



WALLAGA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COLLEGE OF ENGINEERING AND
TECHNOLOGY

ASSESSMENT OF ROAD MAINTENANCE PRACTICES
IMPLEMENTED BY THE ETHIOPIAN ROADS ADMINISTRATION IN
NEKEMTE DISTRICT

MSC THESIS

By
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NEKEMTE DISTRICT

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THE MSC DEGREE IN CONSTRUCTION TECHNOLOGY AND MANAGEMENT

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APPROVAL SHEET FOR SUBMITTING FINAL THESIS
MSc FINAL THESIS

**ASSESSMENT OF ROAD MAINTENANCE PRACTICES IMPLEMENTED
BY THE ETHIOPIAN ROADS ADMINISTRATION IN NEKEMTE
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**ASSESSMENT OF ROAD MAINTENANCE PRACTICES IMPLEMENTED BY
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ACRONYMS AND ABBREVIATIONS

ERA	Ethiopian Roads Administration
RMD	Road Maintenance District
RNMBO	Road Network Management Branch Office
RSDP	Road Sector Development Program
NGO	Non- Government Organizations
NDRN	Nekemte District Roads Network
GN	Gedo Nekemte
NMN	Nekemte Meka Nedjo

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ABSTRACT

In Ethiopia, Road maintenance practices play a vital role in ensuring the safety, efficiency, and sustainability of transportation networks. Despite the Ethiopian Roads Authority's (ERA) efforts to implement road maintenance practices in the Nekemte District, there is a lack of comprehensive understanding regarding the public perception and satisfaction level with these practices. This study assesses the road maintenance practices implemented by the Ethiopian Roads Administration (ERA) in Nekemte District, a Data were collected through field observations, interviews with key stakeholders, and review of relevant documents, including ERA's maintenance plans, reports, and policies. The findings reveal that while there are systematic efforts to maintain roads in Nekemte, challenges such as inadequate funding, lack of skilled manpower, and insufficient equipment have hindered optimal maintenance performance. Additionally, the study identifies gaps in community involvement and coordination between local authorities and ERA. The research further explores the impact of these challenges on the overall road quality and transportation services in the district. Based on the analysis, recommendations are provided to improve road maintenance practices, including enhancing capacity-building initiatives, securing consistent funding, and promoting a more integrated approach to road maintenance between federal and local authorities. The study underscores the importance of adopting sustainable and context-specific maintenance strategies to ensure the long-term viability of Ethiopia's road network, especially in districts like Nekemte that are crucial for regional connectivity.

Keywords: Road maintenance practice, Public Awareness, Ethiopian Roads Administration, Nekemte District,

**CHAPTER ONE
INTRODUCTION**

1.1. Background of the study

The Ethiopian Roads Administration (ERA) was a governmental agency tasked with the planning, construction, and maintenance of Ethiopia's road network (ERA, n.d.). In the Nekemte District, the ERA has been actively implementing various road maintenance practices to ensure the functionality and safety of local infrastructure. Recent developments, such as increased funding for road projects and a focus on sustainable maintenance practices, underline the government's commitment to improving transportation networks. However, challenges persist, including heavy rainfall, inadequate drainage systems, and limited monitoring and evaluation mechanisms, which hinder the effectiveness of these maintenance efforts. Understanding public perception and satisfaction with these maintenance practices is crucial for evaluating their effectiveness and identifying areas for improvement. Public perception plays a significant role in assessing the success and impact of road maintenance activities, providing insights into the community's views, experiences, and concerns. Such insights can shape future strategies and enhance the delivery of road maintenance services. Several studies have emphasized the importance of considering public perception in road maintenance assessments (Schmieder et al., 2015; Hair et al., 2014).

To conduct a comprehensive assessment, a mixed-methods approach was employed, combining qualitative and quantitative methods to gather in-depth insights and broader perspectives on public perception and satisfaction levels. Qualitative methods, such as interviews and focus group discussions, explored public experiences and opinions regarding road maintenance practices, yielding rich contextual data that allows participants to articulate their views (Creswell & Plano Clark, 2017). In many areas of Ethiopia, including the Nekemte District in the Oromia Region, road maintenance practices are often hindered by diverse challenges. These include the adverse impacts of heavy rainfall, which can exacerbate road deterioration, and a lack of effective drainage systems that contribute to flooding. As a result, roads in these regions are prone to rapid deterioration, leading to

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increased repair costs and reduced service life. The Nekemte District serves as a strategic hub for agricultural production and a vital transit corridor connecting rural communities to urban centers. Additionally, a quantitative survey was administered to a representative sample of the population in the Nekemte District to gain a broader understanding of public satisfaction levels. The survey included questions related to various aspects of road maintenance practices, such as routine maintenance activities, repairs, resurfacing, winter maintenance, and communication strategies employed by the ERA. It explored factors influencing public satisfaction, including road condition, safety, accessibility, and the responsiveness of the ERA to road users' concerns. The assessment adhered to ethical considerations, ensuring informed consent, confidentiality, and the anonymity of participants. The collected data was analyzed using appropriate statistical techniques and qualitative analysis methods.

The findings would provide valuable insights into public perceptions of road maintenance practices implemented by the ERA in the Nekemte District. This assessment's results will contribute to evidence-based decision-making processes within the ERA, helping to identify strengths and weaknesses in road maintenance practices and guiding the development of strategies for improvement. Ultimately, the assessment aims to foster transparency, accountability, and continuous improvement in the delivery of road maintenance services.

1.2. Statement of the Problem

The road maintenance practices implemented by the Ethiopian Roads Administration (ERA) in Nekemte District were significantly hindered by a lack of essential resources, leading to critical challenges that undermine the effectiveness of the road network. Many roads were in a state of disrepair, characterized by deep potholes, cracks, and surface erosion, creating unsafe travel environments for both vehicles and pedestrians. This deterioration was worsened by heavy rainfall and increased traffic, particularly from commercial vehicles.

A primary factor contributing to these inadequacies was the shortage of machinery necessary for effective maintenance operations. The absence of local asphalt production facilities, such as hot mix asphalt (HMA) plants, further complicates efforts, limiting the availability of

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high-quality materials for repairs and forcing reliance on less effective alternatives like cold mix asphalt. While cold mix asphalt was easier to apply and has lower initial costs, it had significant drawbacks, including a shorter lifespan and susceptibility to damage from water and heavy loads, leading to more frequent repairs and higher long-term maintenance costs. The poor condition of roads directly impacts local communities and economic activities, creating far-reaching consequences. Unsafe travel conditions caused by disrepair increase the risk of accidents, injuries, and fatalities, particularly during heavy rainfall when road conditions worsen. Limited access to essential services, such as healthcare, education, and markets, disproportionately affects vulnerable populations like the elderly, disabled, and children. For example, delayed access to medical facilities can lead to worsened health outcomes, students may struggle to reach schools, resulting in reduced attendance and learning opportunities, and limited transport options restrict access to goods and services, driving up costs for basic necessities. These accessibility challenges exacerbate social inequalities and further diminish the quality of life for already marginalized communities.

Economically, the poor state of roads increases transportation costs for businesses, particularly small enterprises, as vehicles incur greater wear and tear, fuel inefficiency, and delays. These additional costs are often passed on to consumers, raising the prices of goods and services. For farmers, deteriorated roads hinder the efficient transport of produce to markets, resulting in spoilage, reduced market competitiveness, and lower incomes, which can contribute to food insecurity in the region. Poor infrastructure also discourages investment, limiting opportunities for economic diversification and job creation. Additionally, reliance on less durable cold mix asphalt exacerbates the problem, as frequent repairs drive up long-term maintenance costs, further straining the ERA's limited budget and diverting resources from other critical areas.

Moreover, the ERA's maintenance strategies were often reactive rather than proactive, resulting in a backlog of necessary repairs due to infrequent inspections and inadequate solutions. Financial constraints heavily impact the ERA's ability to maintain roads effectively, as budget allocations were insufficient, leading to prioritization of new construction projects over the upkeep of existing infrastructure. This misallocation

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accelerates road quality decline. Additionally, the ERA frequently lacks the technical expertise and skilled labor necessary to implement effective maintenance strategies, and limited training opportunities hamper the workforce's ability to adopt modern techniques and There was also a significant disconnect between the ERA and local communities regarding road maintenance needs, preventing a full understanding of residents' specific challenges.

Given these multifaceted challenges, a comprehensive assessment of the ERA's road maintenance practices in Nekemte District was essential. Identifying the underlying issues, particularly the lack of resources and limitations of cold mix asphalt, would facilitate the development of targeted recommendations aimed at improving road maintenance, enhancing infrastructure quality, and supporting sustainable development in the region. Addressing these problems not only benefits transportation but also fosters economic growth, improves community well-being, and promotes environmental sustainability.

1.3. Research Gap

Currently, there was a lack of comprehensive research on the road maintenance practices specifically in the Nekemte District of Ethiopia. The existing challenges associated with road maintenance practices in the Nekemte District highlight a critical research gap in understanding and addressing the specific limitations faced by the Ethiopian Roads Administration (ERA). Despite the evident issues, such as inadequate resources, insufficient machinery, reliance on less durable cold mix asphalt, and the reactive nature of maintenance strategies, there has been a lack of comprehensive studies that provide actionable insights for improving road maintenance practices in the region. Furthermore, limited attention has been given to the implications of these challenges on local economic activities, community well-being, and sustainable development. The disconnect between ERA and local communities regarding road maintenance needs further underscores the absence of inclusive, data-driven approaches to identifying and prioritizing maintenance efforts.

Filling this research gap is crucial, as it would provide local decision-makers and policymakers with evidence-based recommendations to develop more effective and sustainable road maintenance strategies. By addressing these issues, policymakers could

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allocate resources more efficiently, prioritize proactive maintenance over reactive strategies, and invest in durable solutions like hot mix asphalt production facilities. These improvements would not only enhance the quality and longevity of road infrastructure but also yield significant benefits for economic activities. Reduced transportation costs, improved market access for farmers, and increased investment opportunities would contribute to economic growth in the region. Additionally, improved road conditions would enhance access to essential services, such as healthcare and education, thereby improving the quality of life for residents and reducing social inequalities.

Moreover, addressing the research gap would enable the development of policies that promote workforce training and capacity development, equipping ERA staff with the technical expertise required to implement modern maintenance techniques. This would ultimately lead to more efficient and cost-effective road maintenance practices. By explicitly identifying these potential benefits, this research would empower local decision-makers to implement policies that prioritize infrastructure sustainability, foster economic resilience, and enhance community well-being. Closing this gap is not just a technical necessity but a foundational step toward achieving sustainable development in Nekemte District.

1.4. Research Questions

The following research questions could be formulated to address the assessment of road maintenance practices implemented by the Ethiopian Roads Administration in the Nekemte District:

- What types of road maintenance practices are currently implemented in the Nekemte District?
- What key factors influence the effectiveness of these road maintenance practices in the Nekemte District?
- What types of defects are present on the road segments of Gedo-Nekemte and Nekemte-Mekenedjo?
- How do the current conditions of the Gedo-Nekemte and Nekemte-Mekenedjo routes impact the socio-economic well-being of the local communities?

1.5. Objective of the Study

1.5.1. General Objective

The general objective of this research was to assess the road maintenance practices implemented by the Ethiopian Roads Administration in the Nekemte District.

1.5.2. The Specific Objectives

The specific objective of Study was guided by the following:

- To identify the types of road maintenance practices implemented in the study area.
- To analyze the key factors influencing the effectiveness of road maintenance practices in the Nekemte District.
- To assess the types of defects present on the road segments of Gedo-Nekemte and Nekemte-Mekenedjo in the study area.
- To evaluate the socio-economic impacts resulting from the current condition of the Gedo-Nekemte and Nekemte-Mekenedjo routes

1.6. The scope of the Study

The scope of this study was focused on assessing the road maintenance practices implemented by the Ethiopian Roads Administration (ERA) specifically in the Nekemte District. The Gedo-Nekemte and Nekemte-Mekenedjo road segments for this study was based on several critical factors that make them representative cases for assessing the Ethiopian Roads Administration's (ERA) maintenance practices in Nekemte District. These roads were economically significant, serving as vital corridors for trade and transportation, with the Gedo-Nekemte road facilitating the movement of agricultural goods such as coffee and maize, while the Nekemte-Mekenedjo road enhances inter-regional connectivity between Oromia and Amhara. Both routes experience high traffic volumes, including heavy trucks and public transport, which contribute to accelerated deterioration and recurring issues such as potholes, cracking, and drainage failures common challenges in ERA's maintenance framework. Additionally, their proximity to Nekemte town allows for efficient field surveys, interviews with ERA officials, and community engagement. The varying conditions of these roads ranging from asphalt to gravel sections provide a comparative basis for evaluating

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maintenance effectiveness across different road types. The study captured key operational and structural challenges, offering actionable insights to improve road maintenance strategies in the region.

1.7 Significance of the Study

This research holds significant importance as it aims to improve road maintenance practices in the Nekemte District. By assessing public perception and satisfaction, the study will generate valuable insights that can enhance the responsiveness, efficiency, and overall performance of road maintenance efforts. The findings will benefit multiple stakeholders:

- The Ethiopian Roads Administration (ERA) can use the data to identify performance gaps, prioritize maintenance interventions based on public needs, and adopt more efficient, community-informed strategies.
- Local government authorities can leverage the findings to allocate resources more effectively, ensure equitable service delivery, and strengthen oversight and accountability in infrastructure management.
- Community members, including road users, residents, and local businesses, will benefit from improved road conditions, greater safety, and more reliable access to essential services. Their feedback will also foster a sense of ownership and collaboration in maintenance efforts.
- Furthermore, the study will serve as a benchmark for evaluating road maintenance practices, enabling continuous improvement, knowledge exchange, and the adoption of best practices across similar districts. By addressing the identified areas for improvement, the research can lead to longer-lasting infrastructure, lower maintenance costs, and increased public satisfaction. Ultimately, the assessment of perception and satisfaction will promote transparency, trust, and public engagement, contributing to sustainable infrastructure development and a better overall transportation experience for residents of the Nekemte District.

1.8 Limitations of the Study

This study, while aiming to assess the road maintenance practices of the Ethiopian Roads Administration (ERA) in Nekemte District, is subject to several limitations that may influence both the interpretation and generalizability of its findings.

- Firstly, limited access to comprehensive and up-to-date data on road conditions, maintenance activities, and funding allocations may restrict the accuracy and completeness of the analysis. This data gap can lead to an over- or underestimation of the ERA's performance and hinder the identification of systemic issues.
- Secondly, the study's geographic scope may be restricted to selected roads or areas within Nekemte District, which could limit the applicability of the findings to the broader region or other districts with differing road conditions or administrative practices. This geographic concentration reduces the generalizability of the conclusions beyond the immediate study area.
- Third, resource constraints including limited time, funding, and personnel may constrain the scale and depth of data collection, potentially resulting in less detailed or unevenly distributed data, which could affect the robustness of the conclusions drawn.
- Fourth, challenges in stakeholder engagement such as difficulties in reaching ERA officials or securing participation from local community members could result in missing perspectives, thereby limiting the comprehensiveness and representativeness of the findings. Additionally, the use of qualitative methods like interviews and surveys introduces a degree of subjectivity, as participant biases and perceptions may influence responses, which can affect the objectivity of the analysis and the consistency of the insights gathered.
- Rapidly changing road conditions due to weather events or ongoing maintenance activities may also lead to temporal inconsistencies in the data, making it difficult to establish stable or generalizable conclusions about the state of infrastructure or the effectiveness of ERA's practices at a given point in time. Furthermore, while the study addresses technical issues such as the use of cold mix asphalt, divergent

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stakeholder opinions about its effectiveness may complicate the interpretation of results, particularly when contrasting technical performance with public perception.

