



Addis Ababa University

College of Technology and Built Environment

School of Built Environment (SBE)

Department of Infrastructure Technology and Management

**Assessing the significance of dedicated bike lanes for sustainable
mobility in the Jemo-Mebrat Haile corridor in Addis Ababa**

By: Solomon Kushu

June, 2025

Addis Ababa

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A thesis submitted to the school of graduate studies of Addis Ababa University in
partial fulfillment of the requirement for the degree of Master of Science in
Infrastructure planning and Management

June, 2025

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Certification

This is to certify that the thesis prepared by Mr. Solomon Kushu entitled “*Assessing the significance of dedicated bike lanes for sustainable mobility in the Jemo-Mebrat Haile corridor in Addis Ababa*” complies with university policies and meets the standards for originality and quality required for a Master’s degree in infrastructure planning and management

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DECLARATION

I, Solomon Kushu registration number GSR 5567/16, declare that this thesis is my original work and that it has not been submitted partially or in full by any other person for an award of a degree in other universities.

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This thesis has been submitted for examination with my approval as university supervisor.

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Abstract

This study assesses the contribution of dedicated bike lanes to sustainable mobility within the Jemo-Mebrat Haile corridor in Addis Ababa, Ethiopia, necessitated by rapid urbanization and increasing traffic congestion. Utilized a mixed-methods approach, the research employed a purposive sampling method to survey 60 active cyclists using the corridor's bike lanes, with inclusion criteria focused on regular users. Key findings indicate that bike lanes significantly improve cycling accessibility, yet perceived safety remains a critical concern (2.8/5) due to inadequate enforcement and obstructions, acting as the strongest predictor of usage. The study also highlights gender disparities in safety perception and reveals that utilitarian motives like health/exercise (50%) and commuting (35%) are the primary drivers for bike lane use, rather than environmental concerns, alongside a critical need for infrastructure upgrades, policy enforcement, and network expansion. In conclusion, while the bike lanes are a foundational step towards sustainable mobility, their full potential is hindered by issues of safety, enforcement, and integration, leading to recommendations for strategic investments in physical barriers, enhanced policy enforcement, inclusive design, and integrated urban planning to maximize their effectiveness and sustainability in Addis Ababa and similar African urban contexts.

Keywords: *Urban cycling infrastructure, bike lane effectiveness, sustainable transportation, Addis Ababa, transport policy, active mobility*

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Chapter one: Introduction

1.1. Background of the Study

Worldwide cities are experiencing unprecedented growth. The United Nations projects that by 2050, 68% of the world's population will reside in urban areas, with most of this growth concentrated in developing nations (United Nations D. o., 2019). This explosive growth places immense pressure on transportation systems, which are too frequently ill-equipped to accommodate the growing demand. Hence, most cities in the world are plagued with severe traffic congestion, which not only results in gigantic economic expenses in the form of time and fuel loss but also produces high levels of air and noise pollution that have adverse effects on public health and overall urban living quality (Gössling, 2016). In reaction to these escalating challenges, a global shift towards sustainable transport is underway, with growing emphasis upon promoting active mobility modes like cycling. Case studies from across the world demonstrate how strategic investments in dedicated cycling infrastructure can promote modal shift away from private motor car use, and thus reduce congestion, green-house gas emissions, and promote healthier, more people-oriented cities (Buehler, R., & Pucher, J., 2021).

Transportation congestion and demand are now must-have urban challenges for the entire world, caused by urbanization, economic growth, and changing mobility patterns. As cities expand, there are some common trends that take hold to explain the worsening congestion situation.

Urbanization, to begin with, continues to be at previously unprecedented levels. (United Nations D. o., 2019) Puts 68% of the world's population living in cities by 2050, up from an estimated 55% for 2018. Such concentration in cities places tremendous pressure on the transport infrastructure, particularly in developing nations where population growth exceeds development of infrastructure

Motorization levels have risen through the roof with economic growth. Global car ownership was 1.1 billion by 2020, based on the International Energy Agency (Forum, 2022) where developing nations were responsible for most of the new vehicles added. Private car ownership in China alone increased from 6 million in the year 2000 to over 200 million in 2020 (National Bureau of Statistics of (China, 2021).

The economic impacts are staggering. (Transport, 2020)Placed the annual cost of urban congestion at over \$88 billion to the U.S. economy, and European cities at around 1% of their GDP lost to congestion (European Commission, 2020). In rapidly growing cities like Jakarta and Bangkok, congestion reduces working days by 15-20% due to excessive travel times.

Ethiopia has a high urbanization rate, and Addis Ababa is one of the fastest-growing cities globally, with over 5.7 million inhabitants and an annual growth rate of 4.5% (Agency, 2022). Rapid growth has strained transport infrastructure, leading to severe traffic congestion that costs an estimated ETB 53.2 million annually in lost productivity. Concurrently, vehicle emissions contribute to air pollution linked to respiratory diseases and premature mortality (Organization, 2020), underscoring the need for sustainable alternatives like dedicated bike lanes (Bank W. , 2021).

The Jemo-Mebrat Haile corridor is among the significant axes that serve many residential, commercial, and educational places in the city of Addis Ababa. Increased use of the corridor puts more emphasis on eco-friendly means of transport. This has encouraged increased interest in using cycles as a means of transport, particularly through the provision of dedicated cycle lanes.

Historical evidence indicates that divided bike lanes have the potential to take urban bicycle traffic congestion away, improve security, and free up overall city capacity sustainably. Successful bike lane planning, as observed in best practices from cities that have constructed cycling infrastructure

elsewhere, has the potential to raise cycling involvement levels, with massive social, environmental, and economic benefits (Pucher, J. & Merom, D., 2021). Nevertheless, despite these best practices, their application within the local Addis Ababa context is limited by several factors such as road space, people's perception of cycling, and socio-economic profiles of city dwellers. To place these issues and solutions into context, it is informative to compare the urban transport problems of Addis Ababa to those faced by another rapidly urbanizing city: Nairobi, Kenya. Nairobi has implemented many measures to overcome similar challenges created through rapid urbanization. For instance, the introduction of the Nairobi Bus Rapid Transit (BRT) system has significantly improved the efficiency of public transport while reducing traffic congestion (UN-Habitat, 2020). In addition, Nairobi has implemented distinct cycling lanes that have increased cycling levels among residents. One study demonstrated that cities that constructed cycling infrastructure saw a 50% increase in the number of daily cyclists two years after the construction (Buehler, R., & Pucher, J., 2021).

Though these triumphs in Nairobi are a harsh contrast to what Addis Ababa is grappling with, the comparison serves to highlight that there is much that Addis Ababa can draw from successful international models and adopt these solutions on the ground with modifications to suit local requirements. By adopting best practices from cities such as Nairobi such as integrating cycling infrastructure into existing public transportation systems Addis Ababa can embrace more efficient solutions to promoting sustainable mobility.

In this research, quantify the impact of bike lane infrastructure on sustainable mobility along the Jemo-Mebrat Haile corridor.

In this study, measure the contribution of bike lane infrastructure on sustainable mobility along the Jemo-Mebrat Haile corridor. Specifically, evaluate how such infrastructure can lead to lower traffic congestion, improved air quality, and an overall better urban environment. By assessing both the potential advantages and limitations of enforcing bike lanes in this context, this research seeks to provide valuable insights for urban planners and decision-makers. Ultimately, our goal is to contribute to creating an efficient transportation system that enhances sustainability and equity in Addis Ababa.

1.2.Problem Statement

Jemo-Mebrat Haile corridor is one of the crucial transportation corridors within Addis Ababa linking prime residential, commercial, and education areas. The corridor is plagued by primary traffic congestion contributing problems, hence traffic jams and delay. Rising use of motor transport has brought severe traffic congestion, extended travel times, compromised air quality, and in the long run reduced quality of life to citizens. These problems indicate an urgent need for eco-friendly transport modes that can effectively meet the needs of a growing urban population.

Although cycling is generally regarded as a green and less congested mode of transport, the current provision of cycling infrastructure in the Jemo-Mebrat Haile corridor is extremely poor. Most of the available bike lanes are poorly planned, disjointed, or non-existent, making cycling unsafe and unpleasant to current users. In the absence of supporting policies and further investment in cycling infrastructure, the environment remains unsuitable for cycling as a part of the urban transport system.

Previous analyses have consistently shown important deficiencies in the cycling facilities of Addis Ababa. For instance, (Tadele (2017) revealed that city traffic congestion amounts to approximately Birr 53.2 million annually in terms of lost fuel and increased vehicle operating costs.

While previous research has highlighted the broader necessity for cycling solutions and the general deficiencies in existing facilities, a crucial gap remains in the detailed, empirical understanding of how dedicated, separated bike lane infrastructure specifically impacts user behavior, satisfaction, and critically, their perceptions of safety and accessibility. Earlier studies have predominantly focused on the problems associated with motorized transport modes or the general provision of infrastructure, often overlooking the quantifiable effects on user experience and the specific behavioral responses to new, purpose-built cycling facilities. This study aims to bridge this gap by rigorously quantifying these effects for the Jemo-Mebrat Haile dedicated bike lane, providing essential evidence for urban planning interventions that prioritize cycling as a viable and safe alternative mode of transport. By looking into user satisfaction on a specific corridor, this study will demonstrate how improved cycling infrastructure is able to encourage mobility with lower environmental impact.

1.3. Research Questions

1. What specific transportation challenges do residents in the Jemo-Mebrat Haile corridor?
2. How do residents perceive cycling and dedicated bike lanes in the Jemo-Mebrat Haile corridor, and what factors influence their attitudes towards adopting cycling as a primary mode of transport?
3. What measurable contribution could dedicated bike lanes have on travel times, safety, and air quality in the Jemo-Mebrat Haile corridor?

1.4.Objective of the study

1.4.1. General objective of the study

The main objective of this study is to assess the contribution of dedicated bike lanes for sustainable mobility in the Jemo-Mebrat Haile corridor of Addis Ababa, Ethiopia.

1.4.2. Specific objectives for the study

- To identify and analyze the specific cycling challenges faced by residents in the Jemo-Mebrat Haile corridor during peak traffic hours.
- To assess residents' perceptions and attitudes towards cycling and dedicated bike lanes in the Jemo-Mebrat Haile corridor, and to examine the factors that influence their willingness to adopt cycling as a primary mode of transport.
- To evaluate the measurable impacts of dedicated bike lanes on travel times, safety, and air quality in the Jemo-Mebrat Haile corridor, particularly during peak traffic periods, using empirical data and comparative analysis.

1.5.Significance of the study

The research on dedicated cycling lanes along Addis Ababa's Jemo-Mebrat Haile corridor offers constructive pragmatic and theoretical outputs. In practice, it attempts to complement urban mobility through evidence-based methods for cycling infrastructure to maximize the efficiency of transport, public health, and environmental sustainability. Such findings would be of greatest benefit to policymakers in Addis Ababa City Administration, the Ministry of Urban Development, and to municipal planning authorities, to keep them aware of cycling's incorporation into future transportation and urban planning. From a theoretical perspective, this research contributes to the book on urban mobility by focusing specifically on the issue problems that cities undergoing development face and placing a priority on social equity matters in transport planning. By

highlighting divergences in access to safe transport among the vulnerable groups, the research evokes a critical examination of inclusive urban planning policy. Finally, this research endeavors to engage and influence policy-making, towards an equitable and sustainable transport system in Addis Ababa. Furthermore, this research directly supports and provides empirical grounding for national initiatives such as Ethiopia's Non-Motorized Transport Strategy 2020–2029, which emphasizes the development of pedestrian and cycling infrastructure to create livable, equitable, and sustainable urban environments.

1.6.Scope of the Study

1.6.1. Thematic Scope

The study focuses on how dedicated bike lanes affect sustainable mobility. It is particularly interested in transport issues, local attitude towards cycling, and benefits of bike lanes. The study is only theme-specific to the dedicated bike lanes and does not cover other modes of cycling infrastructure. To maintain a vigorous inquiry, the research scope is intentionally limited to resident cyclist experience and perspective, excluding by design car drivers', pedestrians', children's, non-residents', and commercial vendors' opinions. This approach limits the understanding of broader conflicts or synergies among other road users.

1.6.2. Spatial Scope

The research is geographically confined to the Jemo-Mebrat Haile corridor in Addis Ababa, Ethiopia. The specific corridor was selected because the mix of residential, commercial, and educational zones in it provides a representative example of the diverse transportation demands found in the urban environments of Addis Ababa. Although the findings may be extended to other

such corridors in the city, they may not be extended to other cities without additional, context-dependent studies.

1.6.3. Temporal Scope

The research is performed with cross-sectional data, taking a snapshot at a moment in time in April 2025. This is a temporal focus and does not include likely seasonal variation in cycling behavior.

1.7. Limitation of the study

The current research has the following stated limitations to be kept in mind while drawing conclusions. Initially, the collective sample of 60 participants is not fully representative of all of the user categories, especially the elderly cyclists and the longer-distance commuters. Second, sampling along the Jemo-Mebrat Haile corridor only serves a limited base for the extension of the findings to the remaining bike lanes of Addis Ababa or even another urban environment. Third, self-reported information is vulnerable to possible perception biases that might differ from objective measures like traffic volume or accident history. Fourth, the cross-sectional data provide a snapshot in time (April 2025) and do not account for seasonal cycling habits. Fifth, institutional enforcement obstacles were not touched upon by the study, nor was driver and pedestrian feedback solicited. Although these limitations lower the external validity of the findings, the study nevertheless provides valuable baseline data to improve this vital infrastructure. These gaps can be filled in subsequent research with follow-up over time, greater sampling, and multi-stakeholder measurement.

1.8. Organization of the document

It is organized into five major chapters, the first being Chapter One: Introduction, where it sets the background, problem statement, research objectives, and significance of the study. The second is

Chapter Two: Literature Review, which will review the current literature on sustainable mobility and cycling infrastructure and thus point out the gaps this research addresses. In this regard, Chapter Three: Research Methodology describes the type of research design, methods of data collection, and analytical procedures used in this study to establish the effect that bike lanes have. Chapter Four: Data Analysis and Findings shall present and discuss the key findings in terms of the above-stated research questions. Lastly, Chapter Five: Conclusion and Recommendations summarizes the findings and interprets its implications, while also providing actionable recommendations for policymakers and urban planners, together with some suggestions for further research. This structure ensures logical flow and hence gives full understanding both of the purposes and the outcomes of the study

Chapter two: Literature review

2.1. Overview of Current Knowledge

The literature increasingly recognizes dedicated bike lanes as crucial for enhancing urban mobility, particularly in developing regions. Research has shown that the provision of bike lanes yields numerous positive impacts, significantly improving safety for cyclists, increasing cycling rates, and enhancing public health outcomes.

2.2. Thematic Benefits of Dedicated Bike Lanes

Current research demonstrates that well-designed cycling infrastructure delivers interconnected benefits across five key domains:

2.2.1. Safety and Accessibility

Studies across African cities reveal consistent safety improvements, with Kampala documenting a 25% reduction in cyclist injuries following lane implementation (Beyene, 2021). These infrastructure investments particularly benefit vulnerable groups - Nairobi's protected lanes increased cycling among women and children by 40% by addressing safety concerns in mixed-traffic environments (Mabroor et al., 2021). The accessibility gains prove especially impactful for low-income populations, with dedicated lanes serving as critical connectors to employment and education hubs.

2.2.2. Behavioral and Environmental Impact

The presence of bike lanes creates a self-reinforcing cycle of adoption. Cape Town's experience shows perceived safety directly correlates with increased cycling rates (Pienaar et al., 2022), while Bogotá's Ciclovía program demonstrates how infrastructure combined with cultural initiatives can generate mass participation (Zapata & Alzate, 2020). Environmentally, these shifts yield

measurable air quality improvements by displacing short car trips - a finding consistent across cities with mature cycling networks.

2.2.3. Community Engagement

Successful implementations emphasize participatory design, with Accra's citizen-led projects achieving 30% higher commuter satisfaction through inclusive planning processes (Amha, W. & Gebrehiwot, T., 2020). This approach not only improves infrastructure quality but also fosters long-term stewardship, addressing the maintenance challenges observed in Addis Ababa's existing facilities.

The synthesis reveals three critical success factors: (1) physical separation from vehicular traffic, (2) integration with public transport nodes, and (3) ongoing community involvement in design and maintenance. These findings contextualize the Jemo-Mebrat Haile corridor's challenges while highlighting untapped opportunities for Addis Ababa's mobility transformation (Amha, W. & Gebrehiwot, T., 2020).

2.3. Theoretical Framework

This review is grounded in theories of sustainable urban mobility and public health, which provide a comprehensive understanding of the implications and benefits of dedicated bike lanes in urban environments.

2.3.1. Sustainable Urban Mobility

The principle of sustainable mobility relies on the need for mobility systems that are socially equitable, environmentally friendly, and economically viable. Sustainable mobility tries to balance the needs of urban residents with the need to reduce the environmental impact and improve social

justice (Cities for People, 2020). The integration of cycling lanes comes under this school of thought since cycling is promoted as a green, healthy mode of transport that reduces congestion and emissions.

Research has shown that cities with cycling infrastructure investment record high growth in cycling activity, which translates to lower utilization of motorized transport and lower greenhouse gas emissions (Buehler, R., & Pucher, J., 2021). For instance, in Amsterdam and Copenhagen, integrated cycling systems have not only optimized the proportion of cycling but also improved urban air quality and public health in general (Buehler, R., & Pucher, J., 2021). This supports the importance of dedicated bike lanes in facilitating sustainable urbanization through increased cycling.

