ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

EXAMINE THE INFLUENCE OF RIDE HAILING SERVICE ON MODE CHOICE BEHAVIOR AMONG COMMUTERS IN ADDIS ABABA

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A Research Submitted to School of Graduate Studies of Addis Ababa University in a Partial Fulfillment of Requirements for the Degree of Masters of Science in Road and Transport Engineering

Advisor: - Dr Yonas Minalu

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By:

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UNDERTAKING

I certify that the research work titled "**EXAMINE THE INFLUENCE OF RIDE HAILING SERVICE ON MODE CHOICE BEHAVIOR AMONG COMMUTERS IN ADDIS ABABA**" is my own work performed under the supervision of my research advisor Dr Yonas Minalu and has not been presented elsewhere for assessment and for a degree in any other university. Where material has been used from other sources it has been properly acknowledged / referred.

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Place of Undertaking: Addis Ababa

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Acronym	Definition
RHS	Ride-Hailing Services
PT	Newly Optimized Public Transport
NCO	Non-Car Owners
AVL	Availability and Accessibility
CMT	Comfort
DRR	Driver Ratings and Reviews
PD	Promotions and Discounts
PRC	Affordability/Price
SS	Safety and Security
TMS	Time Saving
SPSS	Statistical Package for the Social Sciences

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EXECUTIVE SUMMARY

This research examines the influence of ride-hailing services on public transport mode choice among commuters in Addis Ababa, Ethiopia, including both car owners and non-car owners (NCOs). As transportation systems evolve in urban areas, understanding how ride-hailing services impact the choices of all commuters is critical for developing a competitive and efficient public transport (PT) system. The study focuses on identifying the factors that drive commuters' preferences between ride-hailing services and PT, with a specific emphasis on NCOs during the modeling process, as they are more likely to shift to the newly proposed PT system.

The analysis employs Chi-Square and Weibull methodologies to investigate the relationships between socio-demographic variables, service attributes, and mode choice behavior. These techniques allow for a comprehensive evaluation of commuter behavior and the timing or likelihood of mode shifts. Chi-Square analysis assesses the association between categorical variables, such as income, age, and ride-hailing preferences, while Weibull analysis examines time-to-event data, providing insights into the transition between transportation modes over time.

The primary objective of the research is to develop a **competitive public transport proposal** that integrates the convenience and technological features of ride-hailing services, such as Time savings, comfort, and security and safety, while retaining the affordability and broad accessibility of traditional PT. The study aims to:

- **Examine the overall impact of ride-hailing services on commuters' mode choice behavior**: Analyze how ride-hailing services have influenced transportation preferences across all commuter segments.
- **Identify the factors that drive the growing preference for ride-hailing services**: Explore why commuters are increasingly opting for ride-hailing over PT, particularly focusing on key service attributes such as comfort and convenience.
- **Narrow focus to NCOs for the mode shift analysis**: Assess why NCOs are more likely to transition from ride-hailing services to the proposed PT, given that they do not have the option of private car use.

- **Leverage Chi-Square and Weibull analysis**: Apply these methods to evaluate relationships among variables and predict mode shift tendencies effectively.

The findings of this research aim to provide actionable recommendations for policymakers and urban transport planners to enhance PT services and make them more competitive with ride-hailing options. By addressing the needs of NCOs and incorporating the technological advantages of ride-hailing services, this research proposes a public transport system that can effectively meet the needs of diverse commuter groups in Addis Ababa.

Keywords: *Ride-hailing services, public transport, mode choice behavior,* Chi-Square, Weibull analysis, *affordability, safety, competitive public transport, urban transportation, Addis Ababa.*

CHAPTER 1: INTRODUCTION

1.1. Background of the Study

Transportation systems are vital for the functioning and development of cities, acting as the arteries that enable the movement of people and goods. In rapidly expanding urban centers like Addis Ababa, the capital city of Ethiopia, establishing efficient and sustainable transportation networks is crucial. Traditionally, public transport has been the primary mode of transportation for a significant portion of the population, offering affordable and accessible mobility options. However, the rise of ride-hailing services, facilitated through mobile applications, has disrupted the transportation landscape by providing convenient and on-demand alternatives.

Globally, ride-hailing services have revolutionized the transportation sector. These services have gained popularity due to their convenience, user-friendly interfaces, and ability to offer on-demand solutions. Major players like Uber, Lyft, Bolt, and Grab have redefined travel by introducing features such as real-time tracking, cashless transactions, and driver ratings, significantly enhancing user satisfaction. Understanding the historical background, evolutionary trajectory, and significant contributions of ride-hailing services is crucial for assessing their potential impact on the mode choice of public transportation users.

In Addis Ababa, the influence of ride-hailing services has been steadily increasing. According to an article by Miklol Girma (2024) *Evolution of Ride Hailing Apps and Services in Ethiopia*, the city has long struggled with transportation issues, worsened by rapid urbanization and inadequate infrastructure. The shift from unregulated Lada sedans to ride-hailing apps marked a significant change. Pioneers like RIDE (also known as RIDE8294, for its 8294 short number) faced initial resistance but paved the way for many startups, addressing the city's growing demand for efficient transport.

Innovations by ETTA (Ethiopia Taxi), Zayride, and Feres, along with improved telecom services, have driven the market forward despite challenges such as foreign currency shortages, digital literacy, and financial inclusion. As the sector grows, addressing significant gaps such as data privacy, regulatory frameworks, and ensuring equitable regional distribution is crucial for its sustained success. Ride-hailing service providers have been in the market since 2014, with an estimated 180,000+ rides requested daily. Significant milestones include ETTA launching its app-based service in June 2015, Zayride in August 2016, and RIDE 8294's expansion to Djibouti in May 2017. Other notable developments include Adika transitioning from a meter taxi service in 2014 to introducing an app in 2019, and Seregela, which exclusively employs female drivers. Additionally, Little Ethiopia was the first major international ride-hailing service to launch in the country, and Lift Ethiopia was the first to offer a subscription model. VIP's Taxi also entered the market with a fleet including V8, Lexus, and Mercedes vehicles.

Despite the availability of these services, there is a need to understand who uses them and for what purpose within the context of Addis Ababa. This research aims to address this aspect.

Ride-hailing services offer solutions to long-standing challenges in public transport, such as unreliable schedules, overcrowding, and limited route options. As these services evolve in Ethiopia, it is essential to evaluate their impact on the mode choice of public transportation users, considering the unique characteristics and preferences of the local population. By examining this influence, the research aims to illuminate the dynamics between ride-hailing services and traditional transportation options, contributing to shaping the future of transportation in Addis Ababa.

Public transport, including buses, mini-buses, and light rail systems, remains a fundamental component of urban transportation networks. It provides a cost-effective and sustainable mode of transportation for many residents. However, public transport systems face challenges related to efficiency, reliability, and passenger comfort. Identifying best practices and trends in public transport services worldwide can inform potential improvements in Addis Ababa. By understanding the limitations and current issues faced by public transport, this research aims to develop an enhanced hybrid public transport service that combines the benefits of ride-hailing services with the affordability and accessibility of traditional public transport.

This research utilizes a Chi-Square test and Weibull Analysis to analyze the influence of ride-hailing services on mode choice behavior. By examining factors such as travel time, cost, comfort, convenience, and service reliability, the study aims to develop a comprehensive model capturing the dynamics between ride-hailing services and newly proposed public transport. The findings will contribute to developing a hybrid public transport service that balances convenience, affordability, and comfort, promoting sustainable transportation choices in Addis Ababa.

Overall, this research aims to bridge the gap between ride-hailing services and public transport, exploring potential mode shifts and developing a comprehensive understanding of the factors influencing commuters' mode choice decisions. The subsequent sections of this proposal will detail the methodology, data collection techniques, analysis plan, and expected outcomes of the study.

1.2. Statement of the Problem

The rapid expansion of ride-hailing services in Addis Ababa has significantly changed the transportation landscape. This study addresses the following key problems:

- **i)** ***Influence of Ride-Hailing Service Expansion***: The rapid expansion of RHS in Addis Ababa may significantly affect commuters' mode choice behavior. However, the extent of this influence remains unclear. This study aims to examine how this expansion is altering commuter preferences in the city.
- **ii)** ***Demographics and Usage Patterns:*** Despite the growing popularity of ride-hailing services in Addis Ababa, there is limited understanding of the demographics and usage patterns of these service users. This gap in knowledge hinders targeted service improvements and policy development. This study seeks to fill that gap by analyzing who uses ride-hailing services and how frequently they engage with these options.
- **iii)** ***Integration of Ride-Hailing Attributes:*** As ride-hailing services continue to grow, existing public transport systems *may not fully meet* the needs of commuters. There is a clear challenge in integrating ride-hailing service attributes into a cohesive public transport system. This study aims to identify strategies to enhance overall mobility options by proposing recommendations to optimize public transport in light of ride-hailing attributes.

In summary, this study investigates the impact of ride-hailing service expansion on mode choice behavior, explores the factors driving the rapid growth of ride-hailing companies, analyze users' perception towards RHS, and proposes recommendations for an improved and sustainable public transport system in Addis Ababa.

1.3. Research Objectives

1.3.1. General Objective

To examine the impact of ride-hailing services on public transport mode choice and develop a comprehensive understanding of the factors influencing commuters' transportation decisions in Addis Ababa, Ethiopia.

1.3.2. Specific Objectives

To achieve the research goal, the following specific objectives are identified:

1. To assess the influence of ride-hailing service expansion on commuters' mode choice behavior in Addis Ababa.
2. To analyze the demographics and usage patterns of RHS users in Addis Abaab.
3. To identify factors influencing commuters' mode choice decisions, considering both ride-hailing services and public transport options.
4. To propose recommendations for integrating ride-hailing service attributes into an optimized new public transport system to enhance overall mobility options.
5. To develop a comprehensive model capturing the mode shift between ride-hailing services and the newly proposed optimized public transport.

These research specific objectives will guide the study in achieving a thorough understanding of the impact of ride-hailing services on public transport mode choice and enable the development of recommendations to address the challenges and enhance the transportation system in Addis Ababa.

1.4. Research Questions

This research study aims to address the following questions:

1. How does the expansion of ride-hailing services impact commuters' mode choice behavior?
2. What are the key factors driving the rapid growth of ride-hailing companies, considering users' preferences and perceptions?
3. How can the mode choice behavior between ride-hailing services and a new optimized public transport be captured and modeled?

4. What recommendations can enhance the public transport system, considering the advantages of ride-hailing services and limitations of traditional public transport?

1.5. Scope (Delimitation of the Study)

This research focuses on the impact of ride-hailing services on public transport mode choice in Addis Ababa, Ethiopia. The study primarily considers the following aspects:

1. **Commuters in Addis Ababa**: Targeting individuals who regularly commute within the city, the research aims to understand their mode choice behavior and influencing factors.
2. **Ride-Hailing Services**: Investigating the impact of ride-hailing companies operating in Addis Ababa, analyzing their market presence and influence on commuting mode choice.
3. **Newly Proposed Public Transport Mode**: Given that the existing traditional public transport system does not meet service satisfaction compared to ride-hailing services, this research considers a newly proposed public transport mode.
4. **Analytical Approach**: Utilizing a Chi-Square test and Weibull Analysis to capture and analyze the dynamics between ride-hailing services and newly proposed public transport, providing insights into factors influencing mode choice decisions.

This study focuses specifically on Addis Ababa and may not be directly applicable to other cities or regions. It does not delve into detailed financial analyses or profitability aspects of ride-hailing companies, but rather focuses on the impact on public transport mode choice and related implications.

1.6. Significance of the Study

This study holds several significant implications for policymakers, urban planners, transportation service providers, and the general public in Addis Ababa:

1. Policy and Planning: Providing valuable insights for policymakers and urban planners in shaping transportation policies and planning strategies to enhance the efficiency and sustainability of the public transport system in Addis Ababa.
2. Public Transport Improvements: Offer recommendations for improvements to address the needs and preferences of commuters, then propose a newly optimized public transport.

3. Sustainable Transportation: Contributing to the promotion of sustainable transportation choices by evaluating the impact of ride-hailing services on public transport mode choice and proposing strategies for integrated mobility solutions.
4. Stakeholder Collaboration: Encouraging collaboration between ride-hailing service providers, public transport authorities, and other stakeholders to develop a cohesive and efficient transportation network.
5. Academic Contribution: Contributing to the academic understanding of transportation dynamics in Addis Ababa, providing a basis for further research and analysis in the field of urban transportation.

The research findings will serve as a valuable resource for policymakers, transportation planners, and other stakeholders in developing strategies and interventions to enhance the public transport system, promote sustainable transportation choices, and improve overall mobility in Addis Ababa.

1.7. Limitations of the Study

While this research provides valuable insights into the influence of ride-hailing services on public transport mode choice and proposes an optimized public transport system, several limitations should be acknowledged:

- **Sample Size and Generalizability**: The study focuses on a sample of commuters in Addis Ababa, which may limit the generalizability of the findings to other urban contexts or regions with different transportation dynamics or cultural attitudes toward public transport and ride-hailing services.
- **Self-Reported Data**: The data collected through surveys relies on self-reported responses from participants. This method may introduce biases, such as social desirability bias, where respondents provide answers, they believe are more acceptable rather than their true preferences or behaviors.
- **Limited Scope of Variables**: While the study examines several key factors influencing mode choice behavior, there may be other relevant variables not included in the analysis (e.g., environmental concerns, social influences, or personal experiences with specific services) that could impact the findings.

- **Focus on Non-Car Owners in Modeling**: Although the research initially considers all commuters, the analysis narrows down to non-car owners during the modeling process. This focus may overlook valuable insights from car owners who might use ride-hailing services occasionally or those who influence public transport usage in different ways.
- **Regional Variability**: The transportation landscape in Addis Ababa is unique, influenced by local regulations, infrastructure, and socio-economic conditions. The findings may not be applicable to cities with different transit systems or levels of ride-hailing service integration.
- **Temporal Factors**: The research may not adequately address how external factors such as economic conditions, changes in policy, or global events (like the COVID-19 pandemic) could impact the transportation preferences of commuters over time.
- **Potential for Rapid Change**: The transportation industry is rapidly evolving, especially with technological advancements and shifting consumer preferences. Findings from this study may quickly become outdated as new ride-hailing services emerge or public transport systems are updated.

These limitations should be considered when interpreting the findings of this study. Future research could address these limitations by employing longitudinal designs, expanding the scope of variables considered, and including a broader range of geographic contexts.

1.8. Definition of Terms

To ensure clarity and consistency throughout this analysis, the following key terms are defined:

- **Mode Choice Behavior**: Refers to the decision-making process commuters undertake when selecting a mode of transportation (e.g., public transport, private vehicles, ride-hailing services) based on factors such as cost, convenience, time savings, and personal preferences.
- **Non-Car Owners (NCOs):** Individuals who do not own a private vehicle and rely on other modes of transportation, such as PT or RHS, for their mobility needs. This group is the primary focus of the mode shift analysis.
- **Public Transport (PT)**: In this study, PT refers to a newly optimized public transport system that is proposed hypothetically. This optimized PT system incorporates attributes

traditionally associated with private Ride-Hailing Services (RHS), such as improved comfort, availability, and safety. It is positioned as a more affordable yet high-quality alternative to RHS.

- **Ride-Hailing Services (RHS):** On-demand private transportation services provided through mobile applications, such as Ride, Feres, or Yango. These services typically offer greater convenience and comfort compared to PT but at a higher cost.
- **Chi-Square Test**: A statistical method used to determine the association between categorical variables by comparing observed and expected frequencies under a hypothesis of independence.
- **Weibull Analysis**: A statistical technique for modeling and analyzing time-to-event data, commonly used to predict the likelihood and timing of events such as mode shifts or service adoption.
- **Commuters**: Individuals who travel regularly between home and work, school, or other destinations, often relying on a combination of transportation modes.
- **Mode Shift:** The transition of commuters from one mode of transportation to another, typically from private vehicles or on-demand services like RHS to public options like PT. The study aims to explore the potential of shifting commuters from RHS to the newly proposed optimized PT system.
- **Switching Potential**: The likelihood or propensity of commuters to transition from one mode of transportation to another, influenced by factors like convenience, cost, and service quality.

1.9. Organization of the Study

This research study is organized as follows:

Chapter 1: Introduction

This chapter provides the background, statement of the problem, research objectives, research questions, study area, scope, significance, limitations, definition of terms, and organization of the study.

Chapter 2: Literature Review

This chapter reviews relevant literature on ride-hailing services, public transport, mode choice behavior, and transportation dynamics in urban areas. It also explores best practices and trends in public transport services worldwide.

Chapter 3: Methodology

This chapter outlines the research methodology, including the research design, data collection techniques, sampling methods, and analytical approaches used in the study.

Chapter 4: Data Analysis and Findings

This chapter presents the data analysis results, discusses the research findings including the influence of ride-hailing services on commuters' mode choice behavior (Factor Analysis), and model potenital mode shift between RHS and PT.

Chapter 5: Conclusion and Recommendations

This Chapter draws conclusion, explores implications for transportation planning and policy, and provides recommendations for integrating ride-hailing services into the existing public transport system.

- This chapter also summarizes the key findings, highlights the contributions of the study, and suggests areas for future research.

The organization of the study ensures a comprehensive analysis of the impact of ride-hailing services on public transport mode choice, providing valuable insights and recommendations for enhancing the transportation system in Addis Ababa.