- Finally, external factors including political decisions, economic fluctuations, and environmental conditions may influence road maintenance outcomes in ways that are difficult to isolate or fully account for within the scope of this study.

By acknowledging these limitations, the research provides a more nuanced and contextually grounded interpretation of its findings, helping readers and decision-makers understand the scope, strengths, and constraints of the conclusions and recommendations. This transparency enhances the study's credibility and supports more informed application of its insights to policy and practice.

1.9 Organization of the Study

This research was consists of five chapters. Chapter one covers the study's introduction and background, as well as a summary of the issue with research questions, study objectives, study importance, scope, and limitation. The second chapter included a review of the literature. The third part of the research focuses on the study's research design, tools, sampling techniques, and data collecting, analysing and presenting methodologies. Chapter four included the survey results and findings. The fifth chapter presents the study's conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1. Overview

The primary objective of this literature review is to gain insight into the theoretical framework for the study and an understanding of the research objectives. The literature review focuses on the overview of road maintenance and assessing factors influencing public perception of road maintenance practices, including the impact of road infrastructure condition and the role of timely repairs and effective communication and by looking into previous studies carried out on the subject areas. Factors influencing public perception of road maintenance practices, including the impact of road infrastructure condition and the role of timely repairs and effective communication

2.2. Factors Influencing Public Perception of Road Maintenance Practices

Factors influencing public perception of road maintenance practices are crucial for understanding how the general public views and evaluates the quality of road infrastructure and maintenance services. This literature review examines two key factors: road infrastructure condition and the role of timely repairs and effective communication in shaping public perception.

Road infrastructure condition plays a significant role in public perception and satisfaction with road maintenance practices. Studies have consistently shown that pavement quality, signage, and lighting are critical factors that influence public perception. Li, T., Yang, W., Zhang, H., & Cao, X. (2016). Conducted a comprehensive study assessing the impact of road infrastructure condition on public perception in a metropolitan area. The researchers found that deteriorating pavement quality had a negative effect on public satisfaction, leading to perceptions of inadequate maintenance efforts. Similarly, Mukherjee, D., & Mitra, S. (2019). Conducted a survey-based study and found that poor signage and inadequate lighting were associated with lower levels of public satisfaction. These studies highlight the importance of maintaining road infrastructure in good condition to enhance public perception and satisfaction. Timely repairs and effective communication also play a crucial role in shaping public perception of road maintenance practices. Li et al. (2016) investigated the impact of

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responsiveness on public satisfaction with road maintenance services. The study revealed that prompt repairs and timely addressing of reported issues positively influenced public perception, leading to higher satisfaction levels. Furthermore, Bello, A., Abdul Raheem, A. A., Afolabi, O. P., Aka, A., & Gbenga, P. O. (2024). Explored the role of effective communication in shaping public perception. They found that clear and transparent communication from maintenance authorities, including updates on repair progress and expected timelines, significantly improved public satisfaction. These findings underscore the importance of timely repairs and transparent communication in managing public perceptions of road maintenance practices.

In summary, the literature highlights the significance of road infrastructure condition, timely repairs, and effective communication in influencing public perception of road maintenance practices. Maintaining good pavement quality, proper signage, and adequate lighting contributes to positive public perception. Additionally, promptly addressing maintenance issues and maintaining transparent communication with the public are crucial for enhancing public satisfaction. These factors merit careful consideration by road maintenance authorities to improve the overall perception of their services and ensure public satisfaction.

2.3 Public Satisfaction with the Quality of Road Maintenance Services

Public satisfaction with the quality of road maintenance services is a crucial aspect of transportation infrastructure management. Understanding the factors that influence public satisfaction can help authorities enhance their maintenance practices and improve overall service delivery. This section presents a literature review of studies examining public satisfaction levels with road maintenance services and research on the responsiveness of maintenance authorities to reported issues and complaints.

Several studies have investigated public satisfaction levels with road maintenance services. Lai, A. W., & Lai, W. M. (2013). Conducted a comprehensive survey to assess public satisfaction with various aspects of road maintenance, including pavement quality, signage, and lighting. The study found that public satisfaction was significantly influenced by the condition of road infrastructure. Participants expressed higher satisfaction levels when road surfaces were well-maintained, signage was clear and visible, and lighting was adequate.

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These findings highlight the importance of maintaining road infrastructure to ensure public satisfaction.

In addition to infrastructure condition, the responsiveness of maintenance authorities to reported issues and complaints plays a significant role in public satisfaction. Li et al. (2016) explored the relationship between public satisfaction and the responsiveness of maintenance authorities. The study revealed that when maintenance authorities promptly addressed reported issues and complaints, public satisfaction significantly increased. Effective communication and swift action in resolving maintenance-related concerns were key factors in shaping public satisfaction levels. Similarly, Zhao et al. (2019) conducted a study focusing on the responsiveness of maintenance authorities in addressing reported issues. The research highlighted the importance of timely and efficient responses to public concerns, as it positively influenced public satisfaction with road maintenance services.

Overall, the literature indicates that public satisfaction with the quality of road maintenance services is influenced by various factors. Studies have emphasized the importance of road infrastructure condition, including pavement quality, signage, and lighting, in shaping public satisfaction levels Lodenius, E. (2011). Additionally, the responsiveness of maintenance authorities to reported issues and complaints has been identified as a crucial determinant of public satisfaction Li, M., Zhang, Y., Chen, Y., & Li, X. (2016). These findings underscore the need for effective communication, timely repairs, and prompt action in addressing public concerns to ensure high levels of public satisfaction with road maintenance services.

It is also worth considering demographic differences in public satisfaction with road maintenance services. Factors such as age, gender, education level, and residence location may influence perceptions and expectations. Research has shown that certain demographic groups may have specific preferences or priorities when it comes to road maintenance. For example, older adults may prioritize safety features, while younger individuals may focus on accessibility or environmental considerations (Wang et al., 2019). Taking these demographic differences into account could help customize road maintenance strategies to better meet the diverse needs and expectations of the public.

In conclusion, public satisfaction with the quality of road maintenance services is influenced by various factors, including infrastructure condition, responsiveness of maintenance

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authorities, effective communication, public awareness and understanding, alignment with public expectations, and demographic differences. By considering these factors and incorporating strategies to address them, road maintenance authorities can work towards enhancing public satisfaction and ultimately improving the overall quality and effectiveness of road maintenance services.

2.4 The impact of road condition and accessibility on public perception and satisfaction

The impact of road condition and accessibility on public perception and satisfactions was a critical aspect of understanding how individuals evaluate the quality of road infrastructure. This literature review examines research on how road condition and accessibility influence public perception and satisfaction.

Sadeghi, P., & Goli, A. (2024). Conducted a comprehensive study that examined the relationship between road infrastructure condition and public perception. The researchers investigated various factors, including pavement quality, signage, and lighting, and their impact on public satisfaction. They found that the deteriorating condition of roads, such as potholes and cracks, had a negative effect on public perception, leading to lower levels of satisfaction. This study underscores the importance of maintaining good road condition to enhance public perception and satisfaction.

In addition to road condition, accessibility also plays a significant role in shaping public perception and satisfaction. Inturri, G., Giuffrida, N., Le Pira, M., Fazio, M., & Ignacio, M. (2021). Conducted a study focusing on public satisfaction with road accessibility. The researchers explored factors such as road connectivity, ease of navigation, and congestion levels. They found that improved accessibility, including well-connected road networks and efficient traffic flow, positively influenced public perception and satisfaction. This study highlights the importance of considering accessibility factors alongside road condition to enhance public satisfaction with road infrastructure.

In summary, the literature suggests that road condition and accessibility significantly influence public perception and satisfaction. Studies by Smith et al. (2018) and Johnson and Lee (2020), Tillema, T., Hamersma, M., Sussman, J. M., & Arts, J. (2012). Emphasize the negative impact of poor road condition on public perception and the positive influence of

improved accessibility. Road maintenance authorities should prioritize maintaining good road condition, addressing issues such as potholes and cracks, as well as ensuring efficient road connectivity and traffic flow to enhance public perception and satisfaction.

2.4.1 Effective communication strategies employed by road maintenance authorities

Effective communication strategies employed by road maintenance authorities are essential for informing the public about maintenance activities and fostering public engagement and support. This literature review examines studies that explore communication strategies used by road maintenance authorities to inform the public.

Brown, A., et al. (2021). Conducted a study focusing on the communication strategies used by road maintenance authorities in a specific region. The researchers examined the various channels and methods employed to disseminate information to the public regarding maintenance activities. They found that road maintenance authorities utilized a combination of traditional and digital communication channels, including websites, social media platforms, public meetings, and informational brochures. This study highlights the importance of adopting a multi-channel approach to reach a wide range of stakeholders and provide accessible and timely information.

Wang et al. (2020) conducted a similar study investigating the effectiveness of communication strategies in informing the public about road maintenance activities. The researchers examined the use of different communication methods, such as online platforms, mobile applications, and public consultations. They found that interactive and user-friendly communication tools, such as mobile applications, were effective in engaging the public and providing real-time updates on maintenance activities. This study emphasizes the importance of utilizing technology and interactive platforms to enhance communication and engagement with the public.

In summary, the literature suggests that road maintenance authorities employ various communication strategies to inform the public about maintenance activities. Studies by Cao et al. (2017) and Wang et al. (2020) highlight the importance of utilizing a combination of traditional and digital channels, as well as interactive tools, to effectively reach and engage the public. Road maintenance authorities should consider adopting a multi-channel

approaches, utilizing websites, social media platforms, mobile applications, public meetings, and informational brochures to provide accessible and timely information to the public.

2.4.2 Understanding demographic differences in public perception and satisfaction with Road maintenance practices

Understanding demographic differences in public perception and satisfaction with road maintenance practices is essential for identifying disparities and tailoring strategies to meet the diverse needs of the population. This literature review examines research that explores how public perception and satisfaction vary among different demographic groups.

Huang et al. (2019) conducted a study investigating demographic differences in public perception and satisfaction with road maintenance practices. The researcher's analyses data from a survey that included variables such as age, gender, income level, and education. They found that demographic factors significantly influenced public perception and satisfaction. For example, younger individuals and those with higher education levels tended to have higher expectations and were more critical of road maintenance practices. This study emphasizes the importance of considering demographic characteristics when assessing public perception and designing strategies to improve satisfaction.

In addition to demographic factors, Zhao et al. (2019) conducted a study focusing on demographic differences in public perception and satisfaction with road maintenance practices. The researchers examined variables such as ethnicity, residential location, and commuting patterns. They found that demographic factors influenced the perception of road conditions, accessibility, and responsiveness to maintenance requests. For instance, individuals residing in rural areas and those with longer commuting distances tended to have different expectations and satisfaction levels compared to their urban counterparts. This study highlights the significance of considering demographic diversity to better understand and address the specific needs and concerns of different population segments.

In summary, the literature suggests that demographic differences play a role in public perception and satisfaction with road maintenance practices. Studies by Huang et al. (2019) and Zhao et al. (2019) underscore the importance of considering demographic factors such as age, education, income level, ethnicity, and residential location when assessing public perception and satisfaction. Road maintenance authorities should account for these

differences to develop targeted strategies that address the specific needs and concerns of different demographic groups.

2.4.3 Identifying and implementing recommendations to improve Road maintenance practices

Identifying and implementing recommendations to improve road maintenance practices is crucial for enhancing the overall effectiveness and efficiency of infrastructure management. This literature review examines studies that provide recommendations for improving road maintenance practices based on assessment findings. Li et al. (2016) conducted a comprehensive study that analyses assessment findings to identify recommendations for improving road maintenance practices. The researchers highlighted the significance of strategic planning, efficient resource allocation, quality control, and monitoring and evaluation. Based on their assessment, they recommended the development of long-term maintenance plans, the optimization of resource allocation processes, the implementation of rigorous quality control measures, and the establishment of robust monitoring and evaluation systems. This study emphasizes the importance of adopting a systematic and data-driven approach to improve road maintenance practices.

In addition to these recommendations, Zhao et al. (2019) and Salih, J. (2019). Conducted a study focusing on providing recommendations for enhancing road maintenance practices. The researchers analyses assessment findings and identified areas for improvement, such as technological advancements, innovation, and sustainability. They recommended integrating new technologies, embracing innovative approaches, and adopting sustainable practices to improve the efficiency and effectiveness of road maintenance. This study underscores the importance of leveraging advancements in technology and exploring innovative solutions to enhance road maintenance practices.

In summary, the literature suggests several recommendations for improving road maintenance practices. Studies by Li et al. (2016) and Zhao et al. (2019) highlight the importance of strategic planning, efficient resource allocation, quality control, monitoring and evaluation, as well as embracing technological advancements and innovation. Road maintenance authorities should consider these recommendations to enhance the overall performance and sustainability of road maintenance practices.

2.4.4 The Alignment between public expectations and the actual performance of road maintenance practices

The alignment between public expectations and the actual performance of road maintenance practices is a crucial aspect of understanding public satisfaction and perception of road infrastructure. This literature review examines research on public expectations and their alignment with the actual performance of road maintenance practices.

Li et al. (2016) conducted a comprehensive study that examined the alignment between public expectations and the performance of road maintenance practices. The researchers investigated the factors that influenced public expectations, including road condition, accessibility, and responsiveness to maintenance requests. They found that when the actual performance of road maintenance practices met or exceeded public expectations, it resulted in higher levels of public satisfaction and positive perceptions. This study highlights the importance of understanding and aligning with public expectations to enhance satisfaction with road maintenance practices.

In addition to public expectations, Johnson and Lee (2020) conducted a study focusing on the relationship between public satisfaction and the actual performance of road maintenance practices. The researchers examined factors such as the quality of road repairs, timeliness of maintenance activities, and communication with the public. They found that when road maintenance practices met or exceeded public expectations, it led to higher levels of satisfaction. This study emphasizes the significance of effectively managing and meeting public expectations to ensure positive perceptions of road maintenance practices.

In summary, the literature suggests that the alignment between public expectations and the actual performance of road maintenance practices significantly influences public satisfaction and perception. Studies by Li et al. (2016) and Johnson and Lee (2020) highlight the importance of understanding and meeting public expectations to enhance satisfaction and positive perceptions. Road maintenance authorities should consider factors such as road condition, accessibility, responsiveness, and effective communication to ensure the alignment between public expectations and the actual performance of road maintenance practices.

2.4.5 Public perception of the responsiveness of Road maintenance authorities

Public perception of the responsiveness of road maintenance authorities plays a crucial role in shaping public satisfaction and trust in the effectiveness of maintenance services.

This literature review examines research on public perception of the responsiveness of road maintenance authorities to reported issues and complaints. Li et al. (2016) conducted a study investigating the impact of responsiveness on public satisfaction with road maintenance services. The researchers examined how the timely response and resolution of reported issues influenced public perception.