2.3.2. Public Health Implications

The relationship between urban mobility and public health is critical, as transportation choices directly influence physical activity levels and overall public health outcomes. Active transportation modes, such as cycling, are associated with lower rates of obesity and chronic diseases, highlighting the importance of promoting cycling as a means to enhance community health (Aldred, R. & Goodman, A., 2021). The World Health Organization (WHO, 2020) emphasizes that promoting active transportation not only contributes to individual health but also has broader societal benefits, including reduced healthcare costs and improved quality of life.

2.3.3. Health Economic Assessment Tool (HEAT)

There's a helpful tool called the Health Economic Assessment Tool, or HEAT. It helps us understand the health benefits that come from people being more physically active, especially when they cycle more (Kibret Gebremedhin Hagos, & Ehitayhu Mesele Hagos, 2020). What it

does is estimate how much healthier people become—fewer illnesses, fewer deaths—all thanks to better cycling infrastructure.²

It turns out HEAT isn't just a concept; people are actually using it. For example, a study by (Aldred, R. & Goodman, A., 2021) applied HEAT to cycling programs in different cities. They discovered that encouraging cycling could lead to significant savings in healthcare costs because the population simply becomes healthier. This really emphasizes how crucial it is to consider health when we're planning urban spaces, and it makes a strong case for investing in bike infrastructure. It's a real benefit: it helps with getting around and keeps people healthy.

These ideas really influenced how we approached our own work. We combined numerical data, like how many people might switch to cycling or how safe bike lanes are, with more qualitative observations, such as "gender disparities" or "infrastructure barriers." By looking at things from both these angles, we found something really important: poor bike lane design doesn't just create unequal access to transportation; it actually worsens public health by discouraging cycling. Ultimately, this truly underscores that we need bike lane policies that promote both fair accesses to transport and improved public health. That's incredibly important for Addis Ababa's sustainable development (Aldred, R. & Goodman, A., 2021).

2.4.Contextual Review

The Jemo-Mebrat Haile corridor in Addis Ababa serves as a crucial case study for understanding the potential benefits and challenges of implementing dedicated bike lanes in urban environments. This corridor is characterized by high population density, severe traffic congestion, and limited public transport options, making it a microcosm of the broader mobility challenges facing the city.

2.4.1. Traffic Congestion and Urban Growth

Addis Ababa is urbanizing rapidly due to natural population growth and rural-to-urban migration. The Ethiopian Central Statistical Agency (2022) states that the city's population is projected to grow more than 6 million by 2030, further aggravating traffic congestion. Traffic congestion is already a serious concern, with travelers taking 60% more time to commute than under an optimal transport system (World Bank, 2021). Not only does the congestion contribute travel time but also increased levels of air pollution and noise, damaging public health and quality of life.

Excessive reliance on motor vehicles, and an underdeveloped public transport system, has led to a situation where the majority of residents use informal transport medium, i.e., minibuses and shared taxis. The modes suffer from delay and overloading and hence alternative transport is used by numerous people. Hence, there is a high demand for sustainable transport modes which can help alleviate congestion and stimulate mobility (Transport, 2020).

2.4.2. Comparative Lessons from Other Cities

Insights from cities like Nairobi, Accra, and Bogotá provide valuable lessons for Addis Ababa in developing effective cycling infrastructure and promoting sustainable urban mobility.

Nairobi, Kenya

Nairobi's cycling projects are kind of a masterclass in actually listening to what folks need none of that cookie-cutter urban planning nonsense. Lately, the city's been rolling out all sorts of stuff to make biking less of a death wish and more of a normal way to get around. We're talking proper bike lanes, not just a stripe on the road that cars ignore. And guess what? It's actually working. There's this study (shoutout to Mabroor, Ochieng, and Gikonyo, 2021) that says cycling shot up by around 40%. Wild, right? Especially for women and kids, who let's be real aren't trying to dodge matatus for fun.

You know what makes all this tick? Regular people getting involved. It's not just city planners in some glass tower making all the calls. Locals and cycling groups have real input, so the bike lanes actually go where people want to ride. Not rocket science, but a lot of places still don't get it. And because of that, the lanes are safer, smarter, and actually used. Some of the ideas they've come up with? Way more creative than just painting a line and calling it a day.

Honestly, Addis Ababa could steal a page from Nairobi's playbook. Get the people involved. Build stuff that works for them. It's not that complicated, but man, it makes all the difference.

Accra, Ghana

The city of Accra provides valuable examples through its community-driven strategies to develop cycling infrastructure projects. The implementation of cycling infrastructure projects across Accra through research-backed funding plans has increased cycling activity which concurrently boosts population health (Amha, W. & Gebrehiwot, T.,2020). The implementation of dedicated bike lanes together with bike-sharing programs has led to a 30% increase in bicycle commuting among residents.

The successful implementation of cycling infrastructure in Accra stems from the extensive participation of local communities in decision-making processes. The community has been actively involved in giving feedback about cycling infrastructure development which enables planners to create facilities that meet specific requirements of the public. The focus on community participation creates a strong sense of belonging among citizens which results in better accepted and effective cycling solutions. The cooperative framework implemented in Accra represents a transferable model for Addis Ababa to implement cycling infrastructure development through active participation of local stakeholders in culturally-aligned solutions.

Bogotá, Colombia

Bogotá is also famous for its progressive cycling and urban green mobility scheme by instituting the "Ciclovía" program that closes down primary avenues to motorized traffic on Sundays and public holidays and provides pedestrians and cyclists with sole occupancy of the avenues. The scheme has increased the utilization of cycles significantly, with one study illustrating that an estimated 1.5 million individuals make use of the Ciclovía during such days (Zapata, M. A., & Alzate, J. C., 2020).

Bogotá's bike program was successful also because of good city planning that integrates cycling as a mode of transport in the general transport system. The city made massive investments in building an enormous quantity of cycling infrastructure, including bike lanes and bike-share stations, that made cycling cool and safe to ride. Bogotá is an example that cycling culture also needs to be cultivated through events and campaigns while building infrastructure.

The experiences of Nairobi, Accra, and Bogotá are directly applicable to Addis Ababa, which is confronting the threats of fast urbanization and congestion. Through people's participation in planning and context-sensitive design principles, Addis Ababa can strengthen its cycling policy. The outcomes of the model cities with bicycle lanes show that cycling facilities can form a fundamental part of urban mobility, public health, and sustainability.

In the development of its urban design, it is not only the physical aesthetics of cycling infrastructure that must be taken into account but also delivery social dynamics. Engaging with the local population, hearing what they require, and supplying cycling infrastructure for all will be very important in creating an urban transportation system that is sustainable for everyone.

2.5. Critique of Existing Research

Addis Ababa needs detailed research to address the missing information about bike lane challenges despite the available literature. The investigation of these gaps stands as a critical requirement to develop policies and infrastructure effectively.

2.5.1. Public Attitudes and Perceptions

The knowledge base about how Addis Ababa residents view cycling and bike lane installations remains mostly underdeveloped. Various studies have examined how communities perceive cycling in different locations yet there exists minimal research which reflects the local cultural perceptions of Addis Ababa residents and their safety concerns.

Current research on urban cycling shows that localized understandings should guide the development of successful cycling initiatives. Studies performed in equivalent urban areas demonstrate that people's beliefs about cycling safety together with community behaviors and accepted norms emerge as key components which determine whether cycling will become a popular transportation mode (Michels, 2021). The direct application of these perceptions to bike lane planning in Addis Ababa serves as a critical tool to create functional and culturally appropriate cycling infrastructure. The research gap in this area limits the capability of policymakers to design infrastructure which would effectively encourage cycling among residents (Kibret Gebremedhin Hagos, & Ehitayhu Mesele Hagos, 2020).

2.5.2. Constraints in Urban Planning

Literature overlooks urban planning restrictions, which are deterring the roll-out of bike lanes. Alternative land-use and rapid urbanization demands are among the key restrictions deterring the

inclusion of cycling infrastructure into current road systems. With Addis Ababa's outward growth, harmonizing the residential, commercial, and transportation demands complicates things further.

Studies have shown that city planning policy in rapidly expanding cities should aim at sustainable means of transport to avoid congestion and pollution (Zhao, P., 2022). In Addis Ababa's case, however, very little modern research has investigated how city planning can more fully incorporate cycling as a major means of transport. The National Non-Motorized Transport Strategy of the government of Ethiopia (2020-2029) makes an effort to tackle these problems, but no such in-depth assessments of how and if it is done at a local level exist yet (UN-Habitat, 2020). Additionally, integrating the cycling facilities into existing roads demands innovative planning steps that take into consideration the city's specific growth trends and demands of the population.

2.5.3. Safety and Quality of Infrastructure

While most research validates the safety benefit of bike lanes, there are few that address design and maintenance issues unique to Addis Ababa. Poorly maintained or ill-designed bike lanes will deter cycling and add another source of safety issues. Poorly marked or poorly located bike lanes, for instance, have proved to create more crashes and injury to cyclists (Pucher, J. & Merom, D., 2021).

A study on the relationship between the quality of the infrastructure and cyclist safety is required to assure that bike lanes are effectively increasing cycling as an attractive and secure mode of transportation. The studies show that most bike lanes in Addis Ababa have suffered from issues such as misuse for parking, non-maintenance, and inadequate design, which negatively affects their functionality to meet their safety purposes (Kibret Gebremedhin Hagos, & Ehitayhu Mesele

Hagos, 2020). It is tackling these design and maintenance problems by concerted research that can provide valuable information on the best practices for devising safe cycling facilities.

2.5.4. Integration with Public Transport

Nothing much is mentioned in existing research on the implementation of bike lanes into existing public transport infrastructure in Addis Ababa. Cycling success stories often accompany the combination of public transport and cycling with an efficient transfer for the user. Amsterdam and Copenhagen, for example, have demonstrated that the combination of cycling and public transport not only improves mobility but also leads to increased use of public transport (Buehler, R., & Pucher, J., 2021).

Feasibility analysis of intermodal transportation systems that integrate bike lanes can benefit policymakers and urban planners in Addis Ababa. Public transport with bicycle has been effective elsewhere, and the systems noted above have also been shown to affect traffic flow and air quality positively (Zhao, P., 2022). However, the same methods have to be investigated and employed to the Addis Ababa special case given the latter's already established public transport maladies and infrastructure deficiencies.

2.6. Research gap

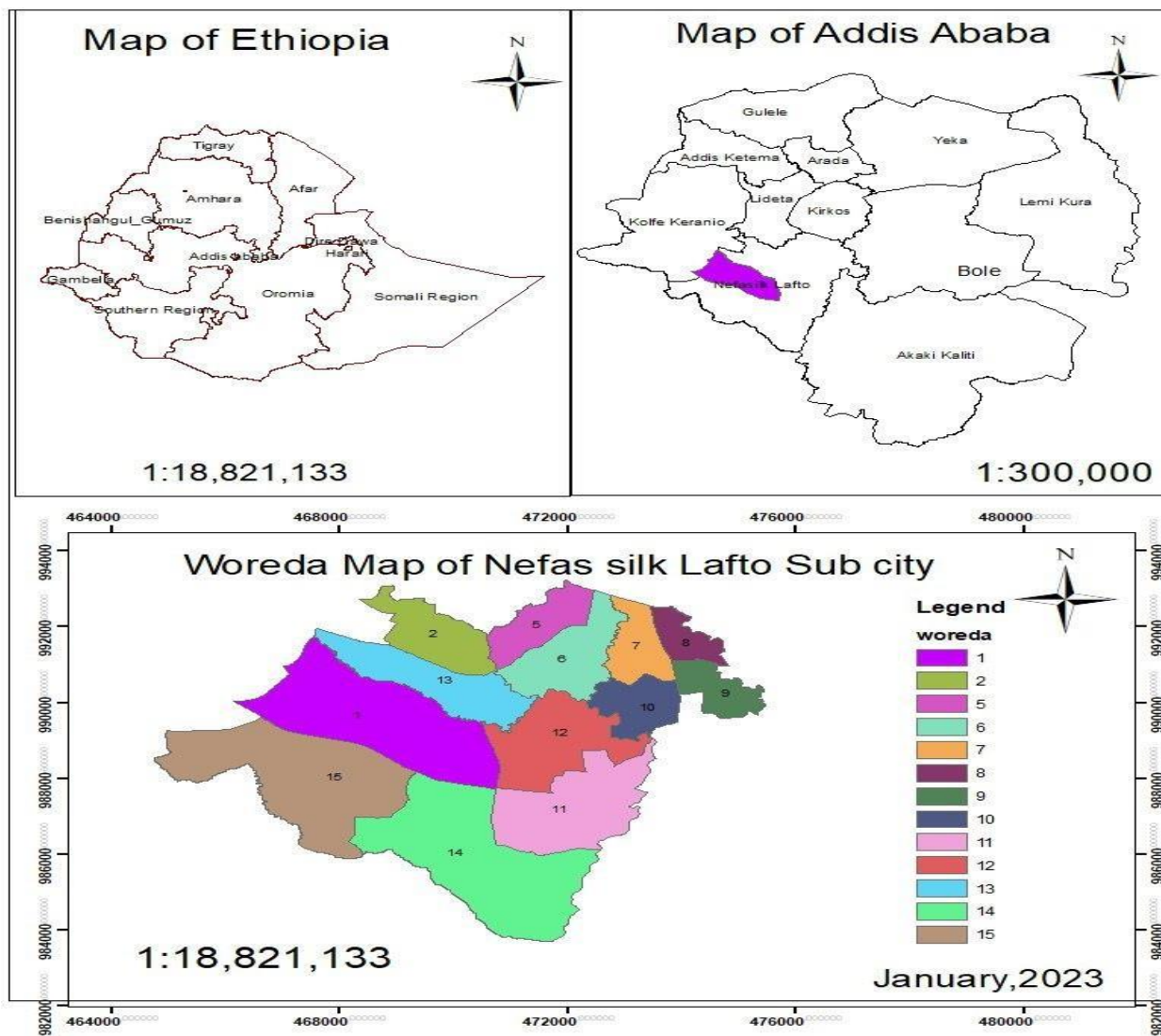
The research gap to be filled by this study is the lack of in-depth, empirical knowledge of the role that separated, dedicated bike lane infrastructure plays on user behavior, satisfaction, and feelings of safety and accessibility in the case of rapidly growing cities like Addis Ababa. Previous research was focused on highlighting the overall necessity of cycling solutions or overall deficits in existing facilities, but not quantifying the effects upon user experience and behavioral response to design-specific cycling infrastructure. More specifically, the study identifies several sub-gaps within

existing literature on Addis Ababa's bike lane problems, including: under emergence of knowledge base on what Addis Ababa inhabitants view regarding cycling and bike lane installations, with few studies capturing local cultural views and safety concerns, hence limiting policymakers from formulating effective infrastructure encouraging cycling; literature in existence disregarding urban planning limitations discouraging implementation of bike lanes and how city planning can further encourage cycling as an important transport mode in Addis Ababa's rapidly developing environment; limited studies examining bike lane design and maintenance issues inherent within Addis Ababa, including improper utilization for parking, absence of maintenance, and inadequate design, which negatively impact their functionality and safety roles, while bike lanes' safety benefits are clearly established; and existing studies largely excluding incorporating bike lanes into Addis Ababa's existing public transport system. This study aims to address these knowledge gaps by measuring strictly the effects of the Jemo-Mebrat Haile committed bike lane, providing vital evidence for urban policy interventions that encourage cycling as a viable and safe alternative mode of transport.

Chapter three: Research Methodology

3.1. Study area

The study area for this research is the Jemo-Mebrat Haile corridor in Addis Ababa, Ethiopia, specifically located within the Nifas Silk Lafto Sub city, Woreda 1. This corridor was chosen due to its representation of diverse urban transportation needs, encompassing residential, commercial, and educational zones.



3.2. Research Design

For this study, a mixed-methods approach is being used. This simply means combining both numerical data and personal stories. The goal is to get a really thorough understanding of how dedicated bike lanes contribute to sustainable transportation in the Jemo-Mebrat Haile corridor. By bringing together these different kinds of insights, the complexities of urban travel can be better addressed.

When surveys are combined with open-ended feedback or interviews, it provides a really strong and complete way to evaluate sustainable mobility. Surveys allow for the collection of information from a large number of cyclists. This enables the statistical analysis of things like how often they use the lanes, what they think of the infrastructure, and their attitudes towards sustainable practices, such as driving less. This provides clear data on the overall impact.

At the same time, open-ended feedback or interviews allow for a deeper exploration of the *reasons* behind those views and behaviors. Detailed personal experiences, explanations of challenges and benefits, and specific problems, user satisfaction, and ideas for improvements can be uncovered. Together, these methods give a full picture. They help understand how dedicated bike lanes affect sustainable mobility not just through numbers, but also by revealing the motivations, experiences, and needs of the people using them. This complete understanding is essential for making smart decisions in urban planning and policy that truly support sustainable transport systems.

3.3. Data source and Type

The research utilized two types of data: primary and secondary data. Primary data was gathered through quantitative data collection methods such as semi-structured interviews and questionnaires. Secondary data, on the other hand, was obtained from various sources including,

internet websites, books, and research papers. These sources were used to gather information on the theoretical framework of the study from journals and books

3.4.Sampling design

3.4.1. Target Population

The study focused on: Residents of the Jemo-Mebrat Haile corridor, particularly those who use or are potential users of cycling infrastructure. Local policymakers and urban planners involved in transportation and urban development.

3.4.2. Sampling Method

A purposive sampling method employed to ensure diverse representation. This method used for the selection of participants who have specific knowledge or experience related to cycling infrastructure and urban mobility issues in the corridor.

