ISSUES AND CHALLENGES CONCERNING FIRST AND LAST MILE TRAVEL IN TWIN CITIES OF PAKISTAN

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CERTIFICATE

This is to certify that this thesis entitled **"Issues and challenges Concerning first and Last Mile Travel in Twin Cities of Pakistan."** submitted by **Mehreen Idrees Khan** is accepted in its present form by the PIDE School of Social Sciences, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in Master of Philosophy in Development Studies.

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Author's Declaration

I **Mehreen Idrees Khan** hereby state that my MPhil thesis titled **"Issues and Challenges Concerning First and Last Mile Travel in Twin Cities of Pakistan"** is my work and has not been submitted previously by me for taking any degree from the Pakistan Institute of Development Economics or anywhere else in the country/world. At any time if my statement is found incorrect even after my Graduation the university has the right to withdraw my MPhil degree.

Date: 11th July 2024

Signature of the Student

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Dedication

I dedicate this dissertation to my parents for their unconditional support and prayers.

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I express deep gratitude and unending praises to Almighty Allah, forever thankful for providing me the opportunity and courage to undertake and complete my thesis. I am immensely appreciative of my supervisor, Dr. Abid Rehman, whose noble guidance, patience, and encouragement played a crucial role in steering this study to completion. Working under his brilliant supervision has been a great pleasure, and I have learned a lot in a comfortable research environment. I also extend my thanks to Dr. Anjeela, the internal reviewer, for providing valuable insights, and Dr. Saba Anwar, my co-supervisor, for her constructive contributions. My heartfelt thanks go to my parents for their unwavering support, and I acknowledge my family's love and care. Special thanks to my friends whose conversations encouraged me to think creatively. Lastly, I express my gratitude to my best friend for continuous support and encouragement, always cheering me up and preventing me from giving up.

ABSTRACT

The research provides an in-depth analysis of the first and last-mile travel needs, and associated costs based on commuter perception in Islamabad and Rawalpindi. The study employs a quantitative research approach and gathers data through a structured questionnaire administered to 360 respondents at 18 selected metro stations. A mixed linear regression (MLR) was employed to assess travel costs. The study highlights the impact of income levels on commuting costs, with gender and age-related patterns influencing commuting priorities. Walking is the preferred mode among commuters. Personal car ownership is prominent among higher-income groups. Despite the popularity of the metro bus service, safety and infrastructure concerns persist. Affordability emerges as a key factor, focusing on the need for comprehensive transportation planning, with 89.7% of respondents agreeing that cost is crucial. Challenges include uneven distribution of transportation modes and inadequate infrastructure. 89.4% of respondents agreed that there are no proper ramps and elevator facilities for elderly people and PWDs. The study concludes with policy recommendations to enhance safety, diversify transportation options, and address affordability and accessibility concerns for a more sustainable and equitable commuting experience in the twin cities.

Keywords: First mile, Last mile, Mode choice, Accessibility, Commuting cost, Urban planning

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LIST OF ABREVIATIONS

CDA	Capital Development Authority
FM/LM	First Mile/Last Mile
MBS	Metro Bus Service
MLR	Multiple Linear Regression
MTS	Mass Transit System
PMA	Punjab Mass Transit Authority
PMBS	Punjab Metro Bus Service
PWDS	People with Disabilities

CHAPTER 1

INTRODUCTION

1.1. Background of Study

The rapid expansion of urban areas in developing countries results in population and economic growth (Cohen, 2006). Urban growth, driven by economic development and rural-urban migration, has led not only to the complex transformation of cities throughout the world (Shirazi & Kazmi, 2020), but also to negative externalities such as lagging infrastructure development and extreme traffic congestion, affecting the urban resident's commute (Vermeiren et al., 2015).

As a result of rapid urbanization, urban mobility is increasing at a higher rate which in turn has increased vehicle usage and this was because people were highly incentivized by government policies. However, in developing nations, transportation systems create predicaments like air pollution, poor services, and congestion. Due to high societal inequalities and low incomes, poor people are forced to walk or bike even for long-distance trips, in developing countries (Motta et al., 2013). On the other hand, middle and upper strata prefer using their own modes of transportation as public transport in terms of its accessibility.

Urban mobility plays a crucial role in determining quality of life and access to goods and opportunities, impacting social structures and daily mobility patterns (Hernández, 2018). However, there has been an unchecked growth of private sector transportation which results in a decrease in urban mobility as distance between economic activities is increased (Litman,2007). Transport systems are also not providing adequate, safe, and attractive mobility choices to commuters which forces commuters to rely highly on personal vehicles, motorcycles, and rickshaws, which results in congestion, parking issues, an increase in travel time, road accidents, and other health problems. Urbanization and population growth have led to expeditious growth of cities due to which the travel demand has increased (Motta et al., 2013). The movement of people requires a well-founded mobility system.

The cost of living and commuting is a big challenge for city management. The increasing cost of living and congestion in cities can lead to urban sprawl (Haque & Nayab, 2020). Transportation disparities and unequal distribution of people and opportunities can lead to social exclusion, low quality of life, and hinder economic growth (Gates et al., 2019). The absence of public transportation results in people exclusion from participating in economic and social activities. Cities are always struggling with a lot of issues due to public transport accessibility and dependence on automobiles. In developing countries, urban areas are increasingly dominated by automobiles, creating transportation challenges. Planning for urban mobility is particularly challenging when it comes to the transit system, which must consider not only cars but also public transportation. Effective planning for urban mobility is crucial for efficient and safe transportation. Commuters face difficulty during their first mile and last-mile travel (Liu et al., 2018).

Transit passengers often spend a considerable amount of time and effort on walking toward transit, and waiting for transit, making the travel experience more complex. Many commuters find it challenging to access transit stations from their origin or destination due to numerous factors such as geography, topology, street network design, and limited transportation options. This often discourages commuters and limits the usage of the transportation system (Fehr and Peers, 2015). In the urban world, the term first and the last mile holds great importance. The literature provides several definitions of first/last mile travel, two of which are:

"The first/last mile travel is the distance walked from the starting point to a boarding stop and from the boarding stop to the last destination when taking public transit (Kumar & Khani, 2021)."

"Distance between public transit and final destination is referred to as first mile, whereas the distance between the residence and public transit is typically known as the last mile (Karesdotter et al., 2022)."

The first and last-mile travel is quite challenging for people, especially for females and people with disabilities (PWDs). The lack of accessible transportation alternatives and infrastructure, poor walkways, and non-availability of public transit make it quite challenging for PWDs to travel freely, which may limit their access to essential services. Poor planning limits people with disabilities from accessing public transportation securely to engage in social activities and necessary services (Ramli et al., 2022).

Cities are seen as modern living hubs, with higher female labor force participation and their social mobility, is typically higher (Cohen, 2006). Female mobility for education purposes and job seeking have increased their need to commute but they have to limit it due to unsafe mobility. When it comes to physical mobility, female workers are more constrained in cities, to conservative norms and a high rate of crime or ability to commute safely (Field & Vyborny, 2022). Women face violence and harassment in public transport when they commute for educational or job-related purposes (Zulfiqar, 2020).

Travelling the first or last mile can be challenging for commuters. Public transportation is often neither reasonable nor safe and may not take passengers to their exact destination. While owning a personal car can be a good solution for some, it may not be financially viable for others. Taxis and ride-sharing services like Uber can be alternatives, but they also contribute to traffic congestion while walking is not always the quickest or safest way to move around the city (Karesdotter et al., 2022).

Improper connectivity between the transit stops and the starting point of the journey can cause first-mile issues. Factors, such as transit accessibility, job accessibility, cost of parking, security while walking, environmental factors, and street crimes are the major problems of first/last mile (Tilahun et al., 2016). Due to the higher level of crime rate people are tended to take more direct routes and avoid such areas as vacant lots and poorly lit streets (Venter, 2020).

Addressing these problems requires a combination of infrastructure improvement, transportation planning, and policy changes. Individual characteristics such as age, gender, income, and car ownership have a significant impact on travel behaviour. Proper transportation planning is needed, and policymakers need to focus on improving transit characteristics, and addressing safety concerns to promote public transportation (Kim et al., 2007).

The research will revolve around the problems faced by commuters which include male, female, elderly people, people with disabilities, and Transgender people and it will also focus on the cost associated with first and last-mile travel and it will also investigate the key factors that are affecting the mode choice behavior of commuters.

1.2. Problem Statement

The rapid urbanization happening worldwide necessitates the active designing of smart and sustainable cities, to achieve sustainable urban development for a sustainable future (Albino, Berardi, & Dangelico, 2015). The rapidly growing urban population in Pakistan has led to issues such as urban overcrowding, urban poverty, and inaccessibility of essentials (Zulfiqar, 2020). The demand for public transportation has increased in recent years. Mobility is crucial for accessing basic needs and services, but public transport may not take people exactly where they need to go, parking may not always be available, and owning a vehicle is not always feasible.

People rely heavily on public transportation due to the increase in the cost. Though the metro bus service operates in Islamabad and Rawalpindi it does not extend its reach to some areas of Islamabad and Rawalpindi. The public is using other transportation options to reach the metro stops such as vans, Suzuki, cabs, and rickshaws. Furthermore, no disabled-friendly transport is in place in Islamabad and Rawalpindi. To address this issue and ensure social and economic inclusivity, there is an urgent need to establish an inclusive, affordable, accessible, and safe transportation system in the twin cities of Pakistan, especially for women, disabled people, transgender people, and elderly people.

This need urges us to investigate and shed light on the problems and challenges faced by people due to the first and last mile, with a particular focus on the difficulties faced by commuters, including women, PWDs, elderly people, and the transgender community in Rawalpindi and Islamabad. It will help to find mode choice behaviour among commuters and their perspective toward first and last-mile travel. The research aims to identify current and future trends in first and last-mile travel, as well as analyze potential issues that may arise.

1.3. Research Questions

The research aims to investigate problems faced by commuters due to first and last-mile travel including the cost associated with it. The study provides insights into the preferences of commuters for existing and new means of first and last-mile modes. The following questions will be addressed by this research.

Research Questions:

1. What are the costs associated with first/last mile travel?
2. What are the challenges commuters face during their first and last-mile travel?
3. What factors influence individuals' mode choice behavior and how do these factors reflect in the mobility patterns of commuters?

1.4. The Objective of the Study

This study aims to investigate how public transportation impacts the mobility of male, females, transgender individuals, elderly persons, and PWDs in Pakistan. The goal is to shed light on the impact of first and last-mile travel on mobility in twin cities in terms of safety, affordability, and accessibility. It will also focus on the costs associated with first/last-mile travel. It will ensure the improvement in the first/last-mile travel of the public transportation system. The research will also focus on participation and the perspective of the public addressing issues and challenges for addressing first and last-mile problems. In this context, the main objectives of this research are:

1. To investigate costs related to first/last-mile travel.
2. To examine the problems faced by commuters during first and last-mile travel.
3. To investigate the factors affecting mode choice behaviour.

1.5. Significance of Study

This research aims to investigate the factors that influence commuters' choice of transportation modes, travel behaviour and travel costs. The outcomes of this research can provide valuable insights for making future demand predictions and provide effective strategies to promote active transportation. Analyzing cost and mode choice behaviour has significant implications for transportation policy-making and planning. The findings suggest potential policy interventions in national transport policy, such as adjusting fare structures, increasing service frequency, reducing travel time, and improving first and last-mile infrastructure to accommodate the needs of gender, people with disabilities (PWDs), and elderly people. These policy interventions aim to plan a well-integrated multimodal public transport system for commuters in the twin cities of Pakistan. By considering the varied travel patterns of different user groups, decision-makers can make optimal decisions aimed at reducing automobile dependency and attracting a larger share of travelers to

public transportation. The findings align with several aspects of Pakistan's national transport policy, aiming to develop an efficient, safe, and sustainable transport system.

This research is significant as it addresses the critical issues and challenges of first and last mile travel, which are essential for creating an efficient, sustainable, and commuter-friendly public transportation system in Islamabad and Rawalpindi. The insights gained can help shape policies that not only improve the current transport system but also contribute to long-term urban planning and environmental sustainability. Public perspective is an important part of research on first and last-mile travel because a solution can only be successful if the public accepts it. It aims to systematically document the diverse needs, concerns, and safety issues of passengers.

Furthermore, it aims to assess how concerned organizations and policymakers can address these needs and concerns. One notable aspect of this study is its contribution to understanding the pivotal role of the metro bus service in alleviating road congestion and traffic-related problems. As this research incorporates primary data collection, it provides fresh perspectives and critical insights into the concept of park-and-ride services, which can significantly benefit commuters and contribute to more effective urban transportation systems. The research will be used as a policy direction for the improvement of the future of transportation by introducing the concept of park and ride and creating awareness about its benefits for commuters.

The research suggests implementing Transit-Oriented Development policies to create high-density, mixed-use areas near public transit centres. This can enhance the effectiveness of first and last-mile travel by reducing the distance commuters need to travel to access public transportation. The research advocates for zoning policies that promote mixed-use developments, making sure that residential, commercial, and recreational areas are easily accessible to each other. This can minimize long commutes and help build sustainable, walkable communities.

1.6.Explanation of the Key Terms:

First/Last Mile

First and last-mile travel describes the modes of transportation people use to move from their starting location to a transit hub and from a transportation hub to the destination. It is often considered the most challenging part of a commuter’s journey as it involves multiple modes of transportation such as walking, taxis, cycling, or a bus. The first mile is the movement of people

from their starting point (home) to the transit stop. The first/last mile refers to the distance walked from the starting point to a boarding stop and from the boarding stop to the destination when taking public transportation (Kumar & Khani, 2021).

Urban Mobility

The movement of people and goods within urban areas is referred to as urban mobility. It connects people to jobs, education, healthcare, and other services. It includes different modes of transportation like walking, bicycling, and public transportation as well. It includes the movement of individuals to obtain various urban services.

First Mile and Last Mile Problem

Travelling the first mile and last mile brings difficulty to a commuter referred to as first and last mile problems. It is referred to as a gap between public transport and an individual's origin. The concept of the first/last mile problem arises from telecommunication or the movement of goods. The first and the last mile problems occur when travellers need a second means of transportation to get to or from their destination. The difficulty of providing safe, efficient, and affordable transportation for people to commute between their homes and the nearest transit hub is the first and last-mile problem.

Sustainable Mobility

Sustainable mobility is defined as the capability to fulfil society's requirements for unrestricted movement, access, communication, trade, and relationship-building without jeopardizing other crucial human or ecological values. EU Green Paper on the Impact of Transport on the Environment states that "sustainable mobility should enable transport to fulfil its economic and social role while reducing its harmful effects on the environment." It promotes modes of transportation that are economically viable, socially inclusive, and ecologically friendly.

Commuting Cost

Expenses incurred while travelling between the residences to other destinations is the commuting cost. It is calculated daily and is based on the method of transportation used for that daily commute. The cost includes various expenses such as transportation costs, vehicle maintenance costs, time costs, and health costs.

1.7.Organization of the Study

This study is organized into five chapters. The first chapter serves as an introduction, laying the groundwork for this study by introducing the topic and emphasizing its significance, the overview of the research such as statement of the problem, key terms, and most importantly the research questions and objectives. Following the introductory first chapter, Chapter 2 provides a review of the existing literature about public transportation and its impact on the mobility of females, elderly people, transgender people, and PWDs. Chapter 3 details the research methodology, including the chosen research approach, the selected research method, the sampling technique employed, the process of collecting primary data, and the subsequent analysis, providing an overview of the study area and research design that was adopted to achieve the research objectives of the thesis Chapter 4 unveils the findings and engages in a discussion, Chapter 5 concludes the research by presenting policy recommendations and proposing avenues for future research.

CHAPTER 2

LITERATURE REVIEW

2.1. Cities and Mobility

Cities serve as a hub for human interactions and can cater to everyone's needs if people come together to shape them collectively. As the world becomes more urban, economic growth and urbanization have become inseparable, to the extent that urbanization has been recognized as a necessary condition for sustainable development. Cities now play a decisive role in the economic growth process (Scott & Storper, 2003). Mobility, particularly commuting from one point to another, plays an important role in cities. Urban mobility is about moving from one place to another, starting with walking and cycling, progressing to buses, trains, and public transport, and finally using personal vehicles like cars and motorbikes. Each mode comes with associated costs, including mobility costs (Litman,2007). As urban transportation undergoes shifts in needs and preferences, it becomes imperative to expand transport options to cater to the diverse requirements of the people, because of demographic shifts. Due to urbanization, people are travelling more which requires a more efficient transportation system (Stam et al., 2021).

People move to cities to find jobs and improve their social and economic status, and firms tend to locate in city centres to be near the market and amenities. As cities grow, the cost of transportation increases with distance, so people need better transportation options that are easily accessible. However, inadequate public transportation, poor facilities for pedestrians and cyclists, and a lack of bike and car lanes have led to increased car ownership, which has discouraged the development of public transport systems and reduced the number of bike and car lanes (Rehman, 2021). Urban mobility in developing nations encounters various challenges, primarily stemming from two significant trends: the process of urbanization and the proliferation of motorization (Santos et al., 2010).

2.2. Quality of First and Last-Mile Travel

First and last-mile travel, referring to the initial and final legs of a journey, has become a critical aspect of urban transportation systems worldwide. The first mile and last mile are now commonly used in the context of urban travel while travelling to or from bus stops, metro stations, or railroad stations.

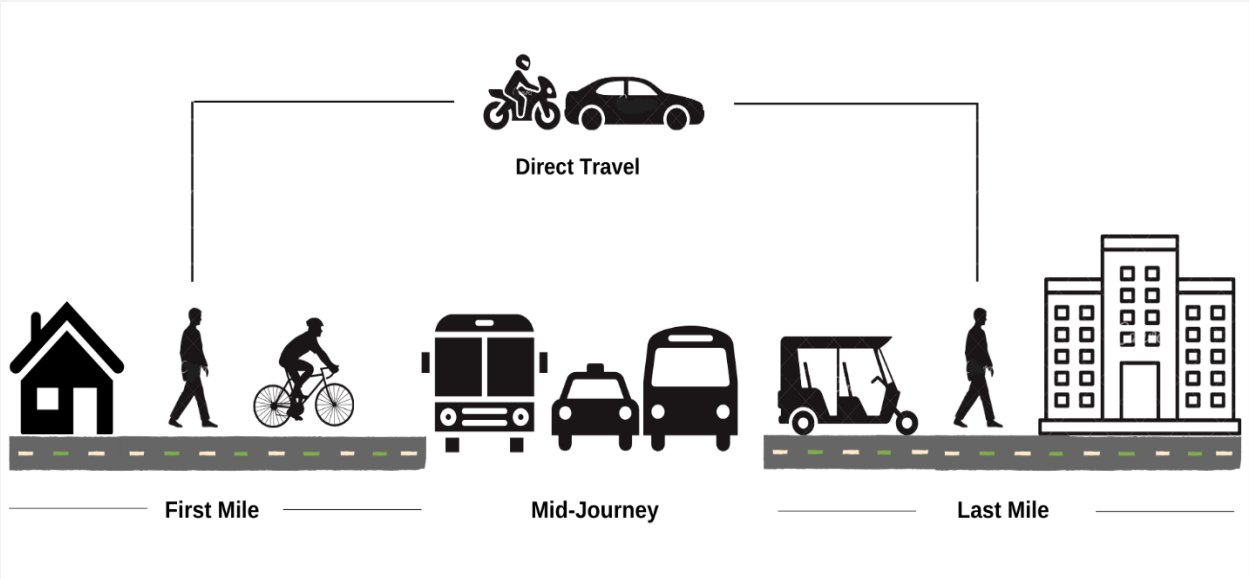

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***Figure 2.1**:* First-Last Mile Connectivity

It refers to the transportation that people use to reach their destination from a transit hub or their starting point to the transit hub as shown in Figure 2.1. The reliance on public transportation for first and last-mile connectivity is often seen as a significant weakness in the overall public transport system. This is due to the numerous challenges that arise during the initial and final stages of a commuter's journey. Factors such as accessibility, convenience, and connectivity can greatly influence a commuter's overall travel experience (Stam et al., 2021). The difficulty that people face while moving to and from a transportation hub is referred to as the first mile and the last-mile problem. Several problems are associated with first and last-mile travel, which include limited access, lack of infrastructure, inefficiency, and safety concerns.