CHAPTER TWO: LITERATURE REVIEW

2.1. Influence of Ride-Hailing Expansion on Commuter Mode Choice

The rapid propagation of ride-hailing services has significantly impacted commuter mode choice across different regions and demographics. This section synthesizes findings from various studies to provide a comprehensive understanding of how ride-hailing influences commuter behavior and mode substitution. And also understanding the factors that influence commuters' mode choice between ride-hailing services and traditional public transportation.

2.1.1. Socio-Demographic Factors Influencing Ride-Hailing Adoption

Several studies have highlighted the socio-demographic factors influencing the adoption of ride-hailing services. Lim (2022) examined the determinants of using ride-hailing services in Malaysia, emphasizing the importance of age, gender, education, income, and vehicle ownership. The study found that younger individuals and those with higher incomes were more likely to choose ride-hailing over traditional taxis due to factors such as shorter waiting times and better driver disposition. These findings align with Edrisi (2021), who noted that ride-hailing services are particularly popular among younger and wealthier individuals in Tehran, with a preference for shared ride-hailing due to its cost-effectiveness.

2.1.2. Convenience and Accessibility

Convenience and accessibility are significant determinants of mode choice. Ride-hailing services such as Uber and Lyft offer door-to-door service, which is often perceived as more convenient compared to traditional public transport modes that require fixed routes and schedules. Sadowsky (2017) highlighted that initially, ride-hailing services complemented public transport by providing first and last-mile connectivity. However, as these services became more established, they began to act as substitutes due to their superior convenience, reducing the reliance on traditional public transit.

Furthermore, ride-hailing services are accessible through mobile apps, offering real-time tracking, cashless transactions, and personalized travel experiences. This level of convenience, coupled with the ability to request a ride from virtually anywhere, makes ride-hailing services particularly appealing to commuters who value time and ease of use. In contrast, traditional public transport often involves multiple transfers, unknown schedules, and longer waiting times, which can be less attractive to time-sensitive commuters.

The demographic trends suggest that ride-hailing services appeal more to those who prioritize convenience and are willing to pay a premium for it. Conversely, traditional public transport remains the preferred choice for individuals who seek cost-effective travel solutions. Additionally, the increasing smartphone penetration and internet accessibility are likely to further boost the adoption of ride-hailing services among diverse demographic groups over time.

2.1.3. Service Availability and Coverage

The availability and coverage of services significantly impact commuters' choices. Public transport is generally more widespread in urban areas, but ride-hailing services offer greater flexibility in less densely populated areas. Zhong (2020) study in China's small and medium-sized cities revealed that ride-hailing services initially increased public transport usage by enhancing overall accessibility. However, over time, as ride-hailing services expanded their coverage, they began to substitute public transport, particularly in areas with limited public transit options.

The flexibility of ride-hailing services to operate beyond fixed routes and schedules allows them to serve a broader geographic area, including suburbs and rural locations where public transport is sparse or non-existent. This expanded coverage can make ride-hailing services a more viable option for commuters who reside in areas with limited public transport infrastructure.

2.1.4. Cost and Pricing Strategies

Cost is another critical factor influencing commuters' decisions. Ride-hailing services often use dynamic pricing models, which can make them more expensive than fixed-fare public transport. However, promotions and discounts offered by ride-hailing platforms can attract price-sensitive commuters. In Germany, Ennen (2020) found that lower fares offered by ride-hailing services led to a significant shift from public transport to ride-hailing, especially among younger and tech-savvy commuters. This price sensitivity underscores the importance of competitive pricing in influencing mode choice.

Moreover, while traditional public transport fares are generally lower and more predictable, the flexibility of ride-hailing services to offer lower prices during off-peak hours or through special promotions can draw commuters away from public transit. This pricing flexibility allows ride-hailing services to effectively compete with public transportation, particularly during periods when cost differences are minimized.

2.1.5. Travel Time and Reliability

Travel time and reliability are also pivotal in determining mode choice. Commuters often prefer modes that offer shorter travel times and higher reliability. Kyunghee-Lee-et (2022) research demonstrated that in urban areas with high traffic congestion, ride-hailing services can sometimes provide faster and more reliable travel compared to buses and trains. This perceived reliability can sway commuters towards choosing ride-hailing over traditional public transport.

The reliability of ride-hailing services is often enhanced by the ability to bypass certain traffic conditions using navigation apps, providing a more predictable travel experience. Traditional public transportation, on the other hand, can be subject to delays, overcrowding, and inflexible schedules, which detract from its reliability and attractiveness. Therefore, the assurance of a timely and dependable ride can significantly influence commuters' preferences.

2.1.6. Commuter Satisfaction and Preferences

Understanding commuter satisfaction with ride-hailing services is crucial for assessing their influence on mode choice. Ali (2022) focused on commuter satisfaction and preferences in Lahore, revealing that convenience, comfort, and social protection positively influenced users' preferences. The study utilized a customer satisfaction index and structural equation modeling, highlighting the need for regulatory enhancements to improve safety and security. SEM (structural equation modeling), a robust statistical technique, was used to model the complex relationships between observed and latent variables, providing deeper insights into commuter behavior and preferences Hair (2010); Kline (2015).

This study highlights the significance of service quality in shaping commuter preferences, a finding consistent with Nguyen-Phuoc et al. (2020), who identified perceived service quality as the most influential factor affecting customer loyalty toward ride-hailing services in Vietnam. Together, these studies underscore the importance of prioritizing service quality and safety measures to improve user satisfaction and loyalty in the ride-hailing industry.

2.1.7. Mode Substitution Effects

The impact of ride-hailing on mode substitution has been a critical area of investigation. Acheampong (2020) explored this phenomenon in Ghana, finding that ride-hailing services often replaced conventional taxis, public transport, and, to a lesser extent, private cars and walking. The study employed a multi-variable structural equation model to analyze these effects, revealing weak multi-modal integration. Similarly, Loa (2021) in Toronto identified socio-economic influences and trip-related attributes as key factors driving the substitution of ride-sourcing for public transit and taxi services. This study emphasized the role of specific demographic groups, such as students and lower-income individuals, in mode substitution.

2.1.8. Factors Affecting Modal Choice

Tyrinopoulos (2013) provided insights into factors affecting modal choice in urban mobility, with a particular focus on reasons discouraging public transport use. The study found that the availability of parking space was a major factor influencing the preference for passenger cars, while high fare levels and lack of public transport information did not significantly deter public transport use. This aligns with the findings of Edrisi (2021), who noted that demographic characteristics such as gender and household size did not significantly affect travel mode choice in Tehran, highlighting a complex interplay of factors influencing commuter behavior.

2.1.9. Policy and Regulatory Implications

The reviewed literature underscores the need for policy and regulatory frameworks to adapt to the changing dynamics of urban mobility influenced by ride-hailing services. Ali (2022) and Nguyen-Phuoc (2020) both stress the importance of regulatory measures to enhance safety, security, and service quality. Key measures include mandatory driver training and certification, rigorous background checks, real-time monitoring systems, standardized service metrics, transparent pricing policies, and robust feedback mechanisms. These measures are essential for maintaining commuter satisfaction, fostering trust, and ensuring the sustainable integration of ride-hailing services into urban transportation systems.

2.1.10. Conclusion

In summary, the influence of ride-hailing on commuter mode choice is multifaceted, involving socio-demographic factors, commuter satisfaction, mode substitution effects, and regulatory considerations. The studies reviewed highlight the significance of service quality, convenience, and cost-effectiveness in driving the adoption of ride-hailing services. As urban mobility continues to evolve, further research is needed to explore the long-term impacts of ride-hailing on travel behaviors and to develop strategies for integrating these services into sustainable transportation planning.

2.2. The Social, Economic, and Environmental Impact of Ride-Hailing Services

The increased usage of ride-hailing services has complex and varied implications for urban congestion, traffic flow, and environmental sustainability. On one hand, these services can improve transit availability, reduce car ownership, and minimize parking need Khavarian-Garmsir (2021). However, they also contribute to the growth of vehicle-kilometers traveled, energy use, greenhouse gas emissions, and congestion in cities Tirachini (2019). The impact on traffic congestion is influenced by urban compactness, with ridesharing services increasing congestion in compact areas and potentially reducing it in sprawling urban areas Li (2021). The entry of ride-hailing services like Uber has been found to increase traffic congestion and reduce public transit demand, particularly in cities with a higher urban compactness index Lee (2019).

In addition to these findings, further research highlights other significant impacts of ride-hailing services. Fageda (2019) examined the influence of Uber on urban congestion and vehicle utilization in Europe and the United States, revealing contrasting effects: a negative impact on congestion in Europe and a positive one in the United States, where ride-hailing has increased the size of the for-hire car sector. Behroozi (2023) discusses the rising national congestion costs in the United States, emphasizing the need to address the broader societal challenges posed by the rapid expansion of ridesharing services, including increased traffic congestion and carbon emissions.

Kyunghee-Lee-et (2022) analyzed the effects of Uber on transportation mode choices for different traveler segments, finding that ride-hailing services increase convenience for walkers and riders while causing a shift in behavior for drivers. This study underscores the varied impacts of ride-hailing services on different commuter groups and the importance of urban compactness in moderating these effects. Furthermore, Lee (2019) focused on the sustainability impacts of Uber, noting that while these services can reduce parking needs and improve security for riders, they also lead to increased congestion and potential environmental concerns.

The literatures collectively points to the dual nature of ride-hailing services: they offer significant benefits in terms of convenience and transit availability but also pose challenges related to increased congestion, environmental impact, and competition with public transport.

2.3. Enhancing Public Transport with Ride-Hailing Integration

The integration of ride-hailing services (RHS) with public transport (PT) systems presents a promising approach to improve urban mobility. By combining the flexibility and convenience of RHS with the efficiency and capacity of PT, cities can create a seamless and comprehensive transportation network. This literature review section examines the potential benefits of such integration, key features preferred by commuters, and effective strategies as discussed by various authors.

2.3.1. Benefits of Integrating Ride-Hailing with Public Transport

Several studies have highlighted the advantages of integrating RHS with PT to address urban mobility challenges. Stiglic (2016) focus on the first and last mile problem, showing that integrating ride-sharing and public transit can significantly enhance mobility in suburban areas. Their computational study demonstrates the potential for increased public transport usage and reduced environmental impact.

Yan (2019) supports this view, emphasizing that RHS can improve last-mile connectivity, operational efficiency, and extend the catchment area of public transit. By reducing wait times and in-vehicle travel times, RHS can make PT more attractive to commuters, potentially increasing ridership and reducing overall transportation costs.

2.3.2. Key Features Preferred by Commuters

Understanding commuter preferences is crucial for successful integration. Studies indicate that commuters value factors such as cost-effectiveness, convenience, reduced travel time, and reliability. Yan (2019) identifies these features as essential for attracting ride-hailing users to public transport. Real-time information systems, as discussed by Cebon (2011), play a vital role in providing commuters with up-to-date information on transport options, enhancing trip planning, and improving the overall travel experience.

Molenbruch (2021) highlights the importance of efficient route planning and scheduling through advanced algorithms. Their study on integrating dial-a-ride services with public transport demonstrates that optimized route planning can lead to significant distance savings and operational benefits. This optimization can make public transport more competitive with RHS in terms of convenience and efficiency.

2.3.3. Effective Integration Strategies

Various authors have proposed strategies for effectively integrating ride-hailing services with public transport. Stiglic (2016) and Yan (2019) focus on operational synergies and connectivity improvements. They highlight the importance of addressing the first and last mile challenge and enhancing operational efficiency to attract commuters.

Cebon (2011) and Molenbruch (2021) stress the need for real-time information systems and advanced routing algorithms to improve service delivery. These technologies help optimize routes, reduce wait times, and provide reliable service, making public transport more attractive to commuters.

Schiffer (2020) offers a strategic perspective on the potential of autonomous ride-hailing services to complement public transport. The study suggests that with careful policy design, autonomous RHS can enhance public transport by providing flexible, on-demand services that fill gaps in the existing network. This approach can help reduce operational costs and increase service availability.

2.3.4. Conclusion

Integrating ride-hailing services with public transport holds significant potential for enhancing urban mobility. By addressing connectivity issues, improving operational efficiency, and incorporating features preferred by commuters, cities can create a more appealing and efficient public transport system. Real-time information systems, advanced routing algorithms, and strategic policy design are crucial elements for successful integration. The insights from existing literature provide a robust foundation for developing comprehensive models and recommendations to achieve effective integration and improve overall mobility options.

2.4. Integrating Ride-Hailing Features into Public Transport

The integration of ride-hailing features into public transport systems represents a significant opportunity to enhance service quality and provide seamless alternatives to traditional transportation options. Different researchers examine the potential benefits, challenges, and strategic considerations for integrating ride-hailing services into public transit.

2.4.1. Enhancing Urban Mobility with Ride-Sharing and Public Transit

Stiglic (2016) discuss the integration of ride-sharing and public transit as a means to improve urban mobility. Their study highlights the potential of such integration to enhance mobility, increase public transport usage, and reduce negative externalities like traffic congestion and pollution. The research emphasizes the importance of driver flexibility and the number of system participants in optimizing the performance of the integrated system. The findings suggest that seamless integration can significantly improve the first and last mile connectivity for suburban riders, thereby increasing the overall efficiency and attractiveness of public transport.

2.4.2. Autonomous Ride-Sharing and Mobility Service Platforms

Schwinger (2021) explores the integration of autonomous ride-sharing services into mobility service platforms. The study identifies distinct user-centered and technical requirements for integrating autonomous services, highlighting the feasibility and potential benefits of such integration. However, it also points out the challenges related to the initial collaboration between public transit and ride-hailing companies and the need for broader exploration of integration impacts. The research suggests that addressing these challenges can lead to more effective and user-friendly mobility service platforms.

2.4.3. Ride-sourcing Services and Public Transit

Yan (2019) evaluates the integration of ride-sourcing services with public transit, focusing on the benefits of improving last-mile connectivity. The study's findings indicate that ride-sourcing can enhance transit by reducing wait times, extending the catchment area, and increasing overall ridership. However, the research also identifies significant deterrents, such as transfers and additional pickups, which need to be addressed to maximize the benefits of integration. By effectively managing these aspects, public transit systems can become more efficient and user-friendly.

2.4.4. Impact of Ride-Hailing Services on Traditional Transport

Gehrke (2019) examines the impacts of ride-hailing services on the traditional transportation system, using data from the Greater Boston region. The study reveals that ride-hailing services significantly influence established travel modes and provides insights for public policies to integrate shared mobility technologies. The findings suggest that while ride-hailing can complement existing transportation options, there is a need for policies to address potential environmental and equity issues. Effective integration can ensure that ride-hailing services enhance rather than disrupt traditional public transport systems.

2.4.5. Promoting the Combination of Ride-Sharing and Public Transport

The RIDE2RAIL project (2023) addresses the challenges of accessing public transport in rural areas with low demand by promoting the efficient combination of ridesharing and public transport. The study highlights the potential of such combinations to reduce single car occupancy and improve public transport access. However, the generalizability of these findings to other regions remains unspecified. By addressing these challenges, the combination of ride-sharing and public transport can provide effective solutions for areas with limited transportation options.

2.4.6. Technological Advancements and Integrated Mobility Solutions

Karnahl (2017) discusses how digitalization and technological advancements are transforming transportation systems, enabling integrated mobility solutions that combine various services on a single platform. The study emphasizes the role of data-driven trip planning and autonomous vehicles in enhancing on-demand services. These advancements can optimize trips and improve service quality, making public transport systems more responsive and efficient. The integration of these technologies can create seamless and user-friendly transportation experiences.

2.4.7. Autonomous Ride-Hailing and Public Transportation: A Strategic Perspective

Schiffer (2020) uses a game-theoretic model to analyze the interplay between autonomous ride-hailing services and public transportation. The study highlights those autonomous systems can either complement or cannibalize public transport, depending on market conditions and policy restrictions. Strategic design options for policymakers are discussed, emphasizing the need to balance these dynamics to enhance overall transportation service quality. By understanding and managing these interactions, policymakers can ensure that autonomous ride-hailing services support rather than undermine public transport.

2.4.8. Conclusion

The reviewed literature underscores the potential benefits of integrating ride-hailing features into public transport systems, including improved mobility, increased ridership, and enhanced service quality. However, challenges such as user-centered requirements, technical integration, and policy considerations must be addressed to maximize these benefits. Future research should focus on exploring more complex transit systems, integrating additional mobility options like bikesharing, and addressing the unique challenges of rural and low-demand areas. By effectively integrating ride-hailing services, public transport systems can become more efficient, user-friendly, and environmentally sustainable, providing seamless alternatives to traditional transportation options.

2.5. Analytical Methods - Chi-Square and Weibull Analysis

Mode choice and mode shift analysis increasingly relies on sophisticated analytical methods to understand commuter behavior and the factors influencing mode choice. Among the various statistical techniques, the Chi-Square test and Weibull Analysis have gained prominence for their effectiveness in analyzing categorical data and modeling time-to-event outcomes, respectively. This literature review examines the theoretical foundations, applications, and limitations of these methods, highlighting their contributions to the field of transportation studies.

2.5.1. Chi-Square Test

The Chi-Square test, introduced by Karl Pearson in the early 20th century, is a non-parametric statistical method used to assess the association between categorical variables. The test compares the observed frequencies in a contingency table to the expected frequencies under the null hypothesis of independence, Pearson (1900). This method is particularly useful for identifying significant relationships among various demographic and behavioral factors in transportation studies.

