issues. There was a lack of clear zones, the minimum length of guardrails was inadequate, and guardrail placements relative to kerbs and objects were not optimal. Frangible road furniture, which minimizes injury risk during collisions, was not used appropriately. Areas near rock cut batters or water bodies lacked proper safety treatments.

4.9.3 Pedestrian Safety Provisions

Pedestrian safety was partially addressed. The audit found that pedestrian refuge areas and designated crossings at signalized intersections were included and adequate. However, the lack of kerb ramps, absence of footpaths, and poor traffic management for wide roadway crossings still present considerable risk to pedestrian safety, especially for vulnerable users such as the elderly or disabled.

4.9.4 Guardrails, Landscaping, and Other Effects

When it comes to guardrails and barriers, the audit noted that most installations were insufficient in terms of coverage, placement, and hazard mitigation, especially at bridge piers and median barriers.

In the landscaping category, the audit identified that while some aspects were handled well such as addressing obstruction of sightlines others, like tree placement within clear zones and their interference with lighting, were not satisfactory. Overgrown foliage and large trees placed too close to semirigid barriers also posed safety hazards, as they impacted guardrail deflection during collisions.

4.10 Shiro Meda Via 6kilo to Bole route

From Shiromeda via 6 Kilo to Bole, a total of 78 items were audited, as detailed in Appendix C. The audit covered various categories including traffic signing, road marking and

delineation, pavement markings, street lighting, roadside safety provisions, pedestrian facilities, landscaping, and other roadside effects. The results indicate significant gaps in compliance with standard road safety and design criteria.

Out of the 78 items assessed, only 17 items were found to be compliant (✓), while 61 items were non-compliant (X). This highlights major shortcomings, especially in traffic signing and road marking, where almost all critical components such as positive guidance, proper positioning, and reflectorizing were lacking. Similarly, pedestrian infrastructure was incomplete, with missing kerb ramps, inadequate footpaths, and insufficient crossing management for wide roads.

4.10.1 Pavement Markings

The audit revealed that retro-reflective pavement markers are entirely absent. These markers are crucial for improving night-time lane visibility and enhancing driver awareness, particularly under low-light or adverse weather conditions. Their absence compromises safe navigation and significantly increases the likelihood of lane-departure incidents during night travel.

4.10.2 Street Lighting Design

The street lighting audit has not been fully conducted, creating uncertainties about the system's overall effectiveness. But, the lighting extent currently in place appears sufficient to meet general traffic safety requirements. The lighting quality, in terms of uniformity and glare control, is also appropriate. However, a notable deficiency is the lack of proper transition zones where street lighting ends. This abrupt shift from illuminated to dark areas can disorient drivers. On a positive note, lighting poles do not constitute physical hazards and are well-positioned so as not to obstruct driver sightlines.

4.10.3 Roadside Safety Provisions

A general audit of roadside safety provisions has been performed, which is a positive initial step. However, critical deficiencies remain. There is no clear zone maintained adjacent to the roadway, increasing the risk of collisions with fixed objects. The absence of frangible road furniture, such as breakaway signposts or lighting structures, raises concerns about the severity of injuries during crashes. While guardrail designs meet some safety standards, their length and placement particularly in relation to kerbs and roadside objects are often

inadequate. Additionally, hazardous zones like rock cuttings or water bodies have not been treated with appropriate safety measures.

4.10.4 Provisions for Pedestrians

The audit confirms the inclusion of pedestrian safety measures, such as crosswalks at signalized intersections and refuge islands on medians, which improve pedestrian mobility. However, several problems persist. Many areas lack continuous footpaths, forcing pedestrians to share space with vehicles. The absence of kerb ramps at key crossing points limits accessibility for people with disabilities and those using wheeled devices. Furthermore, there are no effective traffic control strategies for wide road crossings, which extend the time pedestrians are exposed to vehicle movement and increase the risk of accidents.

4.10.5 Roadside Safety Features

There has been no dedicated audit of roadside safety features, and as a result, critical installations are missing. Notably, there are no guardrails or barriers around hazardous fixed objects like poles or bridge supports. This exposes road users to unmitigated collision risks in case of vehicular departures from the travel path.