According to Venter (2020), the first and last mile refers to the initial and final segments of a public transport trip, which are typically covered by modes such as walking or feeder buses. The absence of connection between transit stations and trip origins and destinations is known as the "first and last mile problem," and it affects the choice of first and last-mile transport modes (Lu et al., 2023). If the first and last mile are unattractive, it will affect the overall travel experience. Shared mobility can help relieve strain on local transportation (Culik et al., 2022).

A study conducted in the Netherlands, reveals a prevailing preference for private vehicles and traditional ride services, over shared and on-demand alternatives, for traditional modes of first and

last-mile travel. Despite 21% of commuters favouring private over shared vehicles and 12% opting for traditional ride services over on-demand (Stam et al., 2021). While in countries like India bicycle plays a less prominent role and rickshaws play a dominant role in first and last-mile travel (Goel & Tiwari, 2016). For shorter-distance trips motorcycles are widely favoured (Tran et al., 2014).

A case study conducted in Stockholm County by Karesdotter et al. (2022) highlights the challenges faced by commuters in accessing and utilizing public transportation, particularly in terms of first and last-mile connectivity. These challenges arise due to the lack of infrastructure, limited access, and poor integration with different modes of transportation. To achieve sustainable mobility and improve first and last-mile connectivity, the study suggests several solutions, including reducing the dependency on personal cars, enhancing infrastructure, increasing shared mobility options, and expanding mobility alternatives.

2.3.Mobility in Rawalpindi/Islamabad

The growth of traffic in urban areas of Pakistan is causing a need for integrated transport planning and road network. This is due to an increase in population, an increase in vehicle ownership, and the migration of people from rural areas to urban areas (Sheikh, 2022). Car ownership in Pakistan has increased, leading to a focus on building roads to accommodate cars at the expense of non-motorized and public transportation. As a result, a significant portion of Pakistan's development budget has been allocated to road construction, which has made it increasingly convenient for people to use cars for travel (Rehman, 2021).

If commuters are provided with good first and last-mile transit options, then it can help reduce car use and public transport become attractive. Good transit options can be provided keeping in view the location as well as the transportation needs. Pakistan is one of the most urbanized countries, which makes it challenging for people to survive in densely populated areas that lack basic services and the majority of the population belongs to the lower income class, which means that only the wealthy can afford to buy and maintain automobiles. As a result, the majority of the population must rely heavily on the public transportation system (Adeel et al., 2016).

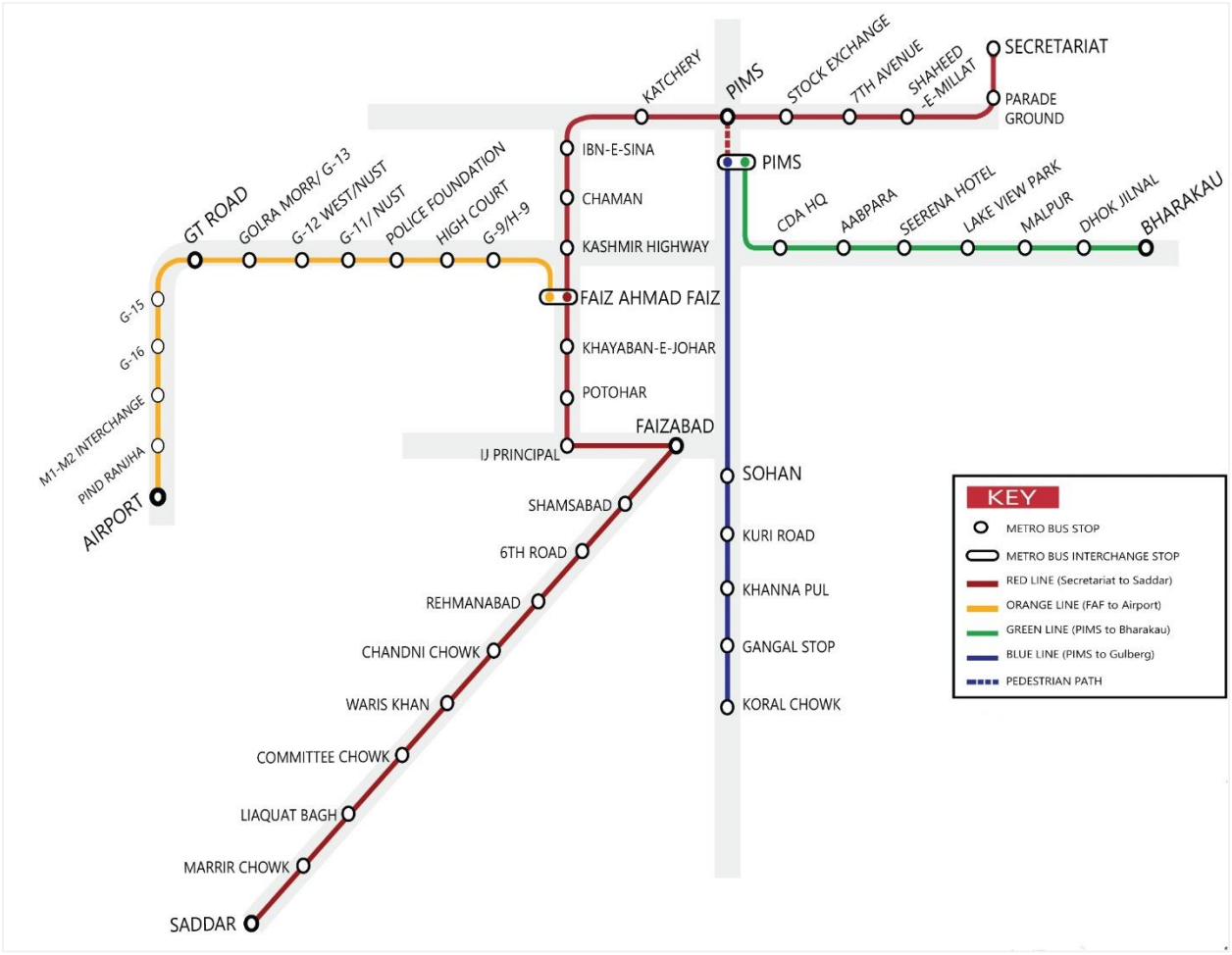
Public transport is the utilization of transport, which is characterized by its accessibility to the public, fixed routes, and standardized fares, and has been recommended as a potential measure to alleviate the negative effects of road traffic on the environment and society (Santos et al., 2010).

2.4. BRT Rawalpindi-Islamabad

Worldwide, the Metro Bus Systems (MBS) are utilized to offer public transportation services to the public, to meet their regular travel requirements. To mitigate the escalating congestion problems in major urban cities, the government of Punjab launched the MBS initiative to modernize the public transportation sector. The need for the MBS was identified to provide an affordable and dependable public transportation facility that ensures the safety and security of commuters. To deliver a secure, efficient, and comfortable public transportation system, the Punjab government established the Punjab Mass Transit Authority (PMA).

The Rawalpindi-Islamabad Metrobus is a comprehensive bus rapid transit system that covers 83.6 km within the Islamabad-Rawalpindi metropolitan area in Pakistan. It consists of four distinct routes: the Red, Orange, Blue, and Green Lines. The Red and Orange Lines feature dedicated lanes and well-constructed stations, providing efficient and rapid transit. On the other hand, the Blue and Green Lines follow the routes along the Islamabad Expressway and Srinagar Highway, contributing to the extensive coverage of the metro bus network in the region.

Metrobus network commenced operations with the Red Line on 4 June 2015, extending 22.5 km from Pak Secretariat in Islamabad to Saddar in Rawalpindi. According to the Punjab Mass Transit Authority, it has a total of 24 stops, 14 in Islamabad and 10 in Rawalpindi. Subsequently, the Orange Line was introduced on 18 April 2022, spanning 25.6 km between Peshawar Morr Interchange and Islamabad International Airport. On 7 July 2022, the Green Line and Blue Lines were added to the network. The Punjab Mass Transit Authority (PMA) manages the Red Line, while the rest are managed by the Capital Development Authority (CDA).



(Source: Bus Rapid Transit Rawalpindi-Islamabad)

***Figure 2.2**:* BRT Routes Rawalpindi-Islamabad

2.5. Public Transport and Female Mobility

Humans have an innate yearning to travel, recognized as a fundamental right. Gender disparities in mobility show that women often exhibit intricate travel patterns, emphasizing safety and high-quality services in their unique mobility needs (Adeel et al. 2013). Women's mobility is restricted due to sexual harassment which limits their access to opportunities, pursue education, and engage in flexible work arrangements and social activities (Shah, 2018). The participation of women can be enhanced by providing a safe, secure, and affordable transport system (Swamy et al., 2021). Public transit needs to address these issues which can help improve gender equity. There has been a large difference in gender mobility. With time there is an increase in female mobility for basic services such as education and employment. They are not now just confined to the household. But females have different travel patterns due to factors such as safety concerns, and social norms.

According to the literature, females exhibit very different mobility patterns as compared to men. Women who travel alone may have to pay an extra charge, on public transportation while waiting, or walking on city streets, they frequently experience intimidation, stalking, and harassment. Families restrict women from travelling alone because they are aware of the hazardous travel circumstances (Adeel et al. 2017).

Women participate less in the labor market in South Asian countries and are influenced by conservative norms, high crime rates, and mobility restrictions, particularly on public transportation due to harassment and violence. These limitations disproportionately impact women's job-seeking, leading to a reduction in their overall labor force participation (Field & Vyborny, 2022).

Adeel et al., (2016), reveal that 95% of women from low-income backgrounds do non-motorized trips for their daily mobility in Pakistan. They cannot afford automobiles, so they choose public transport or walking for commuting. For transport, income has become a key factor. The mobility patterns of women are affected more as compared to men due to poorly designed public spaces and lack of security withal fear of incidents of catcalling and glaring.

In Pakistan, gender is closely tied to mobility, with female commuters prioritizing safety and respect. Women prefer transportation modes offering safety and privacy, yet the current environment lacks hassle-free and secure travel conditions (Khan & Khalil, 2020). Along with female mobility, the cost associated with mobility is also of great importance.

Another empirical study by Adeel et al., (2016), on activity engagement for those who lack access to public transportation in twin cities of Pakistan was conducted. Men were most likely to travel while women on the other hand were engaged less. About 35–42% of respondents had issues with wait times, availability, and distance to the bus, while 57% of respondents had substantial concerns about the cost of transportation services. Female respondents were worried about harassment and discomfort, but men showed more concern about their frequent usage of transportation services.

The results show that people with lower incomes spend a larger percentage of their income on transportation as compared to people with higher incomes. People either buy cars or choose jobs which are within walking distance from their houses due to the discomfort of transit services.

2.6. Public Transport and Disabled People

Urban mobility has become a huge challenge nowadays. Walking, riding, and taxis are common modes of transportation (Huang et al., 2020). Many transit stations are located far from people's homes or workplaces, and it has become quite challenging to access them. Another reason is the infrastructure, especially for people with disabilities; there is a lack of ramps, elevators, or sidewalks. In some cases, the transit system is not designed to facilitate the first and last mile.

Park-and-ride promotes using public transit by allowing commuters to park their cars in designated areas, which is especially beneficial for those living far from transit. Mills & White (2018), demonstrate that the availability of park-and-ride services can reduce traffic congestion, improve air quality and result in economic development.

Another survey-based study was conducted across metro stations in Delhi, India. Chidambaram (2019) used fifteen different modes of last-mile travel in Delhi. The different modes of choice used by commuters were walking, bicycling, cycle rickshaws, e-rickshaws, feeder buses, taxis, buses, company buses, motorbikes, pick-and-drop and park-and-ride. Walking was the predominant mode with 32.5% percentage, about 24.6% using automobiles, 12.9% shared autos and 11.1% e-rickshaws. He postulates that walking is generally the most common transport mode. Cities have introduced mass transit systems to address the concern of sustainable mobility. But still, commuters often use more than one mode of transportation since the transit system alone cannot address all these choices that influence their travel decisions, such as comfort, convenience, and safety. It also draws the attention of last-mile connectivity issues. These issues arise due to various reasons some of them are poor walking and cycling infrastructure, unfavorable walking and cycling conditions, time factors, and lack of direct routes of feeder buses.

Travelling the first and last mile is a huge challenge for people with disabilities (PWDs), as they need special accommodations, such as ramps, elevators, and accessible vehicles to reach and leave transit hubs. Ramli et al., (2022) surveyed the importance of walkability and accessibility in promoting mobility for PWDs. PWDs face difficulties in accessing public transport due to physical barriers such as uneven pavements, steep gradients, and lack of wheelchair ramps. The comfort, attitude, connectivity, readability, safety, and general health of the public transportation system need to be carefully addressed in terms of the welfare of PWDs.

2.7. Public Transport and Tran-genders

Gender inequality is often discussed in access to health, education, and workplace rights, the transportation system receives less attention. Existing literature sheds light on the unique challenges faced by transgender individuals during these critical segments of their journeys, encompassing issues of safety, accessibility, and discriminatory practices. The transport sector is particularly discriminatory towards women and transgenders, where they face unequal provision and accessibility of this public service. Transgenders encounter harassment and discrimination while using public transport and are frequently subjected to additional charges when opting for rickshaws or taxis due to their identity (Panjwani, 2018).

Trans communities experience severe discrimination, aggressive behaviour offensive verbal comments or physical intimidation that make participants feel unsafe or unwelcome in transit. Sometimes they face physical assault while riding or waiting at the transit stop (Lubitow et al., 2017). The transit agencies need to train and educate the staff to avoid such kind of discrimination from other commuters. These discriminatory practices negatively affect transgenders' access to public transit and spaces. Different types of abuse, harassment and violence include sexual comments, catcalling and indecent gestures (Shakibaei & Vorobjovas-Pinta, 2022). This is due to the absence of security officers on buses and trains.

2.8. Public Transport and Elder People

In the context of elderly people, the challenges faced by elderly individuals during first and last-mile travel have gained heightened attention in transportation research. As a critical aspect of overall mobility, the initial and final stage of the journey poses hurdles for seniors, including accessibility concerns, safety issues, and limitations in available transportation options. Literature on this subject delves into the multifaceted nature of these challenges, offering insights into the impact on the elderly's independence and quality of life. Concurrently, scholars explore potential solutions and innovative interventions aimed at enhancing the first and last-mile travel experience for this demographic.

When addressing safety concerns in public transport, several problems, such as theft, verbal and physical abuse, harassment, and social and political violence, become prominent, (Shakibaei & Vorobjovas-Pinta, 2022). Age is identified as one of them. Younger people tend to rely on public transport more frequently, while older people are more car-dependent to meet mobility needs

(Levin, 2019). The availability of public transportation enables older individuals to access goods, services, and various activities. Therefore, public transport holds significance in enhancing the quality of life for older individuals, contributing to their sense of freedom and independence (Hounsell et al., 2016). Efficient transportation systems empower commuters to travel independently, facilitating essential trips and granting access to social activities. The availability of good public transport options, especially for elderly people, who are non-drivers, plays an important role in their well-being (Harris, 2003).

2.9. Research Gap

The existing literature on first and last-mile travel in urban areas has predominantly focused on developed countries, leaving a significant gap in our understanding of this phenomenon in the context of Rawalpindi-Islamabad, Pakistan. While studies abound on mode choice, accessibility, and challenges associated with the first and last mile, there is a dearth of research specifically examining the socio-economic and cultural factors influencing commuters' choices in this South Asian region. Furthermore, limited attention has been paid to the unique challenges posed by the local geography, demographic diversity, and public transportation infrastructure in Rawalpindi-Islamabad. Also, there is limited attention to commuting costs of first and last-mile travel. This study aims to address this literature gap by providing an in-depth analysis of first and last-mile travel behaviours challenges, and perceptions within the specific socio-cultural and geographical context of the twin cities in Pakistan.

2.10. Theoretical Framework

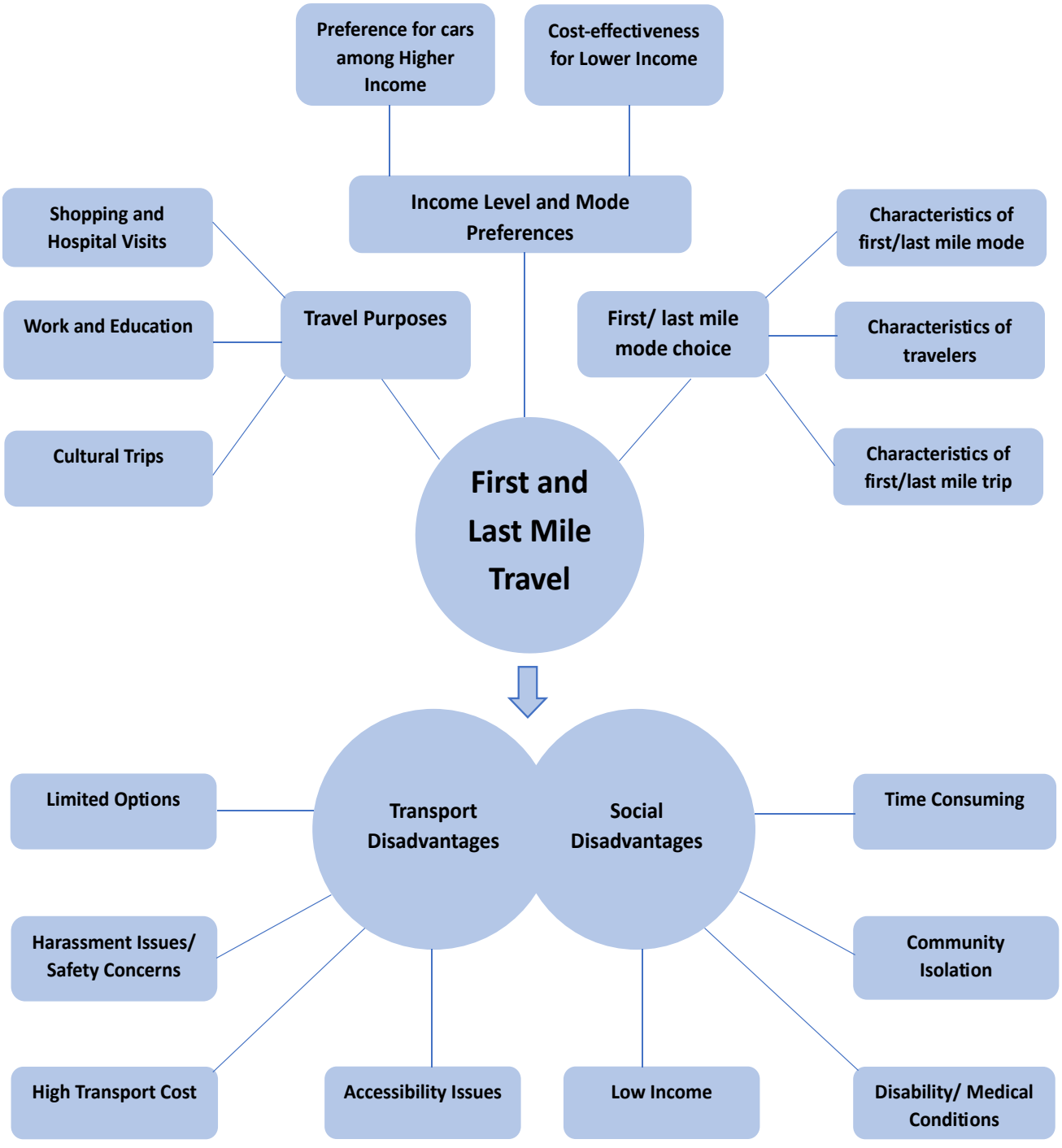


Figure 2.3: Theoretical Framework

The framework illustrated in Figure 2.3 outlines the main factors and dimensions that affect first and last-mile travel in the twin cities of Islamabad and Rawalpindi. It aims to capture the complexity of commuter experiences and the various elements that influence their travel decisions and outcomes. By systematically analyzing these factors, the research provides comprehensive insights into the barriers faced by commuters, which can help identify specific interventions to improve first and last-mile connectivity. Ultimately, this contributes to making urban transportation systems in the twin cities more inclusive and efficient.