Numerous studies have utilized the Chi-Square test to explore the relationship between socio-demographic factors and mode choice behavior. For instance, a study by Bhat (2006) examined the impact of household income and vehicle ownership on public transport usage, revealing significant associations between these variables. Similarly, Nielsen (2015) employed the Chi-Square test to analyze how age and education level affect preferences for different transportation modes, providing insights into targeted policy interventions.

The Chi-Square test has also been applied in studies evaluating the effects of service features and policy measures on commuter choices. For example, Li (2007) used Chi-Square tests to identify the role of real-time information systems in influencing mode preference, while Chowdhury (2016) examined the relationship between accessibility improvements and shifts in public transport ridership. Such applications underscore the test's utility in evaluating interventions aimed at enhancing public transportation systems.

2.5.2. Weibull Analysis

Weibull Analysis is a statistical method primarily used in reliability analysis and survival studies. The Weibull distribution, introduced by Wallodi Weibull, is characterized by its flexibility in modeling various time-to-event data, making it particularly relevant for analyzing commuter behavior over time Weibull (1951). This method is instrumental in assessing the likelihood of commuters switching from public transport to ride-hailing services.

Mokhtarian (2001) applied Weibull Analysis to investigate the temporal dynamics of commuters switching from private vehicles to public transport, shedding light on the factors driving mode transitions. Similarly, Bhat (2006) demonstrated the method's utility in evaluating the influence of service quality dimensions—such as reliability and comfort—on the likelihood and timing of commuter shifts between modes.

Additionally, Bhat (2006) used Weibull Analysis to investigate how service quality impacts the time until commuters switch modes, demonstrating the significance of reliability and comfort in transportation decisions. This method allows researchers to account for various influencing factors, providing nuanced insights into commuter behavior.

2.5.3. Conclusion

The Chi-Square test and Weibull Analysis are essential tools in this research, each offering unique techniques in analyzing commuter behavior and mode choice dynamics. The Chi-Square test excels in assessing relationships among categorical variables, while Weibull Analysis provides a robust framework for modeling time-to-event outcomes. Understanding the theoretical foundations, applications, and limitations of these methods is crucial for researchers aiming to inform policy decisions and optimize transportation systems. Continued exploration of these analytical techniques will enhance the field's ability to address the evolving challenges of urban mobility.

CHAPTER 3: METHODOLOGY

This chapter outlines the research methodology employed in this study, detailing the approach used to collect, analyze, and interpret the data to model mode choice between Ride-Hailing Services (RHS) and a proposed optimized Public Transport (PT) system. The methodology integrates quantitative techniques for data collection and statistical modeling, ensuring a robust analysis of the factors influencing the commuters' transport decisions. This chapter is divided into sections covering the research design, data collection methods, the model specification, and the estimation process.

3.1. Research Study Area

Addis Ababa, the capital and largest city of Ethiopia, United Nations Population Projections estimated the population of metro area of Addis Ababa to be 5,228,000 in 2022, a 4.43% increase from 2021 (Nations, 2024). The city, located in the central part of the country, serves as Ethiopia's political, commercial, and cultural center, the city is the resident place for many international embassies, different NGOs, AU and ECA. Furthermore, Addis Ababa's strategic location makes it a hub for freight transportation. As the venue for a significant portion of the country's import and export activities, the city has become a bustling business center where high-volume transactions take place on a daily basis.

The well-known and largest Airlines in Africa established on December 21st of 1945 famously known as "Bole International Airport" with more than 18,000 employees, 145 fleet size, and has the capacity to handle 22 million passengers per annum is found in the research area "Addis Ababa".

Addis Ababa is home to the largest marketplace in Africa, known as Mercato. Mercato is the largest open-air market in Africa, covering several square miles and employing an estimated 13,000 people in 7,100 business entities. The city also hosts Addis Ababa University, the largest university in the country, which operates across 13 different campuses. In addition to the prominent educational institution, the city is home to numerous large, publicly and privately owned hospitals, as well as many medium-sized health centers that serve patients from across the country.

As of September 2020, around 630,440 vehicles were registered in Addis Ababa according to the Federal Transport Authority, accounting for approximately 53% of nationally registered vehicles. Rapid urbanization has strained the city's infrastructure and public services, particularly in transportation, highlighting the need for evaluating the efficiency and sustainability of the public transport system.

3.2. Research Design

This research adopts a quantitative approach to examine the influence of ride-hailing services on mode choice behavior among commuters in Addis Ababa, including car owners (COs) and non-car owners (NCOs). The study specifically utilizes two major methods to analyze the collected data:

a) Chi-Square Method: This method was used to analyze categorical data, examining the relationship between socio-demographic factors and the mode choice of commuters.
b) Weibull Analysis: This technique assessed the effects of all 14 variables influencing commuters’ decisions to shift from RHS to the newly proposed PT.

3.3. Data Collection

3.3.1. Survey Design

Data for this research is collected through a structured survey targeting commuters in Addis Ababa. The survey instrument is designed to capture various socio-economic characteristics, travel behavior, and perceptions regarding ride-hailing services and public transport. Respondents rated the importance of specific attributes and indicated their mode preferences under hypothetical scenarios where PT offered similar features to ride-hailing services.

3.3.2. Sampling Technique

A random sampling technique is employed to ensure diverse representation across different socio-economic strata among individuals who have used ride-hailing services at least once. Although the exact population size is unknown, the sampling process was designed to approximate randomness by targeting a wide range of users in accessible locations and through online platforms. A total of

731 valid responses were collected, with no missing or excluded observations. This sample size is deemed sufficient for conducting robust statistical analyses, including both Chi-Square and Weibull methods, based on the diversity of the sample and the analytical requirements of the study.

3.3.3. Minimum Sample Size Calculation

For an unknown population size, the minimum sample size required is calculated using the following formula for a 95% confidence level (Z = 1.96), a margin of error (E) of 5%, and an estimated proportion (p) of 50% (0.5), which maximizes variability:

$$n = \frac{Z^2 * p * (1 - p)}{E^2}$$

Substituting the values:

$$n = \frac{1.96^2 * 0.5 * (1 - 0.5)}{0.05^2} = \mathbf{384.16}$$

Thus, the minimum sample size required was approximately ***385 respondents***. Given that ***731 responses*** is collected, the sample size exceeds the minimum requirement, ensuring robust and reliable statistical analysis.

3.4. Variable Definition

The table below presents the variables included in the analysis, emphasizing their definitions and relevance in designing the questionnaire to capture demographic characteristics of respondents and transportation service attributes.

Variable	**Description**	**Values**
AGE	Age categories	1 = Under 18, 2 = 18-25, 3 = 26-35, 4 = 36-45, 5 = 46+
GENDER	Gender of the respondent	1 = Male, 2 = Female
OCCUPATION	Type of occupation	1 = Government, 2 = Private, 3 = Self-employed, 4 = Student, 5 = Unemployed

INCOME	Monthly income category	1 = <3000, 2 = 3001 - 6000, 3 = 6001 - 12000, 4 = 12001 - 24000, 5 = 24,001 - 48000 , 6 = >48,000 Birr
CAR_OWNERSHIP	Whether the respondent owns a car	1 = Yes, 0 = No
RTT	Real-time tracking	1 = Very Dissatisfied, 5 = Very Satisfied
TMS	Time Saving	1 = Very Dissatisfied, 5 = Very Satisfied
CT	Cashless transactions	1 = Very Dissatisfied, 5 = Very Satisfied
VS	Vehicle selection	1 = Very Dissatisfied, 5 = Very Satisfied
DRR	Driver ratings and reviews	1 = Very Dissatisfied, 5 = Very Satisfied
PRC	Affordability/Price	1 = Very Dissatisfied, 5 = Very Satisfied
CMT	Comfort	1 = Very Dissatisfied, 5 = Very Satisfied
AVL	Availability and accessibility	1 = Very Dissatisfied, 5 = Very Satisfied
SS	Safety and Security	1 = Very Dissatisfied, 5 = Very Satisfied
PD	Promotions and discounts	1 = Very Dissatisfied, 5 = Very Satisfied
SWP	Potential Switch to Public Transport	1 = Not likely to switch, 2 = Slightly likely, 3 = Neutral, 4 = Somewhat likely, 5 = Very likely
CHOICE	Choice made by the respondent (RHS, PT)	0 = PT, 1 = RHS

Table 1: Variable Definitions

3.5. Available Modes of Transport

In this study, two primary modes of transport are considered for non-car owners (NCOs):

1. **New Proposed Public Transport (PT)**: Respondents are asked to evaluate the importance of service attributes that RHS provides and assess their willingness to switch if these attributes are incorporated into a new PT system. The newly proposed public transport, hypothetically known for being more economical, though traditionally lacking in some service features offered by RHS.

2. **Ride-Hailing Services (RHS)**: This category includes app-based services like Ride, Feres, and Yango, which offer private, on-demand transportation at a higher cost than PT. RHS is generally more convenient, personalized, and flexible, though its affordability may be a key barrier to broader adoption.

These modes are selected for their competitive dynamics in the study area, offering contrasting features in terms of cost and service quality.

3.6. Analytical Framework

The study uses two main frameworks for analyzing the data: the **Chi-Square Method** and **Weibull Analysis**.

3.6.1. Chi-Square Method

The Chi-Square test is employed to evaluate the relationship between categorical socio-demographic variables and mode choice decisions.

$$X^2 = \frac{(O_i - E_i)^2}{E_i}$$

Where:

- O_i: Observed frequency for category i
- E_i: Expected frequency for category i
- χ^2: Chi-Square statistic

The results identify significant socio-demographic factors influencing the decision to switch between Ride-Hailing Services (RHS) and the proposed Public Transport (PT). And the following major parameters are used to show the relationship:

- **P-value**: If < 0.05, the null hypothesis is rejected, indicating a significant relationship.
- **Effect Size (Cramér's V)**: Used to assess the strength of association (0 to 1, where higher values indicate stronger associations).

3.6.2. Weibull Analysis

The Weibull distribution was used to model the effect of 14 service attributes (*Age, Gender, Occupation, Income, Real-time tracking, Time Saving, Cashless transactions, Vehicle selection,* *Driver ratings and reviews, Affordability/Price, Comfort, Availability and accessibility, Safety and Security, Promotions and discounts*) and socio-demographic variables on the likelihood of mode shift.

$$F(t) = 1 - e^{-(t/\lambda)^{\beta}}$$

Where:

- F(t): Cumulative probability of event occurrence (mode shift)
- t: Variable or service attribute influencing the decision
- λ: Scale parameter (related to mean)
- β: Shape parameter (determines skewness and tail behavior)

The analysis determines which service attributes (e.g., price, comfort, availability) significantly influence commuters' decisions to shift from RHS to PT. Variables with high hazard rates are prioritized for improving PT design.

a) **Shape Parameter (β):**
   - $\beta<1$: Decreasing failure rate (less likely to shift)
   - $\beta=1$: Constant failure rate
   - $\beta>1$: Increasing failure rate (more likely to shift)
b) **Scale Parameter (λ):** Higher values indicate a broader range of influence.
c) **Hazard Function (F(t))**: Analyzed to determine which variables have the greatest impact.

3.7. Conclusion

This chapter has outlined the research design, data collection process, and the analytical framework used to model NCOs' mode choice between RHS and the proposed PT. The Chi-Square and Weibull methods form the core of this analysis, capturing the influence of socio-demographic variables and service attributes on the utility derived from each mode. The next chapter will present the results of these analyses, providing a detailed interpretation of the factors significantly affecting mode choice decisions.

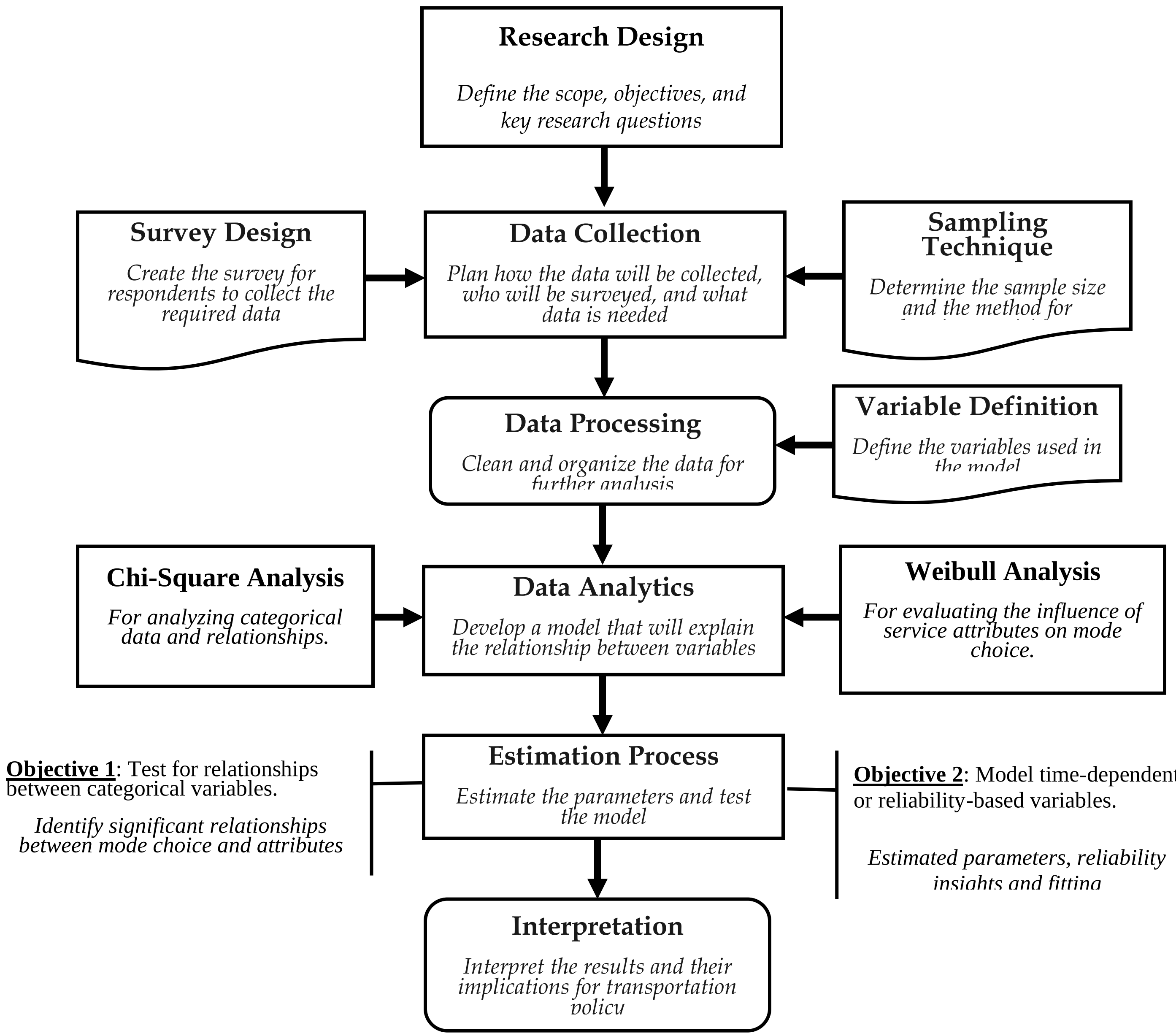

Figure 1: Methodological Flowchart

CHAPTER 4: RESULTS AND DICUSSION

In this chapter, key findings and results are systematically presented to draw conclusions and make recommendations based on the research conducted. The chapter will also outline possible metrics for the model to be derived from the results of the questionnaire and the analysis performed in the following chapter. The first part of this chapter aligns with the first objective outlined in Chapter One, while the second part is aimed at answering specific questions to fulfill the second objective.

4.1. Socioeconomic Characteristics of Commuters

This section provides a detailed overview of the demographic data for ride-hailing service users. The purpose is to understand the socioeconomic characteristics of commuters who utilize these services.