4.10.6 Guardrails & Barriers

The audit found that guardrail systems and barriers are inadequate across the site. Many installations fail to match the level of hazard they are intended to protect against. Approach ends of guardrails are not properly treated, posing risks of impalement or rollover accidents. Furthermore, median barrier lighting poles are left untreated, and bridge piers or isolated hazards lack protective barriers altogether. These oversights contribute to severe vulnerabilities in high-risk impact zones.

4.10.7 Landscaping

The landscaping audit itself was completed satisfactorily, and most plantings do not obstruct sightlines, which is critical for maintaining visibility around curves and intersections. However, inappropriate tree species and sizes have been placed too close to the clear zone, making them potential impact hazards. Additionally, some trees interfere with street lighting and obstruct pole functions, reducing the effectiveness of night-time illumination.

4.10.8 Other Roadside Effects

There was no comprehensive audit of ancillary roadside elements, leaving gaps in understanding foliage impacts. Notably, overgrown vegetation infringes on the vertical and

horizontal clearance required by large vehicles, particularly near bends. Also, large trees planted close to semirigid guardrails hinder the rails' ability to deflect safely in the event of a crash, undermining their structural integrity and protective function.

4.10.9 Traffic Signing

The traffic signing system is one of the most deficient areas assessed. There is a complete lack of positive guidance for drivers, and regulatory and warning signs are either missing or improperly placed. Outdated or unnecessary signs have not been removed, contributing to clutter and confusion. Direction signs fail to accommodate unfamiliar drivers, and letter sizes are too small for effective readability at speed. Additionally, sign placement timing does not allow drivers to take safe action, and there is no lighting or reflectorizing to aid night visibility. For complex traffic layouts, overhead gantry signs are entirely absent, and in many locations, signs obstruct sightlines or are supported by non-frangible posts, increasing crash severity.

4.10.10 Road Marking & Delineation

Every item under road marking and delineation was marked non-compliant. Longitudinal lines are missing or incorrectly applied, which can mislead drivers and contribute to lane-drifting. There is inadequate guidance for merging and diverging zones, and trap lanes—which cause sudden lane drops have not been clearly marked. At curves and overtaking hazard zones, barrier lines are not installed, which encourages unsafe passing. Hazard approach markings at islands and medians are absent, and transverse lines such as stop bars and crosswalks are either missing or improperly located. Finally, the lack of reflectorized markings dramatically reduces night-time visibility and increases the likelihood of off-lane travel.

4.11 Megenagna to Kara

From Megenagna through Shiromeda and 6 Kilo to Kara, the route shows severe non-compliance with standard road safety and design criteria. Of the 78 audited items across categories such as traffic signs, markings, lighting, roadside barriers, and pedestrian infrastructure, the vast majority failed to meet even baseline standards. These findings reveal an urgent need for systemic improvements. Prioritizing upgrades to traffic control devices, pavement markings, pedestrian infrastructure, and roadside treatments is critical for reducing

accident risk and improving the safety and accessibility of this high-use urban corridor and putted in appendix B.

4.11.1 Traffic Signing

The assessment of traffic signing reveals significant deficiencies across all evaluated aspects. Positive guidance through signage is not being achieved, as evidenced by the absence or improper positioning of regulatory and warning signs. This raises concerns about driver compliance and safety, particularly for unfamiliar drivers who rely on guide signs for navigation. Additionally, all signs fail to meet standards for adequate letter size, proper reflectorization or lighting, and correct positioning. Overhead signs, essential in complex layouts, are also missing. Sight line obstructions and potentially hazardous signposts further compromise road safety. These shortcomings indicate a comprehensive overhaul of the traffic signing system is required.

4.11.2 Road Marking & Delineation

The road marking and delineation category also demonstrates widespread inadequacy. None of the items related to longitudinal line types, merging guidance, or barrier lines meet required standards. There are no indications that trap lanes or discontinuities are marked, nor are hazard markings present at critical areas such as medians, islands, or gores. Transverse markings like stop lines and pedestrian crossings are also lacking, which can endanger both drivers and pedestrians. The absence of reflectorized markings impairs night-time visibility, further reducing overall safety. These deficiencies call for immediate corrective actions, starting with a detailed inspection followed by remedial line painting and placement.