To understand the issues and challenges related to first and last-mile travel, a set of interrelated concepts was constructed. Various theoretical concepts have been used to explore issues related to first and last-mile travel, including transport disadvantages, inaccessibility, social disadvantages, and associated costs. The framework considers several key factors that influence commuter behavior and experiences, such as income levels, travel purposes, mode choice influencers, transport disadvantages, and social disadvantages.

In conducting this research, various theoretical concepts have been considered to gain a deeper understanding of first and last-mile travel issues in Islamabad and Rawalpindi. These concepts encompass social exclusion, inaccessibility, and transport disadvantage, as well as social disadvantage. The transport disadvantage, transport poverty, and social disadvantage are closely interconnected. As a result of which commuters place themselves in a position where they are unable to access public transportation, thereby limiting their ability to access employment, social networks, services, and other opportunities and activities.

Transport poverty is mentioned by Titheridge et al., (2014), as a concept that refers to households or areas that face difficulties in accessing essential services due to inadequate or unaffordable transportation options, leading to social exclusion. The theory of spatial mismatch explains how poor people are affected by rapid urbanization and their heavy reliance on cars or other modes of transportation. Those who can afford transportation have better access to jobs and other opportunities compared to those who cannot due to issues such as travel costs, distance to activities from their homes, and income.

The mode choice theory explores the factors influencing individuals' choices of transportation modes. It considers variables such as cost, travel time, convenience, and personal preferences. The

study of first and last-mile travel helps analyze why commuters opt for specific modes in these critical segments of their journeys. Random Utility Theory is used to analyze and understand the choice behaviour of individuals in decision-making situations. It provides a theoretical foundation for modelling and predicting individual choices among a set of alternatives. Random Utility Theory has been widely applied in various fields, including transportation research, to analyze mode choice behaviour, route choice behaviour, and other decision-making processes. Rahman et al., (2022) used Random Utility Theory to analyze the behavior of suburban traveler's in Dhaka towards mode choice. The study applies the principles of Random Utility Theory to understand the factors influencing mode choice behaviour.

The research applies theoretical concepts to analyze the challenges associated with first and last-mile travel. By examining transport disadvantages, inaccessibility, social inequities, and costs, the study aims to gain deeper insights into the commuting difficulties experienced by different demographic groups. The findings of the study will inform the development of targeted interventions and policies intended to enhance first and last-mile connectivity, reduce social exclusion, and promote more inclusive urban transportation systems in the twin cities.

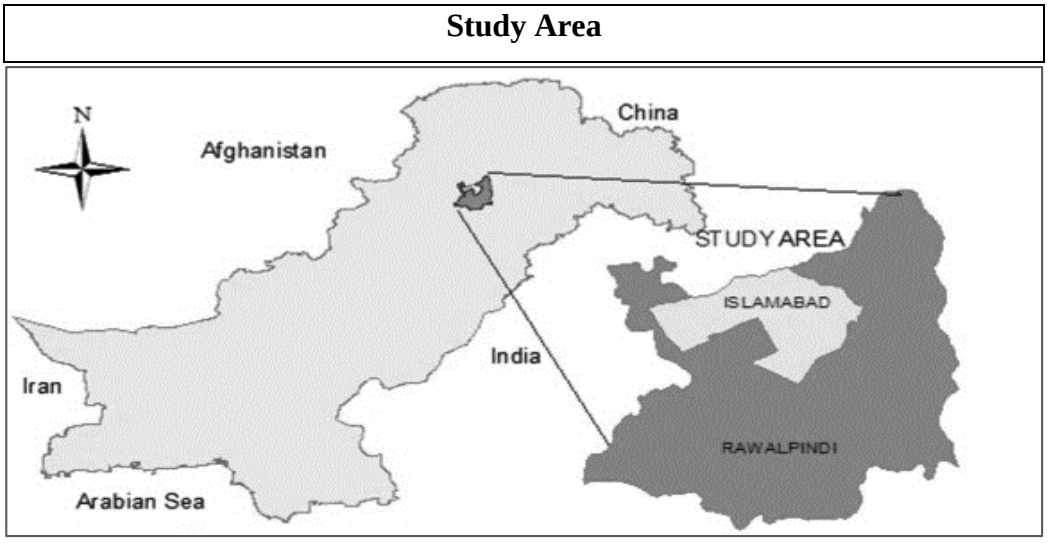
CHAPTER 3

DATA & METHODOLOGY

In this chapter, we are providing an overview of the study area and research design that was adopted to achieve the research objectives of the thesis. Taking a quantitative-method approach, this study explores the impact of first and last-mile challenges on people's mobility and cost associated with it, in the twin cities of Islamabad- Rawalpindi. This study is unique and contributes to the literature and public policy debate as no other study has so far examined the issues and challenges concerning first-mile and last-mile travel in the context of Pakistan.

3.1. Profile of the Study Area

The study employs a case study methodology to collect primary data from Rawalpindi and Islamabad, both of which are facing first and last-mile problems. The case study approach is highly beneficial for research studies that require in-depth, context-specific, and detailed analysis. It offers the flexibility to adapt to various research questions and provides a comprehensive understanding of the subject under investigation, making it a valuable tool in research across multiple disciplines. For this research, the twin cities of Pakistan are selected as study areas. The city has a population of approximately 2,001,579 individuals, representing a diverse range of demographics (Census, 2017).



Source: Google

Figure 3.1: Map of the Study Area

Islamabad and Rawalpindi are in the northern part of Pakistan. Rawalpindi is in Punjab province and Islamabad is located in the Islamabad Capital Territory. The twin cities are adjacent to each other. The area of focus (target population) for this research is Rawalpindi and Islamabad. Islamabad is a well-planned modern city with organized grids, efficient parking lots, public spaces, and a developed public transport system. On the other hand, Rawalpindi is an older city with a more organic structure. It lacks the coordinated planning seen in Islamabad, resulting in congestion and fewer strict land-use planning restrictions.

Although both cities share a total urban area of $373km^2$, their demographic distributions differ significantly. In Islamabad, 95% of the population resides in urban areas and Rawalpindi, in contrast, has a more diverse settlement pattern, with 63% of its population living in urban areas, indicating a mix of urban and suburban living (Rehman & Jamil, 2021). Residents of Rawalpindi and Islamabad frequently travel between the two cities for work, resulting in heavy traffic on most major roads during peak hours. In response to this traffic congestion, the city governments of the twin cities implemented the Mass Transit System (MTS) as a sustainable transport solution in 2012-13 (Sheikh, 2022).

The two cities are in a way dependent on each other, with Rawalpindi offering cheaper accommodation to citizens working in Islamabad as well as to the people of Rawalpindi going to Islamabad for jobs etc. However, residents of Islamabad often visit Rawalpindi for cheaper raw materials and goods from the oldest markets of Rawalpindi. Thus, it involves the use of large-scale transportation and communication between the two major cities of Pakistan. The empirical domain in this study will be the Islamabad-Rawalpindi Metro bus points in Pakistan.

3.2.Survey Design and Data Collection

The study takes a quantitative research approach to explore the issues related to first and last-mile travel in Rawalpindi-Islamabad. The data was collected through a structured questionnaire from 360 respondents from Rawalpindi and Islamabad, covering significant contributory elements, their demographic and economic profile, travel behaviour, location and mode choice, the associated cost for first and last mile travel, and perception towards public transport modes and first and last mile travel. To achieve the objectives a structured questionnaire was designed.

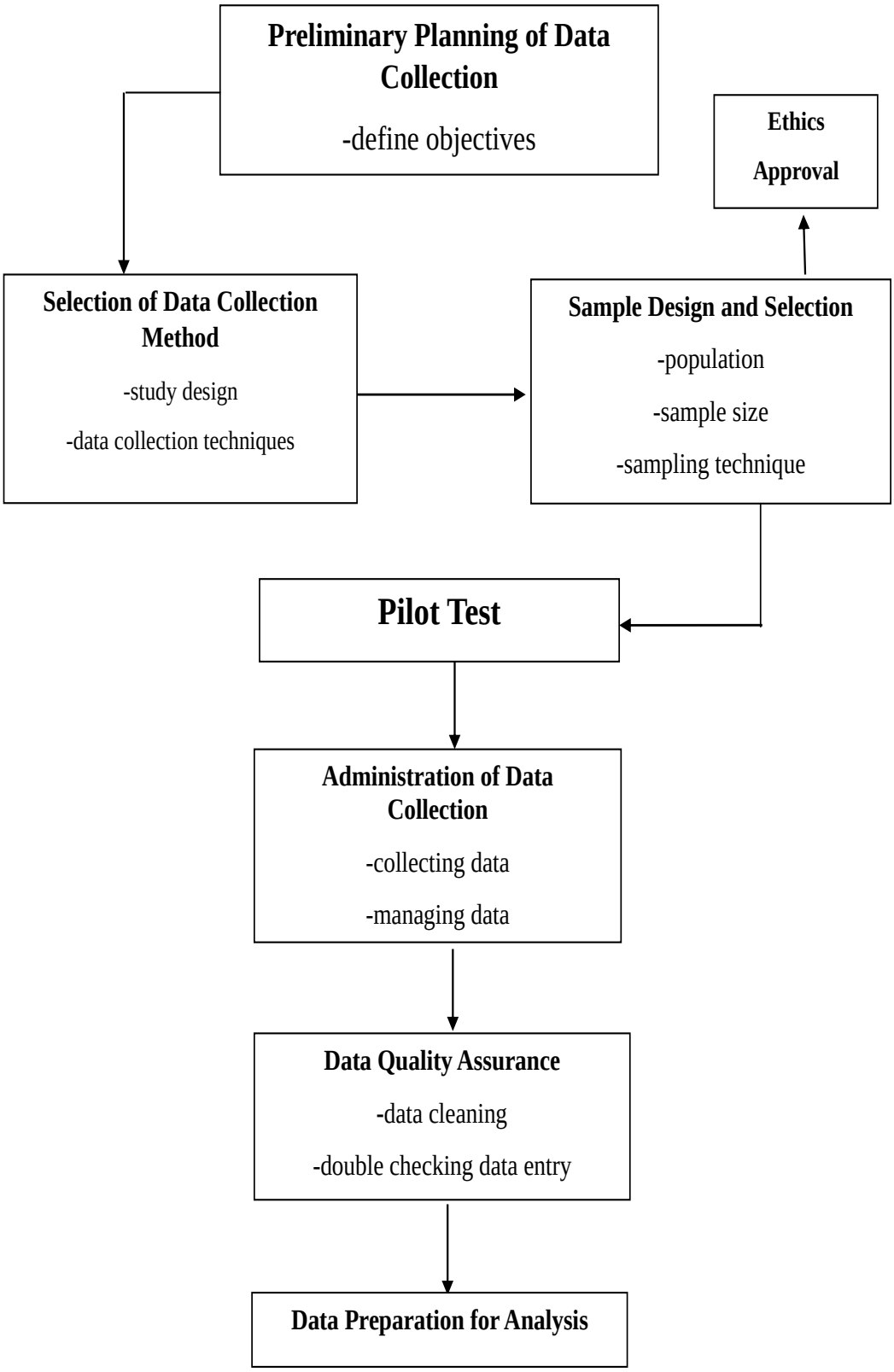


Figure 3.2: Data Collection Framework

The primary data collected from the fieldwork, in Islamabad and Rawalpindi, consisted of questionnaires and field notes. The questionnaire was piloted and finalized after pre-fieldwork visits and consultation with the research supervisor. Piloting was conducted before starting the fieldwork to address any limitations or make desirable changes to the interview questionnaire. Piloting aimed to measure the time required to complete a single interview, test the interview questionnaire, and ensure that the researcher could collect the required data. The design of the questionnaire was influenced by my own understanding of the research topic, as well as insights gained from the reference questionnaire by Md. Mashrur Rahman.

This study collected information from 20 respondents at each selected station. Data was collected during the morning, afternoon, and evening time. The respondents were approached at PMBS, and interviews were conducted after obtaining consent. Most participants were comfortable, but some were hesitant. 10 metro stations were selected from Islamabad and 8 from Rawalpindi. Over a period of three weeks, the fieldwork successfully concluded from August to September 2023 with a total of 360 interviews. It was sometimes challenging to convince commuters for interviews at stations. Each interview took around 10-15 minutes to complete, with a few exceptions where it took longer.

3.3.Questionnaire Design

The structured questionnaire designed for the research consists of four sections, with close-ended questions. Overall, the questionnaire covers a wide range of topics which include demographic and economic profile, travel behaviour of commuters, commuters' location and mode choice, commuting cost and public perception towards first and last-mile travel.

3.3.1. Demographic and Economic Profile

The first section of the questionnaire focuses on capturing the demographic and economic profile of the respondents. This section includes questions that gather information about commuters, covering aspects such as gender, age, educational background, occupation, household type, family structure, monthly income, physical disabilities, and medical conditions. This information serves to provide a comprehensive understanding of the commuters.

3.3.2. Travel Behaviors

The second section of the questionnaire focuses on travel behavior and mode choice is crucial for obtaining a comprehensive understanding of how commuters in Islamabad and Rawalpindi approach their first and last-mile travel. It provides rich data on how and why commuters choose their modes of transportation, what influences their decisions, and what challenges they face during their first and last-mile travel. The questionnaire explores modes of transportation that the respondents use for their first and last-mile travel. Next, the questionnaire explores why the respondents chose their particular modes of transportation to identify the key factors that influence commuting decisions. Finally, the questionnaire collects information about the challenges that the respondents face during their first and last- mile travel. It provides rich data on how and why commuters choose their modes of transportation, what influences their decisions, and what challenges they face during their first and last-mile travel. This section of the questionnaire is designed to understand the commuter's location preferences and mode choices.

This section is divided into six sub-sections, each focusing on a different aspect of the commuters' location and mode choice. The questionnaire collects information about commuter's current location and their ideal location. This question aims to understand the respondents' location preferences and the reasons for relocating to improve their first and last-mile travel. The aim is to understand if the respondents are willing to change their location to improve their commuting experience. The questionnaire provides valuable insights into the respondents' location preferences and mode choices, which can be instrumental in making informed decisions and policies that cater to the needs and preferences of all commuters.

3.3.3. Cost

The questions in the third section of the questionnaire, pertain to transport mode use, commuting costs, travel time, and distance during the first and last mile, and mid-journey, to obtain specific data. The questionnaire allows us to delve into the practical aspects of commuters' experiences, shedding light on the specific modes they choose, the associated costs, and the time and distances involved in their first and last-mile, and mid-journey travel. This data is essential for conducting a detailed analysis of transportation patterns, evaluating the efficiency and effectiveness of existing services, and proposing recommendations for enhancing the overall commuting experience.

3.3.4. Public Perception

The last section of the questionnaire focuses on public perception, encompassing commuters' attitudes toward first and last-mile travel, the barriers they encounter, and policy responses to these challenges. This data will be instrumental in evaluating the current state of transportation services, identifying areas for improvement, and proposing policy recommendations to enhance the overall commuting experience in Islamabad and Rawalpindi.

3.4. Sampling Design and Conduct of Survey

The process of choosing the group from which data will be gathered for research purposes is referred to as Sampling. The data for the study was collected through a two-stage stratified random sampling method and convenience sampling method. The metro stations were divided into strata based on their location in Rawalpindi and Islamabad. Within each stratum, a proportionate number of metro stations were selected (8 from Rawalpindi, 10 from Islamabad). For the first stage, the cities were identified as the primary strata, the metro stations within each city were designated as sub-strata, 8 metro stations were selected from Rawalpindi and 10 from Islamabad, out of 24 stations.

To ensure proportional representation, commuters from each station were assigned 20 questionnaires. The commuters were categorized as male, female, transgenders, elderly people and PWDs. The purpose of categorization was to get clear patterns of different perceptions and experiences based on their differences. This may affect the travelling experience and perception. Moving on to the second stage, within each selected metro station, participants were stratified, creating subgroups that encompassed male, female, transgender individuals, the elderly, and people with disabilities.

This stratification aimed not only for in-depth exploration but also to capture the diverse experiences and perspectives of individuals with varying mobility needs and characteristics. A total of 360 respondents were surveyed using interviewer-administered questionnaires. Of these, 160 respondents were from Rawalpindi while 200 were from Islamabad. An interviewer-administered survey method was employed due to the complexity of the survey and to ensure that the respondents understood the questions correctly.

Convenience sampling was used to collect questionnaire responses from randomly selected individuals at stations. It allows us to gather responses efficiently from a diverse group of individuals, including different genders, age groups, and abilities.

Table 3.1: Sample Sites Selection

Division	
Islamabad	**Rawalpindi**
Khayaban-e-johar	Saddar
Faiz-Ahmed-Faiz	Marrir Chowk
Kashmir Highway	Liaquat Bagh
Chaman	Committee Chowk
Katichery	Chandni Chowk
Pims	Rehamanabad
Stock Exchange	Shamshabad
7th Avenue	Faizabad
Shaheed-e-millat	
Pak Secretariat	

3.5. Reporting the Results

Following the completion of the survey, the next challenge was to manage and process the large dataset collected. All 360 questionnaires were meticulously entered into an Excel spreadsheet for further analysis. The process of data cleaning and checking for mistakes is an essential step in ensuring the accuracy and reliability of the data. In this case, no outliers were found during the data cleaning process. Following the data cleaning process, both descriptive and empirical analyses were conducted. The descriptive analysis provided a summary of the main features of the data, while the empirical analysis allowed for a more in-depth exploration of the relationships between variables.

The analysis focused on several key aspects, including the costs associated with first and last-mile travel, mode choice, and public perception towards first and last-mile travel. These factors were chosen due to their relevance to the research objectives and their potential impact on commuting behavior in Islamabad and Rawalpindi. The next chapter presents detailed results, offering insights into commuting behavior and perceptions, contributing to better suburban commuting understanding and informing future transportation planning in the region.

3.6. Ethical Consideration

Ethical guidelines were strictly followed throughout this research. Every aspect, from designing the structured questionnaire to analyzing the study, ethical compliance was kept in mind. The privacy of the 360 respondents was rigorously maintained, and they were assured that the collected data would be used solely for academic purposes. Participation was completely voluntary, and individuals who chose not to participate in the questionnaire interviews were not pressured. All participants were fully informed about the purpose of the research, promoting transparency and trust. Consent was obtained from respondents before the interviews, emphasizing the voluntary nature of their participation and ensuring their comfort and willingness to contribute to the study.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the demographic profile of respondents, research findings and discussion relating to the issues and challenges concerning first and last-mile travel in twin cities of Pakistan. This chapter is devoted to analyses of Descriptive Statistics and examines the econometric results. The study will briefly elaborate on the empirical results obtained from the empirical methodologies employed to pursue the objectives of the study.

This section will focus on three objectives of research the mode choice, cost associated with first and last mile travel, and public perception toward their first and last mile travel in twin cities of Pakistan. Table 4.1 shows the demographics of 360 survey respondents. The data was collected from eighteen different metro stations in Islamabad and Rawalpindi. The population was divided into various categories based on gender, age, education, and employment status. Among these commuters, 56.9% do not have cars or bikes, and 43.05% have cars and bikes. This distribution is the result of various factors, including financial constraints, lifestyle choices, and the availability and convenience of alternative modes of transportation.

The sample reports, the participant demographic comprised 174 male respondents and 181 female respondents and 5 transgenders. The data presented in Table 4.1, displays a gender distribution, revealing that 48.3% of respondents were male, while 50.2% were female and 1.4% were transgenders.

Regarding vehicle type ownership, 56.9 per cent of respondents reported having no car, 34.1% owned one and 8.8% had more than one car. In terms of motorbike ownership, 56.9% reported having no motorcycles while 40.2% of the sample reported having 1 motorcycle in their house and only 2.7% had more than 2 bikes. Work, education, and shopping trips are the top three travel purposes. Almost 40.2% of people commute daily for work, 12.7% for educational purposes. The lowest percentage is for cultural trips (1.6%). Most of the commuters travel daily, more than half of the commuters are daily users (55.5%), while the remaining use it weekly (18.8%), several times a month (16.4%) or rarely (9.2%).