Category	Sub-Category	Non-Car Owners	Car Owners
Age	18-25	153 (27.18%)	26 (15.48%)
	26-35	339 (60.21%)	87 (51.79%)
	36-45	63 (11.19%)	42 (25.00%)
	46 and Above	8 (1.42%)	13 (7.73%)
	Grand Total	**563**	**168**
Gender	Female	229 (40.68%)	62 (36.90%)
	Male	334 (59.32%)	106 (63.10%)
	Grand Total	**563**	**168**
Occupation	Government	160 (28.42%)	35 (20.83%)
	Private	280 (49.73%)	71 (42.26%)
	Self-Employed	73 (12.97%)	54 (32.14%)
	Student	39 (6.93%)	5 (2.98%)
	Unemployed	11 (1.95%)	3 (1.79%)
	Grand Total	**563**	**168**
Income	12,001 – 24,000	247 (43.87%)	69 (41.07%)
	24,001 - 48,000	93 (16.52%)	37 (22.02%)
	3,001 – 6,000	46 (8.17%)	5 (2.98%)

	6,001 – 12,000	139 (24.69%)	20 (11.90%)
	Less than 3,000	19 (3.37%)	4 (2.38%)
	More than 48,000	19 (3.37%)	33 (19.64%)
	Grand Total	**563**	**168**

Table 2: Demographic Data Presentation

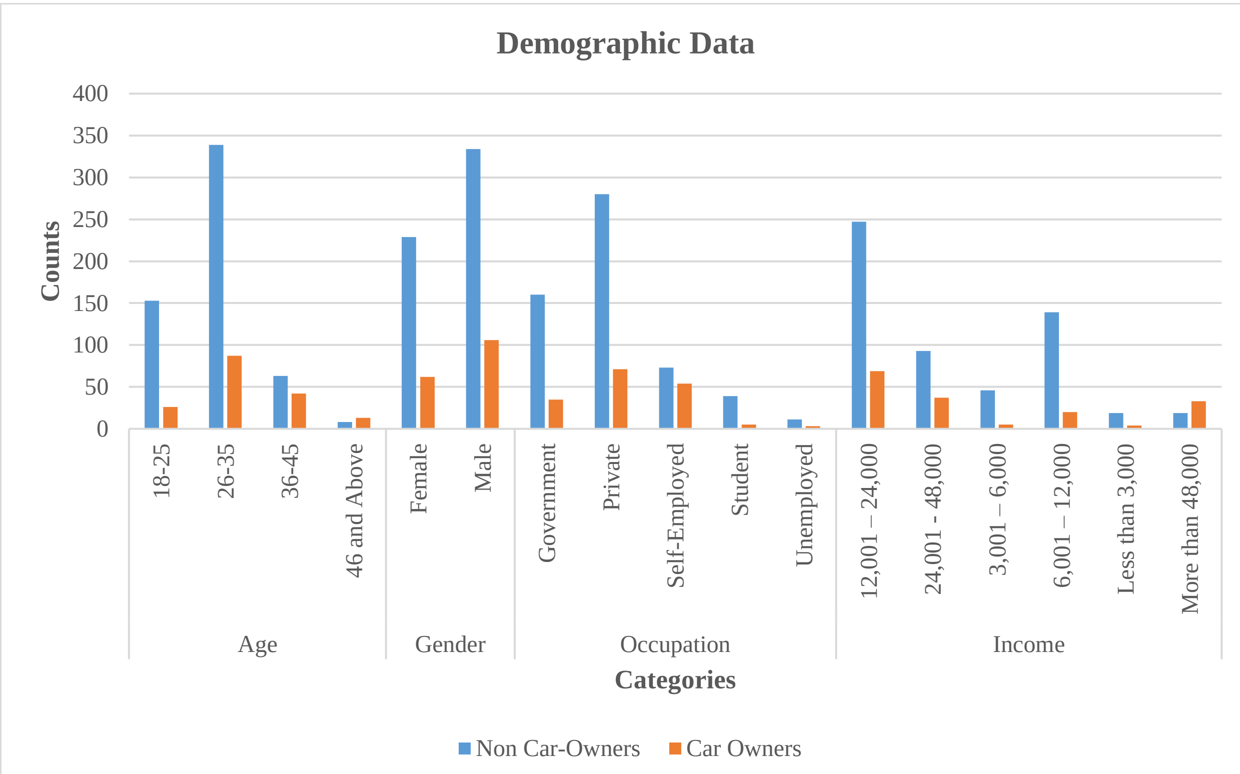

Figure 2: Demographic Data

<u>Age Distribution</u>

- ***Non-Car Owners***: The majority of non-car owners fall within the 26-35 age group (60.21%). This is followed by the 18-25 age group (27.18%), indicating that younger individuals, possibly students or early-career professionals, are more reliant on ride-hailing services. The 36-45 age group constitutes 11.19%, while those 46 and above are the smallest group at 1.42%.
- ***Car Owners***: Similarly, the largest proportion of car owners is in the 26-35 age group (51.79%), but there is a significant difference in the 36-45 age group, which constitutes 25.00%. The 18-25 age group makes up 15.48%, and those 46 and above account for

7.73%. This suggests that older individuals are more likely to own cars compared to their younger counterparts.

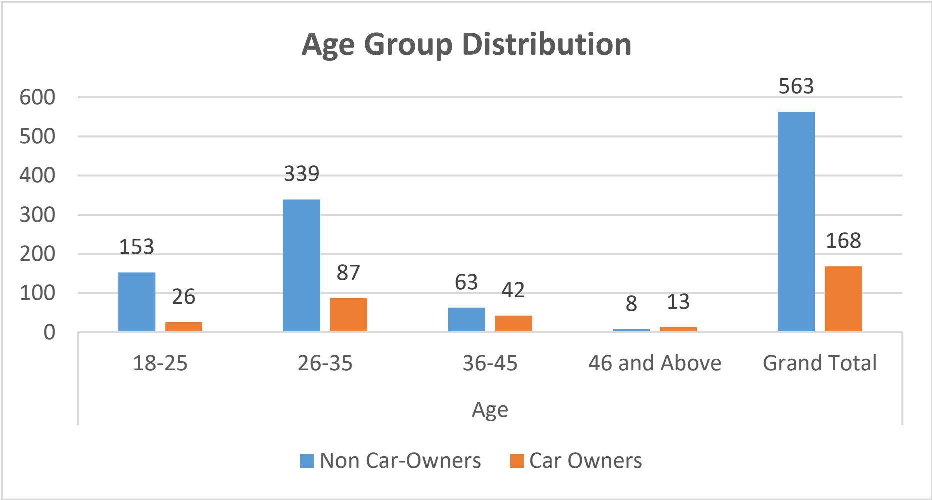

Figure 3: Age Group Distribution

<u>Gender Distribution</u>

- ***Non-Car Owners***: The gender distribution among non-car owners is somewhat balanced, with males making up 59.32% and females 40.68%. This indicates a substantial female demographic that relies on ride-hailing services.
- ***Car Owners***: Among car owners, males are the majority at 63.10%, while females constitute 36.90%. This disparity suggests that males are more likely to own cars, possibly due to higher disposable incomes or traditional gender roles in transportation.

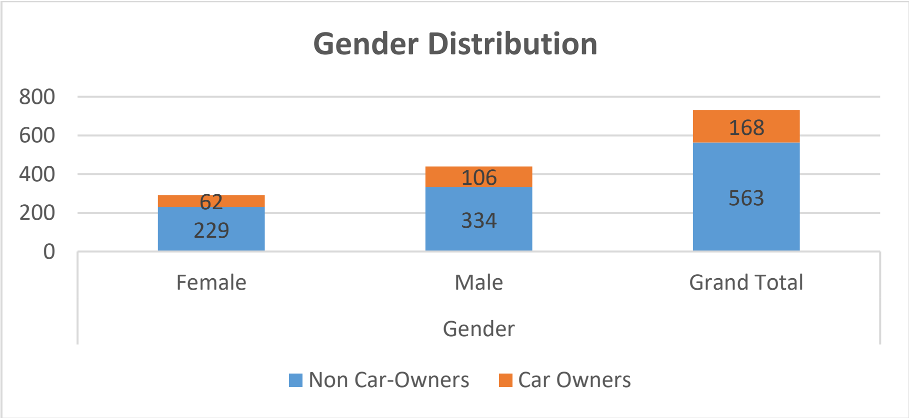

Figure 4: Age Distribution

<u>Occupation Distribution</u>

- ***Non-Car Owners***: The largest occupational group among non-car owners is private employees (49.73%), followed by government employees (28.42%). Self-employed individuals make up 12.97%, students 6.93%, and the unemployed 1.95%. This indicates that ride-hailing services cater to a wide range of commuter profiles, including those who may not have stable incomes or prefer not to invest in car ownership.
- ***Car Owners***: The largest occupational group among car owners is also private employees (42.26%), but there is a higher proportion of self-employed individuals (32.14%) compared to non-car owners. Government employees constitute 20.83%, students 2.98%, and the unemployed 1.79%. This distribution reflects a stable employment status and income level that supports car ownership.

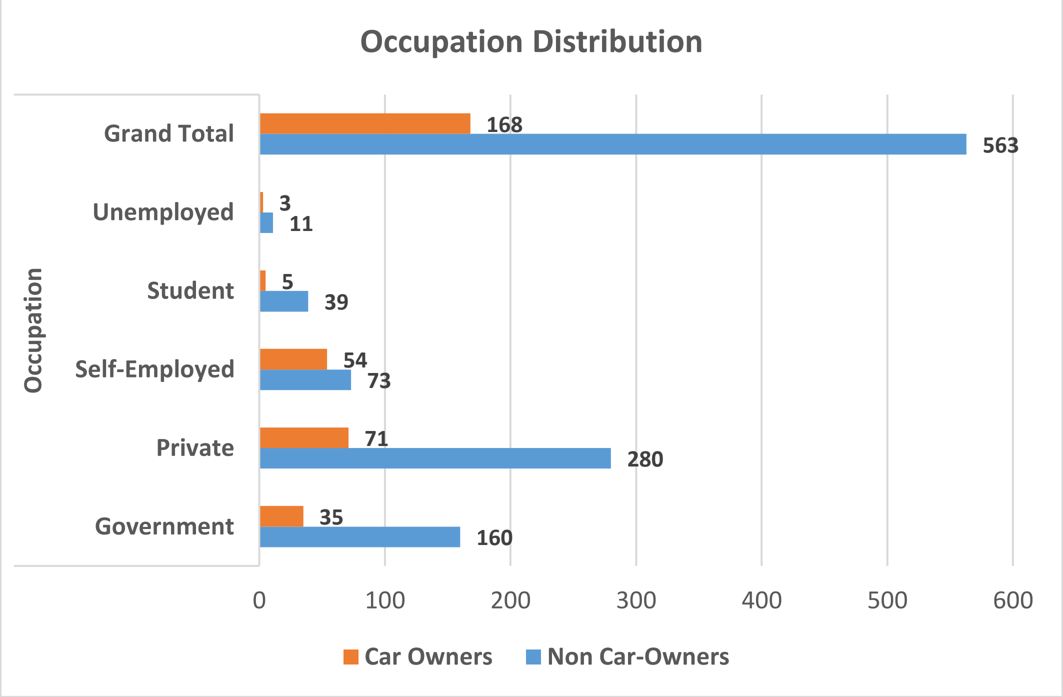

Figure 5: Occupational Distribution

<u>Income Distribution</u>

- ***Non-Car Owners***: Among non-car owners, the most common income range is 12,001 – 24,000 (43.87%), followed by 6,001 – 12,000 (24.69%). The other income ranges are

24,001 - 48,000 (16.52%), 3,001 – 6,000 (8.17%), less than 3,000 (3.37%), and more than 48,000 (3.37%). This highlights economic disparities and suggests that Mid-High-Level income individuals are more reliant on ride-hailing services.

- ***Car Owners***: The income distribution among car owners shows a higher proportion in the 12,001 – 24,000 range (41.07%), similar to non-car owners. However, a significant percentage earns more than 48,000 (19.64%) and 24,001 - 48,000 (22.02%), indicating higher disposable incomes. The proportions for other income ranges are 6,001 – 12,000 (11.90%), 3,001 – 6,000 (2.98%), and less than 3,000 (2.38%).

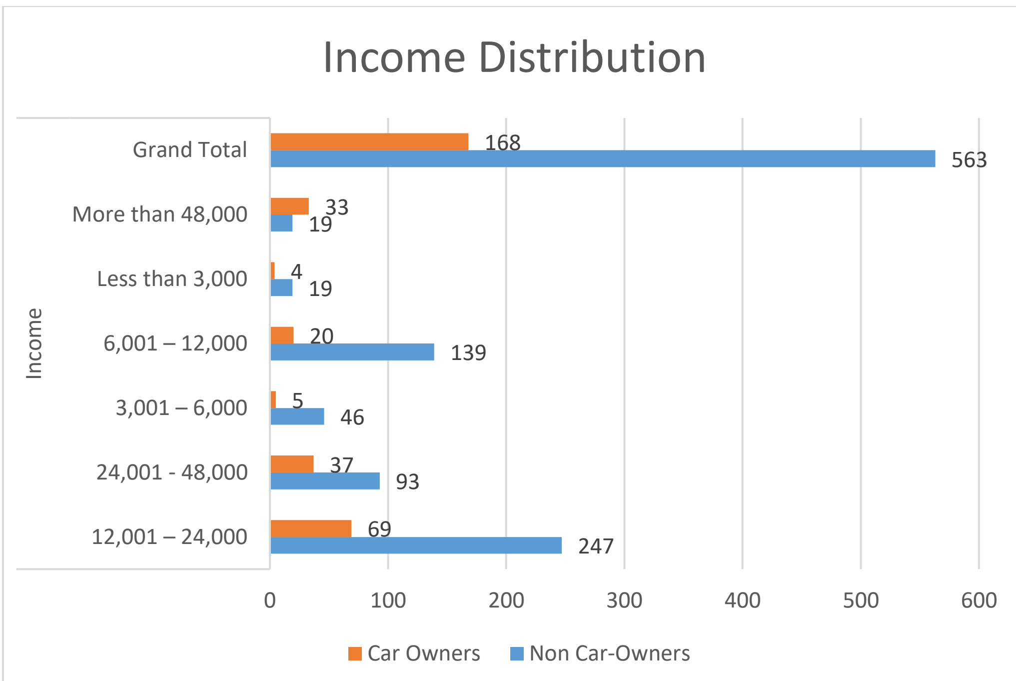

Figure 6: Income Distribution

Summary

The demographic analysis reveals distinct patterns in car ownership and ride-hailing service use. The younger age groups, particularly those aged 18-35, are more likely to use ride-hailing services, while older individuals tend to own cars. Gender disparities indicate that females might rely more on ride-hailing services due to lower car ownership rates. The occupation and income distributions show that ride-hailing services cater to a diverse range of commuter profiles, including those with lower incomes and less stable employment.

4.2. Characteristics of Ride Hailing Users

4.2.1. Pickup and Drop-off Location

The table below provides an overview of the pickup and drop-off locations for both non-car owners and car owners using ride-hailing services, categorized by sub-city.

Sub-Cities	Pickup		Drop-off	
	Non Car-Owners	Car Owners	Non Car-Owners	Car Owners
Addis Ketema	6.04%	4.17%	6.93%	9.52%
Akaki Kaliti	4.62%	2.98%	2.13%	2.38%
Arada	11.37%	6.55%	11.55%	3.57%
Bole	12.26%	22.62%	25.22%	23.21%
Gullele	13.50%	15.48%	7.10%	4.76%
Kirkos	10.30%	8.93%	9.77%	12.50%
Kolfe Keranio	12.61%	12.50%	6.57%	7.74%
Lideta	8.35%	5.36%	11.37%	16.67%
Lemi Kura	5.86%	7.74%	1.42%	4.17%
Nifas Silk Lafto	6.39%	4.76%	4.44%	5.36%
Yeka	8.70%	8.93%	13.50%	10.12%
Grand Total	**563**	**168**	**563**	**168**

Table 3: Pickup and Drop-off Location

This table offers insights into ride-hailing usage patterns among non-car owners and car owners across different sub-cities. However, it is important to highlight that these findings are based on a sample and may not represent city-wide behavior across Addis Ababa. Here are some key insights:

Non-Car Owners:

- ***Bole*** is the most frequent drop-off location, with 25.22% instances, indicating a high demand for ride-hailing services to this area. It is also a significant pickup point with 12.26% instances.

- ***Gullele*** and ***Arada*** are also notable pickup locations, with 13.5% and 11.37% instances respectively. ***Arada*** has a high number of drop-offs (11.55%), suggesting it is a common destination as well.
- ***Kirkos, Kolfe Keranio***, and ***Yeka*** are prominent both as pickup and drop-off locations, showing balanced ride-hailing activity.
- ***Lemi Kura*** has the smallest number of drop-offs (1.42%), indicating fewer rides to this sub-city, although it has 5.86% pickups.

Car Owners:

- ***Bole*** stands out as both a major pickup (22.62%) and drop-off (23.21%) location, similar to non-car owners, highlighting its importance as a hub for car owners using ride-hailing services.
- ***Addis Ketema*** has a higher number of drop-offs (9.52%) compared to pickups (4.17%), suggesting it may be a more common destination than a pickup point for car owners.
- ***Lideta*** shows a significant increase in drop-offs (16.67%) relative to pickups (5.36%), indicating a trend where more car owners are choosing this sub-city as their destination.
- ***Kirkos*** and ***Yeka*** have balanced figures for both pickups and drop-offs, indicating steady ride-hailing usage in these areas.

Generally**, Bole, Arada, and Gullele** are crucial for both non-car owners and car owners, showing high activity in these sub-cities.