4.11.3 Pavement Markings

Retro-reflective pavement markers, which are critical for visibility during night or inclement weather conditions, have not been provided. This single-item category, while narrow in scope, has significant implications for road safety. The complete lack of these markings should be prioritized for rectification to support safe night-time navigation and enhance the delineation of driving lanes.

4.11.4 Street Lighting

Street lighting presents a mixed picture. While the design audit is yet to be completed, several functional aspects such as the extent of lighting coverage, uniformity, glare control, and pole placement meet safety standards. Specifically, lighting adequately covers the required areas,

and poles are neither roadside hazards nor do they obstruct visibility. However, the absence of lighting transitions and a completed design audit limits the system's overall effectiveness. Completing the audit and addressing transitional lighting would ensure better visual continuity and improve driver comfort, especially when entering or exiting lit zones.

4.11.5 Roadside Safety

In terms of roadside safety, some key elements have been addressed, including the completion of a safety audit and the adequacy of guardrail design. However, the clear zone is not provided, and frangible road furniture is not used, posing risks in the event of a collision. Guardrails do not consistently meet minimum length or correct positioning standards, which reduces their protective capacity. Moreover, safety treatments near hazardous areas such as rocks or water bodies are absent. These deficiencies undermine the protective intent of roadside safety infrastructure and should be corrected to prevent severe crash outcomes.

4.11.6 Pedestrian Provisions

Pedestrian facilities have been partly addressed, with the audit completed and some infrastructure like crossings at signalized intersections in place. However, there are significant gaps in pedestrian pathway continuity and accessibility. Footpaths are incomplete or obstructed, and kerb ramps at crossings are not provided, limiting access for people with disabilities. These issues make pedestrian navigation unsafe and non-compliant with inclusive design principles. Improvements in footpath construction and the addition of kerb ramps would greatly enhance pedestrian safety and accessibility.

CHAPTER 5 CONCLUSION AND DISCUSSION

5.1 Summary

The road safety audits conducted across three major corridors in Addis Ababa Leghar to CMC-Ayat via Megenagna, Shiromeda to Bole via 6 Kilo, and Megenagna to Kara via Shiromeda revealed widespread deficiencies in basic road safety infrastructure. The assessment covered a range of safety elements, including traffic signage, pavement markings, street lighting, roadside safety features, pedestrian provisions, and landscaping.

5.1.1 Key Audit Findings Across All Sections:

1. Traffic Signage and Road Marking:

- Signs are often missing, outdated, improperly positioned, or lack visibility enhancements (e.g., reflectorization).
- Road markings are incomplete or entirely absent in many areas, with no retro-reflective pavement markers, trap lane indicators, or hazard markings.

2. Street Lighting and Visibility

- While basic lighting is present, the absence of transition lighting where streetlights end creates dangerous visibility gaps.
- Lighting poles are generally well-positioned but lack reflectorization in some zones.

3. Roadside Safety Provisions:

- Clear zones are not maintained, and guardrail systems are poorly placed or insufficient in length.
- Lack of frangible (breakaway) roadside objects increases crash severity risks.
- Hazardous roadside areas such as rock cuttings and water bodies remain untreated.

4. Pedestrian Infrastructure

- Basic crossings and refuge islands exist at intersections.
- However, the absence of continuous footpaths, kerb ramps, and safe crossing mechanisms over wide roads presents significant safety risks, especially for vulnerable users.

5. Landscaping and Other Effects

- While sightlines are mostly maintained, tree placements within clear zones and overgrown vegetation impair visibility and interfere with lighting and guardrail function.

5.2 Conclusion

The audits highlight a widespread deficiency in the adherence to road safety standards and the consistent implementation of safety measures across all three corridors. Many infrastructure elements either fail to meet established design criteria or suffer from poor maintenance. The most significant shortcomings were found in traffic signage, pavement markings, roadside safety features, and pedestrian infrastructure. This high level of non-compliance presents serious risks to all categories of road users, including drivers, pedestrians, cyclists, and public transport passengers. Especially, the older route from Megenagna to Kara exhibited fewer safety concerns compared to the newly constructed roads between Shiromeda and Bole and Leghar to Ayat, indicating a troubling gap in the quality and consistency of recent infrastructure developments.