Table 4.1: Sample Characteristics of Commuters

Sample Characteristics		Number of respondents	Percentage of respondents
Gender	Male	174	48.3%
	Female	181	50.2%
	Transgender	5	1.38%
Age	18-24	55	15.3%
	25-44	231	64.1%
	45-64	60	16.6%
	65 above	14	3.8%
Education	Illiterate	20	5.5%
	Primary	3	0.8%
	Secondary	6	1.6%
	Matric	56	15.5%
	Intermediate	59	16.3%
	Graduate	147	40.8%
	Masters	68	18.8%
	Other	1	0.2%
Employment Status	Employed	168	46.6%
	Unemployed	31	8.6%
	Student	92	25.5%
	Housewife	55	15.2%
	Retired	14	3.8%
Household Type	Homeowner	154	42.7%
	Tenants	206	57.2%
Family Structure	Joint	31	8.6%
	Nuclear	329	91.3%
Monthly Income	<30,000	75	20.8%
	30,001-50,000	83	23.1%
	50,001-1,00,000	111	30.8%
	1,00,001-1,50,000	65	18.1%
	1.50,001>	26	7.2%
	Yes	6	1.6%

Physical Disability	No	354	98.3%
Medical Conditions	Pregnancy	6	1.6%
	Arthritis/Gout	16	4.4%
	Allergies	11	3.05%
	Menstrual Cycle	5	1.38%
	Infections	3	0.8%
	Mental Health	4	1.11%
	Chronic Health	17	4.7%
No. of cars	0	205	56.9%
	1	123	34.1%
	2 or more	32	8.8%
No. of bikes	0	205	56.9%
	1	145	40.2%
	2 or more	10	2.7%
Travel Frequency	Daily	200	55.5%
	Weekly	68	18.8%
	Several times a month	59	16.4%
	Rarely	33	9.2%
Purpose of Trip	Work	145	40.2%
	Education	46	12.7%
	Shopping Trip	83	23.05%
	Hospital Visit	41	11.3%
	Cultural Trip	6	1.6%
	other	39	10.8%
Total respondents		**360**	**100%**

4.1.Cost associated with First and Last Mile Travel

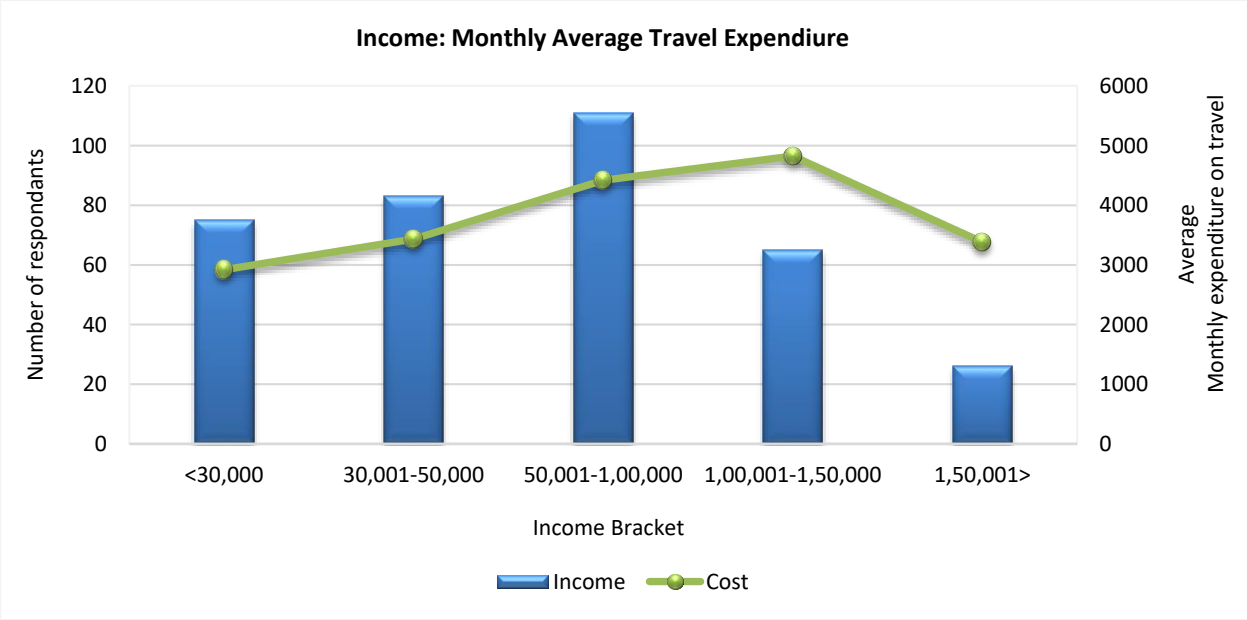


Figure 4.1: Average Travel Experience (Monthly)

The survey results show a clear positive relationship between income level and transportation expenses, as the average monthly travel expenditure increases constantly with the increase in income level. The findings in Figure 4.1 suggest that individuals across various income brackets allocate a higher share of their incomes to transportation expenses. Even within the low-income population, where efforts are made to minimize transportation costs, there remains a substantial portion of income dedicated to this necessity. The data reveals as income levels increase, there is a corresponding increase in expenditure on transportation. This indicates that individuals with higher incomes tend to spend more on their overall journey, encompassing various modes of transportation.

The dissatisfaction among most of the commuters with the existing public transport system compels them to adopt alternative strategies for their daily commute. A significant portion of commuters have chosen to rely on walking. Remarkably, walking emerges as the preferred mode for covering the first and last mile of their journey. For the mid-journey, most commuters express a preference for the metro bus service over other public transportation options. This preference is attributed to a combination of factors, including comfort, safety, and affordability, highlighting the significant impact of these elements on mode choice. This is also because they find work and

activities within walking distance or by curtailing automobile-based travel to minimize transportation expenditures.

Commuters with higher income levels prefer their car for commuting, emphasizing a potential correlation between income and private vehicle ownership. Moreover, the concept of park and ride garners support among some commuters, with the acknowledgement that it offers a practical means to save money while providing flexibility in transportation choices and may offer viable solutions to address commuter dissatisfaction and enhance overall transportation experiences. Half of the respondents (40.3%) live within 10-minute walking distance from a transit stop (Figure 4.2).

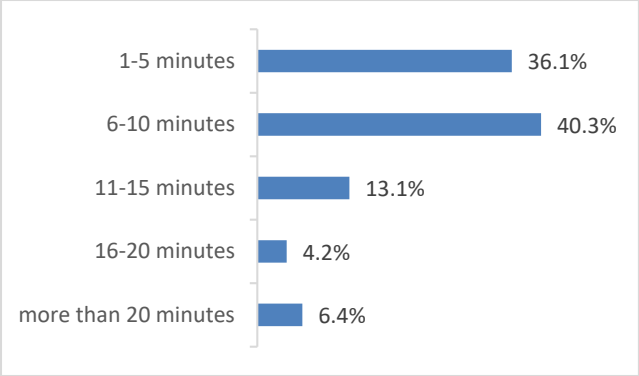


Figure 4.2: Travel Time (Last Mile)

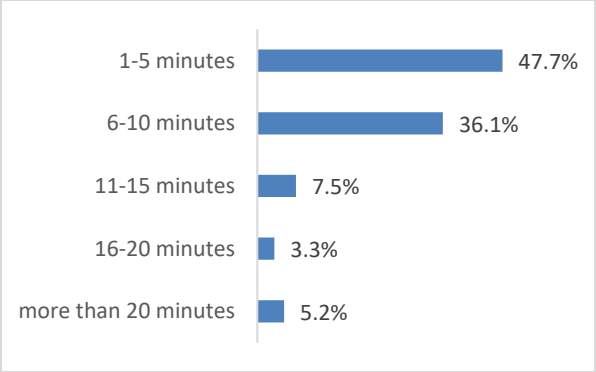


Figure 4.3: Travel Time (First Mile)

Almost 4.2% live further than 20 minutes from the nearest stop location. Almost (6.4%) of the commuters live far from the transit and cover their first mile in their car or bike. 36.1 live within 5 min walking distance so they rely on walking. Figure 4.3 provides a detailed breakdown of the time it takes respondents to cover the distance from transit to their destination.

Almost half of the respondents, 47.7%, reported covering this distance within a notably short duration of 5 minutes. Additionally, 36.1% of respondents indicated that they typically cover the distance within 10 minutes, indicating that a significant majority can reach their destination within a reasonable and convenient time limit. The data also reveals that 8.5% of respondents take longer, with 3.3% covering the distance in 15 minutes and 5.2% in 20 minutes.

4.1.1. Mid Journey Travel

Table 4.2 provides a concise summary of the waiting time during the mid-journey. The mean waiting time is 4.05 minutes, indicating the average duration commuters spend waiting during their mid-journey. The minimum waiting time is 0 minutes, showing that some commuters don't have to wait at all during their mid-journey. The maximum waiting time is 18 minutes, representing the longest waiting duration observed in the dataset. The standard deviation is 3.5 minutes, indicating the extent of variation or dispersion of waiting times around the mean. A higher standard deviation suggests that waiting times can vary, with some commuters experiencing durations significantly different from the average. Moreover, the table identifies the mean travel in the city to be 15.1 mins. However, the min travel time was reported to be 1 minute while the maximum at 50 min. the standard derivation was reported to be 3.5.

Table 4.2*:* Descriptive Statistics of Mid-Journey

	Mean	**Min**	**Max**	**Std**
Waiting time (min)	4.05	0	18	3.5
Travel time (min)	15.1	1	50	7.9
Travel cost (Rs)	33.1	30	120	10.9
Distance (km)	8.9	0.75	34.8	5.02

The average travel cost is Rs. 33.1. This represents the typical or average cost people incur during their journeys. The smallest travel cost observed in the data is Rs. 30. The largest travel cost observed is Rs.120. This represents the highest cost someone experienced in your dataset. The standard deviation is 10.9. So, people might experience travel costs that are significantly lower or higher than the average of 33.1.

The average travel distance, which is 8.9 km, provides insight into the typical length of journeys. On the other hand, the shortest distance recorded in the dataset is 0.75 km, while the longest distance is 34.8 km. This highlights the range of travel distances experienced by individuals. The standard deviation of 5.02 also indicates the variability in travel distances, indicating that some individuals' experiences may differ significantly from the average.

4.1.2. First and Last Mile Travel

The average waiting time for the first mile is 2.27 minutes, indicating a relatively short wait on average. The minimum of 0 minutes suggests that some people experience no waiting time, while the maximum of 20 minutes indicates the longest observed wait. The average travel time for the first mile is 10.3 minutes. The minimum of 1 minute and the maximum of 120 minutes suggest a wide range of travel durations.

The average travel cost for the first mile is Rs 75.4. The minimum of Rs 0 indicates that some people may not incur any cost, this is because they choose walking to cover their first mile, while the maximum of Rs 950 represents the highest observed cost. The large standard deviation of Rs 122.5 suggests considerable variability, with significant differences in individual travel costs.

Table 4.3: Descriptive Statistics of First Mile

	Mean	**Min**	**Max**	**Std**
Waiting time (min)	2.27	0	20	3.5
Travel time (min)	10.3	1	120	10.5
Travel cost (Rs)	75.4	0	950	122.5
Distance (km)	4.3	0.023	350	18.8

As the destinations of some of the commuters are located close and thereby, they must bear less cost for the first/last mile. And the destinations of the few commuters are extremely far so they bear more cost. The average distance for the first mile is 4.3 km. The minimum of 0.023 kilometers and the maximum of 350 km indicates a wide range of travel distances.

The descriptive statistics for the last-mile travel variables shown in the table reveal important insights into the commuting experiences of individuals. On average, commuters experience a waiting time of 2.3 minutes, with some enjoying no waiting time at all, while others face up to a 20-minute wait. Travel times vary widely, with an average of 9.1 minutes, ranging from no time at all to a maximum of 120 minutes. Similarly, the average travel cost stands at Rs 85.4, but individuals' costs fluctuate considerably, with some incurring no expenses and others up to Rs 700.

Table 4.4: Descriptive Statistics of Last Mile

	Mean	Min	Max	Std
Waiting time (min)	2.3	0	20	3.8
Travel time (min)	9.1	0	120	10.8
Travel cost (Rs)	85.4	0	700	120.5
Distance (km)	4.09	0	200	14.3

Distances covered during the last mile exhibit substantial diversity, with an average of 4.09 kilometers and a range from no distance to a maximum of 200 kilometers. These statistics underscore the heterogeneity in last-mile commuting experiences, emphasizing the need for tailored transportation solutions that accommodate the varied needs of commuters.

4.1.3. Gender Specific First and Last Mile Commuting Costs

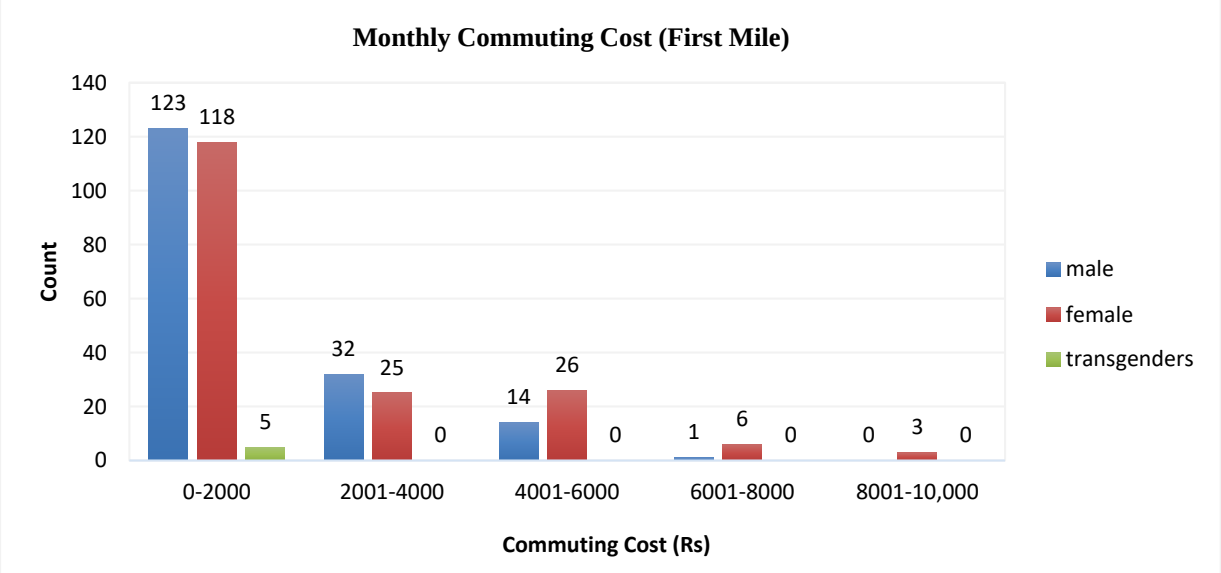


Figure 4.4: Gender Specific First Mile Cost

Figures 4.4 show the monthly expenses of commuting for people in Rawalpindi and Islamabad for first-mile travel. Many respondents have reported in lower income brackets relying on more affordable modes of transportation modes for first-mile travel. The trend of more women in higher

income brackets may suggest that they are paying more for transportation due to safety concerns, long distances, or a preference for private transport.

Transgender individuals tend to have lower costs for transportation as they frequently prefer to walk to avoid potential harassment and discrimination in public areas. Furthermore, the absence of transportation services specifically designed for this community and economic limitations may also contribute to instances of not being charged. Commuters who are living far from cities may have higher commuting costs, typically falling in the range of 20,000-25,000 PKR. This insight highlights the potential financial burden of commuting for individuals who choose to live outside of urban areas.

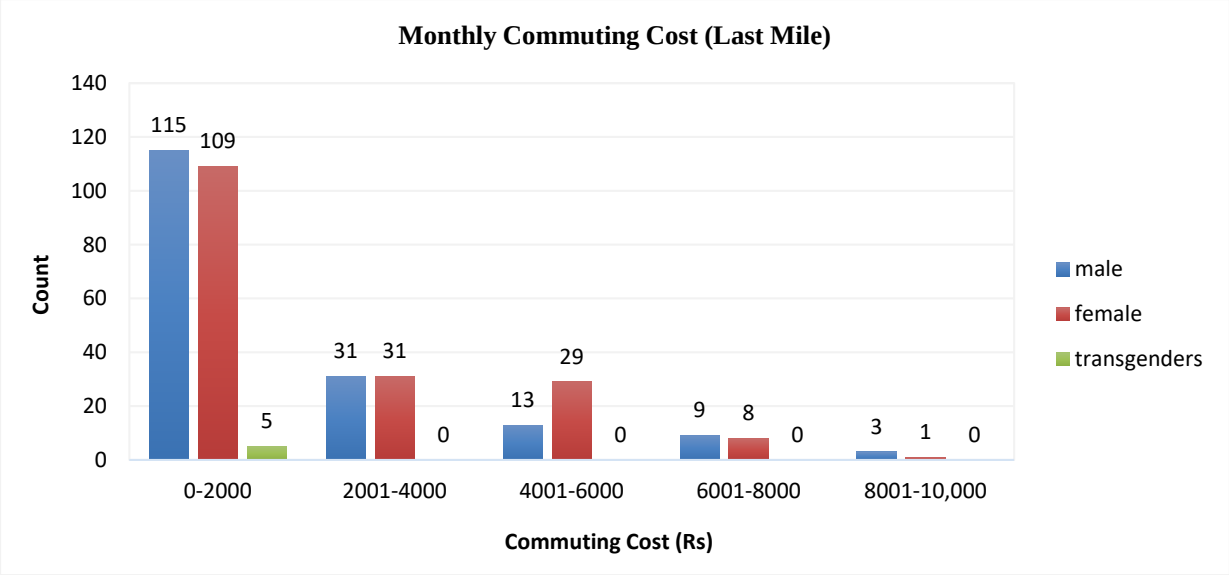


Figure 4.5: Gender Specific Last Mile Cost

Figure 4.5 shows, Trans-genders, who often have lower income sources, exhibit a preference for cost-effective modes of transportation. This inclination is consistent with economic constraints, causing them to opt for more affordable options such as walking. Similarly, both males and females, regardless of their income levels, tend to favor minimal commuting costs. This shared preference for cost-effective transportation modes indicates a commonality in the consideration of economic factors when choosing commuting methods. However, respondents who tend towards high commuting costs suggest a prioritization of comfort and convenience.

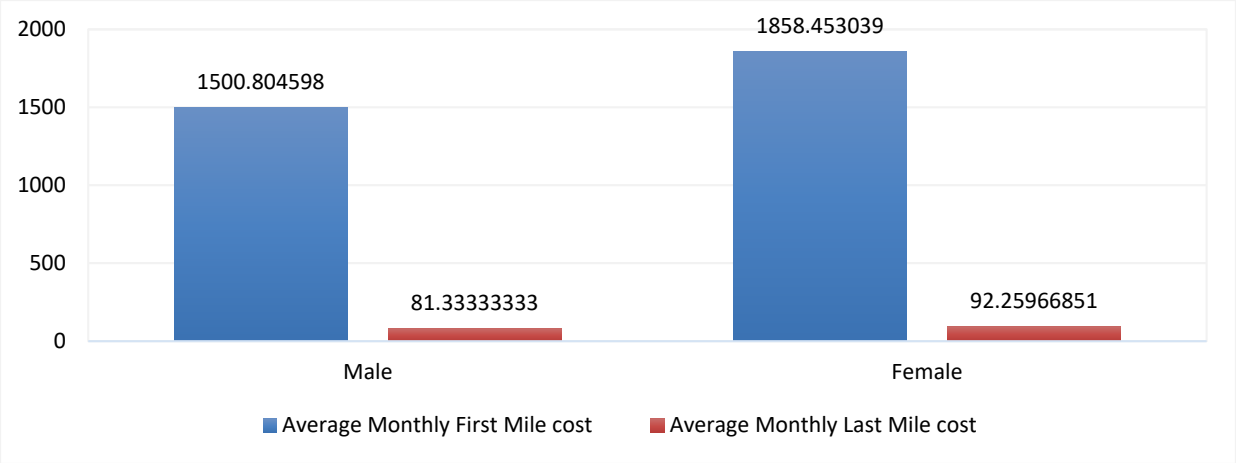


Figure 4.6: Average Monthly First-Last Mile Cost

Regardless of first or last mile, the figure divulges that the average cost of Females is greater than the average cost of males on first and last mile travel. The magnitude of disparity among first and last-mile travel remains the same which can be explained by the fact that females tend to prioritize safety and convenience over the cost-effectiveness of rides due to social dilemmas. Men may be seen opting for bikes as cabs which are far more cost-efficient as compared to taxis for their commute however it is extremely rare to witness females opt for a cab other than a taxi/van.