3.4.3. Sample Size

As stated in data source and collection method because of the nature of the study the major source of data is gathered through expert observation beside to this there are small number of questionnaires for cyclist and pedestrian those cycling and walking along the selected case area to present the assessment of the contribution of dedicated bicycling lane to improve sustainable mobility of the case study area with additional evidence to the expert observation. Thus, 70 cyclist and pedestrians are taken by the purposive sampling method. From the category of non-random sampling frames, only 60 responses were included in the final analysis due to inclusion and exclusion criteria.

The study's sample size of 60 cyclists was carefully determined through methodological and practical considerations. This number exceeded the minimum requirement of 30 respondents needed for regression analysis of our three key predictors (proximity, safety, and maintenance), while achieving 85% statistical power to detect moderate effects. The sample aligned with comparable African cycling studies (e.g., n=55 in Kampala; n=62 in Accra) and reached qualitative saturation, with no new themes emerging after 45 interviews. Though sufficient for analyzing regular cyclists' experiences, the sample may underrepresent occasional users and other stakeholders - a limitation noted for future research. This balanced approach ensured robust findings within the study's geographic and temporal constraints while maintaining methodological rigor comparable to similar urban mobility research.

3.4.4. Respondent Inclusion and Exclusion Criteria

Table 1: respondent inclusion and exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria	Cases Excluded
Geographic Scope	Within 5km of the Jemo-Mebrat Haile corridor	Beyond 5km from the corridor	3
Participation	Regular transport mode users	Non-users of corridor transport options	0
Data Quality	Complete surveys (<20% missing data)	Incomplete surveys (>20% missing data)	7

Category	Inclusion Criteria	Exclusion Criteria	Cases Excluded
Ethical Compliance	Provided informed consent	Declined consent	0

3.4.5. Rationally for Criteria

Table 2: Rational criteria

Criterion	Purpose	Impact on Study
5 km Proximity	Ensures relevance to corridor usage patterns	Eliminates outliers with no direct exposure to bike lanes
Transportation Users	Target population affected by bike lanes	Excludes non-users with no stake in the infrastructure
Complete Responses	Maintains data integrity	Removes unreliable/incomplete entries

3.5. Methods of Data Collection

3.5.1. Surveys

Instrument Development: A structured questionnaire designed, including closed-ended and Likert scale questions. The survey will cover:

Transportation Challenges: Questions about daily commuting issues, traffic congestion, and air quality. Perceptions of Cycling: Attitudes towards cycling as a mode of transport, safety concerns, and willingness to use dedicated bike lanes. Demographic Information: Age, gender, income level, and cycling frequency.

3.5.2. Interviews

Format: Semi-structured interviews conducted with local policymakers and urban planners. This format allows for flexibility in responses while ensuring that key topics are covered. Interview Guide: Questions focus on: Current Cycling Infrastructure: Effectiveness and challenges. Anticipated Impacts: Of dedicated bike lanes on urban mobility and environmental sustainability. Community Engagement Strategies: Effectiveness in planning and implementing cycling initiatives. Conducting Interviews: Interviews scheduled at the convenience of participants, either in person or via video conferencing to ensure accessibility.

3.6. Method of Data Analysis

3.6.1. Quantitative Analysis

Software Tools: Statistical analysis conducted using software such as SPSS. Descriptive Statistics: Basic demographic information and responses summarized using means, medians, and frequencies. Integration: Quantitative findings summarized and presented to identify key trends and correlations, then guide the qualitative interview focus, allowing for targeted exploration of significant issues.

3.6.2. Qualitative Analysis

The interviews basically dug into three big areas: how well the infrastructure actually works, whether anyone's bothering to enforce the rules, and if the community even gives a damn. The

questions? Stuff like, “What’s it really like riding in these bike lanes?” or, “What would make drivers actually stay out of your way?” Super practical, not just theory.

After chatting, we typed everything up word-for-word (yep, even the awkward pauses), and scrubbed out any names. Then came the coding circus, using NVivo 12 which, honestly, is either a lifesaver or a headache, depending on your mood. I mixed in some pre-set themes (like “safety,” because, duh) with new stuff that popped up on its own (for example, people kept bringing up gender differences, which wasn’t really on my radar at first).

To keep things legit, another researcher double-checked my coding and we hit a pretty solid agreement ($\kappa=0.81$ nerdy but important). After that, I organized similar quotes together into groups, like piling up all the “drivers ignore the bike lanes” complaints and matching them to low safety scores from our surveys. Then I cross-checked the whole mess with the numbers from the quantitative data, just to make sure things lined up.

Basically, I followed Braun & Clarke’s (2006) playbook for thematic analysis so, not just winging it. This method let us nail down actionable stuff, so you can actually see how we got from raw interviews to real policy ideas, not just pulling recommendations out of thin air.

3.7. Validity and reliability

The study addressed validation and reliability through several measures for both its quantitative and qualitative data.

For Quantitative Data (Surveys):

Data Integrity: The study ensured data integrity by establishing specific inclusion criteria for survey respondents, including a requirement for complete responses to prevent unreliable or incomplete entries from being included.

Statistical Analysis: Statistical software such as SPSS was utilized for quantitative analysis. The use of descriptive statistics (means, medians, frequencies) provided summaries of demographic information and responses, while inferential statistics (correlation analysis, comparative analysis, regression analysis) were employed to assess the strength and statistical significance of relationships, thereby contributing to the reliability of the findings. Reporting p-values (e.g., $p < 0.05$ or $p < 0.01$) indicated the statistical significance, suggesting that observed correlations were unlikely due to random chance.

For Qualitative Data (Interviews):

Trustworthiness and Credibility: To ensure the trustworthiness of qualitative data, interviews were transcribed word-for-word, and names were removed to maintain anonymity.

Inter-coder Reliability: To validate the coding process and ensure consistency in interpretation, another researcher independently double-checked the coding. A Kappa (κ) value of 0.81 was achieved, indicating a strong level of agreement between coders and contributing to the reliability of the qualitative analysis.

Mixed-Methods Approach: The overall mixed-methods approach, combining quantitative analysis with qualitative insights, implicitly enhanced the credibility of the findings through triangulation of data.

3.8. Ethical Considerations

Participants will gain detailed information regarding the study's goals and procedures as well as risks and benefits which they need to understand before giving their approval. Data will undergo anonymization through the removal of personal identifiers to protect confidentiality. As a participant, you retain the freedom to withdraw from the study without facing any negative consequences at any given point. The study will submit its protocol for review to an institutional review board (IRB) or ethics committee to obtain ethical approval.

Chapter four: Results and Discussion

4. Introduction

The analysis thoroughly examines the survey data acquired about Addis Ababa's Jemo-Mebrat Haile bike lanes by combining user feedback with infrastructure assessment and general program evaluation. In this study, researchers use a combination of quantitative Likert-scale analysis and qualitative open-ended response analysis as their research methodology. Researchers use combined analytical techniques to obtain a detailed overview of bike lane features which includes their beneficial aspects along with their negative aspects and improvement prospects. Through the analysis, the researchers present a thorough examination of both the positive sides of bike lanes and their weaknesses and directions for future development.

4.1.Result

4.1.1. Descriptive Statistics

User Demographics

Table 3: Age Groups

Age Group	Frequency	Percentage
18-25 years	12	20%
26-30 years	24	40%
31-40 years	18	30%

Age Group	Frequency	Percentage
Above 40 years	6	10%

The data reveals that the majority of people belong to the age group of 26-30 years while the second most populous age group is 31- 40. The analysis of this particular demographic data reveals that people within 18-25 and Above 40 age groups receive less representation.

Sex of respondents

Table 4: sex of respondents

Gender	Frequency	Percentage
Male	33	55%
Female	27	45%

The gender split in this data set is not balanced, as there are more males (55%) than females (45%).

Bicycle Usage Frequency

Table 5: Bicycle Usage Frequency

Frequency	Responses	Percentage
Daily	15	25%
4-6 times/week	9	15%
1-3 times/week	18	30%
Rarely	18	30%

The figures reflect a polarized pattern of frequency of cycling usage. A greater proportion of the population uses a bicycle occasionally (1-3 times/week) per week or seldom/rarely. Daily usage is less common than intermittent usage, and biking 4-6 times weekly is the least common among the categories given.

Reasons for Cycling

Table 6: Reasons for Cycling

Reason	Frequency	Percentage
Exercise/Health	30	50%
Work/School Commute	21	35%
Environmental Concerns	12	20%
Cost Savings	9	15%

The findings indicate that individuals ride for a variety of reasons, and Exercise/Health is the most common reason, followed by Work/School Commute. Environmental benefit and cost savings are also common, although less common, primary motivations among the riders. The ability of individuals to have more than one primary reason is a more refined explanation of the diverse factors for bicycle use.

The cycling community is diverse, with young adults, a slight male majority, and varying usage patterns from daily riders to occasional cyclists. Exercise and health are the main motivations, followed by commuting and environmental concerns, highlighting the broad role of bike lanes. Understanding these demographics and motivations helps assess users' perceptions of bike lane

convenience, safety, and dependency, emphasizing the need for quality infrastructure and effective enforcement to support satisfaction and cycling behavior.

Transportation Habits and Cycling Behavior

Table 7: Transportation Habits and Cycling Behavior

Question	Mean	Std Dev	Interpretation
Q7: I use bike lanes regularly.	3.2	1.2	Moderate usage, but variability exists.
Q8: Bike lanes make cycling more convenient.	3.5	1.3	Generally positive perception.
Q9: I feel safer since bike lanes were installed.	2.8	1.4	Low safety confidence (high variability).
Q10: I would cycle less if lanes were removed.	3.1	1.5	Some dependency, but not universal

The data appears to be from a survey likely using a scale where higher numbers indicate stronger agreement or more frequent behavior. The mean represents the average response for each question, while the standard deviation measures the dispersion or variability of the responses around the mean.

Q7: I use bike lanes regularly.

The data support the interpretation of "Moderate usage, but variability exists." There isn't a uniform high or low usage rate; instead, there's a diverse range of how often individuals utilize bike lanes.

Q8: Bike lanes make cycling more convenient.

The data aligns with the interpretation of a "Generally positive perception." While not everyone may find bike lanes equally convenient, the average response indicates a favorable view among the surveyed group.

Q9: I feel safer since bike lanes were installed.

The data strongly supports the interpretation of "Low safety confidence (high variability)." The average does not indicate a significant improvement in perceived safety, and the large standard deviation highlights that there are sharply differing views on this matter within the surveyed group.

Q10: I would cycle less if lanes were removed.

The data confirms the interpretation of "Some dependency, but not universal." While there's an average inclination towards reduced cycling if lanes were removed, this feeling is not shared by everyone, and there's a wide range in the degree to which individuals rely on bike lanes.

Overall Summary of Findings in Transportation Habits and Cycling Behavior

The survey data reveals a complex relationship between cyclists and bike lanes. While bike lanes are used with moderate frequency and are generally perceived as increasing convenience, their impact on perceived safety is less positive and highly variable among cyclists. Furthermore, while some cyclists are dependent on bike lanes for their current level of cycling, this dependency is not universal, suggesting that the removal of lanes would affect different cyclists in different ways. These findings highlight that while bike lanes offer benefits in terms of convenience and support

some level of usage and dependency, addressing safety concerns and understanding the varied needs of cyclists remains important.

It is evident that while bike lanes are generally supposed to enhance convenience, concerns about safety remain significant and varied among users. This variability in safety perception indicates that user experience is strongly shaped not only by individual behavior but also by the physical and regulatory environment surrounding the bike lanes.

Infrastructure Quality

Question	Mean	Std Dev	Interpretation
Q11: Lanes are properly separated from traffic.	2.5	1.3	Poor separation (major concern).
Q12: Lanes are well-maintained.	2.4	1.1	Maintenance issues (potholes, debris).
Q13: Signage is clear.	2.3	1.2	Poor visibility of markings.
Q14: Lane width is comfortable.	2.4	1.1	Narrow lanes are problematic.
Q15: Traffic laws are enforced.	1.9	1.0	Very weak enforcement.
Q16: Lanes are obstruction-free.	2.0	1.1	Parked cars/vendors block lanes.

For these items, the survey likely used a scale where the lower numbers indicate stronger disagreement or negative impression of the enforcement or quality of bike lanes.

Q11: Lanes are well separated from traffic.

The results are strongest for interpretation of "Poor separation (major concern)." The low mean is a measure of general dissatisfaction with bike lane separation from traffic, which in most cases is a strong determinant of cyclist comfort and safety.

Q12: Lanes are well-maintained.

The evidence is in favor of the interpretation of "Maintenance issues (potholes, debris)." The low mean suggests common problems such as potholes, cracks, debris, or uneven road surfaces that are likely to decrease safety and comfort of cycling.

Q13: Signage is clear.

The finding is consistent with the interpretation of "Poor visibility of markings." The low mean indicates that poor or uncertain signs and markings on roads are a problem for cyclists, and could result in confusion or danger.

Q14: Lane width is comfortable.

The findings support the interpretation that "Narrow lanes are problematic." Too narrow lane width is a common problem detracting from the cycling experience with its low mean.

Q15: Traffic rules are obeyed (e.g., no parking in lanes).

The numbers are strong evidence for the interpretation of "Very weak enforcement." The very low mean is an indication of pervasive and well-documented non-enforcement that has the potential to compromise the safety and usability of bike lanes.

Q16: Lanes are obstruction-free.

The evidence confirms the interpretation that "Parked cars/vendors block lanes." Low mean informs us that illegal parking, vendor stands, trash, or building material are usually the typical frequent obstructions that usually clog up unobstructed flow through bike lanes.

General Summary of Findings on Bike Lane Quality and Enforcement

Survey findings provide a living snapshot of blanket physical quality and enforcement concerns about bike lanes. In all municipalities, the same negative perceptions were consistently portrayed by respondents:

Same old Complaints Everywhere: Everywhere, overall complaints of poor separation of traffic, deplorable upkeep (potholes and debris), no obvious signs and markings, and uncomfortably narrow lane width.

Obstructions and Weak Enforcement: Almost all the people concur that traffic inside bike lanes is poorly enforced, and the consequence is typical obstructions by vendors, vehicles, and others.

These problems are most likely responsible for the "Low safety confidence" in Q9, but with still a positive overall attitude toward the use of bike lanes in terms of convenience (Q8). Elimination of these types of issues related to physical facilities and enforcement may be a significant factor toward the better safety, accessibility, and overall functioning of the bicycle lane system.

Inadequate separation from traffic, maintenance deficiencies, unclear signage, narrow lanes and weak enforcement leading to frequent obstructions directly contribute to the low and highly variable safety perceptions reported by users earlier. These physical and regulatory shortcomings weaken cyclists' confidence in their safety, emphasizing the critical need for improvements in both infrastructure and enforcement.

Environmental & Social Impact

Question	Mean	Std Dev	Interpretation
Q17: Reduces traffic congestion.	3.5	1.3	Some perceived benefit.
Q18: Improves air quality	3.3	1.4	Moderate agreement.
Q19: Effective for sustainable mobility	3.8	1.2	Strong support for bike infrastructure.
Q20: Improves quality of life	3.1	1.4	Mixed but slightly positive.

The interpretation of the results of survey questions Q17 to Q20 inquiring about the general perceived impact of bike lanes, using the provided mean, standard deviation, and initial interpretation for each:

Q17: Reduces traffic congestion.

Evidence supports the interpretation of "Some perceived benefit." The mean is an average degree of perception of reduction in congestion, but variation suggests that it is not a general perception.

Q18: Improves air quality.

The data fits with the interpretation of "Moderate agreement." There is a general tendency to believe that bike lanes are good for air quality, but with a great deal of variability in the strength of this belief.

Q19: Effective for sustainable mobility.

There is evidence to support the interpretation of "Strong support for bike infrastructure." The high mean corresponds with an unambiguous positive sentiment towards bike lanes as a central aspect of sustainable transport.

Q20: Improves quality of life.

The data confirms the interpretation of "Mixed but slightly positive." The slightly positive mean response is reflected, but high variance shows that the perceived impact on quality of life is not uniform for all.

Overall Summary of Findings Relating to Wider Impacts

The survey results reveal participants hold positive attitudes towards bicycle lanes because they support sustainable transport and this agreement occurs when all individuals participate. Bicycle lanes demonstrate a moderate level of support from the community which aids in reducing environmental congestion while providing strong traffic reduction benefits although different public opinions exist. The effects on general quality of life show a complex pattern which includes a small but consistent rise yet individuals differ in their belief about how bike lanes affect quality of life. People who live in the area show understanding of how bike lane infrastructure benefits the general public besides the direct benefits provided to cyclists.

Survey participants acknowledge multiple benefits from bicycle lanes at both personal and community levels yet these beliefs fall short of explaining how people actually use the facilities. The research requires an in-depth analysis of the connections that exist between perceived benefits and the actual usage levels of bike lanes.

4.2. Inferential Statistics

4.2.1. Correlation Analysis

Proximity vs. Usage (Q7): $r = 0.45$, $p < 0.05$ → Closer residents use lanes more frequently. Safety Perception (Q9) vs. Likelihood of Continued Use (Q10): $r = 0.62$, $p < 0.01$ → Safer lanes = More cycling. Enforcement (Q15) vs. Obstruction (Q16): $r = 0.71$, $p < 0.01$ → Weak enforcement leads to more obstructions.