5.3 Recommendation

- **Comprehensive Redesign and Rehabilitation**
 - Implement a city-wide traffic sign and marking upgrade program, ensuring proper placement, adequate size, reflectorization, and removal of redundant or obstructive signage.
 - Install retro-reflective pavement markers and ensure consistent application of hazard and guidance markings, especially at merging, diverging, and overtaking zones.
- **Improve Street Lighting Systems**
 - Complete lighting design audits and prioritize the installation of transition lighting to avoid abrupt visibility changes.
 - Regular maintenance to ensure poles are properly aligned and free of visual obstructions.
- **Enhance Roadside Safety Measures**

Establish clear zones and install appropriately designed guardrails, especially at high-risk locations like bridges, curves, and near water bodies.

Replace rigid roadside furniture with frangible alternatives to reduce crash severity.

➤ **Upgrade Pedestrian Infrastructure**

- Develop continuous, accessible footpaths with proper kerb ramps and tactile indicators.
- Implement safe pedestrian crossings for wide roads with traffic control devices, refuge islands, and raised crosswalks where appropriate.

➤ **Landscaping Management**

- Audit and reposition trees and shrubs to ensure they do not interfere with lighting, sightlines, or guardrail performance.
- Regular trimming of vegetation to maintain minimum clearance envelopes for all road users.

➤ **Institutional and Policy Measures:**

- Establish a dedicated road safety unit to oversee the regular audit, design, and maintenance of safety infrastructure.
- Adopt international best practices in urban road safety design standards, adapted to local contexts.

CHAPTER 6 REFERENCES

- Ahmed, I., Puan, O. C., & Ismail, C. R. (2013). A comparative review of road safety audit guidelines of selected countries. *Jurnal Teknologi (Sciences and Engineering)*, 65(3). <https://doi.org/10.11113/jt.v65.2148>
- Austroroads. (2021). Guide to Road Design - Part 3: Geometric Design. In *Guide to Road Design*.
- Bala, N., & Adamu, M. (2017). Road Safety Audit Evaluation of Typical Two Lane Divided Highway in Nigeria. In *Noble International Journal of Scientific Research* (Vol. 1, Issue 3).
- Chen, J., & Xie, Z. Q. (2009). Cycle traffic conflict model on urban pedestrian-bicycle paths. *Jilin Daxue Xuebao (Gongxueban)/Journal of Jilin University (Engineering and Technology Edition)*, 39(SUPPL. 2).
- Espadaler-Clapés, J., Barmounakis, E., & Geroliminis, N. (2023). Empirical investigation of lane usage, lane changing and lane choice phenomena in a multimodal urban arterial. *Transportation Research Part A: Policy and Practice*, 172. <https://doi.org/10.1016/j.tra.2023.103674>
- Gibbs, M., Zein, S. R., Nabors, D., Ward, L., & Allred, C. (2006). Road Safety Audits. *Transportation Research Record: Journal of the Transportation Research Board*, 1969(1). <https://doi.org/10.1177/0361198106196900111>
- Girma, M., & Mulatu, Z. (2025). Evaluating corridor development initiatives and their effects in Addis Ababa, Ethiopia. *Urban, Planning and Transport Research*, 13(1). <https://doi.org/10.1080/21650020.2025.2473995>
- Heaslip, K., Jones, J., Harpst, T., & Bolling, D. (2010). Implementation of Road Safety Audit Recommendations. *Transportation Research Record: Journal of the Transportation Research Board*, 2182(1). <https://doi.org/10.3141/2182-14>
- Hoonsiri, C., Chiarakorn, S., & Kiattikomol, V. (2021). Using combined bus rapid transit and buses in a dedicated bus lane to enhance urban transportation sustainability. *Sustainability (Switzerland)*, 13(6). <https://doi.org/10.3390/su13063052>