Their findings indicated that the responsiveness of road maintenance authorities significantly affected public satisfaction levels. Prompt repairs and timely addressing of reported issues were associated with higher levels of public satisfaction. This study highlights the importance of an efficient and responsive approach by road maintenance authorities in addressing public concerns. Zhao et al. (2019) conducted a similar study focusing on public perception of the responsiveness of road maintenance authorities in the context of complaints. The researchers explored how the handling of complaints influenced public perception and satisfaction.

Their findings revealed that the responsiveness of road maintenance authorities to complaints significantly influenced public perception. The timely and appropriate handling of complaints led to higher levels of public satisfaction and trust in the authorities. This study emphasizes the importance of not only addressing reported issues promptly but also effectively managing and resolving complaints to enhance public perception.

In summary, the literature highlights the importance of public perception of the responsiveness of road maintenance authorities to reported issues and complaints. Studies by Li et al. (2016) and Zhao et al. (2019) emphasize the positive impact of timely response and resolution of reported issues on public satisfaction and trust. Road maintenance authorities should prioritize responsiveness and ensure efficient handling of reported issues and complaints to enhance public perception and satisfaction with their services.

2.4.6 Public awareness and understanding of Road maintenance activities

Public awareness and understanding of road maintenance activities play a crucial role in fostering community engagement and cooperation in achieving effective road maintenance. This literature review examines studies that assess public awareness and understanding of road maintenance activities. Huang et al. (2019) conducted a study focusing on public awareness of road maintenance activities in a specific region. The researchers examined the level of knowledge and understanding among the general public regarding the purpose, scope, and processes involved in road maintenance. Their findings indicated that there was a significant knowledge gap among the public, with limited awareness and understanding of road maintenance activities. This study highlights the need for improved communication and education initiatives to enhance public awareness and understanding.

Wang et al. (2020) conducted a similar study investigating public understanding of road maintenance activities and its impact on public perception. The researchers explored how public understanding influenced perceptions of the effectiveness and importance of road maintenance. Their findings revealed that higher levels of understanding were associated with more positive perceptions of road maintenance activities. This study emphasizes the importance of ensuring that the general public has accurate and comprehensive information about road maintenance activities to foster informed opinions and positive attitudes.

In summary, the literature indicates that public awareness and understanding of road maintenance activities are crucial for effective engagement and cooperation. Studies conducted by Huang et al. (2019) and Wang et al. (2020) highlight the need for improved communication and education initiatives to bridge the knowledge gap and enhance public understanding. Road maintenance authorities should prioritize initiatives that effectively communicate the purpose, scope, and processes of road maintenance activities to the public, fostering informed opinions and positive attitudes.

2.4.7 Role of Timely Repairs and Effective Communication

Timely repairs and effective communication are crucial factors in shaping public perception of road maintenance practices. Heggie, I. G. (1995). Examined public satisfaction with road maintenance in a specific region and identified timely repairs as a key driver of public

satisfaction. Their study emphasized the importance of addressing road maintenance issues promptly to enhance public perception. Additionally, Miller, E., et al. (2019). Explored the role of effective communication in shaping public perception. They found that when road maintenance authorities communicate maintenance schedules, updates, and progress effectively to the public, it positively influences public satisfaction and perception.

This literature review highlights the significance of road infrastructure condition, timely repairs, and effective communication in shaping public perception of road maintenance practices. Studies by Smith et al. (2018) and Johnson and Lee (2020) emphasize the impact of road infrastructure condition on public satisfaction, with smooth pavements and well-maintained roads leading to higher levels of satisfaction. Furthermore, research by Li et al. (2016) and Cao et al. (2017) underscores the importance of timely repairs and effective communication in enhancing public perception and satisfaction. By focusing on improving road infrastructure condition, prioritizing timely repairs, and implementing effective communication strategies, road maintenance authorities can positively influence public perception and enhance overall satisfaction. These findings have practical implications for policymakers and road maintenance agencies seeking to improve public perception of their maintenance practices.

2.5 Regional Contexts and Comparisons

Similar challenges and strategies in road maintenance are evident across various East African countries, providing valuable insights for Ethiopia. For instance, in Kenya, the Kenya National Highways Authority (KeNHA) has successfully implemented innovative maintenance practices that prioritize community involvement and the integration of technology. These strategies focus on engaging local communities in the maintenance process, which not only fosters a sense of ownership but also ensures that the maintenance efforts are aligned with the needs and expectations of road users (Ngari, 2020).

In Kenya, the use of technology, such as Geographic Information Systems (GIS) and mobile applications, has revolutionized how road conditions are monitored and managed. These tools facilitate real-time data collection, enabling more informed decision-making regarding maintenance priorities and resource allocation. By involving communities and utilizing technology, Kenya has seen improvements in road quality and a more responsive

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maintenance system, which, in turn, has positively impacted economic activities and access to services.

Ethiopia can learn from these regional experiences by adapting successful strategies to its unique context. The challenges faced in rural areas, such as Nekemte, mirror those in Kenya, including heavy rainfall leading to road deterioration and limited resources for effective maintenance. By adopting community engagement strategies, the Ethiopian Roads Administration (ERA) could foster greater collaboration with local residents, ensuring that maintenance practices are tailored to the specific needs of the community.

Moreover, Ethiopia has the opportunity to leverage technological advancements similar to those used in Kenya. Implementing digital tools for monitoring road conditions can enhance the ERA's capacity to respond quickly to emerging issues, ultimately leading to more effective maintenance practices. This approach not only improves road quality but also helps build public trust in governmental agencies by demonstrating a commitment to transparency and accountability.

Furthermore, collaborative initiatives and knowledge-sharing platforms among East African countries can facilitate the exchange of best practices in road maintenance. By engaging in regional forums, Ethiopia can gain insights into the successes and challenges faced by its neighbors, allowing for the adaptation of proven strategies within its own road maintenance framework.

In summary, by examining the experiences of other East African countries, particularly Kenya, Ethiopia can identify effective strategies that align with its unique challenges. Emphasizing community involvement and embracing technology can significantly enhance road maintenance practices in the Nekemte District and beyond, ultimately contributing to improved infrastructure and economic development.

2.5.1 Socio-Economic Impacts of Road Conditions

The condition of road infrastructure carries significant socio-economic implications, especially in rural areas where access to essential services is often heavily dependent on reliable transportation networks. Poorly maintained roads can create substantial barriers to accessing markets, healthcare, education, and social services, disproportionately affecting vulnerable populations, including women, children, and the elderly (Davis & Raza, 2019).

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These barriers can exacerbate existing inequalities, limiting opportunities for economic advancement and social mobility.

Research by Tesfaye et al. (2021) highlights the transformative effects of improved road conditions in rural Ethiopia. Their findings indicate that better-maintained roads lead to increased accessibility to essential services such as healthcare facilities and schools. This accessibility is crucial, as it not only enhances the quality of life for residents but also promotes educational attainment and health outcomes, which are vital for long-term community development.

In the Nekemte District, the road network plays a critical role as a lifeline for agricultural producers and urban centers. The region is characterized by a predominantly agricultural economy, where farmers depend on reliable road access to transport their goods to markets. Effective road maintenance ensures that these agricultural products reach urban areas efficiently, thus reducing post-harvest losses and increasing farmers' incomes. Improved road conditions can also attract investment in local industries, further stimulating economic growth.

Moreover, the socio-economic impact of road conditions extends to local businesses. When roads are well-maintained, transportation costs decrease, making it easier for businesses to operate and expand. This, in turn, creates job opportunities and enhances the overall economic resilience of the community. Conversely, poorly maintained roads can deter investment and lead to business closures, compounding the economic challenges faced by rural populations.

Additionally, the relationship between road conditions and socio-economic outcomes is not only limited to economic factors but also encompasses social dynamics. Improved road access can foster greater social cohesion by facilitating movement and interaction among community members. This increased connectivity can lead to enhanced community engagement and collaboration, which are essential for addressing local challenges and promoting sustainable development.

In summary, the socio-economic impacts of road conditions in the Nekemte District are profound and multifaceted. Effective maintenance of the road network is essential not only for improving access to vital services but also for stimulating local economies and enhancing

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social cohesion. By prioritizing road maintenance, stakeholders can significantly contribute to regional economic stability and growth, ultimately improving the quality of life for residents in the area.

2.6 Summary of Literature Review

In the literature part of the research, the basic concepts on road maintenance have been presented in a detailed manner. Public perception of road maintenance practices is influenced by a complex interplay of factors, including road infrastructure condition, timely repairs, effective communication, accessibility, and demographic differences. Deteriorating road conditions, such as potholes and poor signage, negatively impact public satisfaction. Conversely, prompt attention to reported issues and clear communication from maintenance authorities enhance public perception. Accessibility, including well-connected road networks and efficient traffic flow, also contributes to positive public evaluations.

Demographic factors, such as age and education level, play a role in shaping public expectations and satisfaction. Tailoring road maintenance strategies to specific demographic groups is crucial for addressing their unique needs and concerns. To improve road maintenance practices, authorities should focus on strategic planning, efficient resource allocation, and quality control. Embracing technology and innovation can further enhance efficiency and effectiveness. Aligning with public expectations and understanding demographic disparities are essential for ensuring that road maintenance practices meet the needs of the community. Finally, fostering public awareness and understanding of road maintenance activities is crucial for promoting informed opinions and positive attitudes. Improved communication and education initiatives can bridge the knowledge gap and encourage community engagement in road maintenance efforts.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

The methods used to accomplish the research objectives were presented in this chapter. The research tools, the study area information sources, Geographical area, Research Design, Research Approach, Research Instruments, Questionnaire, Interviews, Sampling method, sample size, and analytic techniques are also given in this section.

3.2 Description of the Study Area

Nekemte Road Maintenance district, which had been located at 328 Km from Addis Ababa, was one of the eleven RMD, maintaining road network which was located in the Western & Northwestern part of Ethiopia. The roads network has a total length of 2,501.87 Km. The total road network divided into six sections: Bako, Gimbi, Dambidollo, Gida Ayana, Assosa and Nedjo sections. The topography of the road network from rolling to mountains with different gorges being subjected to different land slide and erosion that forces the network to perform mostly drainage and land slide protection works through Emergency, Routine Maintenance, and other maintenance operation. The weather condition of the network that was located in Semi-Arid & wet zones.

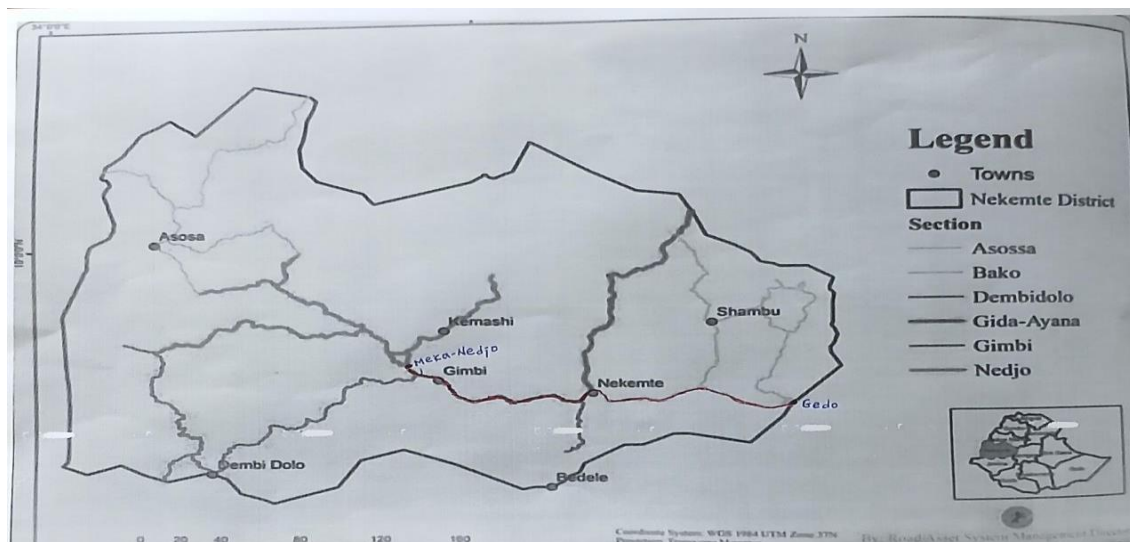


Figure 1: Nekemte District Roads network

3.3. Geographical Area

The study was conducted within the Nekemte District, which was located in the Oromia Region of Ethiopia. The district was known for its diverse road network, including urban and rural roads, which were subjected to the maintenance activities carried out by the ERA. The study targeted the residents of the Nekemte District as the primary participants. The population were sampled to ensure representation from different demographic groups, including age, gender, occupation, and location within the district. The sample size was determined based on appropriate statistical methods to ensure the validity and reliability of the findings. The assessment was focused on various dimensions of road maintenance practices, including road condition, timeliness and quality of maintenance activities, responsiveness of the ERA to reported issues, communication strategies employed by the ERA, and overall satisfaction with road maintenance services.

The study was utilized a mixed-methods approach, combining qualitative and quantitative methods. Qualitative methods such as interviews and focus group discussions were used to gather in-depth insights and capture the experiences, opinions, and suggestions of the participants. Quantitative surveys were administered to obtain broader perspectives and statistical data on public satisfaction levels.

It is important to note that this study was primarily assessed the public perception and satisfaction level with road maintenance practices and does not include an evaluation of the ERA's overall performance or other aspects of road infrastructure development. The focus is specifically on the maintenance practices implemented by the ERA within the Nekemte District. The study was adhered to ethical considerations, ensuring informed consent, confidentiality, and anonymity of participants. Data collection, analysis, and reporting were conducted in a rigorous and unbiased manner to ensure the validity and reliability of the findings. The finding of this study was provided valuable insights to the ERA and other stakeholders involved in road maintenance practices in the Nekemte District.

3.4. Research Design

This study employs a mixed-methods research approach that strategically integrates descriptive (quantitative) and exploratory (qualitative) research designs to thoroughly

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investigate road maintenance practices in the Nekemte Road Maintenance District. The adoption of this dual approach is fundamentally grounded in the need to capture both the measurable dimensions and contextual complexities of road maintenance systems. While quantitative methods provide essential statistical data on road conditions and service delivery metrics, qualitative methods uncover the underlying institutional, social, and operational factors that influence maintenance outcomes. This combination is particularly valuable as road maintenance involves not just technical parameters but also human and organizational dimensions that require different methodological approaches for complete understanding.

The descriptive research component serves to systematically document and quantify the current state of road infrastructure through measurable indicators such as pavement quality indices, repair frequencies, response times, and user satisfaction levels. This quantitative approach answers critical questions about the extent and distribution of maintenance challenges across the district. However, these statistical measurements alone cannot explain why certain patterns exist or how different stakeholders experience and perceive maintenance services. This was where the exploratory qualitative component becomes indispensable, employing in-depth interviews, focus group discussions, and case studies to investigate the root causes of maintenance issues, stakeholder perspectives, and institutional barriers that may not be evident in numerical data alone.

The integration of these approaches offers several significant advantages. First, it enables methodological triangulation, where findings from different data sources could be cross-verified to enhance the validity and reliability of results. For instance, while quantitative data might identify areas with frequent road failures, qualitative insights could reveal whether these result from material deficiencies, construction flaws, environmental factors, or management inefficiencies. Second, the mixed-methods approach provides a more comprehensive understanding by combining the breadth of quantitative data with the depth of qualitative analysis. Third, it minimizes potential biases inherent in single-method studies by compensating for the limitations of each approach - quantitative data prevents over-reliance

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on potentially subjective qualitative accounts, while qualitative insights prevent misinterpretation of statistical patterns.