4.1.4. Commuting Costs Across Age Groups

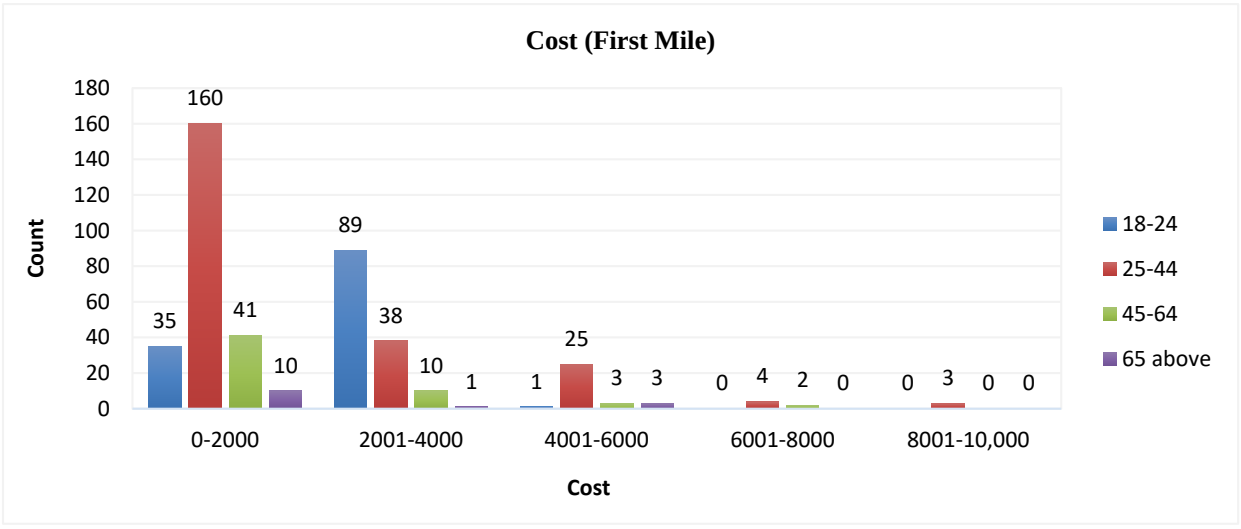


Figure 4.7: Age-based Commuting Cost Patterns (First Mile)

The age of individuals plays an important role in shaping their preferences and behaviours when it comes to first and last-mile commuting costs. The data provided shows clear patterns among different age groups and income levels. Individuals aged 18-24, who have lower incomes (0-4000), often include students or young professionals. These individuals rely on cost-effective modes resulting in lower commuting expenses. Individuals aged 18-44, generally healthier and more mobile individuals may prefer physically active and cost-effective modes like walking.

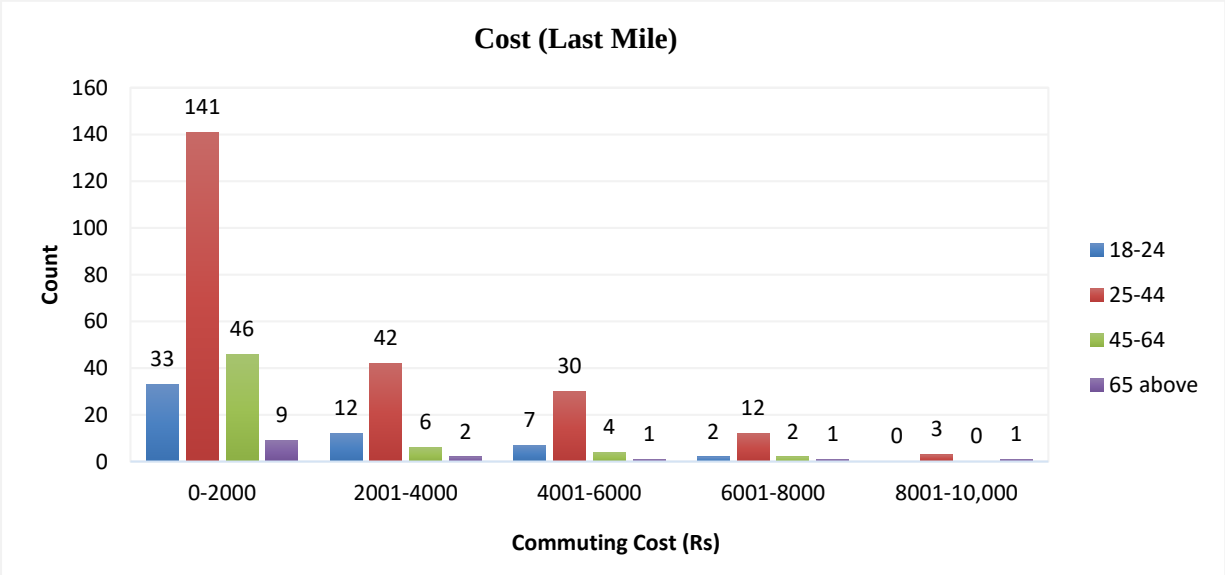


Figure 4.8: Age-based Commuting Cost Patterns (Last-Mile)

The 25-44 age group has a considerable number of individuals (25) who spend between 4001-6000 on their daily commuting, possibly indicating that they prioritize comfort and convenience when it comes to commuting. Additionally, this suggests that the distance between the transit and home may be too far to walk. Individuals who are 65 years or older tend to prefer cheaper commuting options, particularly in the 0-2000 cost bracket. This age group's preference for cost-effective transportation may be due to factors such as retirement, fixed incomes, or a desire to adopt more sustainable and affordable commuting methods. It is also observed that elderly people tend to use their cars to cover the first mile of commuting. On the other hand, commuters who fall in the 8000-10,000 or above cost bracket for commuting are relatively few. This could be due to factors such as distance or the need for more comfortable transportation options.

4.1.5. Cost Variation by Employment Status

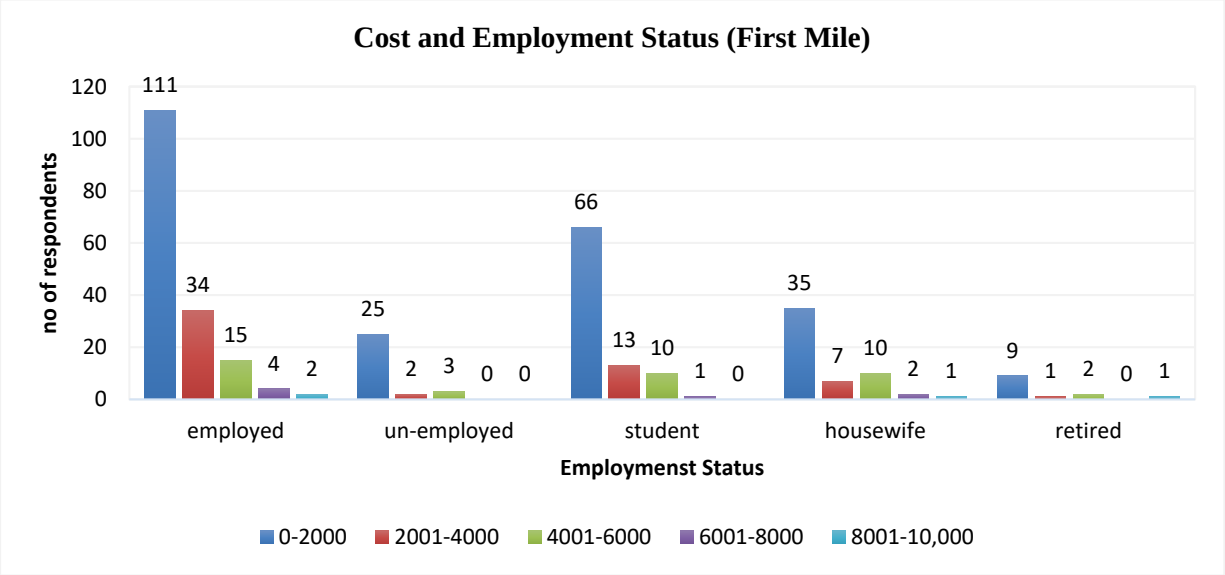


Figure 4.9: Comparative Analysis of Cost across Employment Status (First Mile)

Figure 4.9 shows that first income bracket (0-2000), there are 111 employed individuals, 25 unemployed, 66 students, 35 housewives, and 9 retirees. This shows that a significant number of people in this income range are employed, and many are students or housewives, likely explaining their preference for more cost-effective transportation options due to limited income.

For the second income bracket (2001-4000), 34 employed individuals, 2 unemployed, 13 students, 7 housewives, and 1 retiree were found. It shows that even with slightly higher income, individuals in this bracket continue to choose more affordable commuting options. For higher income brackets (10,000-24,999), the number of employed individuals decreases, reflecting a potential shift toward retirement or other non-employment statuses. The data suggests that in these higher brackets, some individuals, particularly retirees, may have higher commuting costs, possibly due to a preference for more comfortable transportation means.

Figure 4.10 shows that income levels and employment statuses influence last-mile travel decisions. While lower-income brackets exhibit a preference for cost-effective options, higher-income brackets, especially retirees, may lean towards more comfortable and personalized last-mile transportation. Students typically operate on limited budgets, impacting their transportation choices. Many rely on cost-effective modes like public transportation and walking.

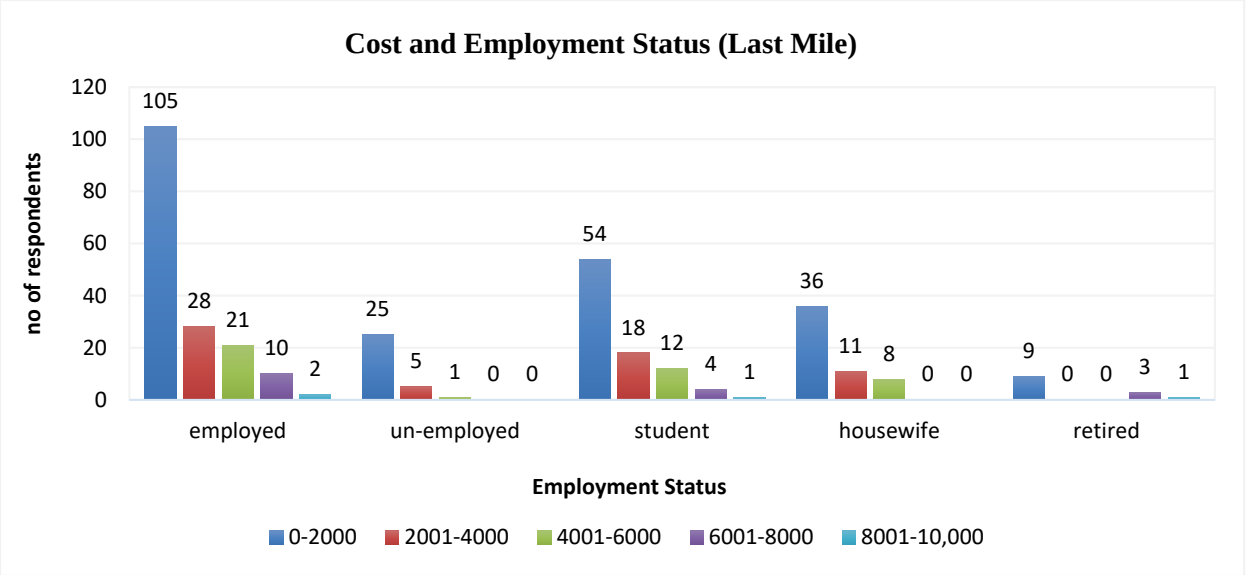


Figure 4.10: Comparative Analysis of Cost across Employment Status (Last-Mile)

The presence of students in the lower income bracket represents this. The presence of housewives in large numbers within this bracket suggests a preference for economical last-mile options. Housewives often have more flexible schedules, influencing their transportation choices. They may prioritize affordability and opt for public transportation or shared modes for daily activities.

4.1.6. Commuting Costs and Income Disparities

Figure 11 provides a comprehensive perspective on the relationship between monthly income and the cost of commuting for the first mile. In the lowest income bracket (0-4999), where monthly incomes are restricted, a significant number of individuals (69) have commuting expenses, likely reflecting their reliance on more economical transportation modes for the first mile. As monthly income increases, particularly in the 30,001-50,000 and 50,001-1,00,000 brackets, the number of individuals with commuting costs also rises, indicating a positive correlation between income and the willingness or ability to spend on first-mile travel. However, it is noteworthy that in the higher income brackets (1,00,001-1,50,000 and 1,50,001>), the number of individuals with commuting costs remains relatively stable or decreases. This could suggest a potential threshold beyond which commuters may prioritize comfort or convenience over minimizing first-mile expenses.

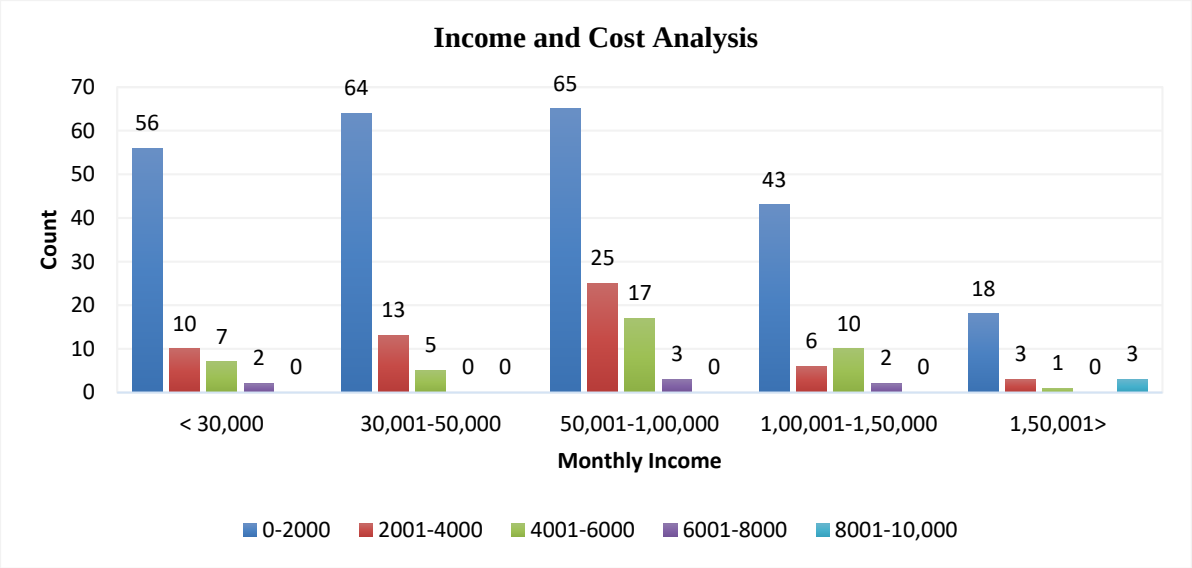


***Figure 4.11**:* Income groups and cost analysis (First-Mile)

Figure 4.12 shows, that in the lowest income bracket, where monthly incomes are limited, a considerable number of individuals (70) still incur last-mile commuting costs, possibly due to their use of more cost-effective transportation options. As monthly income increases, particularly in the 30,001-50,000 and 50,001-1,00,000 brackets, the number of individuals with last-mile commuting costs also rises, indicating a positive correlation between income levels and the willingness or ability to spend on more convenient last-mile travel options.

Interestingly, in the higher income brackets (1,00,001-1,50,000 and 1,50,001>), the number of individuals with last-mile commuting costs stabilizes or decreases, potentially suggesting a threshold where commuters prioritize comfort or convenience over minimizing last-mile expenses. Commuters with higher incomes often have the financial capacity to own and maintain private vehicles, leading to increased commuting flexibility and potential reliance on convenience-oriented options. Middle-income earners may strike a balance between cost and convenience, opting for a mix of private and public transportation based on individual preferences and commuting distances. Low-income individuals prioritize cost-effectiveness, relying predominantly on public transportation such as walking or rickshaws.

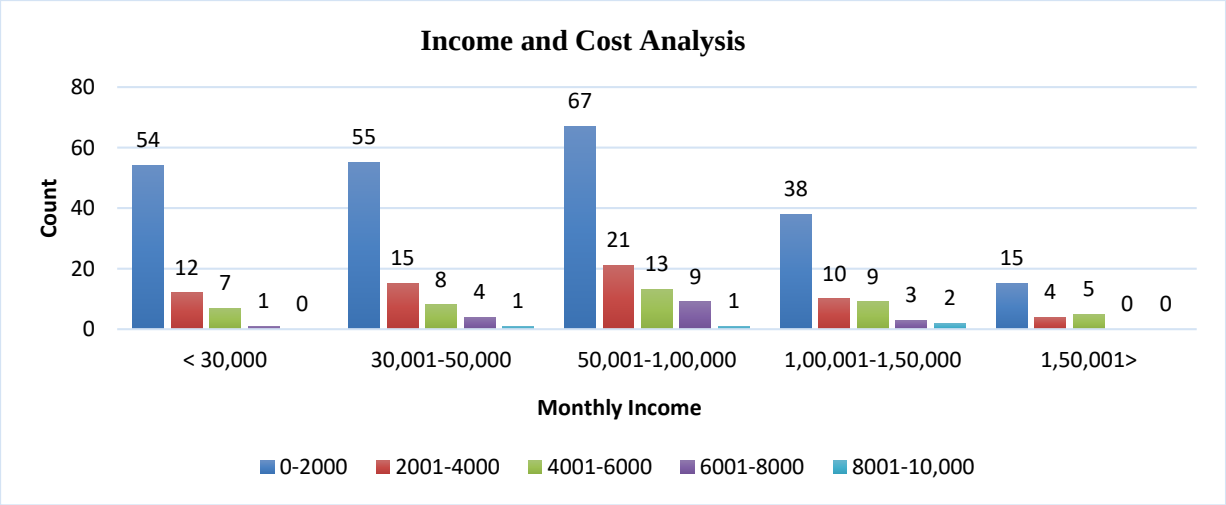


Figure 4.12: Income groups and cost analysis (Last-Mile)

4.1.7. Commuting Cost and First/Last Mile Travel Mode

The relationship between commuting costs and the first and last-mile mode of transportation is important in shaping individuals' travel choices. Figure 4.13 presents a detailed insight into the relationship between commuting costs and the modes chosen by commuters for their first-mile travel. Analyzing the data reveals distinct patterns based on income brackets, shedding light on transportation preferences among different socioeconomic groups.