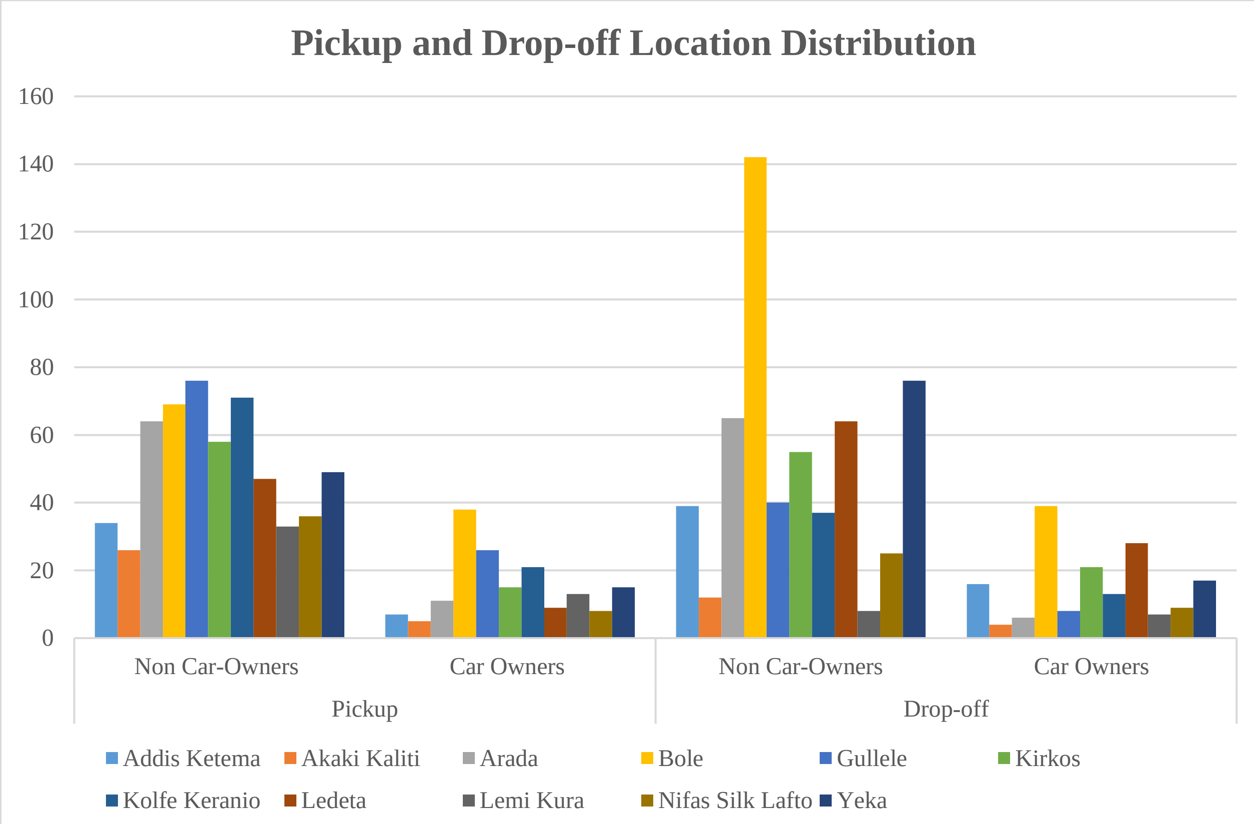

Figure 7: Pickup and Drop-off Location Distribution

The distribution patterns based on the collected sample data suggest that certain sub-cities like Bole are central to the ride-hailing network, serving as key nodes for both pickups and drop-offs.

Overall, the data highlights the diverse usage patterns of ride-hailing services, providing valuable insights for service coverage and addressing the specific needs of different commuter groups across sub-cities.

4.2.2. Trip Durations in Frequent Ride-Hailing Trips: Insights into User Preferences and Variability

The research findings on ride-hailing trip durations provide valuable insights into user preferences, behaviors and typical durations of frequent ride-hailing trips.

<u>Trip Duration Distribution</u>

- 48 respondents (6.6% of the total) reported that their frequent ride-hailing trips usually took between *10 to 20 minutes*.
- The majority of respondents (26.0% of the total) indicated that their typical ride-hailing trips fell within the *20 to 30 minutes* duration range, with a count of 190.
- For 34.4% of the respondents (252 in total), their frequent ride-hailing trips lasted between *30 to 45 minutes*, making this the most common duration range reported.
- A significant portion of respondents (17.2% of the total) were *uncertain* about the duration or experienced variability in their ride-hailing trips, with a count of 126.
- A notable number of respondents (14.6% of the total) mentioned that their ride-hailing trips lasted *more than 45 minutes*, resulting in a count of 107.
- Only a small proportion of respondents (1.1% of the total) reported that their trips lasted *less than 10 minutes*, with a count of 8.

Trip Duration Patterns

The distribution of trip durations highlights the diverse needs and purposes for using ride-hailing services. The majority of respondents reported trips within the ***20 to 45 minutes*** duration range, indicating that ride-hailing is commonly used for *medium-length* commutes or journeys.

The presence of respondents who were uncertain about the duration or experienced variability suggests that ride-hailing trips may be influenced by factors such as traffic conditions, route variations, or specific requirements.

The data suggests that ride-hailing users may prioritize shorter to medium-length trips due to cost considerations. Longer trips typically entail higher fares, which may make them less attractive or feasible for frequent ride-hailing usage. As a result, the count of trips exceeding 45 minutes is relatively lower but notable, constituting 14.6% of the total.

In summary, the data reveals that frequent ride-hailing trips span a range of durations, with the most common durations falling between 20 to 45 minutes. This information can help to understand the preferences and needs of Ride Hailing Service users.

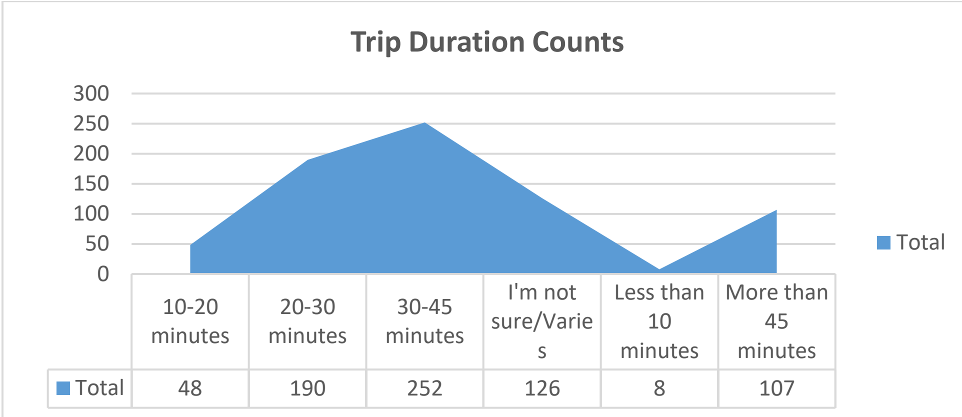

Figure 8: Trip Duration Distribution

4.2.3. Primary Purposes for Using Ride-Hailing Services

This analysis explores the primary purposes for which respondents prefer to use ride-hailing services. The data presents the counts of different trip purposes for each group, providing insights into the usage patterns of these two distinct user segments.

Trip Purpose	Non-Car Owners	Car Owners	Total
Work/Commute	204	46	250
Work/Commute, Social/Leisure	71	20	91
Social/Leisure	49	25	74
Work/Commute, Shopping	35	6	41
Work/Commute, Education	30	5	35
Work/Commute, Shopping, Social/Leisure	27	13	40
Work/Commute, Education, Social/Leisure	26	10	36
Work/Commute, Education, Shopping	24	5	29
Education	22	2	24
Work/Commute, Education, Shopping, Social/Leisure	18	4	22
Shopping	18	11	29
Others (10 or less)	39	21	60
Grand Total	**563**	**168**	**731**

Table 4: Trip Purpose

The reason for segregating the data into car owners and non-car owners is to understand the potential impact of car ownership on the trip purposes for which individuals utilize ride-hailing services. Car ownership can be a significant factor that influences transportation choices and the need for alternative mobility options, such as ride-hailing.

By analyzing the data in these two distinct categories, the research aims to uncover any notable differences in the usage patterns and motivations behind ride-hailing service utilization. This segregation allows for a more nuanced understanding of how the availability or lack of personal vehicle ownership affects the ways in which individuals leverage ride-hailing services to meet their transportation needs.

The respondents were given the following four options to select from, and the table was built accordingly based on the combinations made by the respondents:

- Work/Commute, Education, Shopping, Social/Leisure, Others

The findings reveal several interesting insights. For instance, non-car owners exhibit a higher reliance on ride-hailing services for work/commute purposes, whereas car owners tend to use these services more for social and leisure activities. This suggests that the availability of a personal vehicle may influence the primary motivations behind the use of ride-hailing services.

- ***Work/Commute***: Non-car owners show a significantly higher reliance on ride-hailing services for work/commute purposes, with 36.23% of their trips falling under this category, compared to 27.38% for car owners. This suggests that ride-hailing plays a more prominent role in facilitating the commuting needs of non-car owners.
- ***Social/Leisure***: Car owners tend to use ride-hailing services more for social and leisure activities, accounting for *14.88%* of their trips, compared to *8.70% for non-car owners*. This indicates that car owners may be more inclined to utilize ride-hailing for discretionary, non-essential transportation needs.
- ***Multimodal Trips***: Non-car owners exhibit a *higher tendency to combine multiple trip* purposes, such as work/commute, education, shopping, and social/leisure, when using ride-hailing services. This suggests that they rely on these services to accommodate a broader range of transportation needs in their daily lives. This also highlights the versatility of these

services in addressing the diverse transportation needs of individuals without access to a personal vehicle.

- ***Education and Shopping***: Non-car owners show a greater reliance on ride-hailing services for education-related and shopping-related trips, highlighting their need for these services to access educational institutions and shopping destinations.

4.3. Identifying the factors which affect commuters Ride-Hailing-Service usage

This research utilizes a likert scale to analyze respondents' trip frequency patterns and explore their relationship with demographic factors. The Chi-Square Test was run on SPSS which is a statistical method used to determine whether there is a significant association between categorical variables. It assesses how likely it is that an observed distribution of data would occur by chance if there were no association between the variables.

Non-Car owners

The following graph present the distribution of ride-hailing service trip frequencies among non-car owners, categorized by key demographic factors: age, gender, occupation, and income. The data highlights the percentage and count of individuals who use ride-hailing services with varying regularity, ranging from rare usage to daily trips. The analysis provides insights into how different demographic groups engage with ride-hailing services, offering a comprehensive view of usage patterns and the potential influence of each factor on trip frequency.

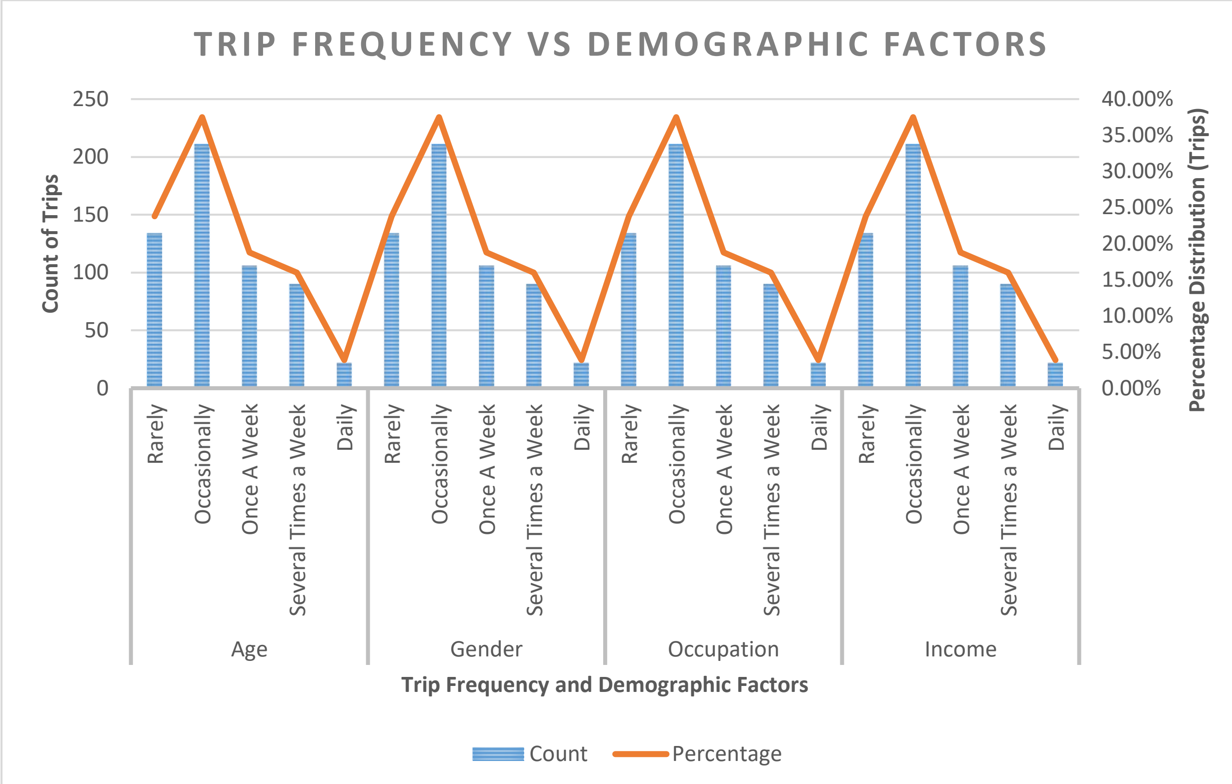

Figure 9: Trip Frequency VS Demographic Factors (Non Car Owners)

a. Trip Frequency vs. Age

The highest frequency of ride-hailing trips occurs "Occasionally" (37.5%) across all age groups. Younger individuals (18-35 years) are more likely to use ride-hailing services occasionally or once a week compared to older individuals.

b. Trip Frequency vs. Gender

Males are slightly more likely to use ride-hailing services "Occasionally" (38.3%) than females (36.2%). However, gender differences in trip frequency are not strongly pronounced.

c. Trip Frequency vs. Occupation

Students and unemployed individuals are more likely to use ride-hailing services "Rarely" (43.6% and 36.4% respectively), while private employees are the most frequent users, particularly "Occasionally" (38.9%).

d. Trip Frequency vs. Income

Individuals with lower income (<3000 Birr) are more likely to use ride-hailing services "Rarely" (47.4%), while those with higher income (>48000 Birr) use it "Daily" (36.8%). Mid-range income groups tend to use the service "Occasionally" or "Once a Week."

4.3.1. Analyzing Factors that Affect Ride Hailing Service Usage amongst Non-Car owners (Demographic Factors)

Below is a combined table that presents both the Chi-Square results for the relationship between Trip Frequency and each demographic factor (Age, Gender, Occupation, and Income).

Variable	Test	Value	df	Asymptotic Significance (2-sided)
Age**	Pearson Chi-Square	21.306	12	0.046
	Likelihood Ratio	21.337	12	0.046
	Linear-by-Linear Association	10.238	1	0.001
	Number of Valid Cases	563		
Gender	Pearson Chi-Square	6.744	4	0.15
	Likelihood Ratio	6.719	4	0.152
	Linear-by-Linear Association	2.477	1	0.116
	Number of Valid Cases	563		
Occupation**	Pearson Chi-Square	30.178	16	0.017
	Likelihood Ratio	32.186	16	0.009
	Linear-by-Linear Association	0.733	1	0.392
	Number of Valid Cases	563		
Income**	Pearson Chi-Square	105.774	20	0
	Likelihood Ratio	73.868	20	0
	Linear-by-Linear Association	34.96	1	0
	Number of Valid Cases	563		

Table 5: Chi-Square test for Non-Car Owners Perceptions toward Ride-Hailing (Demographic Factors)

- The ** markings highlight that **Age**, **Occupation**, and **Income** are significantly associated with trip frequency.

- The Pearson Chi-Square test ($p = 0.046$) and the Likelihood Ratio test ($p = 0.046$) both indicate that there is a statistically significant relationship between age and trip frequency. The Linear-by-Linear Association ($p = 0.001$) further suggests that there is a strong linear trend in how age influences the frequency of ride-hailing service usage. Younger individuals tend to use ride-hailing services more frequently, while older individuals use them less often.
- The Pearson Chi-Square test ($p = 0.150$) and the Likelihood Ratio test ($p = 0.152$) show no statistically significant relationship between gender and trip frequency. The lack of significance implies that gender does not play a crucial role in determining how often individuals use ride-hailing services. Both males and females display similar patterns of usage.
- The Pearson Chi-Square test ($p = 0.017$) and the Likelihood Ratio test ($p = 0.009$) indicate a statistically significant relationship between occupation and trip frequency. This suggests that occupation is an important factor in determining ride-hailing usage, with private employees and students being more frequent users. The non-significant Linear-by-Linear Association ($p = 0.392$) suggests that the relationship is not necessarily linear.
- The Pearson Chi-Square test ($p = 0.000$) and the Likelihood Ratio test ($p = 0.000$) indicate a highly significant relationship between income and trip frequency. The Linear-by-Linear Association ($p = 0.000$) also supports a strong linear relationship, meaning that as income increases, the frequency of ride-hailing service usage also tends to increase. Higher-income individuals are more likely to use these services frequently, while lower-income individuals tend to use them less often.

Overall, the analysis shows that age, occupation, and income significantly influence the frequency of ride-hailing service usage, while gender does not.

4.3.2. Non-Car Owners Perceptions toward Ride-Hailing (Ride Hailing Service Attributes)

This analysis also explores how frequently non-car owners use ride-hailing services based on their evaluations of various ride-hailing attributes, including real-time tracking, time savings, cashless transactions, vehicle selection, driver ratings and reviews, affordability, comfort, availability and accessibility, safety and security, and promotions and discounts. By examining these factors, the study tries to gain insights into the key aspects that influence their ride-hailing choices. The following table provides a detailed summary of the relationship between trip frequency and the perception of different ride-hailing service attributes.