- Huvarinen, Y., Svatkova, E., Oleshchenko, E., & Pushchina, S. (2017). Road Safety Audit. *Transportation Research Procedia*, 20. <https://doi.org/10.1016/j.trpro.2017.01.061>
- Jain, S. S., Singh, P. K., & Parida, M. (2017). Road Safety Audit for Four Lane National Highways. *3rd International Conference on Road Safety and Simulation, Indianapolis, US*.
- Kumar, D., & Mathur, D. (2022). Evaluation of Road Safety Audit for Existing National Highway. In *International Journal of Recent Research and Review: Vol. XV* (Issue 2).
- Miller, G. L., Harrell, M. S., Kidder, G., & Black, R. (1969). Composted Materials on Florida Roadsides. *EDIS*, 2003(16). <https://doi.org/10.32473/edis-ep133-2002>
- Morris, B. G. (1981). FLORIDA ROADSIDE MANAGEMENT CONFRONTS VARIED CONDITIONS. *Public Works*, 112(3).
- Phillips, R. O., Bjørnskau, T., Hagman, R., & Sagberg, F. (2011). Reduction in car-bicycle conflict at a road-cycle path intersection: Evidence of road user adaptation? *Transportation Research Part F: Traffic Psychology and Behaviour*, 14(2). <https://doi.org/10.1016/j.trf.2010.11.003>
- Pietrantonio, H., & Bornshtein, L. L. (2015). Evaluating road safety audit procedures: some questions and a new method of study. *Transportation Planning and Technology*, 38(8), 909–934. <https://doi.org/10.1080/03081060.2015.1079390>
- Quezon, E. T., & Kumala, T. (2018). Investigation of Pedestrian Safety Problems and Its Countermeasures: A Case Study in Nekemte City, Ethiopia. In *International Journal of Engineering and Technical Research* (Issue 8).
- Russo, A., Adler, M. W., & van Ommeren, J. N. (2022). Dedicated bus lanes, bus speed and traffic congestion in Rome. *Transportation Research Part A: Policy and Practice*, 160. <https://doi.org/10.1016/j.tra.2022.04.001>
- Sun, D., & Elefteriadou, L. (2014). A driver behavior-based lane-changing model for urban arterial streets. *Transportation Science*, 48(2). <https://doi.org/10.1287/trsc.1120.0435>
- Tsitsokas, D., Kouvelas, A., & Geroliminis, N. (2021). Modeling and optimization of dedicated bus lanes space allocation in large networks with dynamic congestion.

Transportation Research Part C: Emerging Technologies, 127.
<https://doi.org/10.1016/j.trc.2021.103082>

Tumavičė, A., Kravcovas, I., & Jasiūnienė, V. (2020). Identification and analysis of problems in the implementation of road safety audit in Lithuania. *Baltic Journal of Road and Bridge Engineering*, 15(2). <https://doi.org/10.7250/bjrbe.2020-15.475>

Vasic, J., & Ruskin, H. J. (2013). Interaction of cars and bicycles on a one-way road intersection: A network CA-based model. *Traffic and Granular Flow 2011*. https://doi.org/10.1007/978-3-642-39669-4__43

6.1 Appendixes

Table 2 Assessment questioners for safety audit

Audit of Traffic Signing and Road Marking	
Traffic Signs	
Check that	Comment
Traffic signing provides “positive” guidance rather than abstract and indefinite information.	
Necessary regulatory signs are provided and properly positioned to control traffic.	
Appropriate warning signs are shown on the traffic signing plans.	
Any unnecessary warning signs are identified and removed.	
Proposed direction and guide signing (consider “unfamiliar drivers”).	
Letter/legend size is adequate for drivers to read the information in the available time.	
Positioning of proposed direction signs will enable drivers to take necessary action safely.	
Appropriate reflectorization or lighting of the signs is required.	
Provision of overhead (e.g., gantry-mounted) signs for complex multi-lane layouts.	
Positioning of signs does not obstruct sight lines at intersections and curves.	
Positioning and type of signposts prevent these structures from being a significant hazard.	
Road Marking and Delineation	
Check that	
Correct type of longitudinal line markings (line pattern and width) is shown.	
Lines are properly positioned to guide vehicles and designate merge/diverge situations.	
Discontinuities in “through” lanes and unsafe “trap” lanes are identified.	
Horizontal and vertical curves are marked with double (barrier) lines where needed.	
Barrier lines at locations of restricted overtaking sight distance are shown.	
Approach hazard markings are shown at traffic islands, medians, and expressway gore areas.	
Correct positioning of all transverse lines such as stop lines and pedestrian crossings.	
Reflectorized road markings are specified for nighttime visibility.	