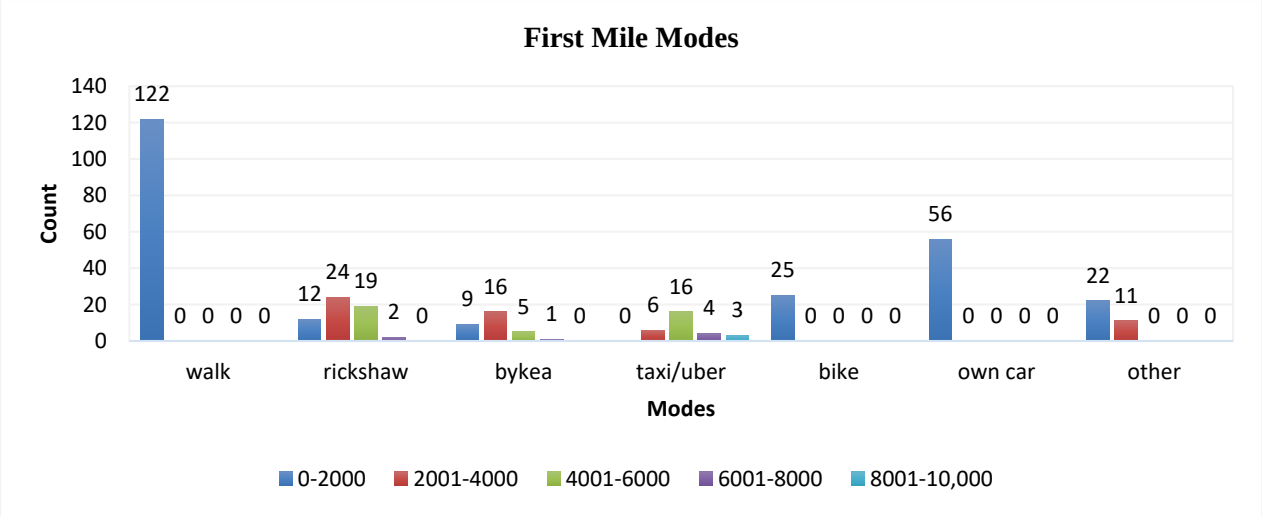


Figure 4.13: Cost associated with First Mile Mode

Individuals with lower incomes tend to prioritize cost-effective modes like walking, rickshaws, and Bykea for the first mile. As incomes increase, there is a subtle shift towards incorporating more diverse options, such as taxis/Uber and bikes, reflecting a correlation between commuting costs and the desire for a mix of affordability and convenience in the choice of first-mile transportation modes.

Figure 4.13 shows that individuals with lower incomes tend to prioritize cost-effective modes like walking, rickshaws, and Bykea for the last mile. As incomes increase, there is a nuanced shift towards incorporating more diverse options, such as taxis/Uber, reflecting a correlation between commuting costs and preferences for a mix of affordability and convenience in the choice of last-mile transportation modes. Walking remains a prevalent choice, but there is a noticeable shift towards more diverse options for the last mile. Interestingly, personal car usage remains limited, indicating that even with higher incomes, individuals may still consider a mix of cost-effective and convenient options for the last mile.

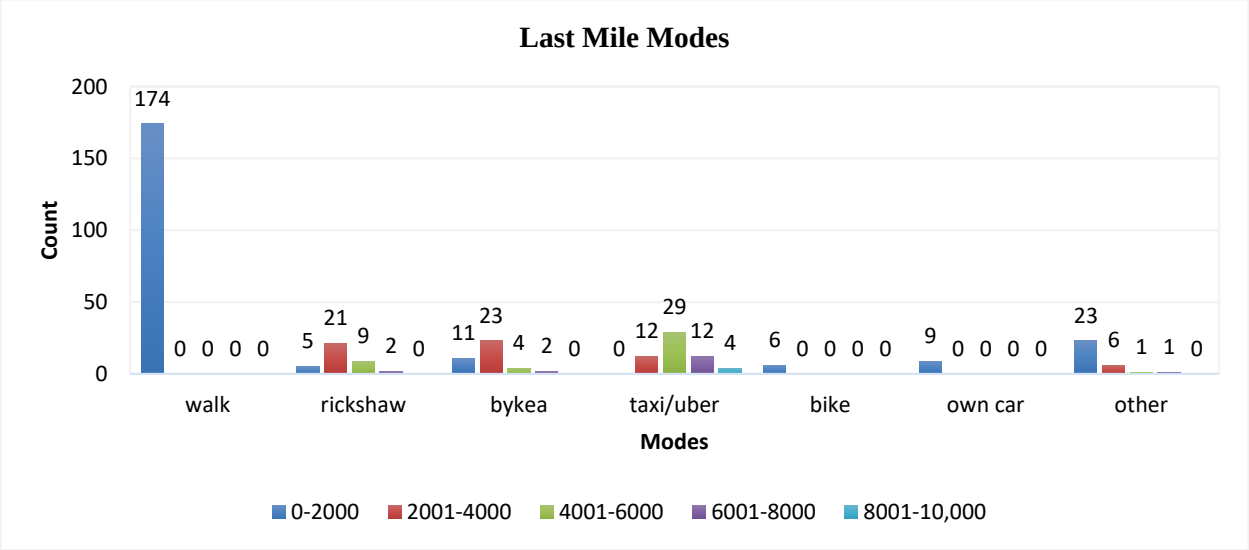


Figure 4.14: Cost associated with Last Mile Mode

4.2. Mode Choice Preferences and First and Last Mile Travel

The choice of commuting mode among urban dwellers is influenced by many factors which act as agents for choosing a particular mode of commuters. The socio-economic attributes of commuters, their travel characteristics, and other significant elements play a pivotal role in shaping their mode decision (Rahman et al., 2022). This section will provide a comprehensive analysis of these factors and their influence on the mode choice behaviour of commuters in Pakistan's twin cities.

4.2.1. Gender-Based Mode Preferences

Figure 4.15 provides insights into gender-specific mode choices for first and last-mile travel. The data reveals intriguing patterns in preferences for various modes, shedding light on the factors influencing these choices. Walking emerges as the overwhelmingly favoured mode across all genders with notably 83 (23 %) men, and 66 (18.3%) women opting for this simple and universally accessible means of travel. Transgenders exhibited a higher likelihood of choosing walking over other modes, due to safety concerns and discriminatory practices as motivating factors. The prominence of walking is also primarily due to the strategic placement of transit stations.

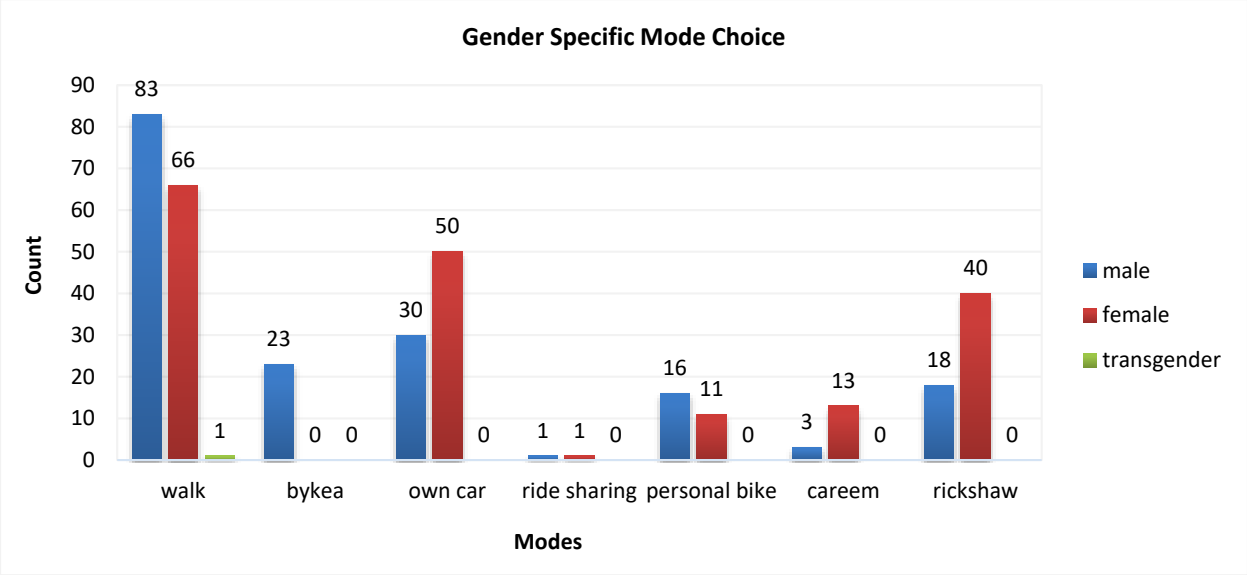


Figure 4.15: Gender-based mobility differences

Personal car ownership is a prominent choice for both males and females, highlighting a shared preference for the convenience and privacy afforded by personal vehicles. Interestingly, 50 (13.8%) women and 30 (8.3%) men opted for a personal car. Female preference is attributed to the family dropping them at the station. This emphasizes the role of familial support and convenience in shaping travel decisions. The lower preference for cars is due to the lack of proper parking spaces near transportation stations. This lack of parking infrastructure poses a challenge for male commuters, leading to a reduced inclination toward car usage for the overall journey.

However, the usage of taxi/Careem was relatively lower among participants. This was primarily attributed to the perceived high fare associated with these services for both males 3 (0.8%) and

females 13 (3.6%). This also indicates that some participants prefer the comfort and convenience of taxi/career services despite the higher cost.

The study found that rickshaws are popular among both males (5%) and females (11.1%) for short-distance travel due to their affordability. This choice is influenced by economic considerations, especially for first and last-mile travel. The research highlights a low usage of ride-sharing services by both genders, with only 1 (0.2%) of both men and women reporting utilizing ride-sharing options. This is attributed to a lack of awareness about ride-sharing services. In addition, 23 (6.3%) males preferred Bykea for quick and convenient rides.

4.2.2. Mode Preferences by Age-Groups

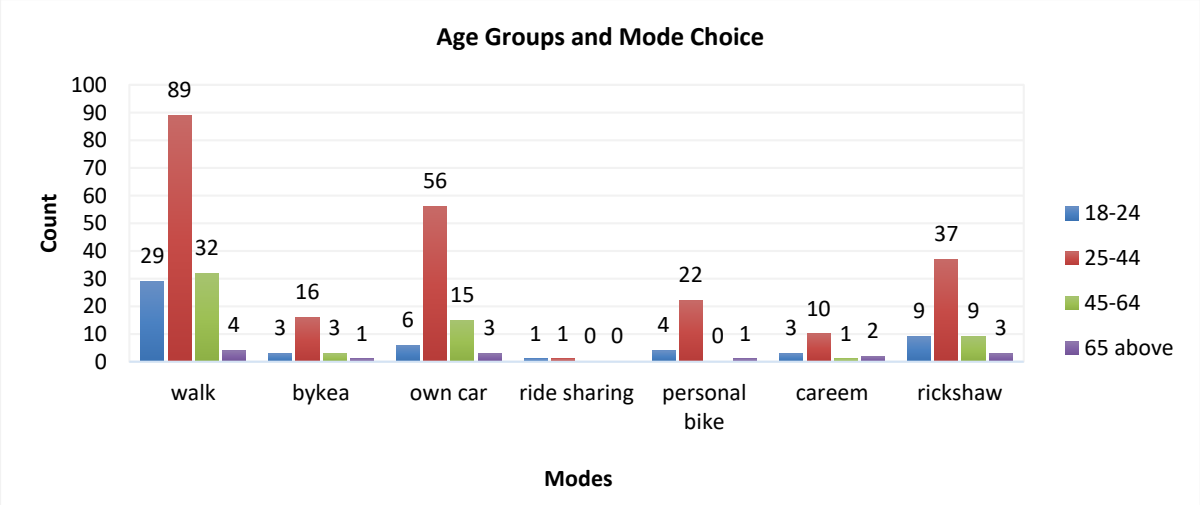


Figure 4.16: Effect of age on Mobility Patterns

Most of the respondents fell within the age group (25-44). Figure 4.16 illustrates preferences for first and last-mile transportation modes across different age groups, shedding light on the diverse considerations that influence commuter's choices and exploring how various factors might influence their choices. Among the 18-24 age group, walking emerges as the predominant choice, it is common among young adults, possibly due to cost-effectiveness and health benefits. While the preference for personal cars is notable, limited use of taxi services suggests a balance between practicality and cost considerations. The 25–44 age group continues to have a high walking prevalence and a more noticeable preference for services such as Bykea. The 45-64 age group showcases a sustained preference for walking, with a notable reliance on traditional modes like rickshaws and a moderate preference for personal cars.

The age group 65 and older continues to favour walking but less possibly due to physical constraints and is less likely to use modern modes of transportation, which may be due to physical limitations or a preference for well-known modes. Elder citizens desire transport services that are accessible and cater to their specific needs outside of the dominant flow of passengers and their daily commuting practice.

4.2.3. Employment Status and Mode Choice

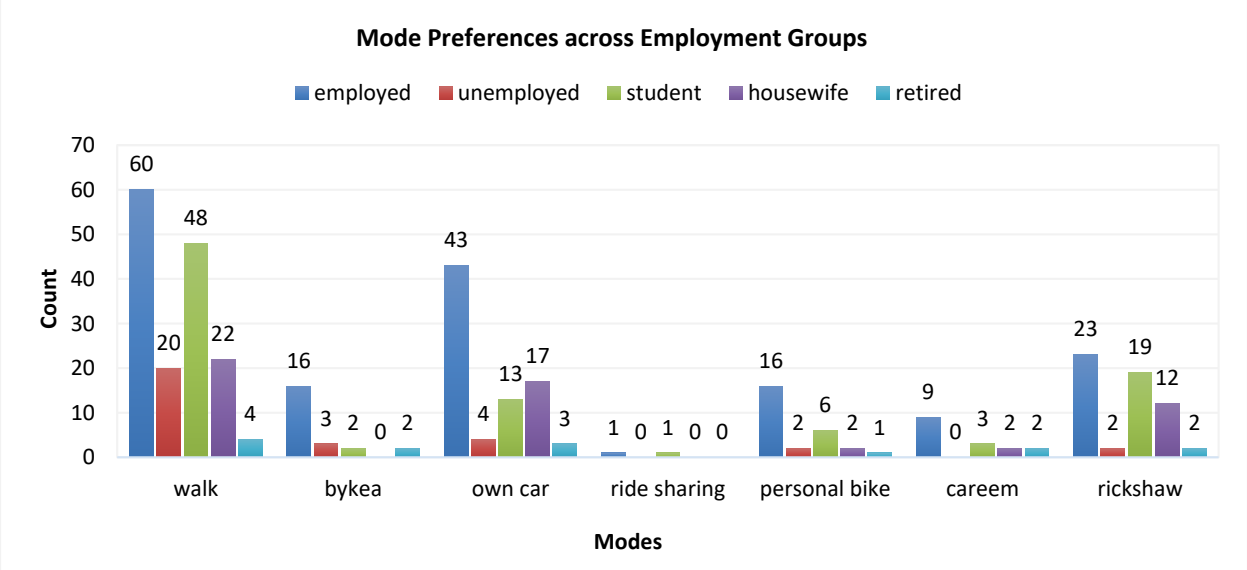


Figure 4.17: Effect of Employment Status on Mobility

Figure 4.17 indicates a comprehensive overview of mode preferences for first and last-mile travel across various employment groups, totaling 360 respondents. Among the 168 employed individuals, walking emerged as the dominant mode among 60 (16.6%) individuals, possibly due to its health benefits or practicality for short commutes. Notably, a substantial preference for personal cars (43) indicated a desire for individual mobility and convenience. Unemployed participants, 31 exhibited a pronounced preference for walking, reflective of budget constraints.

Students represent a diverse range of preferences, 48 preferred walking, likely due to cost-effectiveness. Rickshaws (19) and personal cars (13) were notably favoured among students, reflecting a mix of affordability and convenience among commuters. Housewives had a high preference for walking (22) and private vehicles (17), which is consistent with their requirement for regular home transportation. They also favoured less expensive choices such as rickshaws (12).

Retired individuals exhibited a more conventional form of transportation, such as personal vehicles and rickshaws, and they preferred to walk.

4.2.4. House Ownership Status

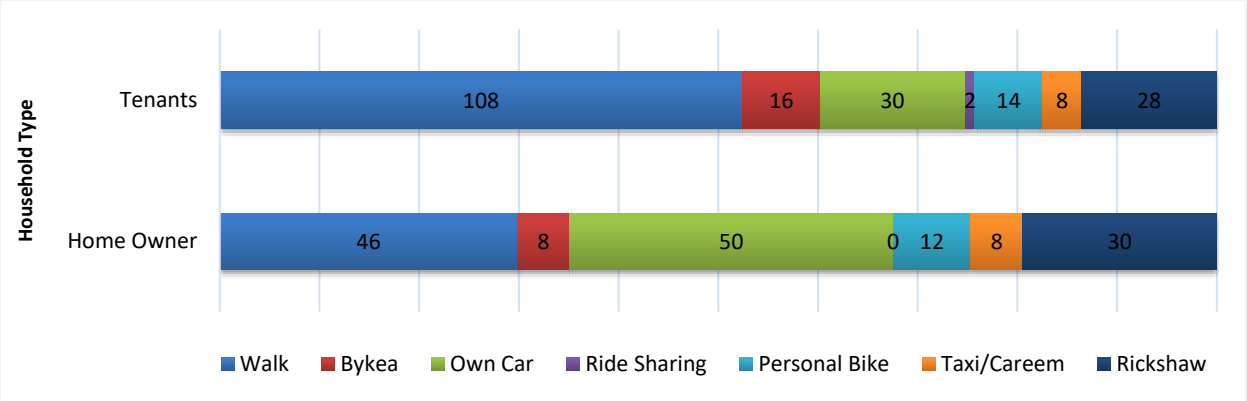


Figure 4.18: House Ownership Count

Figure 4.18 shows the use of different modes of mobility among tenants and homeowners. It was observed that out of 360 respondents 154 respondents own the house and 206 are tenants. It can be observed that the ratio of car ownership is higher among homeowners (13.8%) as compared to tenants (8.3%). However, the use of motorbikes and some public transport was reported higher among tenants, and walking has the highest percentage (42.7%).

Around 12.7% of homeowners are walking to cover the first/last mile while 30% of tenants are walking to cover their first/last mile of the journey. Ridesharing is reported to be the lowest among both tenants (0.5%) and homeowners (0%). The stability and long-term commitment associated with homeownership, encourage investment in personal vehicles. On the other hand, tenants show a higher reliance on motorbikes and certain forms of public transport, suggesting a preference for more flexible and cost-effective transportation options.