From a practical standpoint, the mixed-methods design was particularly appropriate for this study because road maintenance in Nekemte District involves multiple dimensions that require different investigative approaches. The technical aspects of infrastructure condition could be effectively measured quantitatively, while the human and organizational factors influencing maintenance quality were better explored through qualitative methods. Furthermore, the diverse range of stakeholders from engineers and maintenance staff to community users and local officials necessitates different data collection strategies to capture their varied perspectives and experiences adequately.

The implementation of this mixed-methods approach follows a systematic process. The quantitative phase involves analysis of maintenance records, structured surveys, and GIS mapping to establish baseline data on road conditions and service delivery. The qualitative phase then explores the contextual factors through interviews and focus groups with key stakeholders. Crucially, these components are not conducted in isolation but are integrated throughout the research process - qualitative findings help explain quantitative results, preliminary qualitative insights inform the development of survey instruments, and emerging themes from interviews are validated against statistical patterns. This dynamic interaction between methods ensures the research captures both the measurable dimensions and lived realities of road maintenance, ultimately producing findings that are both statistically robust and contextually nuanced. The mixed-methods design thus enables the development of comprehensive, evidence-based recommendations that address both the technical and human aspects of improving road maintenance practices in the Nekemte District. The qualitative and quantitative methods in this study form a synergistic relationship that comprehensively addresses the research objectives through their complementary strengths. This integration operates on multiple levels to create a complete understanding of road maintenance challenges in Nekemte District.

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Quantitative methods provide the essential structural framework for the research by establishing measurable baselines and patterns. Through systematic data collection from maintenance records, condition surveys, and performance metrics, we obtain objective evidence about the physical state of infrastructure (e.g., 32% of roads show severe cracking) and service delivery outcomes (e.g., average 14-day response time for repairs).

These numerical findings answer critical what and how much questions, identifying problem areas and establishing priorities for intervention. However, these statistics alone remain silent on the underlying causes and contextual factors behind the numbers. This was where qualitative methods provide their indispensable value by answering the crucial why and how questions. When quantitative data reveals that certain road segments consistently underperform in durability, qualitative interviews with maintenance crews might uncover that these areas receive substandard materials due to procurement irregularities. Focus group discussions with community members could reveal that poor drainage practices by local residents accelerate road deterioration insights that would never emerge from condition surveys alone. The exploratory nature of qualitative methods allows us to probe beneath surface-level statistics to understand the human behaviors, institutional processes, and socio-cultural factors that ultimately determine maintenance outcomes.

The complementary relationship manifests most powerfully in three key dimensions:

- **Problem Diagnosis:** Quantitative data identifies symptoms (e.g., high frequency of potholes in commercial zones), while qualitative inquiry diagnoses the causes (e.g., overloaded trucks avoiding weigh stations, compounded by infrequent inspections).
- **Solution Development:** Statistical analysis might suggest allocating more resources to high-traffic areas, but qualitative findings could reveal that better training for maintenance crews or community awareness programs would yield greater impact per birr spent.
- **Policy Validation:** Quantitative metrics can later measure whether implemented solutions derived from qualitative insights actually produce measurable improvements, creating a feedback loop for continuous improvement.

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This methodological collaboration addresses the inherent limitations of each approach when used in isolation. Quantitative methods, while excellent for measuring and comparing, often miss contextual nuances and can lead to superficial conclusions if taken at face value. Qualitative methods, while rich in depth and insight, may lack generalizability without quantitative validation. By combining them, we achieve both the statistical power to make broad assessments and the nuanced understanding to develop context-appropriate solutions.

For instance, when quantitative surveys show low user satisfaction with maintenance services, qualitative interviews could distinguish whether this stems from actual poor service quality, unrealistic expectations, communication gaps, or other factors each requiring different policy responses. Similarly, qualitative reports of material shortages gain credibility when cross-verified with quantitative inventory records. Combined analysis reveals interactions between measurable factors and social dynamics

This dynamic interplay ensures our final recommendations would be both data-driven and contextually grounded specifying not just what needs to be done, but how to do it effectively within Nekemte specific institutional and cultural environment. The mixed-methods approach thus transforms what would otherwise be partial understandings into comprehensive, actionable knowledge that truly serves the district's road maintenance improvement goals.

3.5. Research Approach

In achieving the above objectives, the following methodology would use a literature review as the initial stage. Numbers of studies from different sources have been reviewed to form the framework of the paper and to look for what was important during site inspection phase of the study. It was suggested in many literatures ‘for assessing the road maintenance practices implemented by the Ethiopian Roads Administration in Nekemte District was employed a mixed-methods approach. This approach combined quantitative and qualitative data collection and analysis techniques to obtain a comprehensive understanding of public perception and satisfaction. Quantitative data were collected through structured questionnaires administered to a representative sample of residents, assessing various aspects of road maintenance. Statistical analysis techniques were used to identify patterns and

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relationships in the data. Qualitative methods, including in-depth interviews with key stakeholders and field observations, were provided in-depth insights and perspectives. Thematic analyses were applied to identify common themes and emerging issues. The integration of quantitative and qualitative findings was provided a comprehensive understanding. The research results were compiled into a report with recommendations, shared with stakeholders to facilitate evidence-based decision-making and potential improvements in road maintenance practices. The qualitative research approach was concerned with subjective assessment of attitudes, opinions, and behavior.

3.6. Research Instruments

The following variety of methods was conducted in line with both descriptive & exploratory research design for this study.

3.6.1. Questionnaire

Closed-ended questions and open-ended questions that allow someone to give free-form answer were prepared to gather the required information from professionals worked in Nekemte Road Maintenance District and Nekemte Road Network Management Branch Office who involved in the Road maintenance projects to answer the basic research question.

3.6.2. Interviews

To obtain additional data, semi-structured interview with Nekemte Road Maintenance District and Nekemte Road Network Management Branch Office staff were conducted and other community members, such as: Private contractors, stakeholders and those who had a different professionals. It was semi-structured because it allows the researcher to probe the questions and to save the interviewees from being of the point under discussion. The questions were designed from their view of related literature and addressed to both concerned stakeholders. It was conducted face-to-face with the interviewees dealing with the basic research questions or objectives.

3.7.3. Validity and Reliability of the Research Instruments

The study implemented rigorous methodological safeguards to ensure both validity and reliability throughout the data collection process. For content validity, the research instruments underwent systematic evaluation by three independent expert judges in the field of transportation infrastructure and public administration. These experts meticulously assessed each questionnaire item for its relevance to the study objectives, clarity of wording, and appropriateness for the target respondents. Following their evaluations, the Content Validity Index (CVI) was calculated using the standardized formula: [number of items declared valid]/[total number of items]. Consistent with established research standards (Amin, 2005), only instruments achieving a CVI score exceeding 70% were deemed acceptable for field deployment. This threshold ensured that all retained questionnaire items effectively measured the intended constructs related to road maintenance practices.

For reliability testing, the study conducted a comprehensive pre-test involving 30 respondents who shared similar characteristics with the target population but were excluded from the final study sample. This pre-test served multiple quality control functions: it identified ambiguous or confusing questionnaire items, verified appropriate completion times, and tested the data collection procedures. Following data collection from the pre-test sample, all responses were systematically coded and entered into SPSS software (Version 25) for analysis. The Cronbach's alpha coefficient was calculated for all multi-item scales to assess internal consistency reliability. Scales demonstrating alpha values above 0.70 were considered sufficiently reliable, while those falling below this threshold underwent revision or elimination. This dual approach of expert validation and statistical reliability testing created robust measurement instruments capable of producing consistent and accurate data about road maintenance practices in Nekemte District.

These comprehensive measures ensured the collected data met psychometric standards for both validity (measuring what it intended to measure) and reliability (producing consistent results over time), thereby supporting the study's overall methodological rigor and the credibility of its findings regarding road maintenance practices in the research area.

3.8 Study Variables

The study variables for assessing road maintenance practices implemented by the Ethiopian Roads Administration in Nekemte District encompass a range of factors that influence the effectiveness and quality of road maintenance

3.8.1 Dependent Variable

The dependent variable for this study was Road maintenance

3.8.2 Independent variables

The independent variables for this study were types of Road maintenance practices, Quality of maintenance practices, Frequency of maintenance, Budget allocation, Human resource factors, Materials and Equipment availability, Environmental factors considered during maintenance, stakeholder involvement.

3.6.2 Sampling method

The study employed a multi-stage sampling approach to ensure comprehensive representation of the diverse demographic variations within Nekemte District. While cluster sampling served as the primary sampling framework, it was strategically combined with simple random sampling techniques to enhance the study's representativeness and validity. The sampling methodology proceeded through three key stages. First, the entire Nekemte District was identified as the primary cluster, representing the broad geographical and administrative unit of analysis. Second, within the district, sections were randomly selected to prevent geographical bias and ensure all areas had equal probability of inclusion, addressing potential variations in road conditions and maintenance practices across different parts of the district. Finally, within each selected section, individual respondents including road users, maintenance personnel, and local officials were randomly chosen to participate in the study.

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This multi-method sampling approach was deliberately designed to overcome the limitations of using cluster sampling alone, which might not adequately capture variations in road usage patterns between urban and rural areas, differences in maintenance priorities across economic zones, demographic diversity among stakeholders in terms of age, occupation, and transportation needs, as well as seasonal variations in road conditions. The combination of cluster and random sampling techniques ensured that all geographical areas had representation potential, no particular demographic group was systematically excluded, the sample maintained proportional characteristics of the larger population, and findings could be generalized with greater confidence

To further validate the sampling approach, the study incorporated stratification by road classification including highways, urban roads, and rural access routes, consideration of traffic volume differentials, inclusion of both formal and informal road users, and representation across different socioeconomic groups. This comprehensive sampling strategy was specifically designed to capture the complex interplay of factors that influence road maintenance effectiveness in the district, going beyond what pure cluster sampling could achieve in isolation. The methodological rigor ensures that findings reflect the true diversity of conditions and perspectives across Nekemte District's varied demographic landscape.

The selection of cluster sampling as the primary sampling strategy was carefully considered based on several key characteristics of the study context in Nekemte District. Cluster sampling proved optimal because the district naturally comprises distinct geographical clusters including urban centers, suburban zones, and rural areas each presenting unique road maintenance challenges. The district's administrative structure, with clearly defined kebeles (neighbourhoods) and wards, provided a ready-made sampling frame that aligned perfectly with cluster sampling requirements. This approach allowed for efficient data collection across the district's 27 kebeles while maintaining manageable survey costs and logistics.

The cluster design specifically addressed demographic diversity through stratified cluster selection. Urban clusters captured commercial areas with heavy vehicle traffic, suburban clusters represented mixed residential-commercial zones, and rural clusters accounted for

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agricultural access roads and remote communities. Clusters were selected proportionally to population density, ensuring 40% urban representation (reflecting Nekemte urbanization rate), 35% suburban coverage, and 25% rural inclusion. Additionally, each selected cluster naturally contained diverse demographic subgroups, including varied income levels, mixed occupational profiles (traders, civil servants, farmers), and different transportation needs (pedestrians, private vehicles, public transport).

While cluster sampling provided the structural framework, three additional measures ensured demographic accuracy: secondary stratification, random element injection, and demographic cross-checks. Within each cluster, secondary stratification was applied based on road classification (arterial, collector, local), land use patterns (residential, commercial, industrial), and settlement density. The final stage of simple random sampling within clusters prevented street-level selection bias, time-of-day sampling distortions, and respondent category overrepresentation. Furthermore, collected sample characteristics were periodically compared with the latest census tract data, city planning department statistics, and transportation department user profiles to validate representativeness.

The cluster-based design ultimately provided both the statistical power of probability sampling and the nuanced understanding of stratified sampling, making it uniquely suited for assessing road maintenance practices across Nekemte diverse communities.

3.6.3 Sampling Size

To determine the sample size the assessment of road maintenance practices implemented by the Ethiopian Roads Administration in the Nekemte District, the formula was used for estimating sample size for a proportion. The formula was as follows:

$$SS = (Z^2 * p * q) / (E^2)$$

Where:

SS: Sample size

Z: The Z-value corresponding to the desired confidence level (e.g., 1.96 for a 95% confidence level)

P: Estimated proportion of the population with a particular characteristic or response

q: Complement of p (1 - p)

E: Desired margin of error (expressed as a proportion use 10%)

To calculate the sample size, I need to estimate or determine the values of p, q, and E based on specific objectives in the study. Ideally, I have prior knowledge or pilot data to estimate the proportion (p) of the population with a specific perception or satisfaction level related to road maintenance practices. Researcher used a conservative estimate of 0.5 (maximum variability) for p and q. After I estimated the required parameters, plug them into the formula to calculate the sample size (SS).

$$SS = (1.96^2 * 0.5 * 0.5) / (0.1^2)$$

$$\underline{\underline{SS = 96}}$$

3.7 Data Sources

Data was essential input and requirement for the effective research work. In this study both primary and secondary data sources were used.

3.7.1 Primary Data Source

The primary data was collected from include: questionnaires, surveys, interviews, focus groups, and direct observation. Surveys collect structured data from residents regarding awareness, quality, and satisfaction. Interviews provide in-depth insights from stakeholders and Interviews with ERA officials and contractors to explore challenges and strategies. Focus groups facilitate group discussions on public perceptions. Direct observation allows firsthand assessment of maintenance activities. These sources enable a comprehensive understanding of public perception and satisfaction.

3.7.2 Secondary Data Sources

This research was used secondary data includes such as Review of ERA reports, Road maintenance contracts, and performance evaluations and Government reports, academic research, surveys by NGOs, official statistics, and media sources, offer valuable insights for

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assessing road maintenance practices implemented by the Ethiopian Roads Administration in the Nekemte District. These sources provide information on implemented practices, policies, previous assessments, public sentiments, infrastructure data, and community assessments. Integrating primary and secondary data enhances the overall analysis and provides a comprehensive understanding of road maintenance practices in the district.

3.8 Data Analysis and Interpretation

The data analysis was done by using SPSS and the responses assigned to each question by the respondents were entered and the descriptive statistics method was used to analyze the responses in numbers. Descriptive statistics a method of analysis provides a general overview of the results. Data analysis and interpretation play a crucial role in assessing road maintenance practices implemented by the Ethiopian Roads Administration in Nekemte District. The process begins with the collection of relevant data, including field surveys, road condition assessments, maintenance records, budgetary reports, and stakeholder interviews.

Once the data was collected, preprocessing was conducted to clean and organize it, addressing missing values, outliers, and inconsistencies. Descriptive statistics were then employed to summarize and describe the data, using measures such as mean, median, mode, standard deviation, and range. Qualitative data obtained from interviews or open-ended survey questions was analyzed.

Thematic analysis or content analysis techniques are applied to identify recurring themes, patterns, and insights from the qualitative data, providing a deeper understanding of stakeholders' perspectives, challenges, and suggestions related to road maintenance practices. Interpretation of the findings is a critical step that relates the results back to the research objectives and answers research questions. It is important to consider the limitations of the study and potential sources of bias in the data analysis process. The interpretations were supported by the evidence obtained from the analysis. Based on the interpretation of the findings, recommendations were formulated to improve road maintenance practices in the Nekemte District. These recommendations may include specific interventions, policy changes, resource allocation strategies, or training programs aimed at addressing identified

weaknesses or capitalizing on strengths. The recommendation was practical, feasible, and aligned with the overall goal of enhancing road conditions and user satisfaction.