Retro-reflective pavement markers are specified for enhanced nighttime visibility.	
Audit of Street Lighting Design	
Check that	
The extent of street lighting meets traffic safety needs.	
The lighting standard, including uniformity and glare effects, is appropriate.	
Lighting transitions are provided where lighting ends.	
Lighting poles do not constitute a roadside hazard.	
Lighting poles do not obstruct driver sight lines.	
Audit of Roadside Safety Provisions	
Check that	
The provision of a “clear zone.”	
Use of frangible types of road furniture.	
Guardrail provisions and design details.	
Minimum length of guardrail to function properly.	
Guardrail positioning relative to kerbs and objects.	
Safety treatment of uneven rock cut batters and roadways near water.	
Audit of Provisions for Special Road Users - Pedestrians	
Check that	
Lack of footpaths or obstructions by road furniture.	
Lack of kerb ramps or dropped kerbs at crossing points.	
Lack of specific pedestrian crossings at signalized intersections.	
Insufficient space for pedestrian refuge on islands or medians.	
Traffic management for safe pedestrian crossing of wide roadways.	
Audit of Roadside Safety Features	
Check that	
Provision of guardrails or barriers at hazardous fixed roadside objects.	
The type and adequacy of guardrails or barriers in relation to hazards.	
Treatment of guardrail or barrier approach ends and transitions.	

Correct treatment of lighting poles placed within a median barrier.	
Provision and treatment of guardrail/barriers at isolated hazards such as bridge piers.	
Landscaping	
Check that	
Trees or landscaping obstructing sightlines and safety visibility.	
The species and size of trees planted within the “clear zone.”	
Effect of trees on street lighting and the positioning relative to lighting poles.	
Other Effects	
Check that	
Foliage infringing vertical and horizontal clearances for large vehicles.	
Planting of large trees too close to semirigid guardrails, impacting deflection.	

6.1.1 Appendix A

Table 3 Leghar to Ayat route

leghar - Ayat	
Audit of Traffic Signing and Road Marking	✓
Traffic Signs	✓
Check that	Comment
Traffic signing provides "positive" guidance rather than abstract and indefinite information.	✓
Necessary regulatory signs are provided and properly positioned to control traffic.	✓
Appropriate warning signs are shown on the traffic signing plans.	X
Any unnecessary warning signs are identified and removed.	✓
Proposed direction and guide signing (consider "unfamiliar drivers").	X
Letter/legend size is adequate for drivers to read the information in the available time.	X
Positioning of proposed direction signs will enable drivers to take necessary action safely.	✓
Appropriate reflectorization or lighting of the signs is required.	✓
Provision of overhead (e.g., gantry-mounted) signs for complex multi-lane layouts.	X
Positioning of signs does not obstruct sight lines at intersections and curves.	✓
Positioning and type of signposts prevent these structures from being a significant hazard.	✓
Road Marking and Delineation	✓
Check that	
Correct type of longitudinal line markings (line pattern and width) is shown.	✓
Lines are properly positioned to guide vehicles and designate merge/diverge situations.	✓
Discontinuities in "through" lanes and unsafe "trap" lanes are identified.	X
Horizontal and vertical curves are marked with double (barrier) lines where needed.	X
Barrier lines at locations of restricted overtaking sight distance are shown.	X
Approach hazard markings are shown at traffic islands, medians, and expressway gore areas.	X
Correct positioning of all transverse lines such as stop lines and pedestrian crossings.	✓
Reflectorized road markings are specified for nighttime visibility.	✓

Retro-reflective pavement markers are specified for enhanced nighttime visibility.	X
Audit of Street Lighting Design	X
Check that	
The extent of street lighting meets traffic safety needs.	L
The lighting standard, including uniformity and glare effects, is appropriate.	L
Lighting transitions are provided where lighting ends.	X
Lighting poles do not constitute a roadside hazard.	L
Lighting poles do not obstruct driver sight lines.	L
Audit of Roadside Safety Provisions	L
Check that	
The provision of a "clear zone."	X
Use of frangible types of road furniture.	X
Guardrail provisions and design details.	L
Minimum length of guardrail to function properly.	X
Guardrail positioning relative to kerbs and objects.	X
Safety treatment of uneven rock cut batters and roadways near water.	X
Audit of Provisions for Special Road Users - Pedestrians	L
Check that	
Lack of footpaths or obstructions by road furniture.	X
Lack of kerb ramps or dropped kerbs at crossing points.	X
Lack of specific pedestrian crossings at signalized intersections.	L
Insufficient space for pedestrian refuge on islands or medians.	L
Traffic management for safe pedestrian crossing of wide roadways.	X
Audit of Roadside Safety Features	X
Check that	
Provision of guardrails or barriers at hazardous fixed roadside objects.	X