4.2.5. Income and Mobility Modes for First/Last Mile

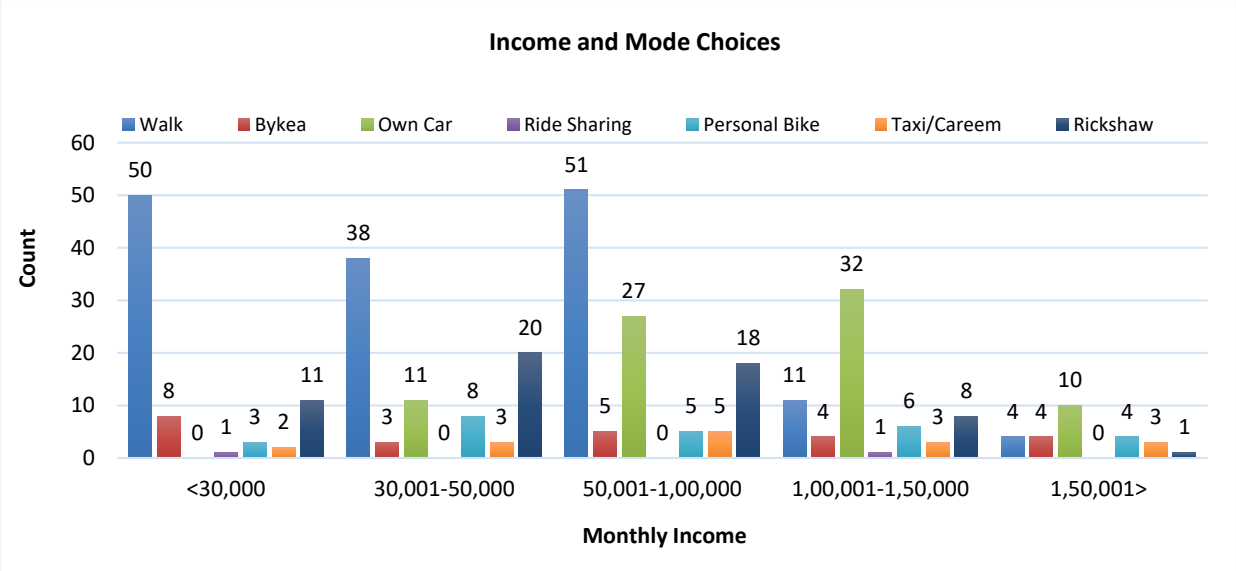


Figure 4.19: Income and Mobility Choices

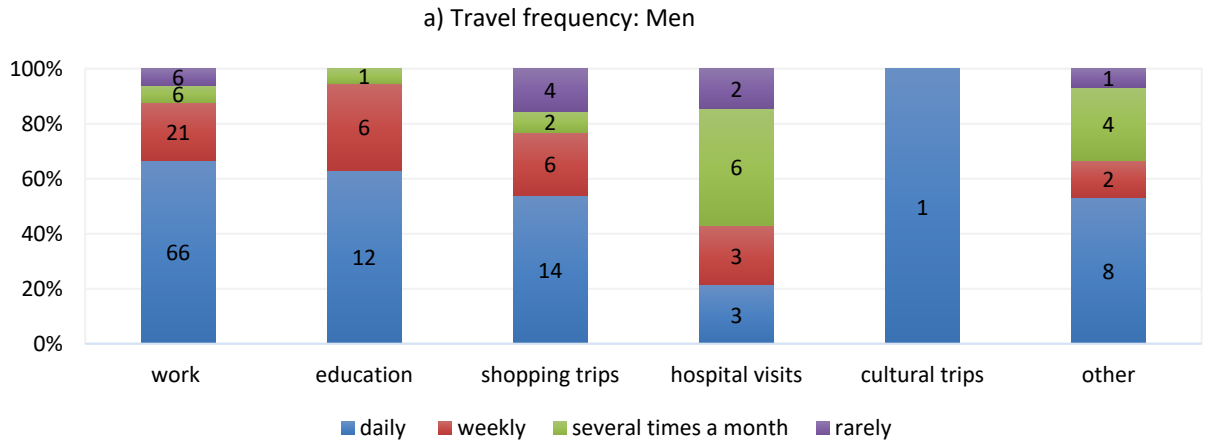
Figure 4.19 shows mode of mobility for the first/last mile differs across different income levels. The trend in each income group can be observed. The lower income groups tend to adopt the mode of mobility which is less expensive as compared to higher income groups. The first income group "0 – 30,000" has not reported a single respondent with a car as their daily mode of commute. Modes like bike, Bykea, rickshaw, and walk are more prevalent, reflecting a reliance on cost-effective and accessible transportation options.

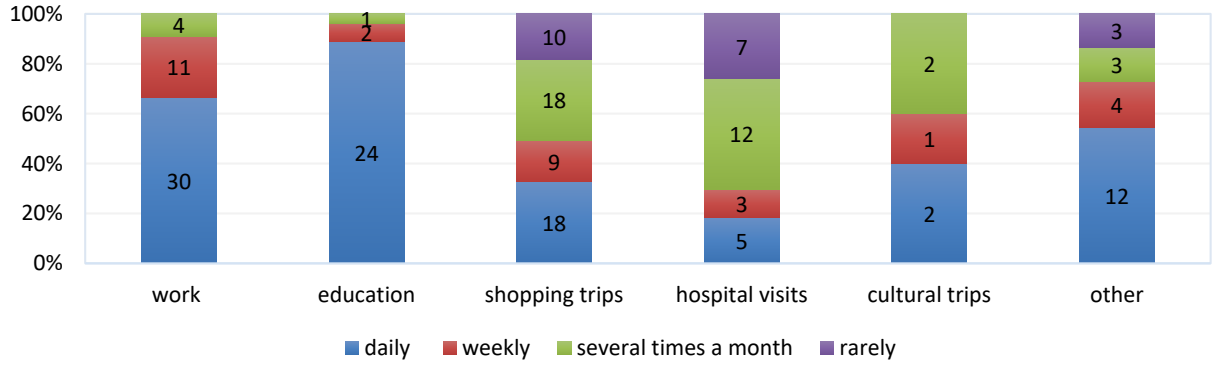
Further, respondents from the income group "30,001 – 50,000", reported personal bike, Bykea rickshaw and taxi/Careem to commute for the first/ last mile of the journey. Commuters start incorporating a broader range of modes, however, the preference for cars becomes more prominent in higher income brackets. Whereas, as in income groups "50,001 – 100,000", "100,001 –150,000" and "150,001 – Above" majority of commuters preferred car as their primary mode of mobility. Around 42.7% of respondents prefer walking for first/last mile travel, 22.2% prefer a car, 16.1% preferred rickshaw, 7.2% preferred personal bike, 6.6% preferred by kea, 4.4% preferred taxi/careem and 0.5% preferred ridesharing. Walking emerges as a consistent choice across income groups, with 42.7% of respondents preferring it for the first/last mile travel. This suggests that, regardless of income, walking remains a widely adopted and cost-effective mode of transportation.

4.2.6. Travel Frequency of Commuters

The difference in the usage of public transport based on gender is relatively small. Table 4.1 displays the differences in mode choice between genders based on the type of activity. More than half of the commuters are daily users (55.5%), while the remaining use it weekly (18.8%), several times a month (16.4%) or rarely (9.2%) as shown in Table 4.1. Most of the respondents commute daily for work (26.9%), and education purposes (10%). Figure 4.20 shows the results of the survey, men travelled more frequently for most of the activities, as compared to women and transgenders. Approximately, 21.6% of men reported travelling daily for work and education. 3.8% of men were reported to travel daily for shopping trips, and 2.5% of men were reported to travel daily for social and cultural trips. Women were reported to travel daily mostly for work (8.3%), education (6.6%) and shopping trips (5%). On the other hand, 1.3% of transgenders engage in daily travel for begging.

Men exhibit a higher frequency of daily travel, primarily driven by work and educational commitments, reflecting societal expectations as primary providers. Women, on the other hand, engage in daily travel for a mix of work, education, and shopping, suggesting a multifaceted role balancing both professional and household duties. Safety concerns contribute to women's cautious approach to daily travel. The low percentage of transgenders indicates socioeconomic challenges and limited employment opportunities, and societal discrimination.





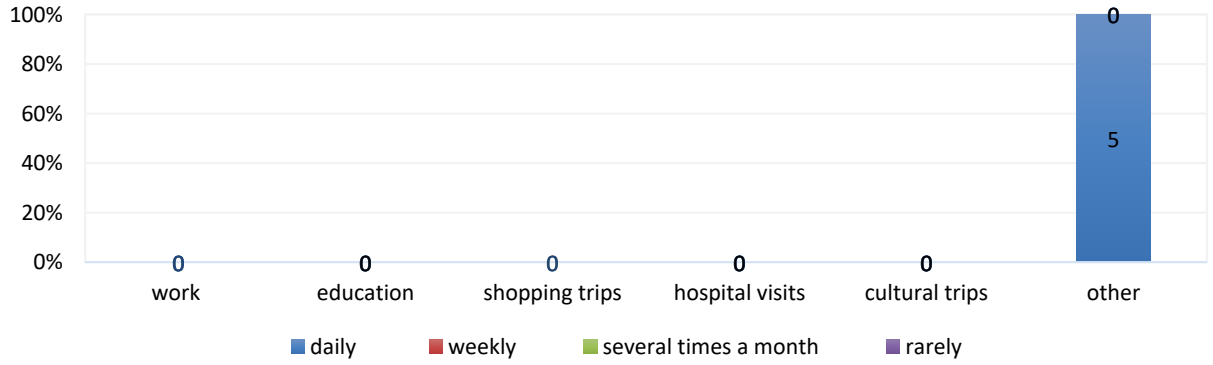


Figure 4.20: Travel Frequency of Commuters

4.3. Public Perception Toward First and Last Mile Travel

4.3.1. Ideal Mode for Mobility

Data on the ideal mode choice of commuters was collected by the survey questionnaire and the results are visualized in Figure 4.21. Overall, it indicates that commuters perceived the metro (76.1%) as an ideal mode. 21.7% consider other modes which include own car, personal bike, or van as an ideal mode, whereas 1.1% believed that coaster is an ideal mode for mobility. Only 0.3% of commuters believe in a wagon and 0.8% choose Suzuki as an ideal mode. Commuters indicated that metro bus routes are accessible and affordable to use while some commuters living in areas far from metro stations consider other modes as their ideal modes and some respondents don't feel safe and comfortable while using the public transport system, especially females. Wagon, Suzuki, and coaster were preferred less because they are less convenient, unsafe, and uncomfortable modes.

Table 4.5: Ideal Mode Preference

Ideal Modes	Male	Female	Transgenders	Total
Metro Bus	138	130	5	273
	(38.3%)	(36.1%)	(1.3%)	(75.8%)
Wagon	1	0	0	1
	(0.2%)	(0%)	(0%)	(0.2%)
Coaster	1	3	0	4
	(0.2%)	(0.8%)	(0%)	(1.1%)
Suzuki	2	1	0	3
	(0.5%)	(0.2%)	(0%)	(0.8%)
other	32	47	0	79
	(8.8%)	(13.05%)	(0%)	(21.9%)
Total	174	181	5	360
	(48.3%)	(50.2%)	(1.3%)	(100%)

4.3.2. Relocate to Improve First and Last-Mile Travel

Figure 4.22 provides a detailed insight into respondents' contemplation of relocation to enhance their first and last-mile travel experiences. Among the 360 participants, 133 individuals expressed a willingness to relocate for distinct reasons, while 227 respondents did not consider relocation. Breaking down the motivations for considering relocation, it becomes evident that several factors

play a pivotal role in respondents' decision-making. A substantial group of forty respondents contemplate relocation due to limited transportation options, emphasizing the critical need for improved accessibility in their daily commute. Fifty-one individuals highlight travel cost as a significant factor prompting consideration for relocation, emphasizing the financial aspect intertwined with their first and last-mile travel. For seventy-three respondents, the desire to minimize travel time emerges as a driving force, indicating the paramount importance of time efficiency in shaping commuting preferences.

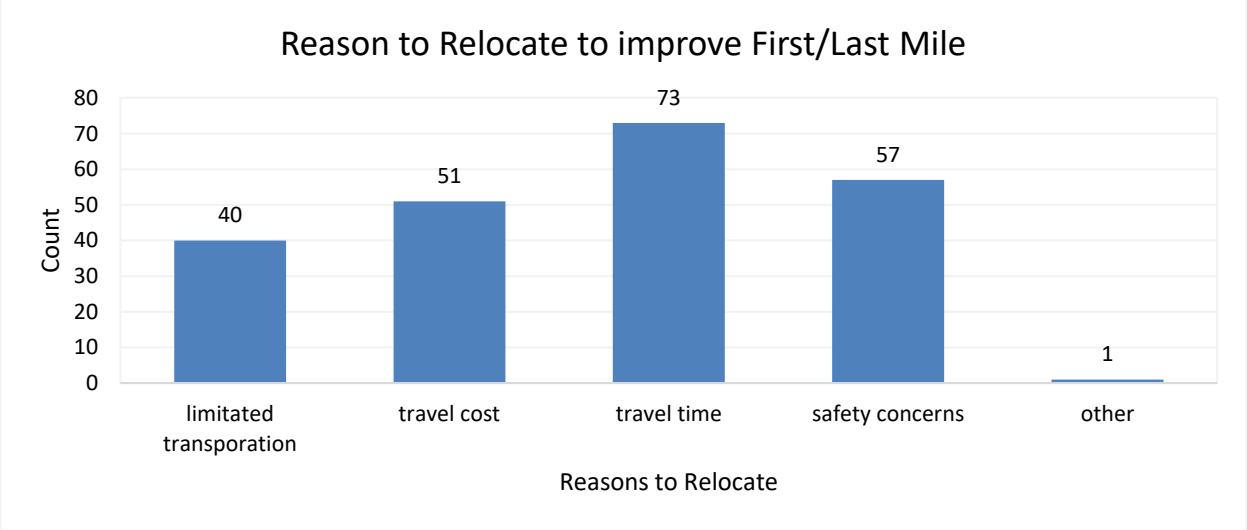


Figure 4.21: Reasons to Relocate

Safety considerations play a prominent role, with fifty-seven respondents expressing an intention to relocate for enhanced safety during their first and last-mile travels, underlining the crucial role of security in commuting decisions. This comprehensive breakdown not only unveils the motivations behind considering relocation but also illuminates the nuanced interplay of factors such as accessibility, financial considerations, time efficiency, and safety in shaping individuals' preferences for their first and last-mile travel.

4.3.3. The Cost Efficiency of Public Transport Systems

The way the public perceives first-mile and last-mile travel can impact the adoption and success of transportation systems. This perception includes people's attitudes, beliefs, and opinions about the convenience, accessibility, and overall experience of these trips. A positive public perception contributes to increased ridership and the overall success of urban transportation systems. The

analysis explores key themes identified through systematic coding and categorization of responses regarding their perceptions of first and last-mile travel, shedding light on the nuances of affordability, safety, convenience, park and ride, maintenance, availability, and comfortability. Figure 4.23 shows the discrepancy between respondents' perceptions of cost efficiency and the actual cost incurred for the first and last-mile travel. For those respondents who indicated that cost efficiency aligns with their first-mile expenditure (perceiving low costs as efficient), the figure demonstrates a congruence between perception and reality.

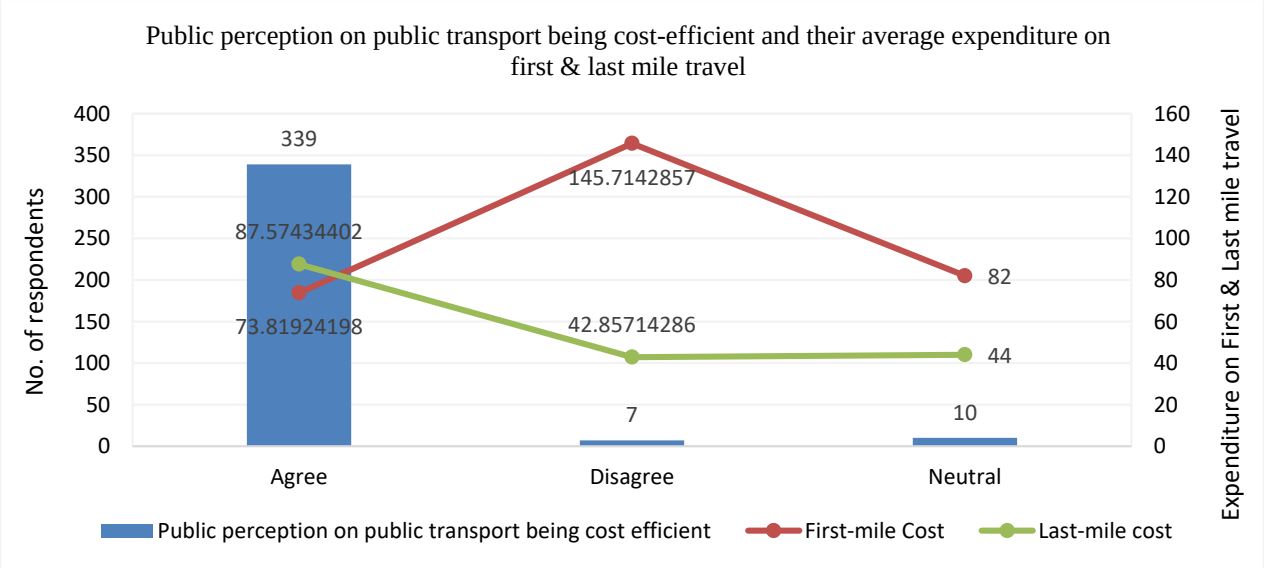


Figure 4.22: Cost Perception

Their first mile costs are indeed low, validating their perception and suggesting a realistic alignment between what they believe to be cost-efficient and the actual expenditures. Conversely, respondents who disagree, perceiving inflated costs as inefficient for the first mile, exhibit higher actual expenditures. This mismatch between perception and reality signals a potential dissatisfaction or lack of alignment between their expectations and the financial realities of the first-mile travel. The situation is reversed when considering the last-mile travel costs. Respondents who perceive high costs as efficient for the last mile indeed incur higher expenditures, confirming the accuracy of their perception. On the other hand, those who disagree, seeing high costs as inefficient, have lower actual last-mile expenditures, indicating a misalignment between their perception and the actual financial outlay for the last mile.

4.3.4. Affordability

Affordability is a paramount consideration for commuters navigating the first and last mile of their journeys. A significant number of respondents (89.7%) strongly agree that cost is a crucial factor influencing their decisions regarding first and last-mile travel. Also with rising petrol prices, commuters are strategically shifting towards public transport options to mitigate the economic impact of individual vehicle usage. 85% of commuters prefer public transport because petrol prices are high. Metro Bus Service is highly affordable for common people. All the respondents have shown satisfaction with the fares charged by metro bus; however, they have to pay extra charges to reach the transit stop or their final destination. The metro bus service is affordable as compared to private services. Owning and maintaining a private vehicle involves substantial expenses related to fuel, maintenance, and repairs. Public transportation eliminates the need for individual vehicle maintenance, reducing the financial burden on commuters.

Table 4.6: Affordability

Question on Survey	Disagree	Neither Agree nor Disagree	Agree
Cost is an influential factor	24 (6.6%)	13 (3.6%)	323 (89.7%)
Shift in transit due to petrol prices	30 (8.3%)	24 (6.6%)	306 (85%)
Budget-friendly	7 (1.9%)	10 (2.7%)	343 (95.2%)

4.3.5. Accessibility and Availability

Availability and accessibility play pivotal roles in shaping the decisions of commuters during their first and last-mile travels. It is difficult to access by those disabled persons who live far away from transit stations. They either have to take a cab or private transport to reach the transit station. Similarly, females have to depend on their family members to provide them with pick and drop or they use a taxi, careem or local transport to access transit stops from their homes, educational institutes and job places.

One significant issue is the uneven distribution of transportation modes, leading to limited accessibility in certain areas. Commuters often encounter difficulties accessing reliable public transit options. This lack of accessibility is compounded by inadequate infrastructure, such as poorly maintained sidewalks and insufficient crosswalks, making it challenging for pedestrians to reach transit stops safely. Additionally, the limited availability of diverse transportation options poses a hurdle for commuters. Insufficient frequency and coverage of public transit modes, coupled with irregular schedules, contribute to prolonged waiting times and unpredictable commuting experiences. The scarcity of options, especially during non-peak hours, forces commuters to rely on fewer alternatives, limiting their flexibility and potentially leading to crowded or overburdened transportation modes.

Table 4.7: Accessibility and Availability

Question on Survey	Disagree	Neither Agree nor Disagree	Agree
Availability of seats	13 (3.6%)	10 (2.7%)	277 (76.9%)
Absence of streetlights	66 (18.3%0	17 (4.7%)	277 (76.9%)
No ramps/elevators	27 (7.5%)	11 (3.05%)	322 (89.4%)
No pickup/drop off areas	35 (9.7%)	15 (4.1%)	310 (86.1%)
Stops are within walking distance	160 (44.4%)	54 (15%)	146 (40.5%)

4.3.6. Infrastructure Maintenance

Commuters face a myriad of infrastructure-related challenges during their first and last-mile travels. One significant issue is the lack of well-maintained sidewalks and pedestrian pathways, making it difficult for pedestrians to navigate safely. Insufficient or poorly designed crosswalks exacerbate safety concerns, leading to potential hazards for pedestrians. Inadequate street lighting poses an additional challenge, particularly during evening commutes, further compromising the safety of those travelling on foot.

Limited accessibility to public transit stops and inadequately designed waiting areas can lead to congestion and discomfort for commuters, especially during peak hours. The absence of designated bicycle lanes and poorly planned road infrastructure can impede the efficiency and safety of cyclists, discouraging the use of environmentally friendly modes of transportation. These infrastructure-related issues collectively contribute to a suboptimal first and last-mile travel experience, emphasizing the urgent need for comprehensive urban planning and infrastructure development to address the evolving needs of commuters in urban settings. There are no proper waiting shelters. The proper bus stops are constructed in some areas but are so dirty smelly and sometimes broken that commuters prefer to wait under the open sky rather than inside the bus stop shelter. Drivers tend to stop upon sighting a passenger on the road, even if there is a properly constructed van stop nearby.