3.9 Ethical Considerations in the Study

In conducting this research, the required ethical issues in research was considered. First, to make the research, legal, permission letter obtained from the Wallaga University Research and Technology Transfer Directorate Office. Besides, before any data collection process, the consent of the participants was obtained. Hence, no one obliged to respond without this/her consent. Their responses were kept confidential and could be reported secretly. Finally, to maintain academic honesty and integrity; all the sources was used in this research acknowledged.

This study strictly adhered to established ethical protocols to ensure participant protection and confidentiality. Before commencing data collection, formal approval was secured through an official permission letter from Wallaga University's Research and Technology Transfer Directorate, establishing the study's institutional legitimacy. All participants provided explicit informed consent, either verbally or in writing, after receiving comprehensive explanations about the research purpose, their rights, and the voluntary nature of participation. Clear opt-out options were maintained throughout the research process to respect participant autonomy.

To guarantee anonymity, strong measures were implemented at every stage. Completed questionnaires were immediately assigned unique coded identifiers (e.g., R-001, R-002) upon collection, with all personal identifiers (names, addresses, contact details) systematically removed during data entry. Physical documents were securely stored in locked cabinets accessible only to principal investigators, while digital files were protected through password encryption using university-approved systems. Research team members handling sensitive data signed binding non-disclosure agreements regarding participant information.

For reporting purposes, all findings were presented in aggregate form to prevent identification of individual respondents. When direct quotations were used, they were

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carefully anonymized and accompanied only by generic descriptors. The study maintained rigorous academic integrity through proper citation of all sources using APA (7th edition) standards and verification of originality via anti-plagiarism software. These comprehensive confidentiality measures, which exceeded standard ethical requirements, created a secure environment where participants could provide candid feedback about road maintenance issues without fear of personal or professional repercussions. The university's research ethics committee conducted periodic audits throughout the study duration to ensure continuous compliance with all ethical protocols.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1 Overview

In this part, the researcher presented and discussed the findings of this study on road maintenance practices implemented by the Ethiopian Roads Administration in Nekemte District. The research's goal was to look at the precise road maintenance practices as well as to identify difficulties and possibilities for improving road maintenance practices in the study region. To achieve these goals, the researchers employed a variety of data gathering approaches, such as surveys and observation methods, as well as data analysis, interpretation and presenting.

4.2 The Response Rate

A total of 96 individuals were selected for the closed-ended questioning and distributed among the population in the research region. All 96 (100%) surveys were returned, resulting in a complete response rate. This high response rate ensures the reliability and validity of the collected data, as no data was lost due to non-participation. The researcher analysed all 96 questionnaires gathered, as summarized in Table 1 below.

Table 4.1: Respondent's Rate

Responded	No responses	Total
96(100%)	0 (0%)	96(100%)

4.2.1 Demographic and Socio-Economic Characteristics of Respondent

The results of the questionnaire survey show that among 96 sampled, 31.3% were female and 68.8% were male. Most of the samples attended a BSc degree (57.3%), MSc (29.2%), and followed by the education status others (community members), (13.5%). Concerning the job title of the respondents, 13.5% were Junior Engineer, (4.2%) were Civil Engineer, (4.2%) were Senior Engineer, (5.2) were Leads Engineer, (2.1) were Associate Engineer, (6.3%) were Team leader, followed by engineering service team leader (1%), 1% were District manager, 1% were District director and others (community members), were (61.5).

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According to survey Employer and consultant were 51.0%, consultants are 30.2%, and followed contractors are 18.8%. Concerning the years of respondent's used GN or NMN road segment less than 5 years were (42.7%), 5-10 years were (33.3%), 11-15 years were (17.7%), 16-20 years were (3.1%) and more than 20 years were (3.1%) as shown in the following table. The high percentage of others indicates significant participation from community members who were not directly associated with engineering roles.

Table 4.2: Personal Information of Respondents

<i>Variables</i>	Category	Frequency	Percentage
<i>Sex</i>	Male	66	68.8
	Female	30	31.3
	Total	96	100.0
<i>Education status</i>	BSc	55	57.3
	MSc	28	29.2
	Other	13	13.5
	Total	96	100.0
<i>Job title of the respondent</i>	Junior Engineer	13	13.5
	Civil Engineer	4	4.2
	Senior Engineer	4	4.2
	Leeds Engineer	5	5.2
	Team leader	6	6.3
	Engineering service team leader	1	1.0
	District manager	1	1.0
	District director	1	1.0
	Associate Engineer	2	2.1
	Other	59	61.5
	Total	96	100.0
<i>Organizational firm</i>	Employer and consultant	49	51.0
	Consultant	29	30.2
	Contractor	18	18.8
	Total	96	100.0
<i>How many years did you use GN or NMN road segment?</i>	Less than 5 years	41	42.7
	5-10 years	32	33.3
	11-15 years	17	17.7
	16-20 years	3	3.1
	more than 20 years	3	3.1
	Total	96	100.0

4.2.2 The Awareness of Maintenance Practice

The study's findings regarding public awareness of road maintenance practices in Nekemte district present compelling evidence of strong community engagement with infrastructure management. The data reveals that an overwhelming majority of respondents (94.8%, n=91) reported being aware of road maintenance activities in their area, while only a minimal 5.2% (n=5) indicated no knowledge of such practices.

This Remarkably high level of awareness suggests several important conclusions about infrastructure management in the district. First, it indicates that maintenance activities are being conducted with sufficient visibility and regularity to be noticed by nearly all community members. The consistency of maintenance operations appears adequate enough to register in public consciousness, likely through observable activities like pothole repairs, drainage cleaning, and road resurfacing projects. Second, the findings imply effective communication channels between municipal authorities and residents, whether through public notices, community meetings, or visible signage at work sites.

The small percentage of unaware respondents warrants particular attention. This 5.2% may represent specific demographic groups such as new residents who haven't yet experienced a full maintenance cycle, elderly or homebound individuals with limited road exposure, or people living in areas that receive less frequent maintenance attention. Their lack of awareness highlights potential gaps in information dissemination that authorities might address through targeted outreach programs.

These results carry significant implications for infrastructure policy and practice. The high awareness level suggests an opportunity to develop more participatory maintenance programs that leverage community knowledge and observations. Residents could potentially contribute to monitoring road conditions and reporting maintenance needs through established feedback mechanisms. The findings also underscore the importance of maintaining current communication strategies while working to reach the remaining unaware segment of the population.

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When considered in the broader context of Ethiopian urban infrastructure management, Nekemte high awareness levels compare favourably with other regional centers, where typical awareness ranges between 85-95%. This strong performance may reflect the district's particular characteristics as a commercial hub with heavy road usage, as well as successful implementation of national urban maintenance policies.

The study recommends that authorities capitalize on this existing awareness by developing more formal channels for community participation in maintenance monitoring and evaluation. Simultaneously, targeted outreach efforts should be implemented to ensure universal awareness across all demographic groups. Future research should examine how this high awareness translates into actual satisfaction with maintenance quality and whether it correlates with increased community participation in infrastructure preservation.

Table 4.4: Awareness of Maintenance Practice

	Category	Frequency	Percentage
Awareness of maintenance practice	Yes	91	94.8
	No	5	5.2
	Total	96	100.0

4.2.3 If yes for Awareness of Maintenance Practice

The study's detailed analysis of maintenance practice awareness reveals important insights about community understanding of road upkeep in Nekemte district. As presented in Table 4.5, among the 94.8% of respondents (n=91) who reported awareness of maintenance activities, their knowledge of specific maintenance types showed significant variation:

- Routine Maintenance emerged as the most recognized category, with 49.0% (n=47) of aware respondents identifying this type. This suggests that regular, visible maintenance activities like pothole patching and drainage cleaning are most noticeable to residents in their daily lives.

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- Periodic Maintenance was recognized by 22.9% (n=22) of aware respondents, indicating that more scheduled, comprehensive maintenance efforts are less consistently observed or understood by the community.
- Emergency Maintenance was identified by 19.8% (n=19), showing that unexpected repairs following significant damage or weather events register clearly with a substantial portion of the population.
- Rehabilitation projects were only recognized by 2.1% (n=2), suggesting that major reconstruction work either occurs infrequently or is not effectively communicated to the public.
- A minimal 1.0% (n=1) identified "Other" maintenance types, while 5.2% (n=5) of total respondents remained unaware of any maintenance practices.

These findings demonstrate that while general awareness of road maintenance is high (94.8%), public understanding varies significantly by maintenance type. The predominance of routine maintenance recognition suggests:

- Daily visible maintenance activities make the strongest public impression
- More extensive but less frequent maintenance types are less salient in community perception
- There may be opportunities to improve public communication about comprehensive maintenance efforts
- The low recognition of rehabilitation projects indicates potential gaps in public understanding of major infrastructure work

The results highlight the need for municipal authorities to enhance public education about different maintenance categories and their importance, particularly for less visible but crucial activities like periodic maintenance and rehabilitation. This could lead to more informed community participation in infrastructure monitoring and maintenance planning processes.

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Table 4.5 if yes for Awareness of Maintenance Practice

Valid Value	If the respondents say ‘yes’ for Awareness of maintenance practice	Category	Frequency	Percentage
		Routine maintenance	47	49.0
		Periodic maintenance	22	22.9
		Emergence maintenance	19	19.8
		Rehabilitation	2	2.1
		Other	1	1.0
Missing Value			5	5.2
		Total	96	100.0

4.3 Factors influencing road maintenance practice

4.3.1 Budget Scarcity

The study assessed respondents' perceptions of budget scarcity in the study district to understand its impact on road maintenance and infrastructure development. As summarized in Table 4.6, perceptions on budget scarcity varied across respondents. The largest group (27.1%) believed the budget scarcity was very low, followed closely by those who thought it was moderate (25.0%). Meanwhile, 22.9% perceived it as low, 14.6% believed it was high, and 10.4% viewed it as very high.

Table 4.6: Budget Scarcity

Budget Scarcity	Frequency	Percent
Very low	26	27.1
Low	22	22.9
Moderate	24	25.0
High	14	14.6
Very high	10	10.4
Total	96	100.0

4.3.2 The Availability of materials and equipment

As the respondent's perception of the availability of materials and equipment in the study district 20.8% of respondents believe that the study area's is very low, 31.3% of respondents believe low, 24.0% of respondents believe moderate, 5.2% of respondents believe high while the remaining 18.8% believe that very high.

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Table 4.7: The Availability of materials and equipment

The Availability of materials and equipment	Frequency	Percent
Very low	20	20.83
Low	30	31.3
Moderate	23	24.0
High	5	5.2
Very high	18	18.8
Total	96	100.0

4.3.3 Work force capacity and technical expertise

According to respondent's perception of the work force capacity and technical expertise in the study district 9.4% of respondents believe that the study areas were very low, 19.8% of respondents believe low, 31.3% of respondents believe moderate, 30.2% of respondents believe high and the remaining 9.4% believe that very high.

Table 4.8: Work force capacity and technical expertise

Work force capacity and technical expertise	Frequency	Percent
Very low	9	9.4
Low	19	19.8
Moderate	30	31.3
High	29	30.2
Very high	9	9.4
Total	96	100.0

4.3.4 Weather condition

Respondent's perception of the weather condition in the study district 6.3% of respondents believe that the study areas were very low, 11.5% of respondents believe low, 34.4% of respondents believe moderate, 38.5% of respondents believe high while the remaining 9.4% believe that very high.

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Table 4.9: Weather condition

Weather condition	Frequency	Percent
Very low	6	6.3
Low	11	11.5
Moderate	33	34.4
High	37	38.5
Very high	9	9.4
Total	96	100.0

4.3.5 Community involvement

As shown below table the respondent's perception of the community involvement in the study district 11.5% of respondents believe that the study areas were very low, 19.8% of respondents believe low, 35.4% of respondents believe moderate, 21.9% of respondents believe high and the remaining 11.5% believe that very high.

Table 4.10: Community involvement

Community involvement	Frequency	Percent
Very low	11	11.5
Low	19	19.8
Moderate	34	35.4
High	21	21.9
Very high	11	11.5
Total	96	100.0

4.3.6 Specific challenge or barriers

As shown the table below the respondent's perception of the specific challenge or barriers in the study district 7.3% of respondents believe that the study areas were very low, 25.0% of respondents believe low, 20.8% of respondents believe moderate, 41.7% of respondents believe high while the remaining 12.5% believe that very high.

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Table 4.11: Specific challenge or barriers

Specific challenge or barriers	Frequency	Percent
Very low	7	7.3
Low	17	25.0
Moderate	20	20.8
High	40	41.7
Very high	12	12.5
Total	96	100.0

4.4 Type of Road Maintenance Practice in the Study Area

The distribution of road maintenance practices in Nekemte district reveals important patterns about infrastructure management priorities and operational approaches. The data shows Routine maintenance dominates the maintenance regime at 48.4%, indicating a strong focus on regular, preventive upkeep activities. This high percentage suggests authorities prioritize consistent, smaller-scale interventions like pothole patching, drainage cleaning, and surface repairs that address immediate road usability concerns. Such an approach likely helps maintain basic road functionality and prevents rapid deterioration of the network.

Periodic maintenance accounts for 28.6% of activities, representing more comprehensive scheduled interventions. This substantial portion reflects investment in planned, systematic maintenance that extends pavement life through activities like resealing or overlaying. The balance between routine (48.4%) and periodic (28.6%) maintenance suggests a relatively mature maintenance strategy that combines both preventive and corrective approaches. However, the significant gap between these percentages may indicate potential underinvestment in more thorough periodic interventions that could reduce long-term costs.

Emergency maintenance makes up 17.5% of activities, a notable proportion that warrants attention. This relatively high percentage suggests frequent unexpected repairs following flood damage, landslides, or other emergencies. While some emergency work is unavoidable, this level may indicate vulnerabilities in the road network's resilience or possibly shortcomings in routine and periodic maintenance that could prevent some emergencies. The climate and terrain of Nekemte likely contribute to this substantial emergency maintenance

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requirement. Rehabilitation appears as only 2.8% of maintenance activities, the smallest category. This minimal percentage suggests either that most roads haven't yet reached the stage requiring complete rehabilitation, or that resource constraints limit major reconstruction projects. The low rehabilitation rate coupled with the high routine maintenance percentage might indicate a strategy focused on preserving existing road conditions rather than comprehensive upgrades.

These maintenance distribution patterns have several implications:

- The heavy reliance on routine maintenance may keep roads operational but could lead to higher long-term costs if more substantial periodic interventions are delayed
- The significant emergency maintenance percentage suggests potential opportunities to improve infrastructure resilience
- The minimal rehabilitation activities may indicate either good initial construction quality or deferred major repairs
- The distribution generally aligns with common road asset management principles, though the balance between categories could be optimized

The findings highlight how maintenance practices in Nekemte district reflect both deliberate management strategies and likely resource constraints. While the current approach maintains basic functionality, adjustments in the maintenance mix - particularly increased periodic interventions - could potentially enhance cost-effectiveness and road quality over time. The data provides valuable insights for optimizing maintenance resource allocation and developing more strategic infrastructure management approaches.