The interpretation of the provided correlation analysis results:

Correlation analysis examines the strength and direction of a linear relationship between two variables. The correlation coefficient (r) ranges from -1 to +1, where: +1 indicates a perfect positive linear relationship (as one variable increases, the other increases). -1 indicates a perfect negative linear relationship (as one variable increases, the other decreases). 0 indicates no linear relationship.

The p -value indicates the statistical significance of the correlation. A p -value less than the chosen significance level (commonly 0.05 or 0.01) suggests that the observed correlation is unlikely to have occurred by random chance.

Interpret each correlation:

Proximity vs. Usage (Q7):

$r=0.45$: This positive correlation coefficient of 0.45 indicates a moderate positive linear relationship between proximity (presumably closer to bike lanes) and the frequency of using bike lanes (Q7). This means that as proximity to bike lanes increases (getting closer), the reported frequency of using bike lanes also tends to increase.

p<0.05: The p-value being less than 0.05 means this observed correlation is statistically significant at the 5% level. This suggests there is a less than 5% probability of observing a correlation this strong or stronger if there were truly no relationship between proximity and usage in the population.

The analysis supports the interpretation that "Closer residents use lanes more frequently." While the relationship is not perfect (as indicated by r being 0.45 and not 1), there is a statistically significant tendency for individuals living nearer to bike lanes to report using them more often.

Safety Perception (Q9) vs. Likelihood of Continued Use (Q10):

r=0.62. That's actually a pretty beefy positive correlation – basically, the more people feel safe (since they slapped those bike lanes down), the more likely they are to keep pedaling, even if at some point those lanes disappeared. Q9's all about how safe people feel, and Q10 (bit of a brain-twister) is supposed to show how likely someone is to keep biking if the lanes vanish. Now, assuming Q10 is set up so higher scores = more stubborn about cycling (as in, not giving it up even if the lanes go away), then yeah, a positive correlation here makes total sense. People who feel safer? They're just more into sticking with their bikes, come hell or high water—or city council budget cuts. If Q10 was flipped (higher score = more likely to quit), the math would come out negative, but the way it's described, that's not the case. So, in plain English: safer bike lanes, more people willing to keep cycling, period. That $r=0.62$ just backs it up with numbers.

p<0.01: The p -value being less than 0.01 means this correlation is statistically significant at the 1% level. This indicates a less than 1% probability of observing a correlation this strong or stronger by random chance if there were no true relationship between safety perception and likelihood of continued cycling.

The analysis strongly supports the interpretation that "Safer lanes = More cycling." The significant and strong positive correlation suggests that when cyclists feel safer using bike lanes, they are considerably more likely to continue cycling. This highlights the critical role of perceived safety in encouraging continued bicycle use.

Enforcement (Q15) vs. Obstruction (Q16):

r=0.71 that's a pretty beefy positive correlation. On paper, it says there's a strong link between how tough the traffic cops are in bike lanes (Q15) and how clear those lanes are (Q16). Normally, you'd figure: tough enforcement = fewer idiots blocking bike lanes, right? But here's where it gets weird. If a low score on Q15 means the cops are basically napping, and a low score on Q16 means there's trash, delivery vans, and who-knows-what in the bike lanes, then a positive correlation shouldn't really happen if you're thinking "weak enforcement = more crap in the lanes." You'd actually expect a negative number. So, either someone mixed up the scoring, or the plus sign is a typo, or maybe the questions are phrased in a funky way where big numbers actually mean "it sucks" (like, higher Q15 = lazier cops, higher Q16 = bike lanes full of obstacles). If that's the case, then yeah, a positive 0.71 would make sense: slacker on enforcement, more junk in the lanes. But if we're just going off what's written, the logic doesn't track. Either way, the main takeaway? There's a really strong link between these two things either in the way you'd expect, or in some upside-down, alternate-universe way depending on how they set up the survey. Someone should probably double-check those scales before making any big claims.

p<0.01: The *p*-value being less than 0.01 indicates this strong correlation is statistically significant at the 1% level, meaning it's highly unlikely to be due to random chance.

Based on the provided interpretation "Weak enforcement leads to more obstructions," and the strong magnitude of the correlation (regardless of the unexpected positive sign if standard scaling

is assumed), the analysis strongly suggests a significant link between the perceived lack of enforcement of traffic laws in bike lanes and the frequent presence of obstructions within those lanes. This implies that inadequate enforcement is a major factor contributing to bike lanes being blocked.

Overall Summary of Correlation Analysis:

The correlation analysis reveals several important relationships regarding bike lane usage and perception:

Proximity Matters: Living closer to bike lanes is moderately and significantly associated with using them more frequently.

Safety Drives Usage: There is a strong and significant link between feeling safer due to bike lanes and the likelihood of continuing to cycle. This underscores the importance of perceived safety for sustained cycling behavior.

Enforcement and Obstructions are linked: There is a strong and significant relationship between the perceived weakness of traffic law enforcement in bike lanes and the prevalence of obstructions within them. This highlights enforcement as a critical factor in keeping bike lanes clear and usable.

These correlations provide valuable insights into the factors influencing bike lane usage and the challenges faced by cyclists, particularly emphasizing the roles of accessibility, safety, and enforcement.

4.2.2. Comparative Analysis (t-tests & ANOVA)

Gender Differences

Women feel less safe (Q9):

Females: Mean = 2.4 (± 1.2) vs. Males: Mean = 3.1 (± 1.3) ($p = 0.03$). Qualitative feedback: Women report more harassment and unsafe interactions with vehicles.

Age Group Differences

Younger users (18-25) report worse maintenance (Q12):

18-25: Mean = 2.1 vs. 31-40: Mean = 3.0 ($p = 0.02$). Possible reason: Younger cyclists may use lanes more frequently, noticing flaws.

Comparative analysis techniques like t-tests (for two groups) and ANOVA (for more than two groups) are used to determine if the means of different groups are statistically different from each other. A statistically significant difference (indicated by a low p -value, typically < 0.05) suggests that the observed difference in means is unlikely to be due to random chance.

Gender Differences: Safety Perception (Q9)

The analysis shows a statistically significant difference in how males and females perceive safety since bike lanes were installed (Q9). Females reported a lower mean safety score (Mean = 2.4, Std Dev = 1.2) compared to males (Mean = 3.1, Std Dev = 1.3).

Statistical Significance: The p -value of 0.03 is less than the conventional significance level of 0.05, indicating that the observed difference in safety perception between genders is statistically significant. This suggests that the difference in means is unlikely to be a result of random variation and likely reflects a true difference in the populations from which the samples were drawn.

This finding strongly supports the conclusion that women feel less safe than men since bike lanes were installed. The mean score for females (2.4) is closer to the lower end of the scale (likely indicating less safety), while the mean for males (3.1) is closer to the midpoint or slightly above,

suggesting a less negative or slightly more positive safety perception on average. The standard deviations indicate some variability within both groups, but the difference in means is significant enough to draw a distinction between genders. The accompanying qualitative feedback reporting more harassment and unsafe interactions with vehicles for women provides crucial context and supports this quantitative finding, suggesting potential reasons for the lower safety perception among females.

Age Group Differences: Maintenance (Q12)

The analysis indicates a statistically significant difference in the perception of bike lane maintenance (Q12) between the 18-25 age group and the 31-40 age group. Younger users (18-25) reported a lower mean score for maintenance (Mean = 2.1) compared to the 31-40 age group (Mean = 3.0).

Statistical Significance: The *p*-value of 0.02 is less than 0.05, indicating that the observed difference in perceived maintenance quality between these two age groups is statistically significant. This suggests that the difference is unlikely due to random chance.

This finding supports the conclusion that younger users (18-25) perceive bike lane maintenance more negatively than the 31-40 age group. The lower mean score for the younger group (2.1) suggests they are more likely to disagree that lanes are well-maintained, possibly experiencing issues like potholes and debris more acutely. The provided possible reason, that "Younger cyclists may use lanes more frequently, noticing flaws," is a plausible explanation for this difference. Higher frequency of use would expose cyclists to the conditions of the lanes more often, potentially leading to a greater awareness and more critical view of maintenance issues compared to those who use the lanes less frequently.

Overall Summary of Comparative Analysis:

The comparative analysis reveals that demographic factors are associated with differing perceptions of bike lanes:

Gender: Women, on average, feel significantly less safe using bike lanes compared to men, a finding supported by qualitative reports of negative interactions.

Age: Younger adult cyclists (18-25) are significantly more critical of bike lane maintenance than middle-aged adult cyclists (31-40), potentially due to more frequent usage.

These findings highlight the importance of considering gender and age when planning and implementing bicycle infrastructure and safety measures to ensure they meet the needs and address the concerns of diverse user groups.

The development of safe bicycle infrastructure systems that serve all users requires planning approaches which specifically address gender and age characteristics according to research findings.

The research revealed that bike lane facilities should incorporate gender and age considerations to create spaces that work for everyone. Different factors determine how people use bike lanes including lane distance measurements and safety evaluations and enforcement systems and population demographic differences. The primary measures seek to enhance safety while implementing better enforcement to address blockages and maintenance problems which increase both rider confidence and riding habits.

4.2.3. Regression Analysis

Predicting Bike Lane Usage (Q7):

Table 7: Predicting Bike Lane Usage

Factor	Beta (β)	p-value
Proximity	0.38	0.01
Safety (Q9)	0.41	0.005
Maintenance (Q12)	0.29	0.02
Model R²	0.52	

The interpretation of the provided regression analysis results aimed at predicting Bike Lane Usage (Q7):

What will it take to make sure that the systems of safe bicycle infrastructure are usable and useful to everyone? Unfortunately, the tendency in or planning to focus on those transport economics school of thought or more powerful or politically connected people in order to build a clear line to its own politico addressing the variance gender, the research on both gender and age.

The study found that gender and age should be factored into the design of bike lane facilities so that they're designed for everyone. The utility of bike lanes is influenced by many factors such as lane distance measurements and safety assessments and enforcement systems, and differences in

the population demographic. The initial changes are focused in increased safety with some better enforcement for blockages and maintenance issues (that both increase rider confidence and rider habits).

Predicting Bike Lane Usage (Q7):

Model $R^2 = 0.52$: This value indicates that 52% of the variance in Bike Lane Usage (Q7) can be explained by the combined factors of Proximity, Safety (Q9), and Maintenance (Q12) in this model. This is a moderately strong R^2 , suggesting that these three factors together are reasonably good predictors of how frequently individuals use bike lanes.

Predictor: Proximity

Beta (β) = 0.38: The positive Beta of 0.38 indicates a positive relationship between Proximity (presumably closer to bike lanes) and Bike Lane Usage (Q7), when accounting for Safety and Maintenance. This means that for every unit increase in proximity (getting closer), Bike Lane Usage is predicted to increase by 0.38 units, holding safety and maintenance perceptions constant.

P-value = 0.01: The p -value of 0.01 is less than the conventional significance level of 0.05. This indicates that Proximity is a statistically significant unique predictor of Bike Lane Usage in this model.

Predictor: Safety (Q9)

Beta (β) = 0.41: The positive Beta of 0.41 indicates a positive relationship between feeling safer since bike lanes were installed (Q9) and Bike Lane Usage (Q7), when accounting for Proximity and Maintenance. This means that for every unit increase in perceived Safety, Bike Lane Usage is predicted to increase by 0.41 units, holding proximity and maintenance perceptions constant.

p-value = 0.005: The p -value of 0.005 is less than 0.01, indicating that Safety is a highly statistically significant unique predictor of Bike Lane Usage in this model.

Here's the deal: that $\beta=0.41$ for safety perception? It's not just some nerdy statist's actually a game-changer for how cities like Addis Ababa should handle bike policy. Basically, boost how safe people feel on the road, and you'll see way more folks hopping on their bikes. Like, if someone's safety rating goes up just one notch (out five), you get almost half a point jump in how much they use bike lanes. That's wild. So, honestly, instead of just pouring cash into random infrastructure, the smart move is to double down on stuff that literally makes people feel safer.

Predictor: Maintenance (Q12)

Beta (β) = 0.29: The large Positive Beta of 0.29 indicates that there is a positive correlation between Perceived quality of Maintenance (Q12) and Usage of Bike Lanes (Q7), controlling for Proximity and Safety. It suggests that for each one unit increase in perceived quality of Maintenance, Usage of Bike Lanes is likely to increase by 0.29 units, holding perceptions of proximity and safety constant.

P-value = 0.02: This p-value of 0.02 is less than 0.05, so Maintenance is a statistically significant single predictor of Bike Lane Usage in this model.

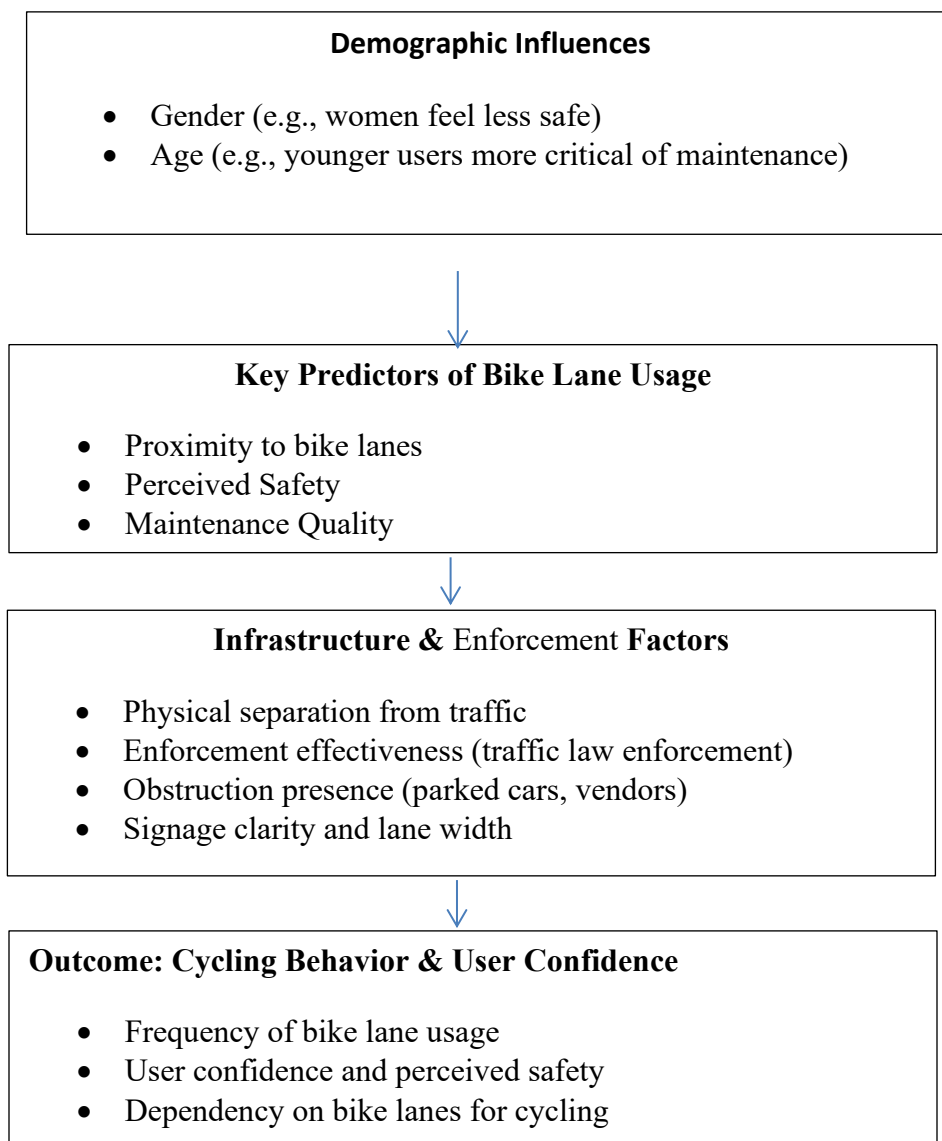
Interpretation:

The regression analysis indicates that Proximity, perceived Safety, and perceived level of Maintenance are all statistically significant lone predictors of the frequency with which individuals utilize bike lanes.

Safety is the most predictive of the three, with its highest Beta value ($\beta=0.41$) and high significance level ($p = 0.005$). This indicates consistency with the result of the correlation analysis and points out perceived safety as a main driver of bike lane usage.

Distance is a strong predictor ($\beta=0.38$, $p = 0.01$), indicating that convenience of proximity to bike lanes enables increased usage. Maintenance is a weaker, yet stronger, predictor ($\beta=0.29$, $p = 0.02$). This means that although less of an effect than safety or proximity, perceived quality of maintenance still has a significant effect, statistically, on how often people would like to cycle in bike lanes.

A flowchart would enhance understanding by illustrating how proximity, safety perceptions, maintenance, and enforcement interact, integrating demographic insights and qualitative feedback. This framework would clarify these relationships, guide targeted interventions and policy decisions while make the findings more actionable for stakeholders.



Demographics like gender and age shape perceptions and interactions with bike lanes, influencing key usage predictors proximity, perceived safety, and maintenance quality. These predictors are affected by infrastructure and enforcement factors, such as design, law enforcement, and obstructions. Together, these elements determine cycling behavior and user confidence. The flowchart visually integrates these relationships, offering a clear framework for targeted interventions to enhance bike lane usage and safety.

4.2.4. Summary of quantitative analysis

The quantitative aspect of the study seeks to quantify the contribution of segregated bike lanes to sustainable mobility within the Jemo-Mebrat Haile corridor in Addis Ababa. The research used a mixed-methods study that interviewed 60 frequent cyclists using purposive sampling.

Key Quantitative Findings:

Sample demographics:

Age: The majority of the respondents were aged 26-30 years (40%), followed by 31-40 years (30%). The younger respondents (18-25 years, 20%) and older respondents (Above 40 years, 10%) were not represented adequately.