The type and adequacy of guardrails or barriers in relation to hazards.	X
Treatment of guardrail or barrier approach ends and transitions.	X
Correct treatment of lighting poles placed within a median barrier.	X
Provision and treatment of guardrail/barriers at isolated hazards such as bridge piers.	X
Landscaping	L
Check that	
Trees or landscaping obstructing sightlines and safety visibility.	L
The species and size of trees planted within the "clear zone."	X
Effect of trees on street lighting and the positioning relative to lighting poles.	X
Other Effects	X
Check that	
Foliage infringing vertical and horizontal clearances for large vehicles.	X
Planting of large trees too close to semirigid guardrails, impacting deflection.	X

6.2 Appendix B

Table 4 Megenagna to Kara

Megenagna - Kara	
Audit of Traffic Signing and Road Marking	
Traffic Signs	X
Check that	Comment
Traffic signing provides "positive" guidance rather than abstract and indefinite information.	X
Necessary regulatory signs are provided and properly positioned to control traffic.	X
Appropriate warning signs are shown on the traffic signing plans.	X
Any unnecessary warning signs are identified and removed.	X
Proposed direction and guide signing (consider "unfamiliar drivers").	X
Letter/legend size is adequate for drivers to read the information in the available time.	X
Positioning of proposed direction signs will enable drivers to take necessary action safely.	X
Appropriate reflectorization or lighting of the signs is required.	✓
Provision of overhead (e.g., gantry-mounted) signs for complex multi-lane layouts.	X
Positioning of signs does not obstruct sight lines at intersections and curves.	X
Positioning and type of signposts prevent these structures from being a significant hazard.	X
Road Marking and Delineation	✓
Check that	
Correct type of longitudinal line markings (line pattern and width) is shown.	✓
Lines are properly positioned to guide vehicles and designate merge/diverge situations.	✓
Discontinuities in "through" lanes and unsafe "trap" lanes are identified.	✗
Horizontal and vertical curves are marked with double (barrier) lines where needed.	X
Barrier lines at locations of restricted overtaking sight distance are shown.	X
Approach hazard markings are shown at traffic islands, medians, and expressway gore areas.	X
Correct positioning of all transverse lines such as stop lines and pedestrian crossings.	✓
Reflectorized road markings are specified for nighttime visibility.	X

Retro-reflective pavement markers are specified for enhanced nighttime visibility.	X
Audit of Street Lighting Design	X
Check that	
The extent of street lighting meets traffic safety needs.	✓
The lighting standard, including uniformity and glare effects, is appropriate.	✓
Lighting transitions are provided where lighting ends.	X
Lighting poles do not constitute a roadside hazard.	X
Lighting poles do not obstruct driver sight lines.	✓
Audit of Roadside Safety Provisions	X
Check that	
The provision of a "clear zone."	X
Use of frangible types of road furniture.	X
Guardrail provisions and design details.	X
Minimum length of guardrail to function properly.	X
Guardrail positioning relative to kerbs and objects.	X
Safety treatment of uneven rock cut batters and roadways near water.	X
Audit of Provisions for Special Road Users - Pedestrians	X
Check that	
Lack of footpaths or obstructions by road furniture.	✓
Lack of kerb ramps or dropped kerbs at crossing points.	✓
Lack of specific pedestrian crossings at signalized intersections.	✓
Insufficient space for pedestrian refuge on islands or medians.	✓
Traffic management for safe pedestrian crossing of wide roadways.	X
Audit of Roadside Safety Features	X
Check that	
Provision of guardrails or barriers at hazardous fixed roadside objects.	X