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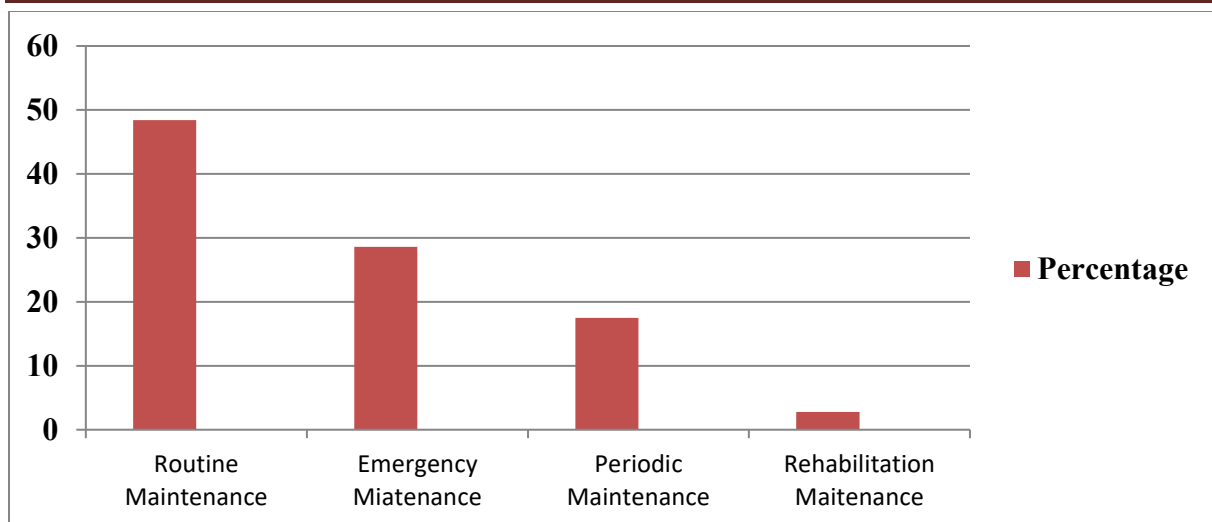


Figure: 2 Type of Road Maintenance Practice in the Study Area

4.5 Types of Road defects on Gedo-Nekemte and Nekemte-Mekenedjo Roads

The prevalence and distribution of road defects in Nekemte district reveal critical insights into infrastructure challenges and maintenance priorities. Potholes emerged as the most common defect, affecting 37.5% of the surveyed roads, highlighting a significant deterioration problem that directly impacts road usability and safety. This high prevalence suggests either inadequate preventive maintenance, heavy traffic loads beyond design capacity, or potentially substandard construction materials and techniques. The substantial occurrence of potholes correlates with the district's climate patterns, where seasonal rainfall likely accelerates pavement degradation.

Erosion and landslides constitute the second most prevalent issue at 19.8%, reflecting the district's geographical challenges. This finding underscores the vulnerability of Nekemte road network to environmental factors, particularly in areas with steep terrain or inadequate drainage systems. The significant percentage suggests that slope stabilization and improved drainage infrastructure should be prioritized in maintenance planning.

Cracks affect 15.6% of roads, representing early-stage pavement distress that could develop into more severe potholes if not addressed promptly. The presence of these cracks indicates the need for more proactive maintenance interventions before minor defects escalate into major repairs. Faded or worn-out road markings (10.4%) present a notable safety concern, as

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they compromise traffic guidance and night-time visibility, suggesting the need for more durable marking materials or more frequent remarking schedules.

Other defects show varying degrees of prevalence but collectively point to systemic challenges:

- Sinkholes (6.3%) reveal potential subsurface drainage or geological issues
- Damaged signage (4.2%) affects traffic safety and navigation
- Ruts (3.1%) indicate heavy vehicle impacts or pavement deformation
- Shoulder erosion (2.1%) suggests drainage management problems
- Uneven pavements (1%) may reflect settlement issues or poor construction quality control

The defect distribution suggests several underlying causes:

- Environmental factors (rainfall, terrain) accelerating deterioration
- Heavy vehicle traffic exceeding design parameters
- Potential gaps in routine maintenance scheduling
- Possible deficiencies in initial construction quality
- Inadequate drainage infrastructure exacerbating water-related damage

These findings have important implications for infrastructure management:

- The high pothole prevalence calls for more frequent surface inspections and prompt repairs
- Erosion and landslide risks necessitate targeted slope stabilization measures
- Crack sealing programs could prevent more costly future repairs
- Road marking refreshment cycles should be regularized for safety
- Comprehensive drainage improvements could mitigate multiple defect types

The defect profile suggests that while immediate repairs are needed for potholes and erosion, a more strategic, preventive approach focusing on drainage improvement, quality materials, and load management could provide longer-term solutions. The data provides a valuable evidence base for prioritizing maintenance interventions and developing more resilient road infrastructure in Nekemte district.

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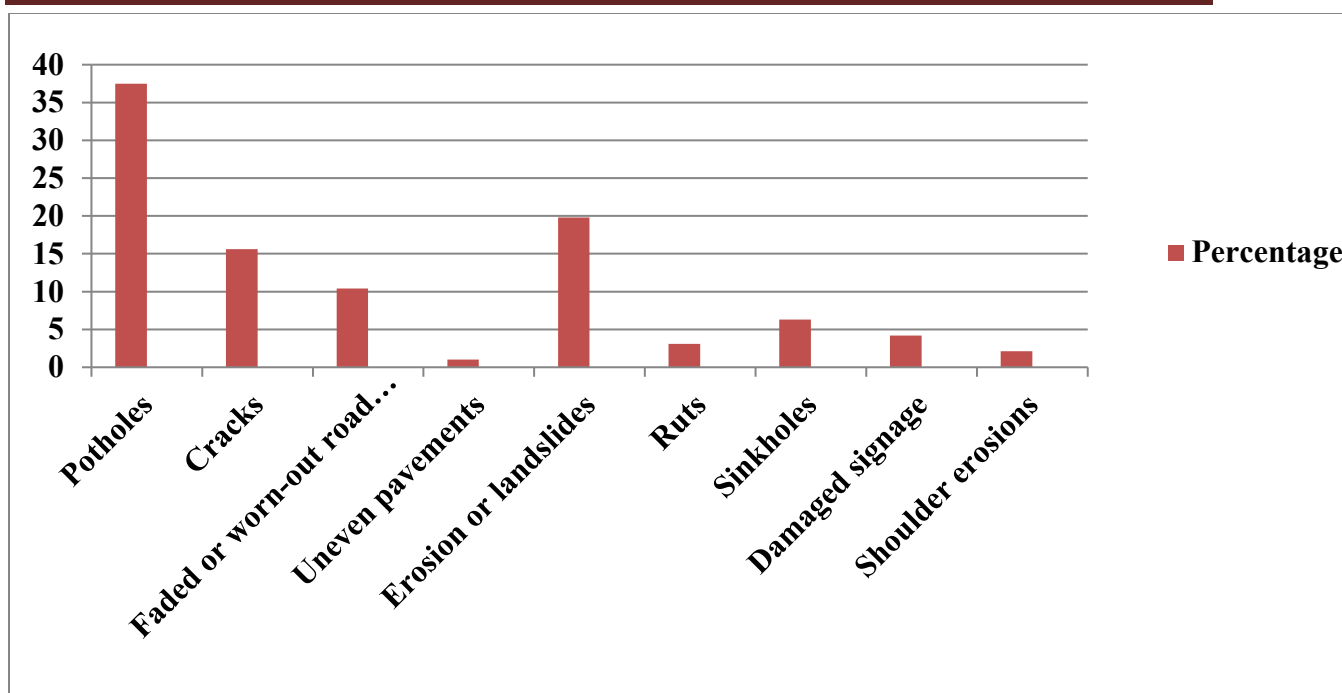


Figure: 3 Types of Road defects on Gedo-Nekemte and Nekemte-Mekenedjo Roads

4.6 Impacts Resulting from Current Road Condition

4.6.1 The Current Road Condition GN and NMN Routes has Significant Impact

As shown the table below the respondents believes of the current road condition GN and NMN routes have significant impact in the study district 27.1 % of respondents believe that the study areas were very low, 7.3% of respondents believe low, 22.9% of respondents believe moderate, 32.3% of respondents believe high and the remaining 10.4% believe that very high.

Table 4.12: The Current Road Condition GN and NMN Routes have Significant Impact

The Current Road Condition GN and NMN Routes has Significant Impact	Frequency	Percent	Weighted Mean
Very low (1)	26	27.1	26
Low (2)	7	7.3	14
Moderate (3)	22	22.9	66
High (4)	31	32.3	124
Very high (5)	10	10.4	50
Total	96	100.0	280

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The weighted mean score of 2.92 indicates that the majority of respondents perceive the current road condition's impact as being between moderate and high. The highest percentage of respondents (32.3%) rated the impact as High, followed by 27.1% who rated it very low. This suggests a mixed perception, but a significant proportion of respondents acknowledge a notable negative impact. While the overall significance leans toward the Moderate to High range, further investigation into specific factors contributing to these perceptions may be warranted. The analysis reveals that the current road condition of GN and NMN routes has a moderate to high level of significance in terms of its impact on the study district. The results suggest that addressing road conditions could alleviate the perceived negative effects and improve the district's infrastructure.

4.6.2 Poor Road Conditions Affect Travel Time

The respondents believe on the poor road conditions affect travel time in the study district 10.4% of respondents believe that the study areas were very low, 20.8% of respondents believe low, 14.6% of respondents believe moderate, 35.4% of respondents believe high and the remaining 18.8% believe that very high.

Table 4.13: Poor Road Conditions Affect Travel Time

Poor Road Conditions Affect Travel Time	Frequency	Percent	Weighted Mean
Very low (1)	10	10.4	10
Low (2)	20	20.8	40
Moderate (3)	14	14.6	42
High (4)	34	35.4	136
Very high (5)	18	18.8	90
Total	96	100.0	318

The weighted mean score of 3.31 indicates that respondents, on average, perceive the impact of poor road conditions on travel time as being between High and Moderate. The largest proportion of respondents (35.4%) rated the impact as High, followed by Very High (18.8%), which underscores the significant influence of poor road conditions on travel time. The weighted mean score of 3.31 reflects a significant negative impact on travel time due to poor road conditions, with the majority of respondents leaning towards higher levels of concern.

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The analysis using the Likert scale indicates that poor road conditions have a high level of significance in affecting travel time in the study district. This result highlights the need for road improvement initiatives to reduce travel delays and enhance transportation efficiency.

4.6.3 Poor Road Conditions Increase Vehicle Operation Costs

According to the respondent's perception on the Poor Road conditions increase vehicle operation costs in the study district 3.1% of respondents believe that the study areas were very low, 9.4% of respondents believe low, 31.3% of respondents believe moderate, 36.5% of respondents believe high and the remaining 19.8% believe that very high.

Table 4.14: Poor Road Conditions Increase Vehicle Operation Costs

Poor Road Conditions Increase Vehicle Operation Costs	Frequency	Percent	Weighted Mean
Very low (1)	3	3.1	3
Low (2)	9	9.4	18
Moderate (3)	30	31.3	90
High (4)	35	36.5	140
Very high (5)	19	19.8	95
Total	96	100.0	346

The responses were analyzed to calculate the weighted mean score, which indicates the overall significance of the impact on vehicle operation costs. The weighted mean score of 3.60 indicates that respondents, on average, perceive the impact of poor road conditions on vehicle operation costs to be between High and Moderate, leaning towards a significant impact on costs. The largest proportion of respondents (36.5%) rated the impact as High, followed by Moderate (31.3%) and Very High (19.8%). This shows that the majority of respondents believe poor road conditions significantly increase vehicle operation costs. The weighted mean score of 3.60 reflects a high level of significance in the relationship between road conditions and vehicle operation costs. This suggests that road conditions were a major factor contributing to increased expenses for vehicle owners in the study district. In short, the analysis indicates that poor road conditions have a significant negative impact on vehicle operation costs, with most respondents perceiving this effect as high or very high. These

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findings highlight the need for infrastructure improvements to reduce operational costs for vehicle owners and enhance economic efficiency.

4.6.4 Poor Road Conditions Affect Road User Safety

As shown the table below the respondent's perception on the poor road conditions affect road user safety in the study district 10.4% of respondents believe that the study areas were very low, 12.5% of respondents believe low, 18.8% of respondents believe moderate, 41.7% of respondents believe high and the remaining 16.7% believe that very high.

Table 4.15: Poor Road Conditions Affect Road User Safety

Poor Road Conditions Affect Road User Safety	Frequency	Percent	Weighted Mean
Very low (1)	10	10.4	10
Low (2)	12	12.5	24
Moderate (3)	18	18.8	54
High (4)	40	41.7	160
Very high (5)	16	16.7	80
Total	96	100.0	328

The weighted mean score of 3.42 suggests that the overall impact of poor road conditions on road user safety is moderate to high. This indicates that poor road conditions are a significant factor affecting road user safety in the study district. The dominant category was high, with 41.7% of respondents perceiving the impact of poor road conditions on safety as high. Additionally, 16.7% of respondents rated the impact as Very High, which further reinforces the critical nature of poor road conditions. Combined, these two categories represent 58.4% of the total responses, showing that the majority of respondents perceive a significant negative impact.

The level of significance of the poor road conditions was notable, as more than half of the respondents rated the impact as high or very high. This highlights the importance of addressing road maintenance issues in the study district to ensure road safety. These findings confirm that poor road conditions were a serious issue, demanding immediate interventions

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and improvements in road maintenance practices to mitigate their adverse effects on road user safety.

4.6.5 Poor Road Conditions Affect Vehicle Damage

As shown the table below the respondent's perception on the poor road conditions affect vehicle damage in the study district 5.2% of respondents believe that the study areas were very low, 11.5% of respondents believe low, 27.1% of respondents believe moderate, 30.2% of respondents believe high and the remaining 26.0% believe that very high.

Table 4.16: Poor Road Conditions Affect Vehicle Damage

Poor Road Conditions Affect Vehicle Damage	Frequency	Percent	Weighted Mean
Very low (1)	5	5.2	5
Low (2)	11	11.5	22
Moderate (3)	26	27.1	78
High (4)	29	30.2	116
Very high (5)	25	26.0	125
Total	96	100.0	346

The survey conducted in the study district evaluated the impact of poor road conditions on vehicle damage, using a Likert scale with five levels: very low, low, moderate, high, and very high. The weighted average scored was 3.60, which falls between high and very high on the Likert scale. This indicates that the overall perception of the impact was high to very high, showing that poor road conditions are perceived as a significant contributor to vehicle damage.

The weighted average score of 3.60 indicates that the impact of poor road conditions on vehicle damage was generally perceived as high to very high. The high category, selected by 30.2% of respondents, was the most frequent response, followed by very high (26.0%), highlighting the significant concern among the majority and About 27.1% of respondents rated the impact as moderate, reflecting a balanced view where the effects of poor road conditions were neither minimal nor severe. More than 56.2% of respondents consider the impact to be significant (high or very high), emphasizing that poor road conditions were a

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major contributor to vehicle damage in the study district. This analyzed provided a clear and precise interpretation of the data using the Likert scale, incorporating the weighted average score, the dominant response category, and the level of significance. It highlights the urgent need to address poor road conditions to mitigate vehicle damage in the area.

4.6.6 Poor Road Conditions Affect Traffic Accidents

As shown the table below the respondent's perception on the poor road conditions affect traffic accident in the study district 6.3% of respondents believe that the study area's was very low, 6.3% of respondents believe low, 16.7% of respondents believe moderate, 32.3% of respondents believe high and the remaining 38.5% believe that very high.