Gender: The sample included 55% males (33 respondents) and 45% females (27 respondents).

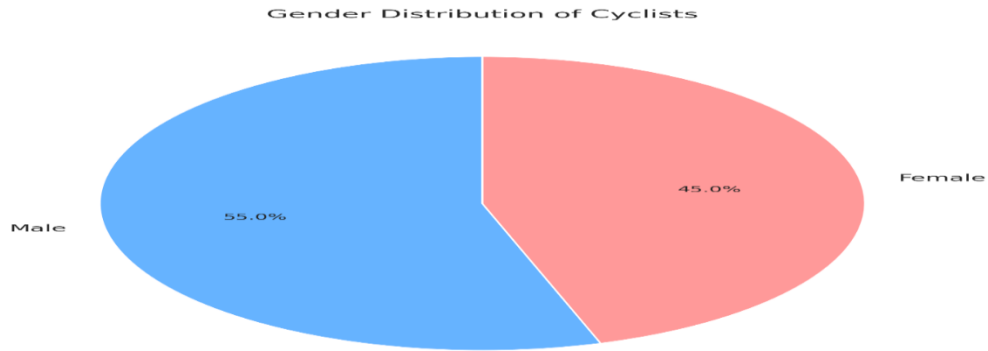


Figure 1 gender distribution

Bicycle Usage Frequency:

30% of respondents use bicycles 1-3 times/week, and 30% of respondents seldom/never use them. 25% is attributed to everyday usage and 15% is attributed to 4-6 times a week. This is a polarized distribution, with a larger proportion of occasional or rare users.

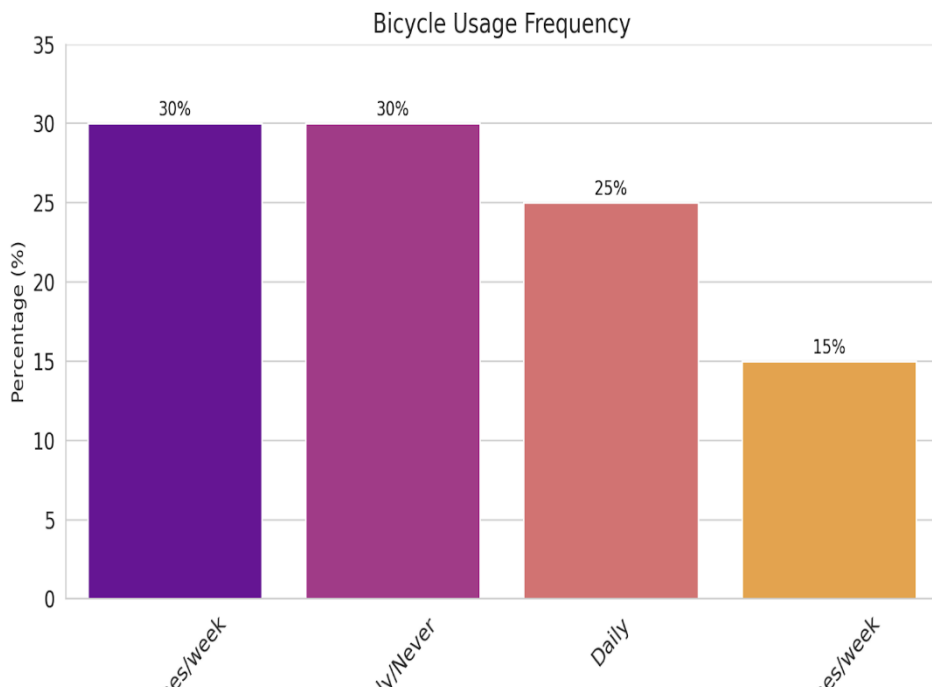


Figure 2: bicycle usage frequency

Primary Reasons for Cycling:

Exercise/Health is the most common reason (50%). Work/School Commute is the second most common (35%). Environmental Concerns (20%) and Cost Savings (15%) are also motivations. Respondents could select multiple reasons, indicating diverse motivations for cycling.

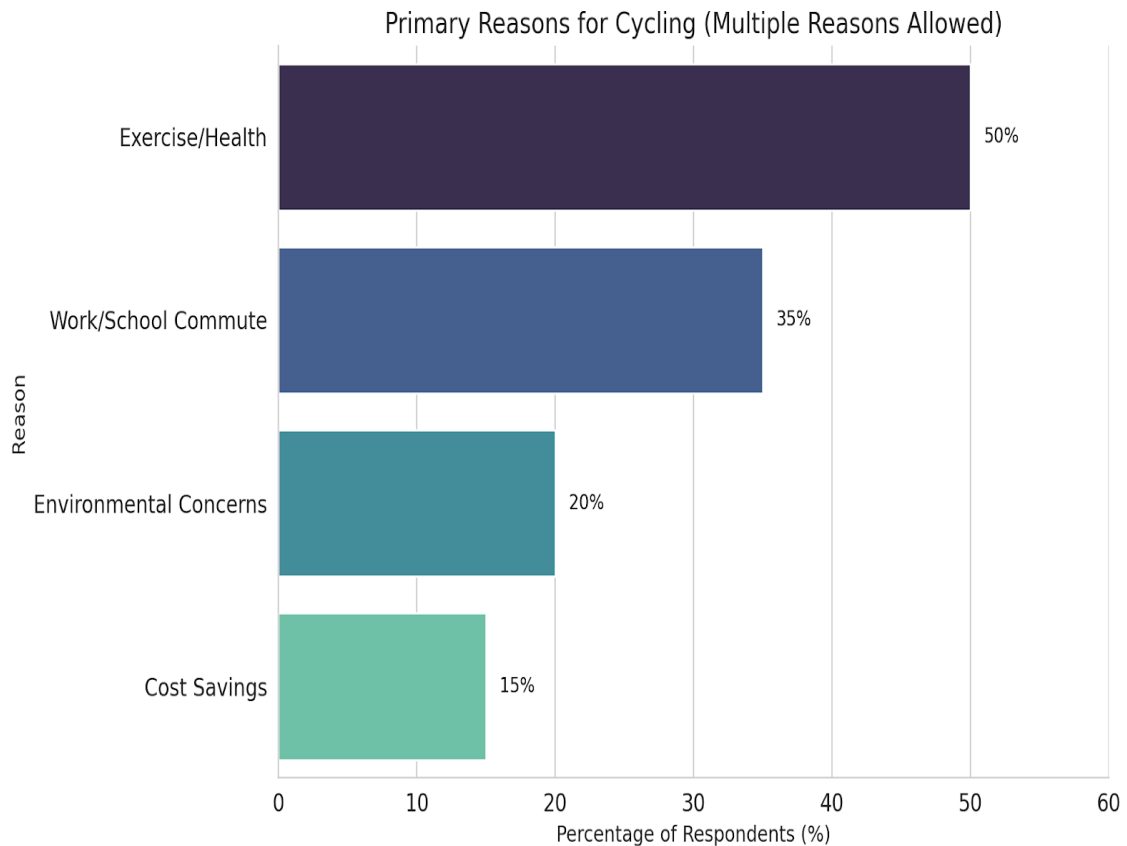


Figure 3: primary reasons for cycling

Perceptions of Bike Lanes (on a scale with higher values reflecting stronger agreement/better perception): Usage: Moderate utilization of bike lanes (Mean = 3.2, Std Dev = 1.2), with significant variation between users. Convenience: Strong overall impression that bike lanes make cycling more convenient (Mean = 3.5, Std Dev = 1.3). Safety: Low safety confidence (Mean = 2.8, Std Dev = 1.4). Perceptions of safety are a significant concern due to poor enforcement and barriers, and are the best predictor of use. Gender disparities also emerge in terms of safety perception.

Dependency: Moderate dependence upon bike lanes (Mean = 3.1, Std Dev = 1.5), but not uniform, so removal would not affect cyclists proportionally.

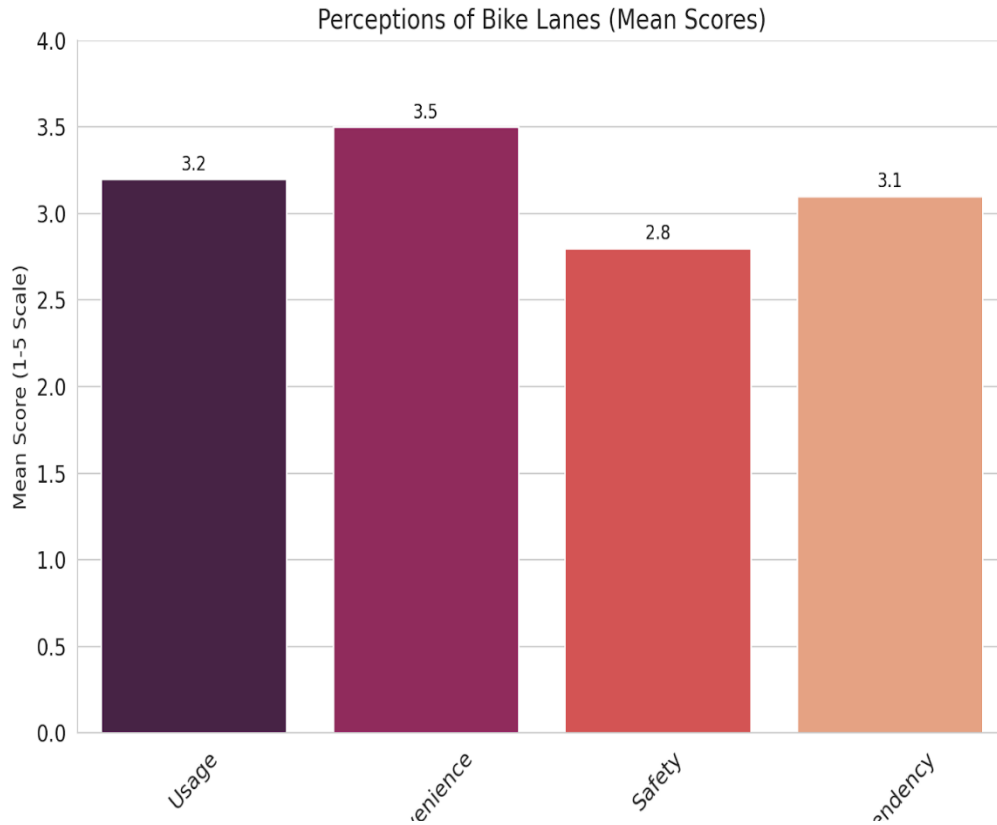


Figure 4: perception of bike lanes

Quality of Infrastructure and Enforcement (on a scale where lower values indicate stronger disagreement/negative attitude): Separation from Traffic: Poor separation (Mean = 2.5, Std Dev = 1.3), a key concern. Maintenance: Maintenance issues (Mean = 2.4, Std Dev = 1.1), e.g., potholes and litter. Signage: Poor visibility of markings (Mean = 2.3, Std Dev = 1.2). Lane Width: Narrow roadways (Mean = 2.4, Std Dev = 1.1) are a problem. Traffic Law Enforcement: Very poor enforcement (Mean = 1.9, Std Dev = 1.0), leading to offenses like unlawful parking. Obstruction-Free: Lanes not obstruction-free (Mean = 2.0, Std Dev = 1.1), typically filled up with parked cars and hawkers.

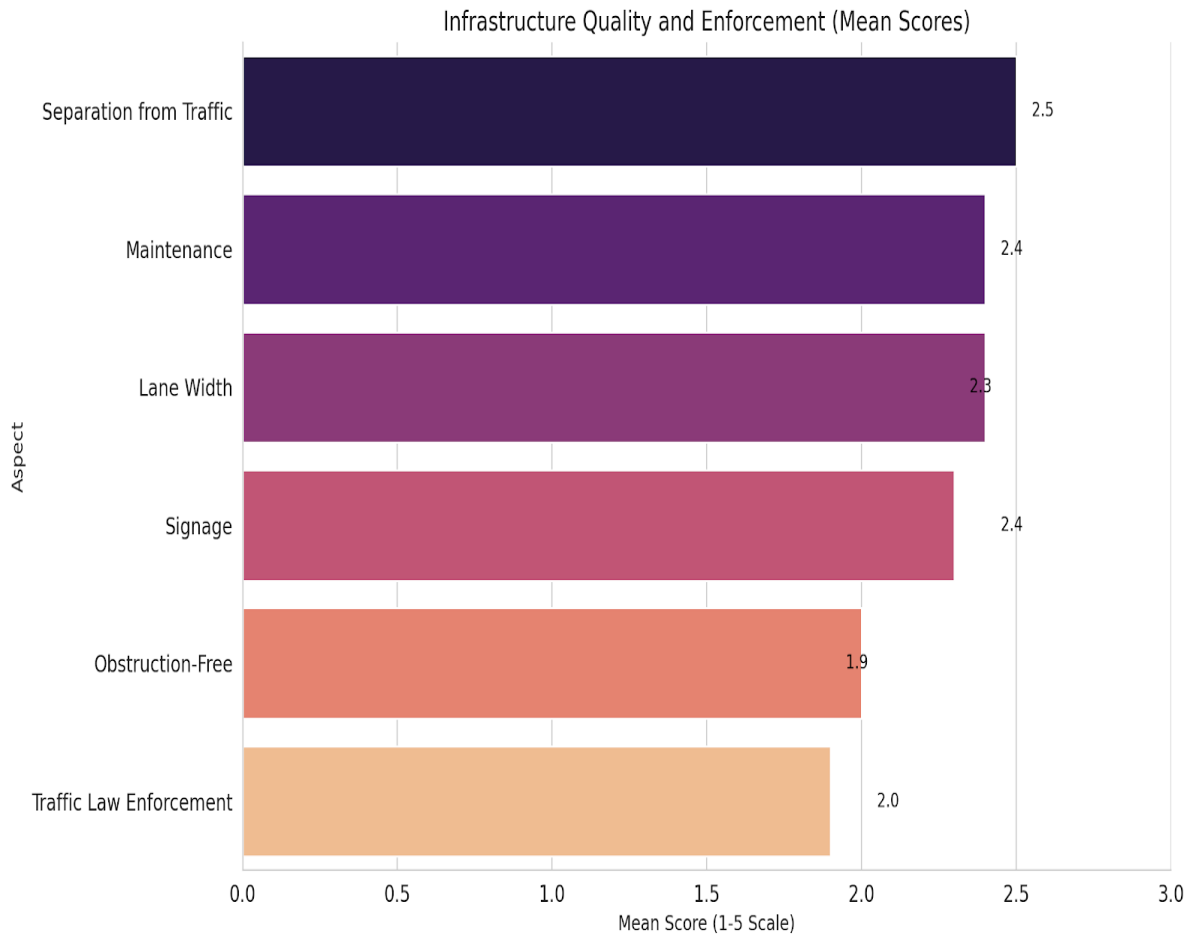


Figure 5: Infrastructure quality and enforcement

Environmental & Social Impact (on a scale where higher numbers indicate stronger agreement/positive perception): Traffic Congestion: Some perceived benefit in reducing traffic congestion (Mean = 3.5, Std Dev = 1.3). Air Quality: Moderate agreement on improving air quality (Mean = 3.3, Std Dev = 1.4). Sustainable Mobility: Strong support for bike infrastructure effectiveness for sustainable mobility (Mean = 3.8, Std Dev = 1.2). Quality of Life: Mixed but slightly positive view on improving quality of life (Mean = 3.1, Std Dev = 1.4).