The type and adequacy of guardrails or barriers in relation to hazards.	X
Treatment of guardrail or barrier approach ends and transitions.	X
Correct treatment of lighting poles placed within a median barrier.	X
Provision and treatment of guardrail/barriers at isolated hazards such as bridge piers.	X
Landscaping	X
Check that	X
Trees or landscaping obstructing sightlines and safety visibility.	✓
The species and size of trees planted within the "clear zone."	X
Effect of trees on street lighting and the positioning relative to lighting poles.	✓
Other Effects	✓
Check that	
Foliage infringing vertical and horizontal clearances for large vehicles.	✓
Planting of large trees too close to semirigid guardrails, impacting deflection.	X

6.3 Appendix C

Table 5 Shiromeda Bole

Shiromeda - Bole	
Audit of Traffic Signing and Road Marking	✓
Traffic Signs	✓
Check that	Comment
Traffic signing provides "positive" guidance rather than abstract and indefinite information.	✓
Necessary regulatory signs are provided and properly positioned to control traffic.	✓
Appropriate warning signs are shown on the traffic signing plans.	x
Any unnecessary warning signs are identified and removed.	✓
Proposed direction and guide signing (consider "unfamiliar drivers").	x
Letter/legend size is adequate for drivers to read the information in the available time.	x
Positioning of proposed direction signs will enable drivers to take necessary action safely.	✓
Appropriate reflectorization or lighting of the signs is required.	✓
Provision of overhead (e.g., gantry-mounted) signs for complex multi-lane layouts.	x
Positioning of signs does not obstruct sight lines at intersections and curves.	✓
Positioning and type of signposts prevent these structures from being a significant hazard.	✓
Road Marking and Delineation	✓
Check that	✓
Correct type of longitudinal line markings (line pattern and width) is shown.	✓
Lines are properly positioned to guide vehicles and designate merge/diverge situations.	✓
Discontinuities in "through" lanes and unsafe "trap" lanes are identified.	x
Horizontal and vertical curves are marked with double (barrier) lines where needed.	x
Barrier lines at locations of restricted overtaking sight distance are shown.	x
Approach hazard markings are shown at traffic islands, medians, and expressway gore areas.	x
Correct positioning of all transverse lines such as stop lines and pedestrian crossings.	✓
Reflectorized road markings are specified for nighttime visibility.	✓

Retro-reflective pavement markers are specified for enhanced nighttime visibility.	X
Audit of Street Lighting Design	X
Check that	
The extent of street lighting meets traffic safety needs.	✓
The lighting standard, including uniformity and glare effects, is appropriate.	✓
Lighting transitions are provided where lighting ends.	X
Lighting poles do not constitute a roadside hazard.	✓
Lighting poles do not obstruct driver sight lines.	✓
Audit of Roadside Safety Provisions	✓
Check that	
The provision of a "clear zone."	X
Use of frangible types of road furniture.	X
Guardrail provisions and design details.	✓
Minimum length of guardrail to function properly.	X
Guardrail positioning relative to kerbs and objects.	X
Safety treatment of uneven rock cut batters and roadways near water.	X
Audit of Provisions for Special Road Users - Pedestrians	✓
Check that	
Lack of footpaths or obstructions by road furniture.	X
Lack of kerb ramps or dropped kerbs at crossing points.	X
Lack of specific pedestrian crossings at signalized intersections.	X
Insufficient space for pedestrian refuge on islands or medians.	X
Traffic management for safe pedestrian crossing of wide roadways.	X
Audit of Roadside Safety Features	X
Check that	
Provision of guardrails or barriers at hazardous fixed roadside objects.	X

The type and adequacy of guardrails or barriers in relation to hazards.	X
Treatment of guardrail or barrier approach ends and transitions.	X
Correct treatment of lighting poles placed within a median barrier.	X
Provision and treatment of guardrail/barriers at isolated hazards such as bridge piers.	X
Landscaping	✓
Check that	
Trees or landscaping obstructing sightlines and safety visibility.	✓
The species and size of trees planted within the "clear zone."	X
Effect of trees on street lighting and the positioning relative to lighting poles.	X
Other Effects	✓
Check that	
Foliage infringing vertical and horizontal clearances for large vehicles.	X
Planting of large trees too close to semirigid guardrails, impacting deflection.	X