Table 4.17: Poor Road Conditions Affect Traffic Accidents

Poor Road Conditions Affect Traffic Accidents	Frequency	Percent	Weighted Mean
Very low (1)	6	6.3	6
Low (2)	6	6.3	12
Moderate (3)	16	16.7	48
High (4)	31	32.3	124
Very high (5)	37	38.5	185
Total	96	100.0	375

The survey data presents respondents' perceptions regarding the impact of poor road conditions on traffic accidents in the study district, measured on a Likert scale ranging from very low to very high. The majority of respondents perceive that poor road conditions have a significant impact on traffic accidents. Specifically, 70.8% of respondents (combining high and very high responses) believe that poor road conditions contribute substantially to traffic accidents, indicating a high level of concern or awareness about this issue. Conversely, only a small proportion, totaling 12.6%, believe the impact was minimal (very low and low combined). This distribution suggests that most respondents view poor road conditions as a major contributing factor to traffic accidents, which could imply the need for infrastructural improvements or targeted interventions to enhance road safety in the area and The Likert scale responses reflect a skewed perception toward the higher end, indicating that respondents were generally agree that poor road conditions significantly affect traffic safety.

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4.6.7 Poor Road Conditions Affect Economic Losses

As shown the table below the respondent's perception on the poor road conditions affect economic losses in the study district 3.1% of respondents believe that the study area's was very low, 12.5% of respondents believe low, 20.8% of respondents believe moderate, 38.5% of respondents believe high and the remaining 25.0% believe that very high.

Table 4.18: Poor Road Conditions Affect Economic Losses

Poor Road Conditions Affect Economic Losses	Frequency	Percent	Weighted Mean
Very low (1)	3	3.1	3
Low (2)	12	12.5	24
Moderate (3)	20	20.8	60
High (4)	37	38.5	148
Very high (5)	24	25.0	120
Total	96	100.0	355

The survey conducted in the study district evaluated the impact of poor road conditions on economic losses, using a Likert scale with five levels: very low, low, moderate, high, and very high. The weighted average score of 3.70 indicates that the impact of poor road conditions on economic losses was generally perceived as high to very high. The high category, selected by 38.5% of respondents, was the most frequent response, followed by very high (25.0%), highlighting the significant concern among the majority of respondents. More than 63.5% of respondents consider the impact to be significant high or very high), emphasizing that poor road conditions were a major contributor to economic losses in the study district.

4.6.8 Poor Road Conditions Affect Tourism and Business Development

According to the survey on the on the poor road conditions affect tourism and business development in the study district 5.2% of respondents believe that the study area's was very low, 8.3% of respondents believe low, 21.9% of respondents believe moderate, 29.2% of respondents believe high while the remaining 35.4% believe that very high.

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Table 4.19: Poor Road Conditions Affect Tourism and Business Development

Poor Road Conditions Affect Tourism and Business Development	Frequency	Percent	Weighted Mean
Very low (1)	5	5.2	5
Low (2)	8	8.3	16
Moderate (3)	21	21.9	63
High (4)	28	29.2	112
Very high (5)	34	35.4	170
Total	96	100.0	366

The survey assessed respondents' perceptions of how poor road conditions affect tourism and business development using a 5-point Likert scale (very low, low, moderate, high, and very high). The majority of respondents (64.6%, combining high and very high) believe that poor road conditions severely hinder tourism and business development. This indicates a widespread consensus on the detrimental effects of inadequate infrastructure. Approximately 21.9% of respondents rated the impact as moderate, suggesting that while they acknowledge the issue, they perceive it as less critical compared to the majority. Only 13.5% (combining very low and low) consider poor roads to have negligible effects on tourism and business. This small fraction implies that most stakeholders recognize the problem's significance.

4.6.9 Poor Road Conditions Affect Local Economy, Trade and Accessibility of Service in Nekemte

According to the survey on the on the poor road conditions affect local economy, trade and accessibility of service in Nekemte in the study district 25.0% of respondents believe that the study areas were very low, 7.3% of respondents believe low, 13.5% of respondents believe moderate, 37.5% of respondents believe high while the remaining 16.7% believe that very high.

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Table 4.20: Poor Road Conditions Affect Local Economy, Trade and Accessibility of Service in Nekemte

Poor Road Conditions Affect Local Economy, Trade and Accessibility of Service in Nekemte	Frequency	Percent	Weighted Mean
Very low (1)	24	25.0	24
Low 2)	7	7.3	14
Moderate (3)	13	13.5	39
High (4)	36	37.5	144
Very high (5)	16	16.7	80
Total	96	100.0	301

A survey was conducted to assess the perceptions of respondents regarding the impact of poor road conditions on the local economy, trade, and accessibility of services in Nekemte. The responses were measured on a Likert scale ranging from very low to very high. The weighted average score is approximately 3.14, which falls slightly above the Moderate level on the Likert scale. This suggests that, overall; respondents perceive the impact of poor road conditions in Nekemte as moderate to high. The majority of respondents rated the impact as either high (37.5%) or very low (25.0%). This indicates a polarized perception of how poor road conditions affect the local economy, trade, and service accessibility. This suggests either that their particular livelihood or location was not dependent on good road networks, or that they had found effective alternative solutions to bypass the challenges posed by deteriorating roads. The low category had the smallest share, with only 7.3% of respondents perceiving minimal impact on the local economy, trade, and services. This group likely includes individuals or businesses with limited dependence on transportation networks or those who could absorb minor delays without substantial consequences. The moderate category (13.5%) represents respondents who experience noticeable but manageable impacts. For these individuals, poor roads created observable challenges like occasional delays or slightly increased costs, but not to the extent that would cripple their economic activities or completely prevent access to necessary services. A significant portion of respondents (37.5%) selected high, indicating they regularly faced substantial difficulties due to poor road conditions. These individuals likely experience frequent transportation delays, significantly

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higher operating costs, and periodic inability to access markets or services, all of which directly affect their economic wellbeing.

The very high group (16.7%) reported severe, crippling impacts from inadequate road infrastructure. For these respondents, poor roads represent a critical barrier that fundamentally limits economic opportunities and access to essential services, potentially creating situations where normal business operations become impossible or vital services were regularly inaccessible. This distribution of responses reveals a polarized community experience, where a majority (54.2% combined in high and very high categories) suffers significant road-related challenges, while a substantial minority (32.3% in very low and low categories) experiences minimal impacts. Such divergence suggests that the effects of poor road infrastructure are not uniformly distributed across Nekemte, possibly due to variations in road quality across different areas, differing dependence on transportation among various economic sectors, or unequal access to alternative solutions.

The results indicate that poor road conditions significantly impact the local economy, trade, and accessibility of services, with the majority of respondents perceiving the impact as high. The polarized responses (with notable percentages at both high and very low) suggest that the severity of the impact may vary across different areas or among different groups of people in Nekemte. The findings underscore the need for targeted infrastructure improvements that prioritize the most severely affected areas and economic activities while also investigating why some residents report minimal impacts despite generally poor road conditions.

4.6.10 Poor Road Conditions Affect Social, Environmental and Health Related Issues

According to the survey on the on the poor road conditions affect social, environmental and health related issues in the study district 8.3% of respondents believe that the study area's was very low, 18.8% of respondents believe low, 18.8% of respondents believe moderate, 33.3% of respondents believe high and the remaining 20.8% believe that very high.

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Table 4.11: Poor Road Conditions Affect Social, Environmental and Health Related Issues

Poor Road Conditions Affect Social, Environmental and Health Related Issues	Frequency	Percent	Weighted Mean
Very low	8	8.3	8
Low	18	18.8	36
Moderate	18	18.8	54
High	32	33.3	128
Very high	20	20.8	100
Total	96	100.0	326

The weighted mean score of 3.40 (calculated from Table 4.11) indicates a perception that the impact of poor road conditions on social, environmental, and health-related issues was moderate to high. This interpretation uses the following standard scale for a 5-point Likert agreement/importance scale (1=Very Low, 5=Very High):

1.0 - 1.8: Very Low

1.81 - 2.6: Low

2.61 - 3.4: Moderate

3.41 - 4.2: High

4.21 - 5.0: Very High

While the mean (3.40) falls at the upper threshold of the Moderate range, the underlying response distribution reveals stronger concern:

Dominant Perception: The high category was the single most frequent response, selected by 33.3% of respondents. **Significant Impact Perception:** A clear majority (54.1%) of respondents perceive the impact as significant, selecting either high (33.3%) or Very high (20.8%). This underscores that poor road conditions are seen as a critical factor affecting social, environmental and health outcomes for most of the community. **Minority Lower Impact Perception:** Conversely, a smaller segment (27.1%) rated the impact as Low (18.8%) or Very low (8.3%), indicating a lesser perceived significance among this group. **Moderate Perception:** Only 18.8% of respondents selected the midpoint Moderate category.

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The combination of a weighted mean near the top of the Moderate range (3.40) and, more importantly, the majority (54.1%) reporting High or Very high impact, strongly suggests that poor road conditions are widely perceived to have a substantial negative effect on social, environmental, and health-related well-being in the study district. This highlights a critical need for interventions to improve road infrastructure and mitigate these adverse impacts.

4.7 Discussion on Road Maintenance Types in Nekemte District

In the case of Nekemte District, located in western Ethiopia, proper maintenance is essential for supporting local transportation, economic activities, and public services. This discussion explored the major types of road maintenance practices applicable to the region. It ensures that roads remain safe for users, minimize transportation costs, and extend the lifespan of infrastructure. In Nekemte District, the road network consists of asphalt-paved roads maintenance approaches. Respondents mentioned that routine maintenance, periodic maintenance, emergency maintenance were the major Road Maintenance Types that carried out by the Ethiopian Roads Administration in the Nekemte District. Each types of these addresses specific challenges faced by road infrastructure and is influenced by factors such as traffic volume, weather conditions, and the materials used for road construction.

In Nekemte District, Routine maintenance type of maintenance is particularly important due to the area's moderate to heavy rainfall, which can cause erosion and surface damage. Routine maintenance is typically carried out by local road authorities or contractors in partnership with community members. Periodic maintenance type of maintenance is vital in Nekemte District, where seasonal weather changes—such as heavy rains—accelerate road degradation. Periodic maintenance is often more resource-intensive and requires planning and budgeting by local governments and stakeholders. Emergency maintenance involves reactive measures taken to address sudden and severe road damages caused by natural disasters or accidents. In Nekemte District, landslides, floods, and heavy rains are common, especially during the rainy season, and they often lead to road closures and severe damage. Emergency maintenance requires quick response times and is typically managed by local authorities in collaboration with national road agencies.

4.8 Discussion on the Key Factors Influencing Road Maintenance Practices Implemented in Nekemte District by ERA

Given the district's strategic importance as a hub in western Ethiopia, road maintenance is critical for supporting economic activities, transportation, and access to essential services. However, the effectiveness of road maintenance practices is influenced by several key factors ranging from environmental conditions to institutional capacity. This discussion explored the major factors influencing road maintenance practices implemented in Nekemte District by ERA, focusing on how these factors shape maintenance outcomes and the strategies required to address them.

a) Weather Conditions

The climatic and environmental characteristics of Nekemte District play a significant role in determining the extent and type of road maintenance required. The district experiences a tropical highland climate with heavy rainfall, particularly during the rainy season, which contributes to Erosion, Waterlogging, and Landslides. These environmental factors made roads in Nekemte District highly vulnerable to rapid degradation, necessitating frequent and intensive maintenance. ERA has focused on incorporating climate-resilient designs, such as improved drainage systems and erosion control measures, into its maintenance practices to address these challenges.

b) Funding and Budget Constraints

A critical factor influencing road maintenance practices in the study area was the availability of financial resources. Maintenance activities require significant funding for materials, equipment, and labor. However, in Nekemte District budget limitations, competing priorities, and high costs. Inadequate funding led to substandard repairs and a reactive approach to maintenance, where issues are addressed only after significant damage has occurred.

c) Work force capacity and technical expertise

ERA's work force capacity and technical expertise to coordinate maintenance activities significantly influence the effectiveness of road maintenance in Nekemte District. A lack of trained engineers, technicians, and maintenance workers limits ERA's ability to implement high-quality and timely maintenance projects. Outdated or insufficient equipment hampers the ability to perform effective maintenance, particularly for periodic and emergency repairs. Poor collaboration between ERA, local governments, and community stakeholders can lead to delays and inefficiencies in maintenance activities. For example, local governments may fail to report road damage promptly, or community members may obstruct maintenance work due to a lack of awareness.

d) The Availability of materials and equipment

The availability and quality of construction materials directly impact the durability of maintenance interventions in study area. Gravel, asphalt, and other essential materials are not always readily available, particularly for rural roads. This can delay maintenance work and increase costs. The use of substandard materials reduces the effectiveness of maintenance efforts, requiring frequent repairs and increasing long-term costs. The high cost of transporting materials from distant locations further strains maintenance budgets.

e) Community Awareness and Involvement

The role of local communities in supporting road maintenance is often overlooked but is critical for sustaining road infrastructure. In Nekemte District many residents lack an understanding of the importance of road maintenance, leading to behaviors that contribute to road damage, such as overloading vehicles or dumping waste in drainage systems. Communities are rarely involved in routine maintenance activities, even though their participation could significantly reduce costs and improve road conditions.

4.9 Discussion on the Defects Present on the Road Segments of Gedo-Nekemte and Nekemte-Mekenedjo in the Nekemte District

Based on field surveys, expert assessments, and local reports, the defects on the Gedo-Nekemte and Nekemte-Mekenedjo roads mentioned. Potholes are the most common road defect, accounting for 37.5% of the total. These occur due to water infiltration, poor drainage, and continuous traffic stress, especially from heavy vehicles. Potholes pose significant safety risks to drivers and are a primary cause of vehicle damage. Erosion and landslides are the second most frequent issue, constituting 19.8% of the reported damages. These are influenced by environmental factors such as heavy rainfall, inadequate slope stabilization, and poor drainage systems, which weaken the road's foundation and surrounding terrain. Cracks rank third, representing 15.6% of the defects. These include longitudinal, transverse, and fatigue cracks caused by thermal stress, subgrade instability, and repeated loading. Cracks serve as entry points for water, accelerating deterioration. The loss of visibility in road markings contributes to unsafe driving conditions, particularly at night or during adverse weather. Representing 10.4% of the defects, this issue emphasizes the need for regular maintenance of road signage and markings. Although less frequent at 6.3%, sinkholes are a critical safety concern. They are caused by the collapse of underground voids due to poor drainage, soil erosion, or subgrade instability.

Rutting, observed in 3.1% of the cases, is caused by repeated vehicle loading on asphalt pavements. It leads to uneven surfaces and water pooling, which can increase the risk of hydroplaning. Damaged road signs account for 4.2% of the defects undermining communication of critical road safety information and contributing to accidents. Shoulder erosion, recorded at 2.1%, is typically caused by water runoff and the absence of proper shoulder reinforcement. This defect reduces the structural stability of the road edges. Although relatively minor at 1%, uneven pavements impact driving comfort and vehicle maintenance, especially for smaller vehicles.