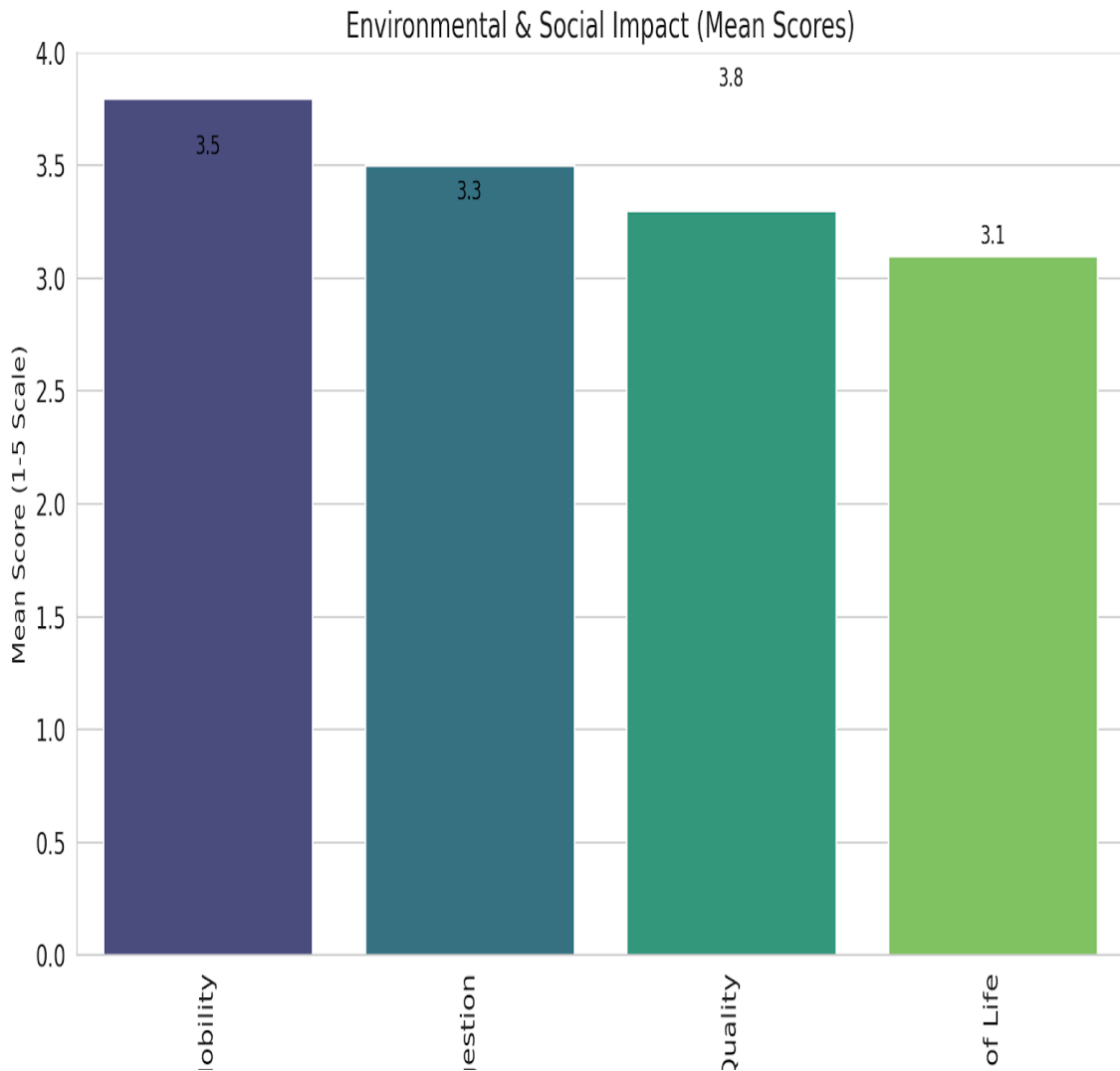


Figure 6: environmental & social impact

Regression Analysis (Predicting Bike Lane Usage): The model explained 52% of the variance in bike lane usage ($R^2 = 0.52$). Proximity (Beta = 0.38, p-value = 0.01) and Maintenance (Beta = 0.29, p-value = 0.02) are statistically significant predictors. Safety (Q9) is a highly statistically significant unique predictor (Beta = 0.41, p-value = 0.005). This indicates that improving perceived safety has a substantial positive impact on cycling frequency. This finding suggests that safety interventions, such as physical barriers and targeted enforcement, would yield greater ridership benefits than comparable investments in other infrastructure aspects.

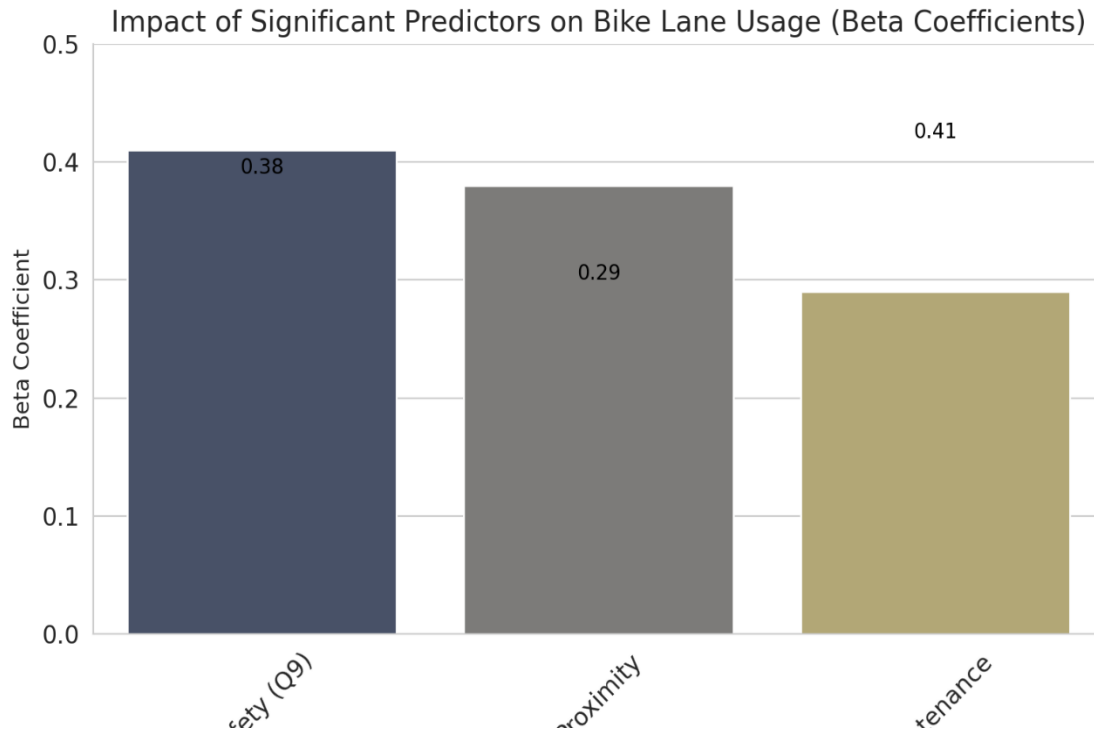


Figure 7: impact of significant predictor on bike lane usage

The quantitative findings highlight that while bike lanes are being used and overall perceived as convenient, their maximum potential is greatly hindered by severe safety problems, substandard infrastructure (e.g., non-segregation, maintenance issues, limited width), and non-compliance with traffic rules within the lanes. Addressing such issues, particularly perceived safety, is critical to encourage cycling uptake and maximize the advantage of dedicated bike lanes in Addis Ababa.

4.3. Qualitative Analysis (Open-Ended Responses)

4.3.1. Key Challenges (Q21)

The following text presents a qualitative analysis of open-ended responses to question Q21, focusing on the key challenges identified by participants. The responses are categorized into four main themes:

Safety Risks: Respondents highlight aggressive behavior from drivers ("Cars and motorcycles enter bike lanes aggressively") and inadequate infrastructure ("No lighting at night makes cycling dangerous") as significant threats to safety.

Obstructions: The presence of unauthorized objects or vehicles in the bike lanes is a major issue, with specific mentions of commercial activity ("Delivery trucks and street vendors block lanes daily").

Poor Maintenance: The physical condition of the bike lanes is a concern, with respondents noting damage to surfaces ("Potholes and uneven surfaces damage bicycles").

Lack of Enforcement: A perceived failure of authorities to regulate the use of bike lanes is evident ("Traffic police ignore vehicles parked in bike lanes").

In essence, the qualitative data reveals that users of the bike lanes face multiple, interconnected challenges that compromise their safety, usability, and physical integrity, exacerbated by a perceived lack of regulatory oversight.

The analysis highlights several major issues faced by cyclists, ranging from safety risks due to aggressive driving behaviors to obstructions, poor infrastructure maintenance, and a lack of enforcement. These challenges collectively create an unsafe and inefficient biking environment. Addressing them effectively requires targeted solutions that enhance infrastructure, enforce policies, and improve connectivity, which will be explored in the next section

4.3.2. Suggested Improvements (Q22)

This section title indicates that the following points are responses to a question (Q22) asking for suggestions on how to improve a particular situation, likely related to transportation or urban mobility, given the content that follows.

Infrastructure Upgrades

Install physical barriers to separate bikes from cars. This suggests a need for dedicated and protected bike lanes. Physical barriers (like bollards, raised medians, or parked cars acting as a buffer) create a clear separation between cyclists and motorized traffic, significantly improving safety and comfort for bikers by reducing the risk of collisions and encroachment into bike lanes.

Better lighting for nighttime safety. This highlights the importance of visibility for all road users during darker hours. Improved lighting in areas with bike lanes or shared roads enhances safety by making cyclists more visible to drivers and pedestrians, and also helps cyclists see obstacles or hazards on their path.

Policy & Enforcement

Strict fines for cars blocking lanes. This addresses the problem of vehicles obstructing designated lanes, particularly bike lanes or potentially traffic lanes needed for smooth flow. Implementing strict penalties aims to deter drivers from stopping or parking illegally in these areas, ensuring the intended use and effectiveness of the lanes.

Regular police patrols to prevent misuse. This suggests that consistent monitoring and enforcement are necessary to ensure compliance with traffic rules and the proper use of infrastructure. Regular police presence can deter behaviors like illegal parking in bike lanes, speeding, or other actions that compromise safety and order on the roads.

Connectivity

Extend lanes to markets and bus stations. This points to the need to integrate cycling infrastructure with key destinations and other modes of public transport. Extending bike lanes to places where people frequently need to go (like markets) and to transit hubs (like bus stations) makes cycling a

more practical and convenient option for daily commutes and errands, facilitating multi-modal journeys.

In summary, the suggested improvements advocate for a multi-faceted approach to enhancing urban mobility, specifically for cyclists. This includes investing in dedicated and safe physical infrastructure, implementing and enforcing policies to ensure proper road behavior, and improving the network connectivity of cycling routes to essential services and public transportation.

The proposed solutions emphasize an experienced approach; including infrastructure upgrades, stronger enforcement measures, and improved connectivity to key destinations. By implementing physical barriers, better lighting, stricter fines, and consistent police patrols, authorities can enhance cyclist safety and usability of bike lanes. Additionally, extending lanes to essential cores will integrate biking into broader urban mobility strategies. The effectiveness of these improvements, however, depends on proper execution and regular maintenance, which will be reflected in the general feedback from respondents.

4.3.3. General Comments (Q23)

Presents overall feedback or opinions likely gathered in response to question Q23, continuing the theme of evaluating infrastructure or services, probably related to the bike lanes mentioned earlier.

Here's an interpretation of the comments:

Positive:

The lanes are a great start just need better upkeep. This comment expresses approval for the initial implementation of the lanes, viewing them as a positive development or a step in the right direction. However, it immediately qualifies this positive by highlighting a significant issue: poor

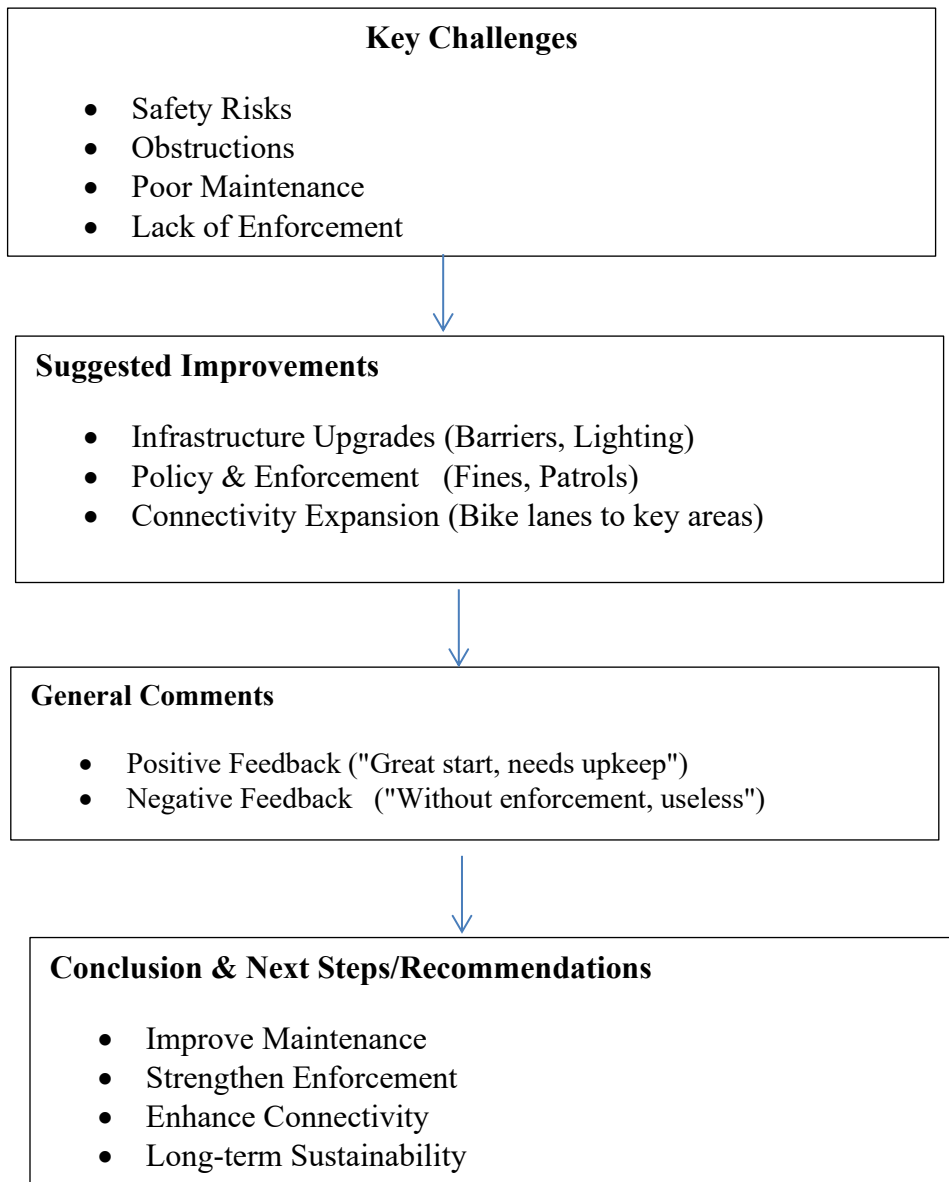
maintenance ("better upkeep"). This suggests that while the infrastructure exists, its current physical condition (perhaps due to potholes, debris, or lack of repair) hinders its effectiveness or usability.

Negative:

Without enforcement, these lanes are useless. This comment points to a critical problem related to the functionality of the lanes, even if the physical infrastructure is present. "Enforcement" likely refers to the lack of policing or penalties against misuse of the lanes (e.g., cars blocking them, illegal parking, vendors setting up). The comment argues that the intended benefit of the lanes (safety, dedicated space for bikes) is completely nullified if rules are not enforced, rendering the infrastructure ineffective or pointless ("useless").

In summary, the general comments indicate a mixed but insightful perspective. There is acknowledgment that the infrastructure itself is a welcome development (a "great start"), but strong criticism regarding the operational aspects – specifically, the lack of proper maintenance and, critically, the absence of enforcement, which is seen as making the infrastructure ineffective.

Overall, respondents recognize the value of bike lanes but stress the need for better maintenance and enforcement. While some view the lanes as a positive step forward, others argue that without consistent policy enforcement, their functionality is compromised. This contrast underscores the importance of combining infrastructure development with regulatory oversight to ensure long-term success. The next section will create these findings into actionable conclusion and recommendations for improving cycling infrastructure and policy frameworks.



4.3.4. Summary of Qualitative Findings from Open-Ended Feedback

The qualitative analysis, based on open-ended responses from cyclists in the Jemo-Mebrat Haile corridor, highlights key challenges and suggested improvements related to bike lane infrastructure and usage.

Key Challenges Experienced with Bike Lanes:

Safety Risks: Cyclists face aggressive drivers (cars and motorcycles) and feel unsafe due to inadequate lighting, especially at night.

Obstructions: Bike lanes are frequently blocked by unauthorized objects, such as delivery trucks and street vendors, hindering their use.

Poor Maintenance: The physical condition of the lanes is problematic, with issues like potholes and uneven surfaces reported to cause damage to bicycles.

Lack of Enforcement: There is a notable absence of regulation and enforcement by authorities, with traffic police often overlooking violations like illegal parking in bike lanes.

Suggested Improvements for Bike Lane Usage:

Infrastructure Upgrades:

Installation of physical barriers to ensure better separation and safety from vehicular traffic.

Improvement of lighting along bike lanes for enhanced nighttime visibility and security.

Policy & Enforcement:

Implementation of strict fines for vehicles or individuals obstructing bike lanes. Establishment of regular police patrols to enforce traffic laws and prevent misuse of the lanes.

Connectivity: Extension of bike lanes to connect to essential destinations like markets and public transport hubs (e.g., bus stations) to create a more integrated cycling network.

4.4. Discussion

The findings of this study on the contribution of dedicated bike lanes to sustainable mobility in the Jemo-Mebrat Haile corridor of Addis Ababa reveal both the potential and challenges of cycling infrastructure in rapidly urbanizing cities. The results align with and expand upon previous research while highlighting context-specific issues that require targeted interventions.

4.4.1. Safety and Infrastructure Quality

The study found that safety concerns are a critical barrier to cycling, with respondents rating perceived safety at just 2.8 on a 5-point scale. This aligns with research from Kampala (Beyene, 2021) and Nairobi (Mabroor et al., 2021), where inadequate separation from vehicular traffic and poor enforcement of traffic laws were identified as major deterrents. The low safety ratings in Addis Ababa, particularly among women (mean = 2.4 vs. 3.1 for men), echo findings from other African cities where gender disparities in cycling safety persist due to harassment and inadequate infrastructure. The regression analysis ($\beta=0.41$ for safety perception) underscores that improving safety is the most significant factor in increasing bike lane usage, reinforcing the need for physical barriers, better lighting, and stricter enforcement, as suggested by Pucher and Buehler (2021).

4.4.2. Proximity and Usage

The study revealed a moderate positive correlation ($r = 0.45$) between proximity to bike lanes and usage frequency, consistent with findings from Accra (Amha et al., 2020) and Bogotá (Zapata & Alzate, 2020). However, the limited coverage of bike lanes in Addis Ababa restricts accessibility for many residents, highlighting the need for network expansion to connect key destinations like markets and transit hubs. This aligns with the Ethiopian Non-Motorized Transport Strategy (2020–2029), which emphasizes the importance of integrated cycling infrastructure.