Attributes	**Trip Frequency**	**Very Poor**	**Poor**	**Neutral**	**Good**	**Excellent**	**Total**
Real-time tracking	Rarely	13.6%	27.0%	23.0%	27.4%	17.8%	134
	Occasionally	50.0%	32.4%	36.5%	37.3%	40.2%	211
	Once A Week	9.1%	21.6%	17.6%	15.1%	28.0%	106
	Several times a week (At least 3)	18.2%	13.5%	20.3%	15.6%	12.1%	90
	Daily	9.1%	5.4%	2.7%	4.7%	1.9%	22
Time Saving	Rarely	21.4%	17.9%	16.9%	24.6%	27.8%	134
	Occasionally	21.4%	30.4%	40.8%	39.4%	36.7%	211
	Once A Week	42.9%	19.6%	16.9%	18.2%	18.4%	106
	Several times a week (At least 3)	14.3%	26.8%	16.9%	14.4%	14.6%	90
	Daily	0.0%	5.4%	8.5%	3.4%	2.5%	22
Cashless transactions	Rarely	20.8%	15.8%	29.5%	25.0%	18.4%	134
	Occasionally	33.3%	28.9%	42.3%	38.6%	34.5%	211
	Once A Week	20.8%	25.0%	12.8%	20.0%	20.7%	106
	Several times a week (At least 3)	20.8%	22.4%	12.2%	13.2%	23.0%	90
	Daily	4.2%	7.9%	3.2%	3.2%	3.4%	22
Vehicle selection	Rarely	25.0%	16.0%	27.4%	24.2%	22.4%	134
	Occasionally	37.5%	37.0%	36.9%	40.7%	31.8%	211
	Once A Week	8.3%	18.5%	17.9%	18.6%	24.7%	106
	Several times a week (At least 3)	29.2%	18.5%	15.1%	13.9%	16.5%	90

	Daily	0.0%	9.9%	2.8%	2.6%	4.7%	22
Driver ratings and reviews	Rarely	4.0%	28.7%	24.9%	24.3%	21.5%	134
	Occasionally	32.0%	35.6%	35.8%	41.6%	35.5%	211
	Once A Week	20.0%	18.4%	17.3%	16.2%	26.9%	106
	Several times a week (At least 3)	36.0%	13.8%	17.9%	14.6%	11.8%	90
	Daily	8.0%	3.4%	4.0%	3.2%	4.3%	22
Affordability/Price	Rarely	30.8%	22.9%	23.4%	22.4%	27.9%	134
	Occasionally	38.5%	42.7%	33.5%	38.5%	31.1%	211
	Once A Week	15.4%	19.7%	22.2%	16.1%	16.4%	106
	Several times a week (At least 3)	15.4%	12.7%	17.1%	20.5%	9.8%	90
	Daily	0.0%	1.9%	3.8%	2.5%	14.8%	22
Comfort	Rarely	0.0%	10.0%	22.5%	26.8%	23.8%	134
	Occasionally	71.4%	25.0%	38.2%	40.5%	32.3%	211
	Once A Week	14.3%	25.0%	17.6%	18.7%	18.5%	106
	Several times a week (At least 3)	0.0%	32.5%	18.6%	10.9%	20.8%	90
	Daily	14.3%	7.5%	2.9%	3.2%	4.6%	22
Availability and accessibility	Rarely	16.7%	14.8%	26.3%	27.2%	19.1%	134
	Occasionally	33.3%	31.1%	33.1%	44.0%	31.3%	211
	Once A Week	16.7%	26.2%	17.8%	16.7%	20.9%	106
	Several times a week (At least 3)	25.0%	24.6%	18.6%	9.3%	22.6%	90
	Daily	8.3%	3.3%	4.2%	2.7%	6.1%	22
Safety and Security	Rarely	16.7%	20.4%	27.7%	22.5%	23.5%	134
	Occasionally	41.7%	42.9%	33.8%	40.5%	34.1%	211
	Once A Week	16.7%	14.3%	20.9%	18.0%	19.7%	106

	Several times a week (At least 3)	16.7%	20.4%	13.5%	16.7%	15.9%	90
	Daily	8.3%	2.0%	4.1%	2.3%	6.8%	22
Promotions and discounts	Rarely	23.5%	24.8%	22.1%	19.7%	32.9%	134
	Occasionally	39.2%	37.2%	38.4%	42.6%	26.0%	211
	Once A Week	7.8%	19.3%	21.5%	18.0%	20.5%	106
	Several times a week (At least 3)	27.5%	14.5%	15.7%	13.9%	15.1%	90
	Daily	2.0%	4.1%	2.3%	5.7%	5.5%	22

Table 6: Non-Car Owners RHS users' perception towards RHS Attributes

The table presents the distribution of trip frequency across different service attributes (e.g., Real-time tracking, Time Saving, etc.) with corresponding ratings of those attributes (Very Poor, Poor, Neutral, Good, Excellent).

Attribute	Pearson Chi-Square	df	Asymptotic Significance (p-value)
Real-time tracking	20.732	16	0.189
Time Saving	20.496	16	0.199
Cashless transactions	24.295	16	0.083
Vehicle selection	20.943	16	0.181
Driver ratings and reviews	20.303	16	0.207
Affordability/Price**	32.087	16	0.01
Comfort**	31.274	16	0.012
Availability and accessibility**	30.326	16	0.016
Safety and Security	11.28	16	0.792
Promotions and discounts	19.163	16	0.26

Table 7: Chi-Square Test Result (RHS Trip frequency against the service attributes)

A Chi-Square test run to check whether there is a significant association between the attributes and trip frequency. In the above table, the ** on **Affordability/Price**, **Comfort**, and **Availability and accessibility** indicates that these attributes have a **statistically significant association (p-value <**

0.05) with the dependent variable, **trip frequency**, meaning they likely influence how often users take trips. Attributes without ** (e.g., Real-time tracking, Safety and Security) do not show a significant association with trip frequency. The following interpretation has been made:

- **Affordability/Price (p = 0.01)**, **Comfort (p = 0.012)**, and **Availability and Accessibility (p = 0.016)** have **p-values less than 0.05**, indicating a statistically significant association with trip frequency. This suggests that changes in these attributes are likely to influence how often commuters use the service. **These Attributes** are key factors in influencing commuter behavior.
- Other attributes like **Real-time Tracking**, **Time Saving**, **Cashless Transactions**, and **Driver Ratings and Reviews** have **p-values greater than 0.05**, meaning there is no statistically significant relationship between these attributes and trip frequency.

Car owners

The following data suggests that younger adults, particularly those in their late twenties and early thirties, are the primary users of ride-hailing services. Usage is also higher among males, private sector employees, and those with moderate to higher incomes. Understanding these patterns can help this research to tailor Ride Hailing Services offerings to meet the needs of their primary user demographics.

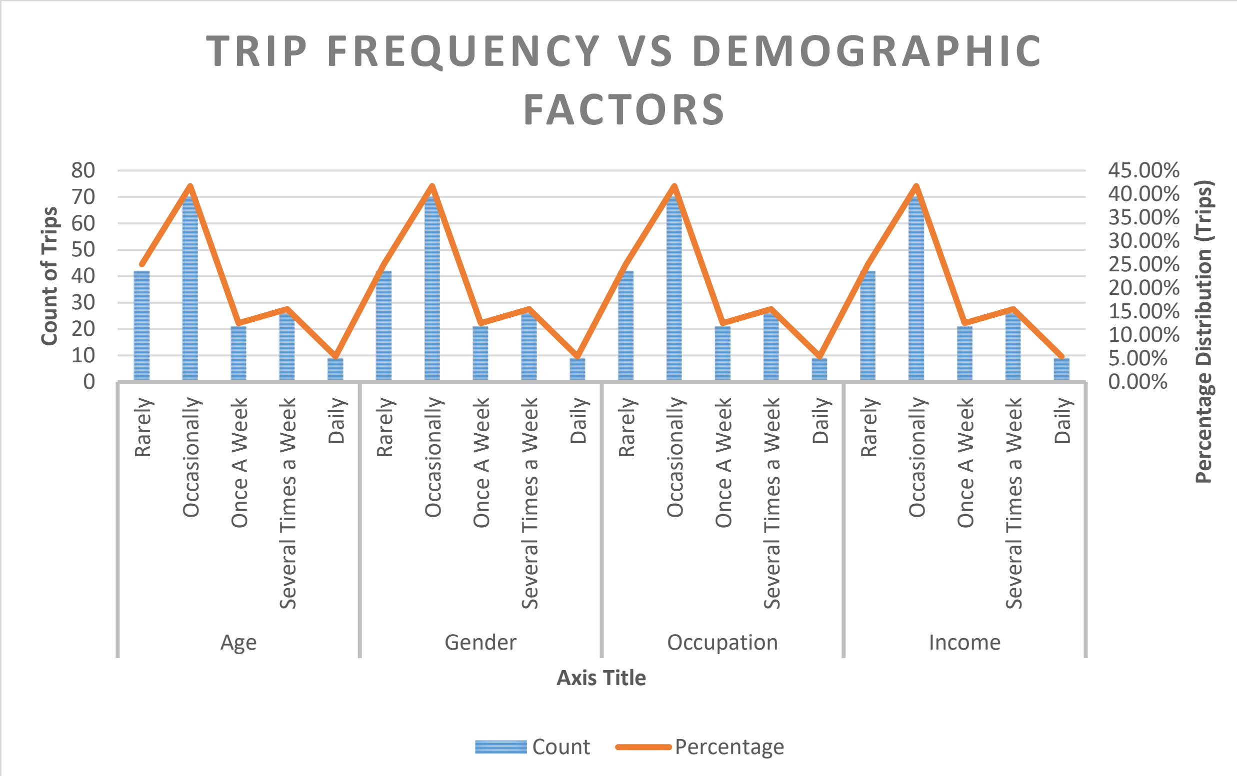

Figure 10: Frequency Distribution (Trip Frequency versus Demographical Factors)

a. Trip Frequency vs. Age

Most car owners aged 26-35 and 36-45 use ride-hailing services occasionally (41.7%). A smaller percentage (5.4%) use the service daily, with a similar trend observed across different age groups.

b. Trip Frequency vs. Gender

Both males and females follow a similar usage pattern, with 41.7% using ride-hailing services occasionally and only 5.4% using them daily. The usage distribution across genders is fairly even.

c. Trip Frequency vs. Occupation

Across different occupations, 41.7% of respondents use ride-hailing services occasionally, with government employees and private sector workers showing similar patterns. Daily usage remains low across all occupations (5.4%).

d. Trip Frequency vs. Income

Regardless of income, 41.7% of respondents use ride-hailing services occasionally, while 25% use them rarely. Higher-income groups have a slightly higher tendency for occasional use, but daily use is consistently low across all income levels (5.4%).

4.3.3. Analyzing Factors that Affect Ride Hailing Service Usage amongst Car owners (Demographic Factors)

In order to understand the factors influencing the adoption and frequency of ride-hailing service usage among car owners this research some analysis. Car owners, who already possess personal vehicles, present a unique demographic whose engagement with ride-hailing services may differ significantly from the general population. This analysis delves into how demographic factors such as age, gender, occupation, and income shape car owners' perceptions and usage patterns of ride-hailing services, providing insights into the motivations and barriers that influence their transportation choices.

Variable	Test	Value	df	Asymptotic Significance (2-sided)
Age**	Pearson Chi-Square	26.642	12	0.009
	Likelihood Ratio	25.554	12	0.012
	Linear-by-Linear Assoc.	9.408	1	0.002
	Number of Valid Cases	168		
Gender	Pearson Chi-Square	4.341	4	0.362
	Likelihood Ratio	4.692	4	0.32
	Linear-by-Linear Assoc.	0.768	1	0.381
	Number of Valid Cases	168		
Occupation**	Pearson Chi-Square	27.612	16	0.035
	Likelihood Ratio	27.587	16	0.035
	Linear-by-Linear Assoc.	2.05	1	0.152
	Number of Valid Cases	168		
Income**	Pearson Chi-Square	50.298	20	0
	Likelihood Ratio	50.528	20	0
	Linear-by-Linear Assoc.	28.466	1	0
	Number of Valid Cases	168		

Table 8: Chi-Square Result (Trip Frequency vs Demographic Factors) For Car Owners

- The ** next to **age, occupation,** and **income** indicates that these variables have statistically significant associations (p-value < 0.05) with trip frequency. This suggests that different age groups exhibit different patterns in how frequently they use ride-hailing services. Age impacts trip frequency, with younger individuals more likely to use ride-hailing services frequently, while older individuals tend to use them less often. The clear statistical significance suggests that age is a crucial demographic factor in understanding and predicting ride-hailing service usage patterns.
- The non-significant p-values imply that **gender** is not significantly associated with **trip frequency**. This means that male and female users likely have similar patterns of ride-hailing service usage.
- These significant p-values suggest a moderate association between occupation and trip frequency. People in different occupations may have varying usage patterns for ride-hailing services. This indicates that the relationship is not linear, meaning the changes in trip frequency do not follow a simple linear trend with occupation.
- The very significant p-values (Pearson Chi-Square ($p < 0.001$), Likelihood Ratio ($p < 0.001$), and Linear-by-Linear Association ($p < 0.001$)) show a strong association between **income** and trip frequency. Higher or lower income levels significantly influence how often people use ride-hailing services. The data shows that higher-income groups, particularly those earning between 24,001 to 48,000 Birr and above 48,000 Birr, use ride-hailing services more frequently.

The Chi-Square tests reveal that age, occupation, and income are significantly associated with trip frequency. In contrast, gender does not show a significant association with trip frequency. This suggests that trip frequency is influenced by age, occupation, and income but not by gender.

4.3.4. Car Owners Perception toward Ride-Hailing (Ride Hailing Service Attributes)

This section examines how specific ride-hailing service attributes, such as real-time tracking, time savings, cashless transactions, vehicle selection, driver ratings and reviews, affordability, comfort, availability and accessibility, safety and security, and promotions and discounts, impact car owners' perceptions and decisions to use these services. The analysis highlights which attributes are most valued and how they influence overall service satisfaction and usage frequency.

Comparison	Chi-Square Value	df	Asymptotic Significance (2-sided)
Real-time tracking*	27.883	16	0.033
Time Saving**	39.212	16	0.001
Cashless transactions*	29.657	16	0.02
Vehicle selection	25.53	16	0.061
Driver ratings and reviews**	39.197	16	0.001
Affordability/Price*	29.547	16	0.021
Comfort**	39.014	16	0.001
Availability and accessibility**	42.652	16	0
Safety and Security*	31.276	16	0.011
Promotions and discounts	25.971	16	0.055

Table 9: Chi-Square Result (Trip Frequency versus RHS Attributes)

For Car Owners (** = has strong statistical significance, * = Moderate)

- Attributes such as **Time Saving**, **Driver ratings and reviews**, **Comfort**, and **Availability and accessibility** have very low p-values (0.001 or 0.000). This indicates a strong, statistically significant association between these attributes and the trip frequency. The results imply these factors play a crucial role in influencing commuter behavior towards using ride-hailing services. These attributes are strongly associated with higher usage or preference patterns.
- **Safety and Security** (p = 0.011), **Affordability/Price** (p = 0.021), **Cashless transactions** (p = 0.020), and **Real-time tracking** (p = 0.033) also show significant associations but with slightly higher p-values. These attributes are also influential but to a somewhat lesser degree.

- **Vehicle selection** (p = 0.061) and **Promotions and discounts** (p = 0.055) show marginal significance. These attributes are not as strong as the rest, and the relationship may not be as robust.

Summary

The analysis identifies key demographic factors influencing ride-hailing service usage among non-car owners, revealing significant relationships between age, occupation, and income, while gender showed no significant effect. Younger individuals (18-35 years) and private employees are more frequent users of ride-hailing services, while lower-income individuals tend to use them rarely, and higher-income individuals use them daily. The study also examines non-car owners' perceptions of ride-hailing attributes, such as real-time tracking, time savings, cashless transactions, vehicle selection, and affordability. Higher satisfaction with these attributes tends to correlate with more frequent usage, highlighting their importance in shaping consumer behavior. Overall, the research underscores the role of demographic and service factors in influencing the adoption and frequency of ride-hailing services among non-car owners.

4.4. Preferences for Switching to an Optimized Public Transport Service

The research aims to examine the preferences of various commuters regarding switching to a newly optimized public transport service. This service incorporates the features rated as important and is comparable to ride-hailing services in terms of convenience, cost, and reliability. The data summary provided give valuable insights into these preferences.