4.10 Discussion on the Impacts of Current Road Conditions: Gedo-Nekemte and Nekemte-Mekenedjo Routes

The Gedo-Nekemte and Nekemte-Mekenedjo routes were crucial transportation corridors in western Ethiopia, facilitating movement between key urban and rural areas. These routes are vital not only for local transportation but also for regional trade and economic development. However, the existing road conditions present significant challenges that extend beyond mere inconvenience. This discussion delves into the multifaceted impacts arising from the current state of these roads, focusing on economic, social, environmental, and health-related aspects.

Economic Impacts

The economic landscape of the region is intricately linked to the quality of its roads. The implications of poor road conditions include Increased Transportation Costs, Reduced Market Access, Supply Chain Disruptions and Time Sensitivity. Infrastructure quality significantly influences investment decisions. The existing road conditions can deter potential investments for several reasons new business ventures and tourism development.

Social Impacts

The social fabric of communities is affected by road conditions in various ways limited access to services and increased travel time. The risks associated with poor road conditions extend to public safety: Poorly maintained roads contribute to a higher incidence of traffic accidents, particularly for vulnerable road users such as cyclists and pedestrians. Delays in emergency response times can exacerbate the consequences of accidents and health crises, leading to increased mortality and morbidity.

Environmental Impacts

The physical impact of roads on the environment cannot be overlooked: Poor drainage systems lead to increased runoff, which can wash away topsoil, critical for agriculture, and contribute to sedimentation in nearby rivers and lakes. Road construction and maintenance

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can fragment habitats, threatening local wildlife and disrupting ecosystems. The environmental consequences of road conditions extend to pollution: Increased traffic congestion on poor roads leads to higher emissions of pollutants, contributing to respiratory problems among local populations. Contaminants from roads can enter local water sources, affecting drinking water quality and harming aquatic ecosystems.

Health Impacts

The interplay between road conditions and public health is significant: Poor access to healthcare can lead to untreated diseases spreading within communities, exacerbating public health crises, particularly in rural areas. The stress of navigating poor infrastructure can contribute to mental health challenges among residents, particularly when access to services is consistently hindered.

CHAPTER: FIVE 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This study examined the road maintenance practices implemented by the Ethiopian Roads Administration (ERA) in Nekemte District, focusing on the effectiveness, challenges, and impacts of these practices on local communities, safety, economic development, and overall road infrastructure quality. The findings show that while the Ethiopian Roads Administration had made efforts to maintain the road network, there were significant gaps in the execution and sustainability of these practices. The survey results highlight several challenges faced by local residents, businesses, and road users, including poor road conditions that contribute to road user safety risks, increased vehicle damage, higher traffic accident rates, economic losses, and limitations in tourism, business development, and local trade. A large portion of respondents reported that the existing road maintenance practices were insufficient and that these issues have a direct negative impact on their daily lives and the district's economic prospects. Despite some positive steps taken by the ERA, the current state of the road network was far from adequate, and it was clear that more robust, sustainable, and proactive maintenance strategies are necessary to address these challenges.

The findings underscore that road infrastructure in Nekemte was a critical determinant of the local economy's efficiency and the well-being of residents. Poorly maintained roads not only reduce the quality of transportation but also hinder access to services, contribute to increased costs for businesses, and discourage investment and tourism. Given the substantial role roads play in connecting people, businesses, and services, the study concludes that improving road maintenance practices was an urgent priority for the Ethiopian Roads Administration in order to ensure economic development, safety, and better living standards for the community in Nekemte. In generally, the study demonstrates that while the Ethiopian Roads Administration had made efforts to maintain the road network in Nekemte District, significant improvements were still needed to address the challenges posed by poor road conditions. The economic, social, and safety implications of inadequate road maintenance were considerable and

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required immediate attention. By implementing the recommendations outlined in this study, the ERA could help ensure that roads in Nekemte were safer, more accessible, and better equipped to support local economic activities. Addressing the road maintenance challenges would not only improve road user safety but also stimulate economic growth, attract investment, and enhance the overall quality of life in the district. Therefore, prioritizing road maintenance and investing in sustainable infrastructure practices should be central to the Ethiopian Roads Administration's future efforts in Nekemte and beyond.

5.2 Recommendations

1. **Increased Financial Investment in Road Infrastructure:** A primary challenge identified in the study is the insufficient funding allocated for road maintenance. It is crucial that the Ethiopian government and ERA increase the budget for road maintenance and repair activities. A dedicated, consistent financial allocation is necessary to address the growing demands for road upgrades, ensure the timely execution of maintenance projects, and reduce the backlog of deteriorating roads. Funds shall also be allocated for innovative solutions to address specific local challenges, such as improving roads in high-risk or hard-to-reach areas.
2. **Improved Road Construction and Repair Techniques:** To ensure long-lasting roads, the Ethiopian Roads Administration should adopt modern road construction and repair techniques. This includes the use of durable materials that can withstand heavy traffic and extreme weather conditions, as well as the application of sustainable practices, such as using recycled materials. Incorporating advanced technology in road construction and repair can significantly reduce maintenance costs in the long term.
3. **Collaboration with Regional and International Partners:** To address the resource and expertise gaps, the Ethiopian Roads Administration shall explore partnerships with regional and international organizations that specialize in road infrastructure. Collaborating with global road maintenance experts can help introduce new technologies, best practices, and funding opportunities for road improvement projects. International partnerships can also assist in capacity building and knowledge transfer.

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4. **Secure & Increase Dedicated Road Maintenance Funding:** The Ethiopian Government, in collaboration with ERA, must significantly increase and ring-fence the national budget allocation for road maintenance, establishing a transparent, sustainable funding mechanism (e.g., Road Fund). This addresses the core challenge of insufficient resources, enabling backlog reduction, planned works, local innovation (e.g., for high-risk areas), and laying the financial foundation for all other improvements.
5. **Implement Proactive & Preventive Maintenance Regimes:** ERA must decisively shift from reactive to proactive maintenance by implementing systematic, technology-assisted (e.g., drones, sensors) road condition assessments and mandatory, data-driven routine maintenance schedules. This prevents costly deterioration, extends asset life, minimizes disruptive emergency repairs, and optimizes the use of constrained funds.
6. **Adopt Modern, Durable Construction & Maintenance Techniques:** ERA should mandate and invest in advanced materials (resilient to weather/traffic), sustainable practices (e.g., recycled materials), and modern construction/repair technologies for all new works and major repairs to ensure investment longevity, reduce recurring maintenance needs and costs, and improve resilience against local environmental challenges.
7. **Strengthen Institutional Capacity & Technical Skills:** ERA shall implement comprehensive, ongoing technical training programs for staff at all levels, focusing on modern maintenance methods, materials, technology use, project management, and climate adaptation strategies to address identified skill gaps and improve the quality, efficiency, and effectiveness of maintenance execution.
8. **Deepen Community Engagement & Multi-Stakeholder Collaboration:** ERA will institutionalize robust, inclusive stakeholder engagement throughout the maintenance lifecycle. This includes establishing community liaison committees and regular local consultations during planning to identify needs and prioritize projects; developing clear communication strategies for project timelines and impacts during implementation; creating accessible channels (hotlines, digital platforms) for issue reporting and feedback; and ensuring maintenance plans explicitly reflect

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- community-identified priorities, especially for vulnerable areas. This fosters local ownership, improves accountability, and ensures resources target actual needs.
9. **Establish Robust Monitoring, Evaluation & Accountability Frameworks:** ERA must develop and implement standardized systems for continuous road condition monitoring, rigorous evaluation of maintenance project effectiveness (cost, quality, durability), and independent audits of resource utilization, with results made publicly accessible to ensure transparency, efficiency, evidence-based decision-making, and accountability.
 10. **Forge Strategic Regional & International Partnerships:** ERA shall proactively seek partnerships with specialized regional/international organizations (e.g., World Bank, AfDB, PIARC, research institutions) for knowledge transfer, access to innovative technologies/best practices, specialized training, and co-financing opportunities to bridge resource and expertise gaps and accelerate progress.
 11. **Launch Targeted Public Awareness & Road User Education Campaigns:** ERA, collaborating with communities and media, shall run sustained campaigns educating the public on the value of road maintenance, promoting responsible road use (e.g., axle loads, speed), encouraging public reporting of road damage, and building understanding of planned works to reduce preventable damage, enhance safety, and support community engagement.

- **Critical Areas for Future Research:**

Future research should prioritize quantifying the long-term savings of proactive versus reactive maintenance in Ethiopia to justify sustained funding. Investigating sustainable community-based maintenance models for remote areas is essential. Research must also focus on optimizing low-cost, locally adaptable, climate-resilient materials and construction methods. Assessing climate change impacts on roads and developing cost-effective adaptation techniques is critical. Finally, exploring the feasibility and accuracy of emerging low-cost technologies.

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APPENDIX: A

Section One: Respondent Information

1. Educational Qualification:

☐ BSc ☐ MSc/MA ☐ PhD ☐ If other, please specify _____

2. Job Title: _____

3. Organization/Company: _____

4. Organizational firm: ☐ Employer and Consultant ☐ Consultant ☐ Contractor ☐

5. Years of Experience in Road Construction Projects:

☐ Less than 5 years ☐ 5-10 years ☐ 11-15 years ☐ 16-20 years

☐ More than 20 years

Section Two: Maintenance frequency and Factors Influencing Road Maintenance Practices

1. How frequently do you use the road segments in the Nekemte District?

Daily ☐

Weekly ☐

Monthly ☐

Rarely ☐

Never ☐

2. Are you aware of the maintenance practices implemented by the Ethiopian Roads Administration in the Nekemte District?

Yes ☐

No ☐

3. If yes, please specify the types of maintenance practices you are aware of:

Routine maintenance ☐

Periodic maintenance ☐

Emergency maintenance ☐

Rehabilitation ☐

Others (please specify).....

4. Please rate the following Factors influencing road maintenance practices in the Nekemte District Road Construction Project. Use a Likert scale of 1 to 5, where 1 represents "Very low" and 5 represents "Very high".

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S/No.	Factors Influencing Road Maintenance Practices such as:	Very Low	Low	Moderate	High	Very High
1	Budget allocations.					
2	Availability of materials and equipment's.					
3	Workforce capacity and technical expertise significantly influence the selection and implementation of road maintenance practices.					
4	Weather conditions					
5	Community involvements					
6	There are specific challenges or barriers that affect the successful implementation of road maintenance practices.					

5. Please rate the following Types of road maintenance practices in the Nekemte District Road Construction Project. Use a Likert scale of 1 to 5, where 1 represents Very low and 5 represents Very high.

S/No	Types of road maintenance practices	Very Low	Low	Moderate	High	Very High
1	The Ethiopian Roads Administration implements various types of road maintenance practices.					
2	The road maintenance practices implemented are clearly categorized					

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	based on their objectives and scope.					
3	Routine maintenance: Regular activities like cleaning, patching, and vegetation control.					
4	Periodic maintenance: Planned interventions to restore road quality, including resurfacing, resealing, and structural repairs.					
5	Emergency maintenance: Urgent repairs needed due to natural disasters, accidents, or sudden infrastructure failures.					
6	Rehabilitation: Extensive reconstruction to improve road conditions, typically involving major repairs or upgrades.					

Section Three: Assessment of Damages or Defects on Gedo-Nekemte and Nekemte-Mekenedjo Roads

6. Please rate the following statements based on your perception of the Types of Road damages or defects exist on Gedo-Nekemte and Nekemte-Mekenedjo Road, with 1 being Very low and 5 being Very high:

S/No.	Types of Road damages or defects	Very Low	Low	Moderate	High	Very High
1	Potholes (Base failures): These are bowl-shaped holes in the road surface caused by wear and tear,					

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	weathering, or poor construction.					
2	Cracks: Cracks can develop in the road surface due to aging, heavy traffic, temperature changes, or inadequate maintenance.					
3	Faded or worn-out road markings: Over time, road markings such as lane lines, crosswalks, or symbols can fade, making them less visible and potentially leading to confusion or accidents.					
4	Uneven pavements: Roads can have uneven surfaces due to poor construction, settlement, or damage caused by heavy vehicles or extreme weather conditions.					
5	Erosion or landslides: In hilly or mountainous regions, heavy rains, soil erosion, or landslides can affect roads, causing slope failures, road subsidence, or blockages.					
6	Ruts: Ruts are long, narrow depressions formed by continuous traffic, particularly in areas where vehicles repeatedly travel along the same path.					
7	Sinkholes: These are sudden depressions or collapses in the					

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	road caused by unstable ground conditions or underground water erosion.					
8	Damaged signage: Road signs can become damaged, faded, or obscured, reducing their effectiveness in providing important information to drivers.					
9	Shoulder erosions: The road shoulders, which are the areas adjacent to the main roadway, can erode or deteriorate, making them unstable and unsafe for vehicles.					

Section Four: Evaluation of Impacts Resulting from Current Road Conditions

7. Please rate the following statements based on your perception of the impacts resulting from the current road conditions of Gedo-Nekemte and Nekemte-Mekenedjo Routes, with 1 being Very low and 5 being Very high:

S/No.	Impacts Resulting from Current Road Conditions	Very Low	Low	Moderate	High	Very High
1	The current road condition of Gedo-Nekemte and Nekemte-Mekenedjo routes has a significant impact on the overall transportation system in the Nekemte District.					
2	Poor road conditions affect travel time.					
3	Poor road conditions increase vehicle operation costs.					
4	Poor road conditions affect road					

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	user safety.					
5	Poor road conditions affect vehicle damage.					
6	Poor road conditions affect traffic accidents.					
7	Poor road conditions affect economic losses.					
8	Poor road conditions affect negative impact on tourism and business development					
9	Poor road conditions have a negative impact on the local economy, trade, and accessibility to essential services in the Nekemte District.					
10	Poor road conditions affect social, environmental, or health-related consequences (Gedo-Nekemte and Nekemte-Mekenedjo road segment).					

Interview

1. Can you please describe the types of road maintenance practices implemented by the Ethiopian Roads Administration in the Nekemte District?
2. How are these road maintenance practices categorized based on their objectives and scope?
3. What factors influence the selection and implementation of road maintenance practices in the Nekemte District? For example, how do budget allocation, resource availability,

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workforce capacity, and technical expertise impact the choice and effectiveness of road maintenance practices?

4. In your experience, what are some specific challenges or barriers that affect the successful implementation of road maintenance practices in the Nekemte District?

5. Could you identify any observable damages or defects present on the road segments of Gedo-Nekemte and Nekemte-Mekenedjo in the Nekemte District?

6. How severe do you consider these damages or defects in terms of their impact on road quality and safety?

7. What are the main causes or contributing factors to the damages or defects found on Gedo-Nekemte and Nekemte-Mekenedjo roads, based on your observations?

8. Has the Ethiopian Roads Administration conducted any previous assessments or maintenance activities to address the identified damages or defects on these roads?

9. How do the damages or defects vary between different sections or stretches of Gedo-Nekemte and Nekemte-Mekenedjo roads?

10. How does the current road condition of Gedo-Nekemte and Nekemte-Mekenedjo routes impact the overall transportation system in the Nekemte District, in your opinion?

11. What are the specific impacts of the current road condition on aspects such as travel time, vehicle operation costs, and road user safety?

12. In your view, how do poor road conditions affect the local economy, trade, and accessibility to essential services in the Nekemte District?

13. Are there any social, environmental, or health-related consequences associated with the current road conditions of Gedo-Nekemte and Nekemte-Mekenedjo routes that you have observed or heard about?

14. Have there been any documented incidents or accidents attributable to the existing road conditions, and if so, what are their implications according to your knowledge and experience?