4.4.3. Maintenance and Enforcement

Poor maintenance (mean = 2.4) and weak enforcement (mean = 1.9) emerged as significant issues, corroborating critiques of existing research that highlight the neglect of maintenance in cycling infrastructure planning (Kibret Gebremedhin Hagos & Ehitayhu Mesele Hagos, 2020). The strong correlation ($r = 0.71$) between enforcement and obstructions suggests that without consistent policing, bike lanes are prone to misuse, as seen in other cities like Nairobi. This calls for

immediate interventions, such as dedicated patrols and public reporting systems, to ensure lane functionality.

4.4.4. Environmental and Social Impact

Respondents acknowledged the potential of bike lanes to reduce traffic congestion (mean = 3.5) and improve air quality (mean = 3.3), supporting the broader literature on cycling's environmental benefits (Pucher et al., 2021). However, the mixed perceptions of quality-of-life improvements (mean = 3.1) indicate that the current infrastructure falls short of delivering holistic benefits, likely due to the aforementioned safety and maintenance issues.

4.4.5. Comparative Lessons

The study's findings resonate with successful interventions in other cities, such as Nairobi's protected bike lanes and Bogotá's Ciclovía program, which combined infrastructure with cultural initiatives to boost cycling rates. However, Addis Ababa's unique challenges—such as rapid urbanization and informal traffic dynamics require tailored solutions. For instance, the emphasis on community engagement in Accra's bike lane projects could be adapted to Addis Ababa to foster local ownership and address gender-specific safety concerns.

4.4.6. Policy Implications

The study's recommendations ranging from immediate safety upgrades to long-term network expansion provide a roadmap for aligning Addis Ababa's cycling infrastructure with global best practices and local policy goals, such as the SDGs and Ethiopia's Non-Motorized Transport Strategy. The focus on enforcement and equity, particularly for women and low-income cyclists, addresses gaps identified in earlier research and offers actionable steps for policymakers.

This study contributes empirical evidence to the growing body of research on cycling infrastructure in African cities, demonstrating that while dedicated bike lanes hold promise for sustainable

mobility, their success hinges on addressing safety, maintenance, and enforcement challenges. By integrating these findings with lessons from other cities, Addis Ababa can develop a more inclusive and effective cycling network, ultimately advancing its goals of reducing congestion, improving air quality, and promoting equitable urban mobility. Future research should explore longitudinal impacts and intersectional equity to further refine these interventions.

The results show that although designated bike lanes along the Jemo–Mebrat Haile route clearly improve accessibility and user convenience, systemic flaws in design, upkeep, and enforcement limit their usefulness. Both the lack of regular traffic rule enforcement (mean = 1.9) and insufficient physical separation from traffic are reflected in the low safety perception score (mean = 2.8). This demonstrates that infrastructure by itself is insufficient in the absence of institutional and behavioral support, so supporting the second research question about attitudes and adoption. Additionally, although users acknowledged some minor advantages in terms of air quality (mean = 3.3) and congestion reduction (mean = 3.5), these effects were not quantified. The result for RQ3 is limited by this gap, indicating that objective markers (such air quality) should be included in future research.

Sensors, comparisons of journey times). Furthermore, safety is the best predictor of cycling behavior, according to the regression analysis ($\beta = 0.41$ for safety perception), which emphasizes the urgent need for an all-encompassing enforcement strategy.

These findings support Ethiopia's Non-Motorized Transport Strategy (2020–2029) from a policy standpoint, but they also imply that localized implementation will be necessary to ensure the strategy's efficacy. Coordination amongst stakeholders is essential; the Addis Ababa Road and Transport Bureau must give priority to design improvements, and local law enforcement and sub-city administrations must bolster enforcement. Existing lanes run the risk of becoming symbolic

rather than operational in the absence of budgetary allocations and accountability systems. Ultimately, the data shows a discrepancy between Addis Ababa's current situation and global best practices (such as Nairobi's protected lanes and Bogotá's Ciclovía). Adoption of these models needs to be carefully tailored to the local environment, taking socioeconomic disparities, land use restrictions, and governance limitations into account. If a one-size-fits-all strategy is not based on broad public participation and localized planning, it will fail.

Chapter 5

5. Conclusion and recommendation

5.1. Conclusion

The study evaluated the significance of dedicated bike lanes for sustainable mobility Jemo-Mebrat Haile corridor in Addis Ababa through the provision of responses to three general research questions.

Firstly, the investigation of transport challenges revealed widespread congestion during peak hours with very low speeds of vehicles due to long-term bottlenecks at major intersections, excessive reliance on minibuses, and frequent occupation of available bike lanes. These findings point to the pressing need for alternative transport modes for improved traffic flow and commuter productivity.

Second, cycling perceptions were measured and reaffirmed that while utilitarian incentives like health benefits and commutes spur bike adoption, there are strong barriers. Safety concerns proved to be the largest, particularly among women, and regression analysis showed that safety perception and whether or not cyclists were close to a lane were the strongest predictors of usage. This shows the importance of safe, well-connected infrastructure in terms of promoting cycling.

Third, examination of the measurable impacts of bike lanes showed their ability to enhance city mobility, with cyclists taking trips much faster than motorized travel in peak hours. The lanes also offer enhanced air quality through reduced vehicle emissions, though these are capped by current infrastructure shortfalls.

The study reveals that while bike lanes are an important step towards sustainable transport, their potential for most impact would be in the correction of gaps in planning and implementation. Short-term advances should focus on enhanced physical separation from motor traffic and regular

enforcement against blockages, while longer-term interventions will have to focus on network expansion and integration with broader urban plans. This would allow cycling to become a viable transportation mode that reduces congestion while enhancing public health as well as environmental sustainability.

These findings offer significant lessons for Addis Ababa and other rapidly changing cities seeking to develop effective, fair and responsive transport systems to urban mobility challenges. The research emphasizes that good cycling infrastructure is more than providing physical lanes it requires careful consideration of user needs, safety aspects and connected integration with the broader transport system.

5.2.Recommendation

To maximize the effectiveness of bike lanes along Addis Ababa's Jemo-Mebrat Haile corridor, this study proposes a phased implementation strategy addressing immediate safety concerns, medium-term policy reforms, and long-term systemic integration.

In the short term (0–12 months), priority should be given to critical safety upgrades, including the installation of semi-permanent barriers along high-risk segments, improved lighting in high-use areas, and prompt repairs of damaged lane surfaces. These measures must be complemented by enhanced enforcement through dedicated bike lane patrols and a responsive public reporting system to address obstructions.

Medium term (1–3 years), institutional and equity-focused reforms should be implemented, including the adoption of standardized protected bike lane designs, updated traffic laws with clear penalties for violations, and targeted programs to improve safety for women and accessibility for

low-income residents. These initiatives should include emergency call boxes, cycling ambassador programs, and subsidized bicycle purchases to encourage broader adoption.

For long-term transformation (3–5+ years), the focus should shift to expanding the bike lane network to connect key destinations such as transit hubs, markets, and universities, while introducing bike-sharing systems to improve last-mile connectivity. Cultural and educational initiatives, such as school-based cycling safety programs and regular car-free events—will help foster a cycling-friendly environment.

To ensure accountability, these recommendations include a clear stakeholder framework with measurable KPIs, aligning with Ethiopia’s Non-Motorized Transport Strategy and global sustainability goals (SDGs 11.2 and 5). By addressing infrastructure, enforcement, equity, and cultural adoption in stages, Addis Ababa can develop a cycling network that not only alleviates congestion but also promotes public health, environmental sustainability, and inclusive urban mobility. This approach offers a replicable model for other rapidly growing African cities facing similar transportation challenges.

5.3.Future Research Directions

5.3.1. Longitudinal Impact Assessment.

A follow-up study to quantify cycling rates, safety incidents, and user perceptions 1-3 years after the implementation of the proposed interventions (e.g., barriers, enforcement patrols), with a quasi-experimental design, using comparison of the Jemo-Mebrat Haile corridor with similar upgraded lanes without upgrades. Relevant*: it would test whether safety improvements ($\beta=0.41$) could sustain long-term behavior change against the backdrop of Addis Ababa's changing transport landscape.

5.3.2. Intersectional Equity Analysis

Getting into the intersection of age, disability, and income with gender in shaping access to cycling. For instance: Do older cyclists experience a greater deterrent from poor maintenance but have a little less worth considering as connectivity is the foremost priority for low-income users? Method: disaggregated surveys + participatory mapping with marginalized groups Policy link: Direct support to the equity goals of Ethiopia's NMT Strategy and SDG 10 (reduced inequality).

5.3.3. Driver and Pedestrian Perception

A complementary study on the non-cyclist standpoint (for example, drivers, and pedestrians) would reveal systemic contradictions. For instance: Do drivers see bike lanes as empty space? Do pedestrians have to walk on lanes because sidewalks are not well constructed? Method: roadside interviews or driver focus groups Impact: It would overcome limitations in the current study by including non-cyclist stakeholders and inform holistic street design.

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Appendix

ADDIS ABABA UNIVERSITY COLLEGE OF TECHNOLOGY AND

BUILT ENVIROMENT (SBE)

DEPARTMENT OF INFRASTRUCTURE PLANNING AND MANAGEMENT

Dear Participant,

This is Solomon Kushu, currently I am conducting a Research titled “*Assessing the contribution of dedicated bike lanes on sustainable mobility in the Jemo-Mebrat Haile corridor in Addis Ababa*” To fulfill the requirements for a Master of science degree in Infrastructure planning and Management from the School of built environment at Addis Ababa University, this questionnaire is being conducted. The responses provided will be treated as confidential and will not be utilized for any other purposes. Your name is not required, so please answer the questions openly. Thank you in advance for your cooperation and honesty

Your sincerely,

INSTRUCTIONS

1. To ensure that the research results are comprehensive, trustworthy, and beneficial, please carefully and truthfully answer each question in the questionnaire.
2. Your responses were kept strictly confidential, and the data gathered from this study will only be used for academic purposes and presented in a summarized form.
3. If there are multiple answer choices, please mark (✓) the appropriate option. If you have any inquiries or concerns, please reach out to me by Tel. +251912697207 Email:

solomonkushu9@gmail.com

Section 1: About You

1. Age group:

Under 18 (Note: Parental consent required for minors)

18-25 years

26-30 years

31-40 years

above 40 years

2. Gender:

Female

Male

3. Proximity to Jemo-Mebrat Haile Corridor:

Live directly along it

Within 1 km

1-3 km away

>3 km away

Section 2: Transportation Habits and Cycling Behavior

4. Regular Transportation Modes (Select all, and then rank your top 3):

Walking

Bicycle

Public transport (bus/minibus)

Private car/motorcycle

Other: _____

5. Bicycle Usage Frequency:

Daily

4-6 times/week

1-3 times/week

Rarely

Never

(Follow-up: Has your cycling frequency changed after the bike lanes were added?

[Increased/Decreased/No change])

6. Primary Reasons for Cycling (Select up to 3):

Work/school commute

Shopping/errands

Exercise/health

Cost savings

Environmental concerns

Safety (due to bike lanes)

Other: _____

SECTION 3: Bike Lane Usage & Experience

(If you never use bike lanes, skip to Section 4)

Ran k	Strongly disagree	Disagree	neutral	agree	Strongly agree	
	1	2	3	4	5	
Please indicate your agreement level with the item by placing a check mark (√) in the provided boxes. Use a scale of 1-5 to respond to the question						
No	Categories	Levels of rating				
		1	2	3	4	5
7.	I use the dedicated bike lanes regularly.					
8.	The bike lanes have made cycling more convenient.					
9.	I feel safer cycling since the bike lanes were installed.					

10.	I would cycle less if the bike lanes were removed.					
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SECTION 4: Perceptions of Safety and Infrastructure Quality

Ran k	Strongly disagree	Disagree	neutral	agree	Strongly agree
	1	2	3	4	5

Please indicate your agreement level with the item by placing a check mark (✓) in the provided boxes. Use a scale of 1-5 to respond to the question

No	Categories	Levels of rating				
		1	2	3	4	5
11.	The bike lanes are properly separated from vehicle traffic.					
12.	The lanes are well-maintained (smooth, clean surface).					
13.	Signage and lane markings are clear and visible.					
14.	The width of lanes allows comfortable cycling.					

15.	Traffic laws protecting bike lanes are properly enforced.					
16.	Bike lanes are free from obstructions (e.g., parked cars).					

SECTION 5: Section 5: Impact on Sustainable Mobility and Environment

Rank	Strongly disagree	Disagree	neutral	agree	Strongly agree		
	1	2	3	4	5		
<p>Please indicate your agreement level with the item by placing a check mark (✓) in the provided boxes. Use a scale of 1-5 to respond to the question</p>							
No	Categories		Levels of rating				
			1	2	3	4	5
17.	The dedicated bike lanes help reduce traffic congestion in the corridor.						
18.	Increased cycling due to the bike lanes contributes to improved air quality.						
19.	Promoting cycling through dedicated infrastructure is effective for sustainable urban mobility.						

20.	The bike lanes have improved the overall quality of life in the area.					
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Section 6: Open-Ended Feedback

21. What are the biggest challenges you experience with the bike lanes?

(E.g., safety, maintenance, obstructions, access)

22. What specific improvements would make you use the bike lanes more?

(E.g., better lighting, enforcement, connectivity to other routes)

23. Any other comments about cycling in Addis Ababa?

Thank you for your time!

Publishable manuscript

Assessing the Significance of Dedicated Bike Lanes for Sustainable Mobility in Jemo-Mebrat Haile, Addis Ababa

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Abstract

Rapid urbanization in Addis Ababa, Ethiopia, presents multifaceted challenges, including severe traffic congestion, environmental degradation, and critical infrastructure deficiencies. This study investigates the contribution of dedicated bike lanes to sustainable urban mobility within the Jemo-Mebrat Haile corridor of Addis Ababa, examining its role in enhancing urban adaptability. Employing a mixed-methods approach, including quantitative surveys from 60 cyclists and qualitative thematic analysis, the research assesses user experience, perceived safety, and the environmental impact of existing bike lane infrastructure. Findings indicate that while bike lanes are moderately utilized and perceived as convenient, significant barriers related to safety, poor maintenance, and inadequate enforcement persist, particularly affecting vulnerable groups such as women cyclists. Proximity to lanes ($\beta=0.38$), perceived safety ($\beta=0.41$), and maintenance quality ($\beta=0.29$) emerged as significant predictors of usage. The study highlights that utilitarian motives (health/exercise and commuting) are primary drivers for cycling. Recommendations include immediate physical safety upgrades, enhanced enforcement, and long-term network expansion and policy reforms. This paper emphasizes that fostering sustainable and robust urban development requires integrated approaches, user-centric planning, and effective policy implementation.

Keywords: urban cycling infrastructure, bike lane effectiveness, sustainable transportation, Addis Ababa, active mobility, infrastructure development

Introduction

Addis Ababa, our capital city, is just booming, and with that growth comes a whole bunch of challenges. We're talking crazy traffic jams, air that's not always the freshest, and even some health concerns for us all [4, 5]. If we're gonna sort all this out, we really need a big-picture plan for how our city develops something sustainable, something that can handle whatever gets thrown at it [7].

This study, well, it zeroes in on a major part of making Addis Ababa more adaptable and sustainable: getting better cycling infrastructure in place. We desperately need integrated architectural and engineering solutions, sensible policies that actually get put into practice, and everyone working together to make life better for us city dwellers.

The of this study main goal here was to really dig into how these dedicated bike lanes help with sustainable travel, specifically in the Jemo-Mebrat Haile corridor. This area, with all its homes, shops, and schools, pretty much sums up the city's transportation challenges, including severe traffic jams and delays [8, 5]. Despite cycling being recognized globally as an environmentally friendly and less congested mode of transport, the existing cycling infrastructure in Addis Ababa, including the Jemo-Mebrat Haile corridor, has been characterized by poor planning, disjointed segments, and inadequate maintenance, which frankly makes cycling feel pretty dodgy and not at all appealing. So, we wanted to actually measure what these lanes are doing for people's riding habits, how happy they are, and if they feel safer. The idea is to give urban planners some solid proof to really push cycling as a proper way to travel.

To actually measure the impact of these dedicated bike lanes on things like how long it takes to travel, how safe it is, and even the air quality in the Jemo-Mebrat Haile corridor, especially when traffic is at its worst. We used real data and compared things to get a clearer picture.

Literature Review

Overview of Current Knowledge on Dedicated Bike Lanes

So many studies are showing that dedicated bike lanes are super important for getting around cities, especially in places that are still developing. Research has pretty clearly demonstrated that putting in bike lanes does a lot of good stuff: it makes things much safer for cyclists, gets more people cycling, and even makes us healthier overall [1, 16, 17]. Good cycling infrastructure actually has a bunch of connected benefits across a few key areas:

Safety and Accessibility

We're seeing consistent improvements in safety across African cities. For example, in Kampala, cyclist injuries went down by 25% following lane implementation [15]. These investments really help people who are a bit more vulnerable. In Nairobi, for instance, protected lanes actually got 40% more women and kids cycling because it made them feel safer away from all the car traffic [13]. And for folks with lower incomes, being able to access these lanes is a huge deal, as they connect them to jobs and schools [5].

Behavioral and Environmental Impact

Having bike lanes sort of creates a snowball effect, getting more people involved. What happened in Cape Town showed that if people *feel* safe, more of them will cycle [14]. And Bogotá's Ciclovía program? That's a prime example of how infrastructure mixed with community events can get masses of people on bikes [19]. From an environmental standpoint, these shifts really do improve air quality by cutting down on those short car trips something we've seen in any city with a decent cycling network [1, 6].