The probability of switching to the newly optimized public transport service, categorized by the two distinct groups of NCOs and COs, is distributed as follows:

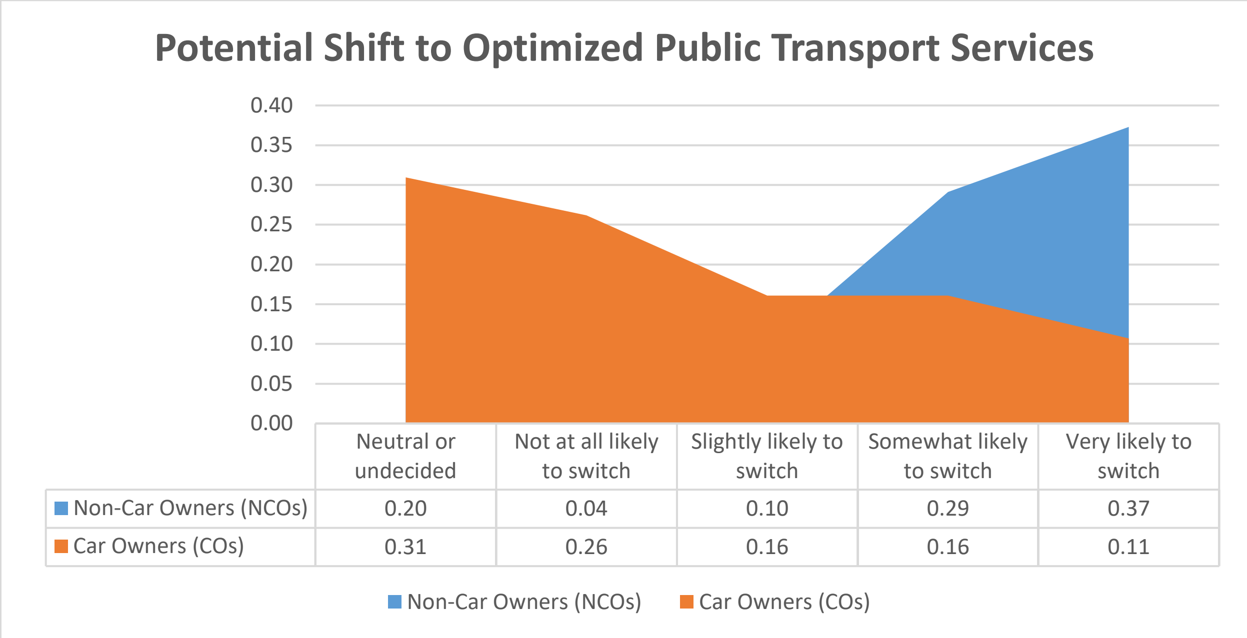

Figure 11: Analyzing Commuter Preferences for Switching to an Optimized Public Transport Service

This distribution shows that a significant portion of respondents (57.3%) are somewhat or very likely to switch to the new public transport service if it matches ride-hailing services in terms of convenience, cost, and reliability. Only 20.1% are either not at all or slightly likely to switch.

The data reveals that NCOs are significantly more likely to switch modes of transport, with 66.4% (374 respondents) either somewhat or very likely to do so, while COs show much more reluctance, with only 26.8% (45 respondents) displaying a strong inclination to switch. Efforts to encourage transport mode switching would need to focus more on providing compelling incentives for COs, as NCOs already exhibit a readiness for change.

Given the clear unwillingness among COs to switch, the analysis of commuter switching potential in the next sub-chapter focuses solely on Non-Car Owners (NCOs). This approach allows for a more targeted analysis of the factors influencing NCOs' choices. In the next session, the research delve into modeling to better understand NCOs' decision-making processes and the variables that drive their likelihood to switch.

4.5. Analysis of Commuter Switching Potential

This sub-chapter delves into the analysis of commuter responses concerning their potential switching behavior from ride-hailing services to the newly proposed public transport system. From the initial pool of 731 participants, responses from 374 individuals (51.2%) were included in this analysis. Among the 563 non-car owners, 189 respondents (33.6%) indicated that they were unlikely to switch to the new public transport service, leading to their exclusion. Similarly, responses from car-owning participants, representing 23% of the total sample, were omitted as they did not yield significant insights for the research objectives. The survey was designed to assess the perceived importance of various attributes in shaping respondents' likelihood of transitioning to the optimized public transport system.

4.5.1. Influence of Demographic Factors on Commuter Switching Behavior

The role of demographic factors in shaping commuter preferences and switching behavior is critical as discussed on chapter 2 for understanding of the modal choice, and adoption of the newly proposed public transport system. Table 10 below presents the Weibull model parameters shape (β) and scale (α) for Age, Gender, Occupation, and Income, providing insights into the distribution and concentration of commuter preferences across these variables.

Parameter	Shape (β)	Scale (α)
Age	2.94	2.1
Gender**	4.06	1.79
Occupation	2.37	2.35
Income**	4.05	4.17

Table 10: Weibull Model Parameters for Demographic Factors

Using the above parameters, the study applied the Weibull probability distribution function $f(t;k,\lambda) = \lambda/k\,(\lambda/t)^{(k-1)}\,e^{-(\lambda/t)^{\wedge}k}$, to assess the switching potential of commuters based on each variable. The computed probability values for various x-values illustrate how each demographic factor influences commuter switching behavior. This is visualized in Figure 1, where the probability curves for Age, Gender, Occupation, and Income reveal distinct trends.

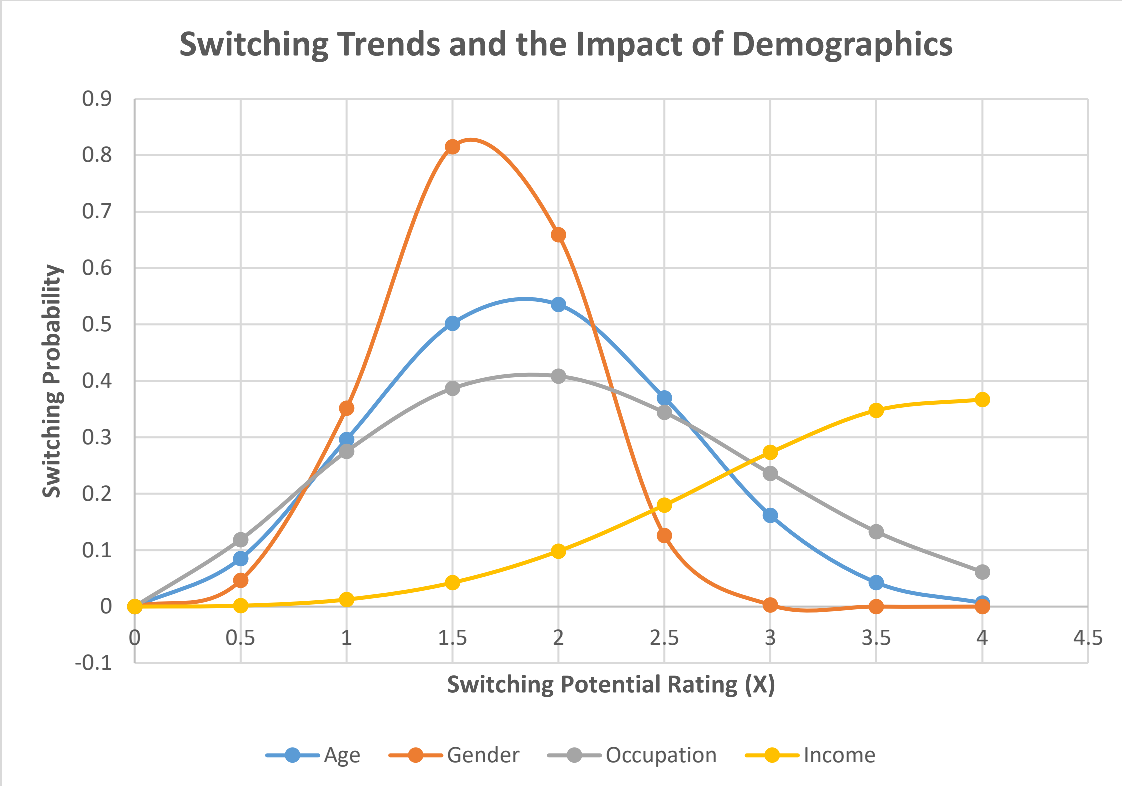

Figure 12: The Impact of Demographic Factors on Commuters Switching Trend

This graph illustrates the interplay of key demographic factors in shaping commuters' switching behavior to the newly proposed public transport system. The x-axis represents the **switching potential**, rated on a scale from 1 (Not at all likely to switch) to 5 (Very likely to switch), as chosen by respondents. By leveraging the Weibull probability density function, the study uncovers distinct behavioral trends for each variable, offering valuable insights into their influence on decision-making. For clearer interpretation, each variable will be presented in separate graphs with explicitly labeled axes in subsequent revisions.

The “Age” curve peaks sharply between x = 1.5 and x = 2, highlighting a significant propensity for switching among certain age groups. The “Gender” curve is characterized by a steep ascent and a rapid decline, peaking around x=1.5. This pronounced and narrow peak underscores the concentrated influence of gender-specific factors.

In contrast, “Occupation” presents a broader distribution, with its peak near x = 2. This suggests that switching behavior is influenced by professional roles and associated commuting needs, but the effect is more evenly distributed across occupational categories.

Finally, “Income” demonstrates a delayed but sustained influence, with its peak observed closer to x=3.5. The gradual rise and prolonged probability density at higher x values suggest that higher-income groups, while slower to switch, exhibit a strong potential over time.

Together, these insights reveal the multifaceted impact of demographic factors on switching behavior. They underscore the need for targeted strategies that address the unique motivations and barriers of each group. By doing so, the proposed public transport system can achieve greater resonance and adoption among diverse commuter segments, paving the way for its long-term success.

4.5.2. Influence of Key Attributes on Commuter Switching Behavior

To further understand the impact of various attributes on the likelihood of switching behavior, the Weibull distribution was employed to estimate the shape (Beta) and scale (Alpha) parameters for each attribute. The analysis captures the variability and significance of attributes such as real-time tracking, time saving, affordability, and safety in influencing commuter preferences.

Parameter	Shape (β)	Scale (α)
Real-time tracking	3.352364	3.120775
Time Saving**	5.805491	3.605893**
Cashless transactions	2.848874	2.923771
Driver ratings/reviews	2.920836	2.932915
Affordability/Price**	3.710216	3.367109
Comfort**	4.992871	3.463808
Availability**	4.942957	3.547144
Safety/Security**	5.366999	3.628267
Scheduling	3.15057	3.11164
Promotions/Discounts	2.817055	2.944215

Table 11: Weibull Parameters for Attributes

Attributes marked with ** indicate higher significance based on the shape (β) and scale (α) parameters.

These parameters highlight the critical attributes influencing commuter preferences and serve as key focus areas for improving the proposed public transport system.

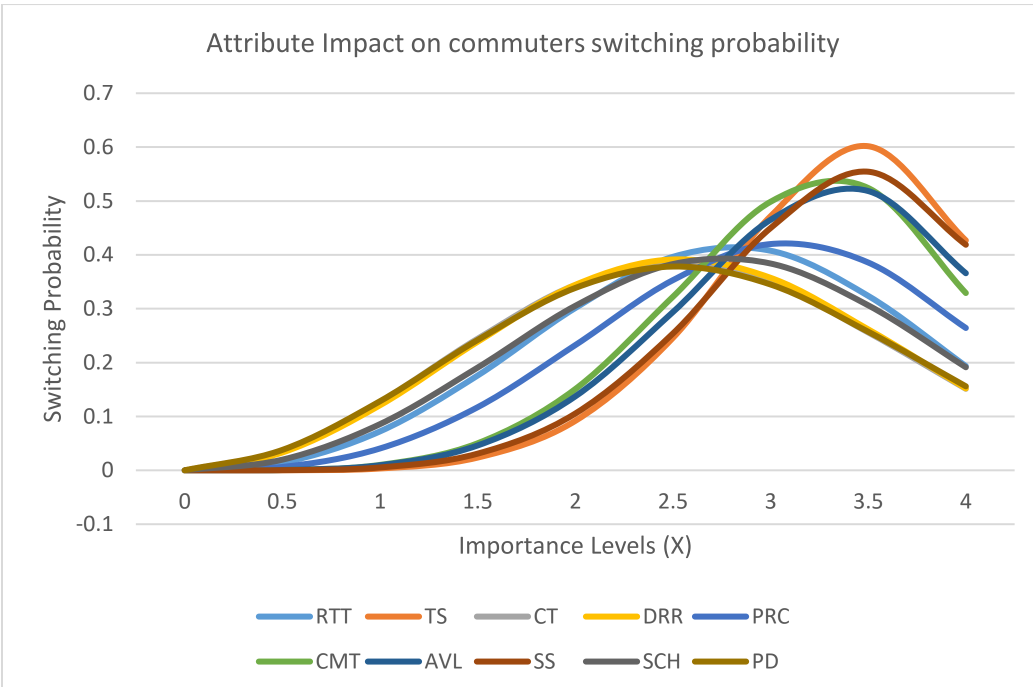

Figure 13: The Impact of Different Attributes Factors on Commuters Switching Trend:

The graph above provides a nuanced depiction of the influence of various attributes on commuters' switching potential from Ride-Hailing Services (RHS) to the proposed public transport system. The Weibull distribution curves reveal distinctive patterns in commuter preferences, allowing the study to categorize attributes based on their peak relevance and the dynamics of their probability densities.

Attributes like Comfort (CMT), Availability (AVL), Safety and Security (SS), and Time Saving (TS) demonstrate a consistent upward trend, reaching their peak influence at higher value ranges (x > 3). This suggests that these attributes are critical for commuters who place greater emphasis on quality and efficiency, highlighting their role in decision-making processes at advanced stages of consideration.

In contrast, attributes such as Promotions and Discounts (PD), Scheduling (SCH), and Price (PRC) exhibit their highest probability densities in the mid-range values ($x \approx 2.5$). This indicates their appeal to a more cost-conscious segment of the commuter population, who prioritize affordability and time management over premium features.

Interestingly, Real-Time Tracking (RTT), Driver Ratings and Reviews (DRR), and Cashless Transactions (CT) follow a moderate rise-and-fall pattern, peaking at $x \approx 2.5$. These attributes appear to cater to a transitional group of users who value convenience and trust in the service but do not prioritize these features as primary drivers of their switching decision.

The Weibull distribution's ability to model the rise and decline of each attribute's importance offers a comprehensive view of commuter preferences. This analysis underscores the multifaceted nature of switching behavior, where different attributes resonate with distinct segments of the population. Tailoring strategies to emphasize key attributes like safety, comfort, and availability could prove instrumental in encouraging widespread adoption of the proposed public transport system. Meanwhile, leveraging promotions and affordability could attract those motivated by economic considerations, bridging the gap between diverse commuter priorities.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

This chapter summarizes the key findings of the research and offers recommendations based on the analysis of mode choice behavior between ride-hailing services (RHS) and the proposed optimized Public Transport (PT) system. The research aimed to assess the impact of ride-hailing services on commuters' mode choices and to propose strategies to make PT a more competitive and attractive option.

5.1. Conclusion

This study analyzed the socioeconomic characteristics, preferences, and behaviors of commuters using ride-hailing services, with a specific focus on the potential for switching to an optimized public transport system. Based on the findings in Chapter 4, the following key conclusions are drawn:

A. Demographics and Usage Patterns:

- Among non-car owners, 60.21% fall within the 26-35 age group, with 27.18% in the 18-25 age range, indicating a reliance on ride-hailing services by younger commuters. Similarly, 51.79% of car owners belong to the 26-35 age group, showing some overlap in the demographic profile.
- Gender disparities were minimal, with males representing 59.32% of non-car owners and 63.10% of car owners, while females constituted 40.68% and 36.90%, respectively.
- Income levels varied significantly, with 43.87% of non-car owners earning between 12,001 and 24,000 Birr monthly, compared to 41.07% of car owners. Higher income groups (≥48,000 Birr) were more likely to use ride-hailing services frequently.

B. Key Attributes Influencing Ride-Hailing Service Usage:

- Among non-car owners, attributes like affordability ($p = 0.01$), comfort ($p = 0.012$), and availability/accessibility ($p = 0.016$) were statistically significant in determining trip frequency.

- For car owners, attributes such as time saving ($p = 0.001$), driver ratings/reviews ($p = 0.001$), and safety/security ($p = 0.011$) emerged as critical determinants.

C. Switching Potential to Optimized Public Transport:

- 66.4% of non-car owners and 26.8% of car owners indicated they were somewhat or very likely to switch to an optimized public transport system if it matched ride-hailing services in terms of convenience, cost, and reliability.

- Attributes like comfort (4.99 scale parameter), availability (4.94), and safety/security (5.37) significantly influenced the likelihood of switching, as shown in the Weibull analysis.

D. Weibull Analysis of Switching Behavior:

- Younger individuals, particularly those aged 18-35, exhibited stronger preferences for switching to the new system. Higher-income groups, earning above 48,000 Birr, also showed increased interest in transitioning to optimized public transport.
- Service attributes like comfort, affordability, and availability demonstrated peak relevance for commuters prioritizing quality and efficiency.

This study highlights the potential for public transport to compete with ride-hailing services if key service attributes such as comfort, availability, and reliability are prioritized. Understanding commuter demographics and preferences is essential to driving successful transitions in urban mobility systems.

5.2. Recommendation

Based on the conclusions, the following recommendations are proposed to enhance the competitiveness of PT and encourage a mode shift from RHS:

A. Integrate Key Ride-Hailing Features:

- Incorporate attributes like comfort (scale parameter 4.99), real-time tracking, and time-saving scheduling to align with commuter expectations.

B. Target Non-Car Owners:

- Design campaigns to raise awareness of the benefits of the optimized public transport system among non-car owners, who make up 76.9% of the total commuter base.
- Collaborate with private stakeholders to enhance accessibility and coverage, especially in underserved areas like Lemi Kura, where only 1.42% of non-car owners reported frequent drop-offs.

C. Develop Incentives for Switching:

- Offer discounted passes, cashless payment options, and promotions to encourage trial use of the optimized system. For instance, targeting the 57.3% of respondents who are somewhat or very likely to switch could maximize adoption.