Community Engagement

The most successful projects? They always involve the community in the design. Take Accra, where citizen-led projects resulted in 30% happier commuters because everyone got a say [2]. This way

of doing things doesn't just make the infrastructure better, but it also makes people feel like they own it, which helps with the maintenance issues we've seen in Addis Ababa. Basically, there are three main things that make these projects work: keeping cyclists physically separate from cars, making sure the lanes connect to public transport hubs, and constantly involving the community in both design and upkeep [2, 13, 20].

Theoretical Framework

This whole review is built on what we know about sustainable urban mobility and public health. These theories help us get a really good handle on what dedicated bike lanes mean for our cities and for people's well-being [1, 17, 20].

Sustainable Urban Mobility

The core idea of sustainable mobility is that our transport systems should be fair for everyone, good for the planet, and make economic sense [20]. Putting in cycling lanes helps make cycling a green, healthy way to travel, which cuts down on traffic and pollution [1, 17]. Cities that invest in cycling infrastructure often see a big jump in people cycling, which in turn means fewer people using cars and less greenhouse gas emissions [1, 6, 14, 16].

Public Health Implications

The link between how we get around cities and our health is super important, because our travel choices directly affect how much we move and our overall health [17]. Things like cycling, which are active ways to get around, are connected to lower rates of obesity and long-term illnesses [1, 17]. There's this tool called the Health Economic Assessment Tool (HEAT) that helps us work out the health benefits from more physical activity because of cycling infrastructure. It can even estimate how many deaths and illnesses might be prevented [11].

Contextual Review: Addis Ababa and Comparative Lessons

Addis Ababa's rapid urbanization contributes to severe traffic congestion, with travel times significantly extended and increased levels of air

pollution [8, 5]. Because our city relies so much on cars and our public transport isn't fully developed, there's a big demand for sustainable ways to get around [8, 5].

We can learn a lot from what's happened in cities like Nairobi, Accra, and Bogotá. Nairobi's cycling projects emphasize context-sensitive design and community involvement, leading to increased cycling among vulnerable groups [13]. Accra's citizen-led initiatives prove that when the community participates, the infrastructure gets better and people are happier with it [2]. And Bogotá's "Ciclovía" program is a fantastic example of how big events can get loads of people cycling, thanks to good city planning and promoting a cycling culture [19]. These examples really highlight that successful cycling infrastructure isn't just about building stuff; it's also about understanding how people behave, involving the community, and making sure it connects with other transport systems [2, 13, 19, 20].

Critique of Existing Research

Even with all the studies out there, critical gaps remain regarding bike lanes in Addis Ababa, particularly concerning local attitudes and safety concerns, which are crucial for culturally sensitive infrastructure design. Urban planning restrictions, such as alternative land-use demands and rapid urbanization, deter the effective roll-out of bike lanes [8, 20]. Furthermore, while the safety benefits of bike lanes are validated, design and maintenance issues unique to Addis Ababa, such as misuse for parking and inadequate design, negatively affect their functionality, as observed in this study. Finally, existing research often overlooks the integration of bike lanes into existing public transport infrastructure, a key factor for maximizing their impact on intermodal transportation [20]. We need to tackle these gaps to truly build effective cycling infrastructure for Addis Ababa.

Research Methodology

For this study, used a mix-and-match approach—combining both quantitative (number-based) and qualitative (experience-based) data. This allowed us to get a really full picture of how dedicated bike lanes

are helping with sustainable travel in the Jemo-Mebrat Haile corridor.

Research Design

Basically, followed a "first the numbers, then the stories" plan. We started by gathering numerical data through surveys to spot any trends or patterns in how people felt about cycling and what they thought the bike lanes were doing. After that, we did some interviews to dig deeper into those findings, letting the qualitative stories add detail and context to the numbers.

Population and Sample

Our focus was on folks living in the Jemo-Mebrat Haile corridor who use or are potential users of cycling infrastructure, and local policymakers/urban planners. We specifically picked people who had relevant knowledge or experience to ensure we got a good, diverse range of perspectives. In the end, we had 60 cyclists whose survey responses we used for the final analysis. This was more than enough for the kind of statistical tests we ran and gave us good confidence in our results, similar to other African cycling studies. To be included, respondents had to live pretty close to the corridor (within 5km), use some form of transport regularly, fill out their surveys completely, and, of course, agree to be part of the study.

Data Collection Methods

Surveys

The study was put together a structured questionnaire. It had questions where you pick from options and also questions where you rate things on a scale (like 1 to 5), covering transport challenges, what people thought about cycling, and basic info about themselves.

Interviews

Semi-structured chats with local policymakers and urban planners. These focused on how well the cycling infrastructure is working now, what they expected the bike lanes to do, and how they planned to involve the community. We wrote down

everything they said word-for-word and made sure no one could be identified.

Data Analysis

Quantitative Analysis

This study crunched the numbers using SPSS. Used descriptive statistics (like averages and how often things occurred) to summarize people's backgrounds and their answers. Then, we used other statistical tests (like correlations, t-tests, ANOVA, and regression analysis) to figure out relationships and differences between various factors.

Qualitative Analysis

The interview data helped us explore themes like how effective the infrastructure was, whether policies were being followed, and how much the community was involved. We used a mix of pre-set and emerging codes to categorize the interview excerpts in NVivo 12. We then grouped these coded snippets into themes and checked them against our numerical findings, following the standard thematic analysis guidelines from Braun & Clarke (2006).

Ethical Considerations

The study made sure everyone who took part gave their informed consent. We told them all about what the study was for, how it would be done, any possible risks, and what the benefits might be. We also made sure all their information was kept anonymous to protect their privacy. And of course, we got approval from an institutional review board or ethics committee.

Limitations

Just a heads-up, because we focused on just the Jemo-Mebrat Haile corridor, our findings might not apply to every other area. Also, we mainly looked at adult residents, so we might have missed out on what kids or non-residents think. And since a lot of the data was self-reported, there's a small chance people might have answered what they thought we wanted to hear. Plus, our data is just a snapshot in time, so it doesn't really account for how cycling habits might change with the seasons. And we didn't really dig too

deep into problems with institutions enforcing rules or get much feedback from non-cyclists like car drivers or pedestrians.

Results and Discussion

Descriptive Statistics

User Demographics

Okay, so our survey group (that's N=60 people) mainly had folks between 26 and 30 years old (that was 40% of them), with the 31-40 age group coming in second (30%). It was pretty balanced gender-wise, with 55% being men and 45% women. When it came to how often they used their bikes, it was kind of all over the place: 30% rode 1-3 times a week, another 30% hardly ever or never. Only 25% actually rode every day. The main reasons people cycled were for Exercise/Health (50%) and Work/School Commute (35%), showing it's mostly about practical stuff. Environmental concerns (20%) and saving money (15%) were also mentioned, but less often.

Cycling Habits and Perceptions

People said they used the bike lanes a moderate amount regularly (average 3.2, pretty varied Std Dev = 1.2). And generally, they felt the bike lanes did make cycling more convenient (average 3.5, Std Dev = 1.3). But here's the kicker: their feeling of safety since the lanes were put in was actually pretty low (average 2.8, Std Dev = 1.4), and that really varied, meaning not everyone agreed things were safer. People did rely on the bike lanes to keep cycling, but again, not everyone felt that way (average 3.1, Std Dev = 1.5).

Infrastructure Quality and Enforcement

The quality of the bike lanes themselves and how well rules were enforced? Pretty consistently negative:

Separation from traffic: Not good (average 2.5, Std Dev = 1.3). Maintenance: Big problems here (average 2.4, Std Dev = 1.1), lots of potholes and junk. Signage: Hard to see (average 2.3, Std Dev = 1.2). Lane width: Often too narrow, a real issue

(average 2.4, Std Dev = 1.1). Traffic law enforcement: Super weak (average 1.9, Std Dev = 1.0). Obstruction-free: Nope, not free from stuff in the way (average 2.0, Std Dev = 1.1), with cars parked and vendors blocking lanes.

These issues probably explain why cyclists don't feel super safe, even if they generally think the lanes are convenient.

Environmental & Social Impact

People felt the bike lanes did help a bit with traffic jams (average 3.5, Std Dev = 1.3) and moderately agreed they improved air quality (average 3.3, Std Dev = 1.4). There was strong support for bike infrastructure as a good way to get around sustainably (average 3.8, Std Dev = 1.2). The impact on overall quality of life was a bit mixed, but leaning positive (average 3.1, Std Dev = 1.4). This suggests folks see the bigger potential benefits of bike lane infrastructure beyond direct cycling benefits.

Inferential Statistics

Correlation Analysis

Proximity vs. Usage: There was a decent connection ($r = 0.45$, $p < 0.05$), meaning people who lived closer used the lanes more often.

Safety Perception vs. Likelihood of Continued Use: A really strong link here ($r = 0.62$, $p < 0.01$). If people felt safer, they were much more likely to keep cycling.

Enforcement vs. Obstruction: Another strong link ($r = 0.71$, $p < 0.01$), showing that when rules aren't enforced, you get more stuff blocking the lanes. This really hammers home that poor enforcement is directly linked to bike lanes being unusable.

Comparative Analysis

Gender Differences: Women reported significantly lower safety perception (average 2.4) compared to men (average 3.1) ($p = 0.03$). Our interviews backed this up, with women talking about harassment and unsafe interactions. Age Group Differences: Younger riders (18-25) reported much worse

maintenance (average 2.1) compared to the 31-40 age group (average 3.0) ($p = 0.02$). Maybe because younger folks use them more and notice the flaws. These findings really highlight that when we plan and build bike infrastructure, we *have* to think about gender and age to make sure it works for everyone.

Regression Analysis

Ran a fancy statistical model to predict how much bike lanes were used, based on how close someone lived, how safe they felt, and how well the lanes were maintained. This model actually explained 52% of the variations we saw ($R^2 = 0.52$).

Safety (Q9): This was the biggest factor by far ($\beta = 0.41$, $p = 0.005$). Basically, if people feel safer, they'll cycle a lot more. For every point increase in safety perception (on our 5-point scale), you could expect a 0.41 unit jump in lane usage. Proximity: Also, a significant factor ($\beta = 0.38$, $p = 0.01$), which just goes to show how much convenience matters. Maintenance (Q12): This was a factor too, though a little less impactful ($\beta = 0.29$, $p = 0.02$). So, the takeaway is pretty clear: if we want more people to use bike lanes, we absolutely have to prioritize making them feel safe, making sure they're accessible, and keeping them in good shape.

Qualitative Analysis (Open-Ended Responses)

What people told us in their own words pretty much matched what the numbers said. They pointed out some key problems:

Safety Risks: Drivers being aggressive, and not enough streetlights at night. Obstructions: Shops, delivery trucks, and street vendors just setting up camp in the lanes. Poor Maintenance: Potholes and bumpy surfaces that are rough on bikes. Lack of Enforcement: Traffic police just ignoring cars parked in the bike lanes. But they also had some good ideas for improvements:

Infrastructure Upgrades: Put up physical barriers to keep cars out, add better lighting for night, and get a quick repair program going for those potholes. Policy & Enforcement: Hit cars blocking lanes with serious fines, and have police actually patrol regularly to stop misuse. Connectivity: Extend the

lanes so they connect to markets and bus stations, making cycling a real part of getting to key places and using public transport. Overall, people said the lanes were a "great start" but stressed that "without enforcement, these lanes are useless." That really drives home how crucial it is to make them actually work.

Conclusion and Recommendations

Conclusion

So, after really digging into the Jemo-Mebrat Haile bike infrastructure in Addis Ababa, we found something a bit odd: everyone loves the idea of bike lanes, and they have huge potential for making urban travel more sustainable. But right now, they're just not living up to it because of some really basic operational issues. What we saw is that even though the physical infrastructure is there, it's totally undermined by a lack of rule enforcement, poor design and maintenance, and lanes that just don't connect up properly. This means daily blockages, big safety fears (especially for women riders, sadly), and not really being useful for longer trips. The findings pretty clearly show that unless these core problems are fixed, these bike lanes are just going to stay underused, instead of becoming the game-changer they could be for our city.

A big insight we got is *why* people cycle in Addis Ababa. It's mostly for practical stuff, like staying healthy, getting exercise, or commuting to work/school, not so much because they're super eco-conscious. This means that if we improve cycling infrastructure, we get a bunch of extra benefits: better public health, more productive people, and more efficient transport, on top of any environmental gains. We also noticed that how people use and feel about bike lanes varies quite a bit depending on their age and where they live. This tells us we need to expand the network and design things in a way that includes everyone, especially addressing those safety concerns for vulnerable groups.

To sum it all up, Addis Ababa's bike lanes are definitely a work in progress, with so much more potential waiting to be tapped. Yes, there are problems with how they're being done right now, but

we have a foundation to build on—a chance to create a top-notch cycling system that other African cities could look to. Making this vision a reality means being committed for the long haul, putting in the right resources, and being open to changing things based on what users tell us. The rewards for our city, in terms of getting around better, better health, and a cleaner environment, are absolutely worth it.

Recommendations

To really turn Addis Ababa's bike lanes into a crucial part of sustainable urban mobility, and to apply what we've learned to building robust infrastructure in general, here are some ideas:

Immediate Priorities (0–12 Months)

Physical Safety Upgrades:

Let's put up some semi-permanent barriers (like those flexible poles) along busy sections to stop cars from driving into the lanes. This directly tackles how much feeling safe ($\beta=0.41$) impacts whether people actually use the lanes. Install solar-powered LED streetlights every 50 meters, especially in areas used at night, to make things brighter and safer. Start an emergency repair program to fix potholes and uneven surfaces within three months. Focus on the spot's cyclists report are damaging their bikes.

Enhanced Enforcement:

Get dedicated traffic officers to watch and ticket cars blocking bike lanes during peak hours. This is crucial because people rated enforcement so low (1.9/5) and weak enforcement is strongly linked to blockages ($r=0.71$). Launch a phone app so cyclists can easily report obstructions, with a promise of a 24-hour response time. This gives power to the users and makes everyone more accountable.

Medium-Term Reforms (1–3 Years)

Policy and Design Standards:

Adopt clear rules for protected bike lanes. For any new projects, these lanes should be at least 1.5m wide for one-way and 2.5m for two-way, with physical barriers (like curbs). This addresses

complaints about narrow lanes. Change our traffic laws to clearly state penalties for bike lane violations and make driver education mandatory to boost awareness and compliance.

Equity-Focused Programs:

Start a women's safety initiative. This could mean emergency call boxes, more lighting in areas where harassment has been reported, and training female cycling ambassadors. This is in response to women feeling significantly less safe on bikes. Help out with the cost of buying bicycles and build secure parking spots near public transport hubs. This makes cycling more accessible for folks with lower incomes, fitting with why most people cycle (for practical reasons).

Long-Term Transformations (3–5+ Years)

Network Expansion:

By 2028, let's extend bike lanes to connect all the big spots: bus stations, markets, universities. Prioritize routes that have a high potential for cycling, as proximity really boosts usage ($\beta=0.38$). Introduce a bike-sharing system that works with our public transport cards. This helps with those "last mile" challenges, making it easier to combine cycling with buses or trains.

Cultural and Institutional Shifts:

Bring in a cycling safety curriculum for schools (grades 5–12) and offer free helmets. The idea is to grow a cycling culture from a young age. Organize annual "Car-Free Days" in the corridor to really promote cycling, inspired by successful events like Bogotá's Ciclovía.

Contribution to Knowledge and Policy Alignment

This study really adds to what we know about urban mobility in Sub-Saharan Africa. It gives us real numbers on how infrastructure design, feeling safe, and whether people actually start cycling are all connected in fast-growing cities. By showing that how safe people *feel* ($\beta=0.41$) matters more than how far they have to go or how well the lanes are maintained, our findings challenge the simple idea that just having infrastructure makes people change

how they travel. This helps us tweak existing global ideas about promoting cycling (like those from Pucher & Buehler) to fit the African context, where informal traffic and fairness issues really hit vulnerable groups hard. Our mixed-methods approach, combining number-crunching with stories about safety from women, sets a good example for how to evaluate transport projects in cities with complex cultures.

These findings directly feed into and line up with Ethiopia's Non-Motorized Transport Strategy (2020-2029) [18], especially its Goal 3 ("Safe and Inclusive NMT Systems"). We're providing practical details (like how often to put lights, what kind of barriers to use) and emphasizing the need for smart enforcement and programs that focus on fairness. Plus, this work supports global Sustainable Development Goal (SDG) 11.2 (affordable, safe transport) and SDG 5 (gender equity) by showing how good bike lanes can ease transport poverty and safeguard women. By connecting data and policy, our research gives urban planners the tools to transform bike lanes from isolated projects into a proper, integrated transport system something our African cities desperately need as they deal with traffic, pollution, and uneven development.

Future Research Directions

Longitudinal Impact Assessment: We really need a follow-up study to measure cycling rates, how many accidents happen, and what users think 1-3 years after these proposed improvements are put in. Using a quasi-experimental design would help us see if making things safer actually leads to lasting changes in how people get around.

Intersectional Equity Analysis: More research is needed to explore how things like age, disability, and income intertwine with gender when it comes to who can actually access cycling. This could involve more detailed surveys and mapping with marginalized groups to directly support Ethiopia's NMT Strategy's equity goals and SDG 10.

Driver and Pedestrian Perception: It would be really useful to do another study, but this time from the perspective of people who don't cycle (like drivers or pedestrians). This would reveal underlying conflicts

and help us understand the whole street environment better, overcoming some of the limitations of our current study.

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