D. Enhance Key Service Attributes:

- Ensure affordability while maintaining service quality to attract cost-sensitive users, particularly the 60.4 % of non-car owners earning between 12,000 Birr to 48,000 Birr monthly.
- Focus on comfort and availability by increasing the fleet size and ensuring quality service, addressing the 60.21% of non-car owners aged 26-35 who rely on ride-hailing services for their commutes.
- Emphasize safety features and driver quality through rigorous training and monitoring, as safety/security scored a significant influence (scale parameter 5.37) in determining switching likelihood.

5.3. Future Studies

The current study provides a foundation for understanding commuter preferences and behaviors. However, several areas warrant further exploration:

- ***Longitudinal Studies***: Assess how changes in socioeconomic factors (e.g., income levels, urbanization) influence commuter behavior over time.
- ***Technology Integration***: Investigate the impact of integrating advanced technologies (e.g., AI-driven scheduling, electric vehicles) into public transport systems.
- ***Behavioral Insights***: Explore the psychological barriers and motivators influencing the decision to switch from ride-hailing to public transport.
- ***Broader Scope***: Expand the analysis to include car owners and assess strategies to incentivize their shift to shared mobility options.

This study highlights the pivotal role of service quality, affordability, and demographic alignment in shaping commuter choices. By leveraging these insights, stakeholders can effectively design and implement systems that meet the evolving needs of urban commuters.

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Annex

A. Questionnaire

Thank you for participating in our research study. The following questionnaire aims to gather information about your experiences, perceptions, and preferences regarding transportation modes, specifically ride-hailing services and public transport. Your responses will remain confidential and will be used for research purposes only.

1. **Demographic Information:**

1.1. Age: Under 18 ☐ 18-25 ☐ 26-35 ☐ 36-45 ☐ 46 and Above ☐

1.2. Gender: Male ☐ Female ☐

1.3. Occupation: Private ☐ Government ☐ Unemployed ☐ Student ☐ Self-Employed ☐

1.4. Income: < 5,000 ☐ 5,001 – 1,0000 ☐ 10,001 – 20,000 ☐ 20,001 – 40,000 ☐ > 40,001 ☐

1.5. Car Ownership - Car Ownership - Do you have a car?: Yes ☐ No ☐

1.6. Have you ever use ride hailing service before?

☐Yes

☐No

Specific Questions:

1. **Car Owners and Potential Shift to Optimized Public Transport**

This section is designed to gather information specifically from car owners. Your feedback as a car owner is crucial to help the research understand your preferences, experiences, and needs related to owning and using a car. Please provide honest and detailed responses to the questions below.

1.1. How frequently do you currently use your private car for your daily commuting or transportation needs?

☐Daily

☐Several times a week (at least 3 times a week)

☐Once a week

☐Occasionally

☐Rarely

1.2. What are the main reasons for choosing your private car over public transport for your daily commuting or transportation needs? Please select all that apply:

☐ Convenience and flexibility

☐ Comfort

☐ Privacy

☐Avoiding crowded spaces

☐Other (Please specify: ___________________)

1.3. On a scale of 1 to 5, where 1 is "Not at all likely" and 5 is "Extremely likely," how likely are you to consider using a newly introduced public transport services as an alternative to your private car?

☐ 1 (Not at all likely) ☐ 2 (Unlikely) ☐ 3 (Neutral)

☐ 4 (Likely) ☐ 5 (Extremely likely)

1.4. What factors would encourage you to shift from using your private car to the newly introduced public transport services? Please select all that apply:

☐ Improved service frequency and reliability

☐ Reduced travel time

☐ Cost-effectiveness

☐ Enhanced comfort and amenities

☐ Other (Please specify: ___________________)

2. Ride-hailing Users

This section aims to gather information about your experience and usage of ride-hailing services. Please provide your honest feedback to help the research to understand your preferences and perception.

2.1. Specific Residential Area/Usual Pickup location: (Sub-City and Woreda)

____

2.2. Usual Drop of location: (Sub-City and Woreda) ___________________________

2.3. How frequent you use Ride-Hailing service?

☐ Daily

☐ Several times a week (at least 3 times a week)

☐ Once a week

☐ Occasionally

☐ Rarely

2.4. How long does your frequent ride-hailing trip usually take?

☐Less than 10 minutes

☐10-20 minutes

☐20-30 minutes

☐30-45 minutes

☐More than 45 minutes

☐I'm not sure/Varies

2.5. ☐Which ride-hailing service(s) have you used in the past? (Select all that apply)

☐RIDE

☐ZayRide

☐Feres

☐Seregela

☐ETTA Addis

☐Meter Taxi

☐Hello Taxi

☐Pick Pick

Other (Please specify: ____________________________)

2.6. What are the primary purposes for which you prefer to use ride-hailing services? Please select all that apply:

☐Work/Commute

☐Education

☐Shopping

☐Social/Leisure

☐Other (Please specify: __________________)

2.7. How would you rate the overall service quality of ride-hailing companies? (Scale: 1-5)

☐ 1 (Poor) ☐2 (Fair) ☐3 (Average) ☐4 (Good) ☐5 (Excellent)

2.8. What features of ride-hailing services do you find most appealing? Specifically Rate each metric on a Scale of 1-5:

Features	Very Dissatisfied (1)	Dissatisfied (2)	Neutral (3)	Satisfied (4)	Very Satisfied (5)
Real-time tracking	☐	☐	☐	☐	☐
Time Saving	☐	☐	☐	☐	☐
Cashless transactions	☐	☐	☐	☐	☐
Vehicle selection	☐	☐	☐	☐	☐
Driver ratings and reviews	☐	☐	☐	☐	☐
Affordability/Price	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Availability and accessibility	☐	☐	☐	☐	☐
Safety and Security	☐	☐	☐	☐	☐
Promotions and discounts	☐	☐	☐	☐	☐

Other (Please specify: __________________)

3. About the new Optimized Public Transport:

This section aims to gather your valuable opinions and preferences regarding a new optimized public transport system. Your feedback will play a crucial role in helping this research to

understand your needs and expectations, enabling the research to analyze, recommend and capture enhancements to a new hypothetical public transportation experience.

3.1. What are the primary purposes for which you prefer to use public transport? Please select all that apply:

☐Work/Commute

☐Education

☐Shopping

☐Social/Leisure

☐Other (Please specify: __________________)

3.2. *Historical Behavior*: Before the introduction or awareness of ride-hailing services, What did you typically choose as a mode of transportation for your trips? Please select the option that best represents your behavior:

☐Public Transport (bus, subway, train, etc.)

☐Personal Vehicle (car, motorcycle, bicycle, etc.)

☐Walking

☐Taxi Services

☐Carpooling/Ridesharing with friends or colleagues

☐Other (Please specify: ________________)

3.3. *Hypothetical Scenario*: If ride-hailing services were to accidentally stop operating, Which alternative mode of transportation would you choose for your trips? Please select your preferred alternative mode(s) in order of preference:

☐Public Transport (Buses, Higer, LRT, etc.) (Please specify: __________)

☐Personal Vehicle (car, motorcycle, bicycle, etc.) (Please specify: __________)

☐Walking

☐Taxi Services

☐Carpooling/Ridesharing with friends or colleagues

☐Other (Please specify: ________________)

3.4. Please rate your satisfaction with the overall service quality of the following specific public transport modes on a scale of 1 to 5, where 1 indicates "Very dissatisfied" and 5 indicates "Very satisfied." Place a checkmark (✓) in the corresponding checkbox to indicate your satisfaction level.

Modes	Very Dissatisfied (1)	Dissatisfied (2)	Neutral (3)	Satisfied (4)	Very Satisfied (5)
City Buses (Anbesa/Sheger)	☐	☐	☐	☐	☐
Minibus	☐	☐	☐	☐	☐
Higer	☐	☐	☐	☐	☐
LRT	☐	☐	☐	☐	☐
Public Service	☐	☐	☐	☐	☐

3.5. What improvements would you suggest to enhance public transport services? Please rate the following improvements on a scale of 1 to 5 based on their importance in enhancing public transport services, where 1 indicates "Not important" and 5 indicates "Very important." Place a checkmark (✓) in the corresponding checkboxes to indicate your rating. You can also specify any other improvements not listed.

Improvements	Not Important (0)	Neutral (1)	Very Important (2)
Real-time tracking	☐	☐	☐
Time Saving	☐	☐	☐
Cashless transactions	☐	☐	☐
Driver ratings and reviews	☐	☐	☐
Affordability/Price	☐	☐	☐
Comfort	☐	☐	☐
Availability and accessibility	☐	☐	☐
Safety and Security	☐	☐	☐
Scheduling	☐	☐	☐
Promotions and discounts	☐	☐	☐

Other (Please specify: __________________)

3.6. If a newly optimized public transport service, incorporating the features you rated earlier, were available and comparable in terms of convenience, cost, and reliability to ride-hailing services, how likely would you be to switch from using ride-hailing services to the newly optimized public transport service?

☐Not at all likely to switch

☐Slightly likely to switch

☐Neutral or undecided

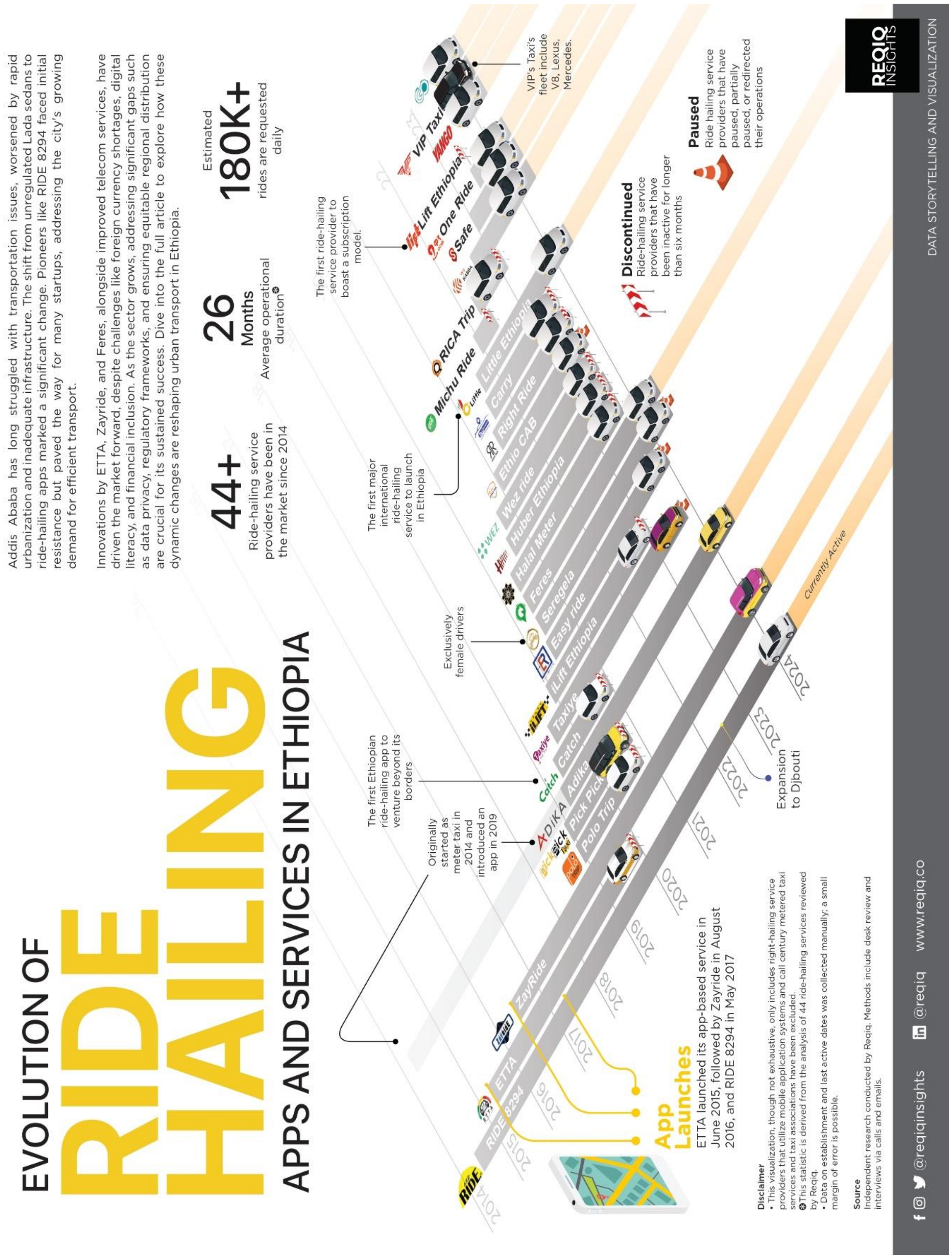
☐Somewhat likely to switch

☐Very likely to switch

3.7. Considering the features of the newly optimized public transport service you rated earlier, please indicate how much you would be willing to pay for each feature. Please select the price range that you find reasonable.

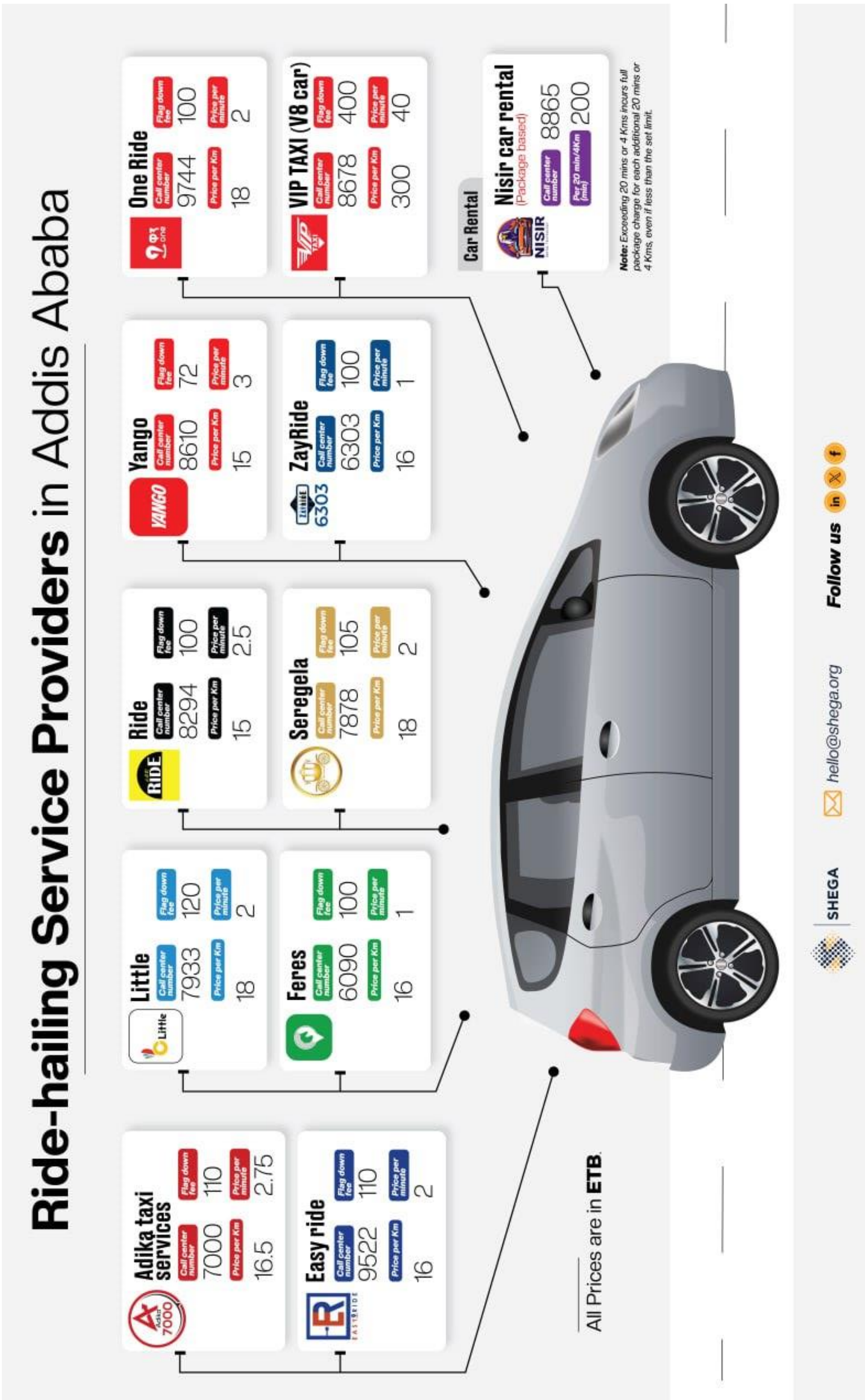
Improvements	**Price Range You would be willing to pay (In Birr)**				
	0 - 10	11 - 30	31 - 50	51 - 80	81 – 110
Real-time tracking	☐	☐	☐	☐	☐
Time Saving	☐	☐	☐	☐	☐
Cashless transactions	☐	☐	☐	☐	☐
Driver ratings and reviews	☐	☐	☐	☐	☐
Affordability/Price	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Availability and accessibility	☐	☐	☐	☐	☐
Safety and Security	☐	☐	☐	☐	☐
Scheduling	☐	☐	☐	☐	☐
Promotions and discounts	☐	☐	☐	☐	☐

B. About Ride-Hailing Service



Source 1: Reqiq.co

C. Fares of Popular Ride Hailing Service Providers



Source 2: Shega Media