Table 4.8: Infrastructure

Question on Survey	Disagree	Neither Agree nor Disagree	Agree
No proper waiting shelters	42 (11.6%)	21 (5.8%)	297 (82.5%)
Poor maintenance of sidewalks	28 (7.7%)	16 (4.4%)	316 (87.7%)
Clean and well-maintained transit	10 (2.7%)	6 (1.6%)	344 (95.5%)
Willing to walk if the infrastructure is well-designed	20 (5.5%)	6 (1.6%)	334 (92.7%)

4.3.7. Safety Issues

Safety issues in first and last-mile travel are crucial considerations that impact the overall commuting experience. Inadequate street lighting in certain areas can pose safety risks, especially during evening or night travel. Insufficient or poorly maintained sidewalks and crosswalks can make it challenging for pedestrians to navigate safely. Some areas have a higher incidence of crime, making commuters susceptible to theft, harassment, or assault. This concern about personal

safety discourages commuters from using public transport or walking. The use of verbal communication, body language, and gestures by drivers, conductors, and passengers in local transport can make females feel uncomfortable and insecure. Lack of accessible infrastructure, such as ramps and elevators, can create challenges for individuals with disabilities and elderly people with medical conditions such as arthritis.

Table 4.9: Safety Concerns

Question on Survey	Disagree	Neither Agree nor Disagree	Agree
Safety while waiting/walking	164 (45.5%)	18 (5%)	178 (49.4%)
Unsafe pedestrian walks	21 (5.8%)	6 (1.6%)	333 (92.5%)
Public transit is a safe choice to use	128 (35.5%)	44 (12.2%)	188 (52.2%)
Safety measures can prevent crimes	4 (1.1%)	8 (2.2%)	348 (96.6%)

4.3.8. Convenience and Comfortability

Individuals with disabilities, including those who are blind, have locomotor disabilities and can move with difficulty, are likely to use public transportation, but they do not prefer it due to overcrowding. The front seats of the van provide sufficient space for such individuals to comfortably sit and spread their legs, but these seats are often given to non-disabled individuals. Even if a front seat is available, drivers usually charge double the fare. The drivers of public transportation are insensitive to the needs of the disabled and elderly communities. They often avoid stopping for these individuals because they are in a hurry to load passengers and prefer to pick up someone who can quickly get in and out of the van. The disabled and elderly take longer to board and disembark from the van, which the drivers perceive as a waste of time, so they prefer to pick up someone who can move more quickly. Elevators and lifts have been installed in every Metro Bus Station to provide convenience for disabled individuals and elderly people; however, these facilities are often out of order due to technical issues.

This poses a challenge to PWDs as they can only access by stairs. Moreover, it takes several days for the companies to repair these lifts and elevators, leaving disabled persons with difficulties in the meantime. Many of the Metro Bus Stations lack slopes or ramps on the footpaths leading to the station, making it impossible for wheelchair users to access the bus station independently.

Table 4.10: Convenience and Comfortability

Question on Survey	Disagree	Neither Agree nor Disagree	Agree
Provide convenient routes and schedules	50 (13.8%)	29 (8.05%)	281 (78.05%)
Provide good travel choice modes	45 (12.5%)	37 (10.2%)	278 (77.2%)
Distance is time-consuming	97 (26.9%)	39 (10.8%)	224 (62.2%)
Always crowded	11 (3.05%)	36 (10%)	313 (86.9%)

4.3.9. Public Perception Toward Park and Ride Facilities

Park and Ride is a transportation strategy designed to address the challenges of first and last-mile travel, particularly for individuals commuting to city centers or other destinations. Park-and-ride facilities combine private and public modes by offering parking spaces on the outskirts of towns and cities and connecting them to a public transportation stop, such as a bus stop, (Meek et al., 2008). Park-and-ride serves as a hub for ridesharing interchange. Park and ride services are operated by local authorities and are less expensive as compared to parking in city centers. The park-and-ride scheme has achieved some success in motivating individuals to replace private car usage with public transportation. Furthermore, the scheme appears to have led to a decline in the number of car trips, (Marshall & Banister, 2000). This can help to reduce urban congestion and air pollution. The survey shows majority of respondents (80.5%) express a lack of familiarity with the concept of park and ride. A notable but comparatively smaller percentage (16.9%) were familiar with the park-and-ride concept.

A significant majority (80%) agree that the cost of using park and ride does affect their decision. 70.2% of commuters responded that they could use park-and-ride facilities as petrol prices are very

high. Respondents preferred park and ride over other modes of transportation because it can help reduce traffic congestion. 87.2% of respondents have safety concerns as park and ride locations are not safe. Park and ride encourage people to use personal vehicles for shorter distances. By parking their vehicles at a park-and-ride facility, commuters avoid the challenges of driving into congested city centers or areas with limited parking space.

Table 4.11: Park and Ride Facility

Question on Survey	Disagree	Neither Agree nor Disagree	Agree
Familiar with the concept of park-and-ride	290 (80.5%)	9 (2.5%)	61 (16.9%)
Park and Ride cost influence choice	29 (8.05%)	43 (11.9%)	288 (80%)
Willing to pay for park and ride	118 (32.7%)	55 (15.2%)	187 (51.9%)
Park and ride reduce congestion	53 (4.16%)	104 (28.8%)	203 (56.3%)
Park and ride and petrol prices	15 (14.7%)	92 (25.5%)	253 (70.2%)
Park and ride and other modes	69 (19.1%)	133 (36.9%)	158 (43.8%)
Safety concerns at Park and Ride.	22 (6.11%)	24 (6.6%)	314 (87.2%)

4.3.10. Barriers Toward First and Last Mile Travel

The study asked respondents about the barriers toward first and last-mile travel and to rank them on a scale of 1 to 5. Not surprisingly, the safety of transportation was the issue of major concern expressed by respondents as 86% agree that there are insufficient and unsafe pedestrian walks which discourage them from first and last-mile travel. The lack of safety infrastructure, such as poorly maintained sidewalks or inadequate street lighting, is a significant barrier. This is due to safety issues or experiences of unsafe conditions.

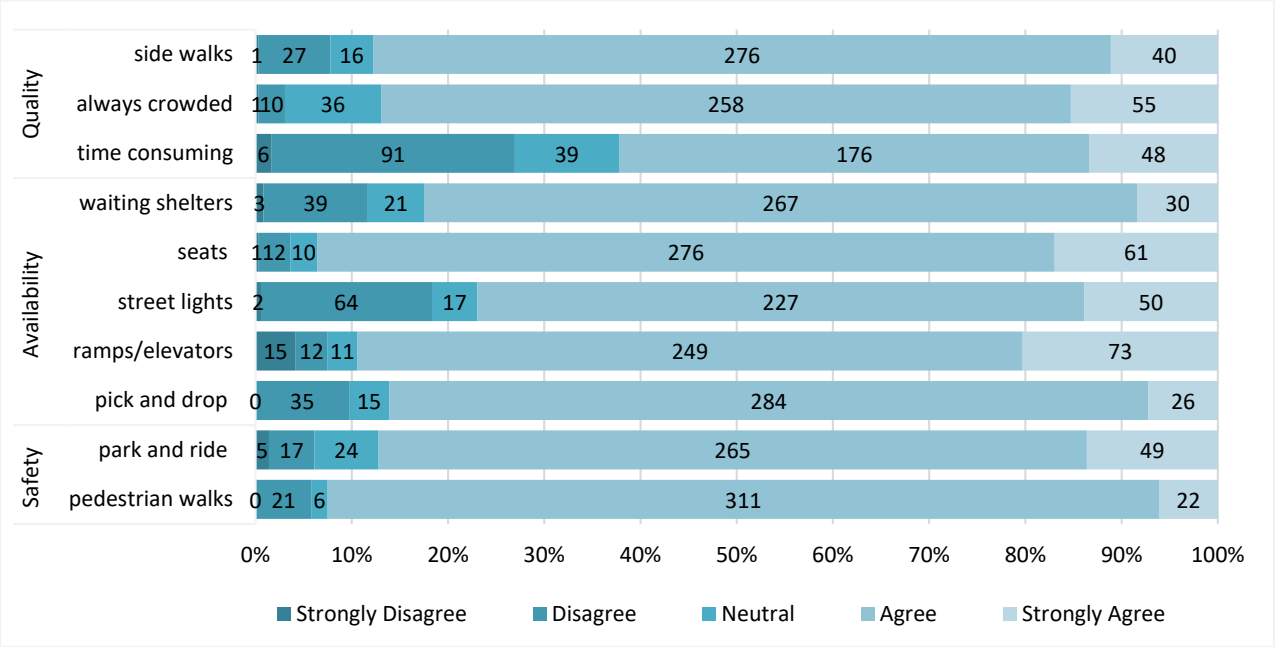


Figure 4.23: First/Last Mile Barriers

The set of issues related to availability and quality of public transport were also identified as problematic. Approximately 87.2% of respondents expressed that the park and ride locations are not safe, 6.1% disagreed and the remaining 6.6% were indifferent. Availability of pick and drop points was reported as the top issue of first and last-mile travel. Approximately 93.6% of respondents expressed the availability of seats as an extreme issue, and 76.9% expressed streetlights as a key issue. Availability of seats is also a major issue, this is due to overcrowding, lack of adequate public transport options, or inadequate seating facilities. Issues related to the quality, (poor maintenance of sidewalks, discomfort and always crowded, and distance is time-consuming) were also considered as a problem of major concern.

4.4. Econometric Analysis

The software used for the econometric analysis of this thesis is STATA. The survey results show that respondents use a variety of modes for the first mile and last mile of travel and the cost associated with it.

Variables Explication

Table 4.12 shows the list of dependent and independent variables that we are using in the analysis. To conduct an econometric analysis, we have gathered relevant data on the key variable. We have

one dependent variables the travel cost (first mile and last mile cost). For cost linear regression (MLR) has been employed.

Table 4.12: List of Variables

Variables	Description
Travel cost	Overall travel cost (first mile + last mile)
First and Last-Mile Travel Mode	Chosen mode for first/last mile travel
Travel time	First and last mile time
Waiting time	First and last mile waiting time
Distance	Distance between home to transit and transit to destination
Monthly Income	Monthly household income of respondents
Gender	Gender of respondents
Main Mode	The main mode of commute
Physical disability	Physical disability (dummy variable)

4.4.1. Modelling the Cost Variable for First and Last Mile Travel

The cost parameter for first-mile travel in Table 4.15 suggests that users are more sensitive to travel costs. The positive sign of the distance coefficient shows that for a longer distance the cost of travelling increases and for shorter distances it is less or not at all, for example for non-motorized modes. The gender coefficient shows a positive association between gender and cost, which shows significant gender-related differences such as travel preferences, and commuting patterns. The model estimation yields negative signs for first-mile waiting time, showing the disutility of this factor for travel cost. The coefficients for first-mile waiting time, first-mile travel time, and first-mile distance are also significant. The negative coefficient for the first-mile mode (-0.1805) suggests that choosing a specific mode for the first mile is associated with lower travel costs.

The positive coefficient suggests that, on average, an increase in first-mile travel cost is associated with a corresponding increase in travel time. Longer travel times are likely to contribute to higher first-mile travel costs. This is due to factors such as increased fuel consumption, higher transportation expenses, or a higher charge for time-related services. Similarly, the positive sign of the first-mile distance indicates that an increase in distance will increase the travel cost.

Table 4.13: Estimation Results (FM/LM)

	First Mile Travel Cost		Last Mile Travel Cost	
Variables	Coefficient	p-value	Coefficient	p-value
Gender	0.38	0.001	0.45	0.000
Disability	1.9	0.000	1.97	0.000
Income	0.18	0.000	0.16	0.001
Mode	-0.18	0.000	-0.16	0.000
Waiting Time	-0.11	0.313	0.24	0.017
Travel Time	0.28	0.018	-0.14	0.393
Distance	0.14	0.166	0.42	0.002

For the last-mile travel cost the coefficients, Gender, Income, Disability, and last-mile mode are significant predictors. An increase in last-mile travel costs is associated with a higher expected increase in income. Commuters with higher incomes are more willing or able to afford increased last-mile travel costs. The coefficient for income indicates that a one-unit increase in income is associated with a 0.16-unit increase in last-mile cost.

Similarly, the coefficient for disability is 1.97, implying that individuals with disabilities incur significantly higher last-mile travel costs. An increase in last-mile travel costs is associated with having a disability. This implies that individuals with disabilities face additional costs in their last-mile travel. This is due to several reasons. People with disabilities often prioritize safe and comfortable modes of travel due to their unique needs and considerations. Accessibility features, ease of boarding, and accommodation for mobility aids become crucial factors in their choice of transportation. Furthermore, some public transport systems also impose higher fares on individuals with disabilities. An increase in last-mile travel costs is associated with a decrease in the expected last-mile mode. This shows that as last-mile travel costs increase, commuters may shift away from certain modes of transportation.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

This research quantifies the different mobility patterns among commuters and addresses transportation inequalities by examining first and last-mile travel issues in Islamabad and Rawalpindi, Pakistan. It identifies costs, and factors influencing mode choice, and proposes sustainable mobility strategies. While the study reaffirms previously known facts about travel behaviour, in Pakistan and other countries. Most of the previous studies in Pakistan focused on public transport and people's perception in general, and the already known literature needed fresh evidence for knowing current travel behaviour and the challenges related to first and last-mile travel in Rawalpindi and Islamabad. The literature explores the complex dynamics of urban mobility, emphasizing the significance of first and last-mile travel. It examines the issues that different people experience using theoretical frameworks such as transportation disadvantage, inaccessibility, and social disadvantage. Since there is a lack of information about first and last-mile transportation in twin cities of Pakistan, this research aimed to explore the topic in more depth and provide further insights into the preferences of commuters for existing and new means of first and last-mile transportation options.

The study shows a clear positive relationship between income level and transportation expenses, with higher-income individuals spending more on their overall journey. Despite efforts to minimize transportation costs, even within the low-income population, a substantial portion of income is dedicated to this necessity. The average cost for females is greater than the average cost of males on first and last-mile travel, which can be explained by the fact that females tend to prioritize safety and convenience over the cost-effectiveness of rides due to social dilemmas. Age-related patterns suggest a shift in commuting priorities from cost-effectiveness for younger individuals to comfort and convenience for older age groups. Lower-income brackets exhibit a preference for cost-effective options like walking, rickshaws, and Bykea for the first and last mile, while higher-income brackets, especially retirees, may lean towards more comfortable and personalized last-mile transportation.

The analysis of mode choice preferences and first and last-mile travel in Pakistan's twin cities, revealed several key findings. Walking was the most preferred mode of travel for all genders, with 23% of men and 18.3% of women choosing this mode. More than half of the commuters were daily users, with most of the respondents commuting daily for work and education purposes. Men travelled more frequently for most of the activities, as compared to women. Personal car ownership was also a popular choice, with 13.8% of women and 8.3% of men opting for this mode. The use of taxi-Careem was relatively low due to the perceived high cost, and rickshaws were popular for short-distance travel due to their affordability. Lower-income groups tended to adopt less expensive modes of mobility, while the preference for cars became more prominent in higher-income brackets.

Furthermore, the research provides a comprehensive analysis of public perception towards first and last-mile travel. The study reveals that 76.1% preferred the metro bus service as the ideal mode of transport due to its accessibility and affordability. However, there are concerns about safety and comfort, especially among female commuters. Accessibility and safety issues pose significant challenges, with 89.4% of respondents agreeing that there are no proper ramps and elevator facilities for elderly people and PWDs. Nearly half of the respondents (49.4%) do not feel safe while waiting and walking for transit. The data also indicates a willingness among a significant number of respondents to relocate to enhance their commuting experiences, with factors such as limited transportation options, travel cost, travel time, and safety playing pivotal roles in their decision-making. The research also highlights the importance of cost efficiency in public transport systems. While some respondents perceive low costs as efficient and their actual expenditures align with this perception, others perceive high costs as inefficient, indicating a potential dissatisfaction or lack of alignment between their expectations and the financial realities of commuting.

Affordability emerges as a key consideration for commuters, with a significant number of respondents agreeing that cost is a crucial factor influencing their decisions regarding first and last-mile travel. Commuters prefer personal cars for a safer and more comfortable trip. The study revealed that 56.9% of respondents do not own cars, opting for public transport due to fuel expenses, while ride-sharing and shared vehicles are unpopular due to safety concerns and discomfort with sharing rides with strangers, exacerbated by a lack of awareness. Additionally,

transferring between different modes is perceived as stressful. The study also underscores the importance of accessibility and availability of public transport, with respondents highlighting issues such as the uneven distribution of transportation modes and inadequate infrastructure. Infrastructure maintenance is another area of concern, with respondents pointing out the lack of well-maintained sidewalks and pedestrian pathways, inadequate street lighting, and poorly designed waiting areas. Safety issues, including inadequate street lighting and poorly maintained sidewalks, also impact the overall commuting experience. The study also explores the concept of park-and-ride facilities, with most respondents expressing a lack of familiarity with the concept. However, those who are familiar with it agree that the cost of using park-and-ride does affect their decision, and they could use such facilities as petrol prices are high.

5.2. Policy Recommendations

The findings of research on first and last-mile travel in Islamabad and Rawalpindi have a significant impact on various urban policies in Pakistan. Here are some recommendations that can influence key urban policies and address the identified issues to improve the overall transportation system.

5.2.1. Transport Policy

First and last-mile travel face specific challenges that are often overlooked in transport policies. Transport policies should explicitly tackle the unique challenges of first and last-mile travel by understanding commuter's preferences and devising targeted solutions. It should focus on improving infrastructure and facilities, integrating different transport modes, and promoting sustainable transport solutions. Safety, accessibility, and inclusivity for all road users should be prioritized for a well-rounded transportation system. The promotion of non-motorized transport and public transportation aligns with the policy's focus on sustainability and reducing carbon emissions.

5.2.2. Urban Planning and Development Policy

The research provides critical insights into first and last-mile travel, shaping urban planning and development policies in Islamabad and Rawalpindi. Urban planners can create a more inclusive, efficient, and sustainable transportation system by upgrading pedestrian pathways and installing accessible facilities, which promote inclusive infrastructure development. Urban planners and policymakers must prioritize the development and promotion of park-and-ride facilities at strategic

locations. These facilities must be well-connected to major public transport routes and provide secure and convenient parking options for commuters. These policies not only improve mobility and accessibility but also contribute to reducing urban congestion, enhancing social equity, and promoting sustainable development.

5.2.3. Social Welfare and Inclusion Policy

The research underscores the disparities in transport accessibility, guiding policies to focus on the needs of elderly people, PWDs, and the transgender community. Make public transport accessible for people of all ages and abilities by providing wheelchair ramps, low-floor buses, elevators, escalators, priority seating, and audible announcements to ensure that, commuters can safely get on and off public transport vehicles. The lack of awareness of gender sensitivity among public transport officers and other commuters highlights the urgent need to address the concerns of transgender individuals. Sensitization training for policymakers and public transport staff is important to create a safe and inclusive environment for transgender individuals in the city. Engaging and responding to the needs of the transgender community can effectively bridge the gap between policy formulation and policy implementation.

This could involve providing better training for drivers, ensuring the availability of more accessible vehicles, and making transit stops more accessible for everyone. The study also highlights the need to educate the public about sustainable commuting practices and public transportation options through awareness programs. The low usage of ride-sharing services can be attributed to a lack of awareness. Therefore, awareness campaigns about the benefits of ridesharing, such as cost-effectiveness and convenience, can be conducted to promote its usage.

5.3.Limitations of the Study

This research on the issues and challenges concerning first and last-mile travel in the twin cities of Islamabad and Rawalpindi has several limitations that should be acknowledged.

Firstly, the study primarily targeted regular commuters who use public transportation, thereby excluding those who travel by car. Although they may be fewer in number, understanding the mode choice behavior of automobile users could provide additional insights and a more comprehensive view of transportation preferences and challenges in the area. Second, due to time constraints, the study could not cover all bus stops and areas of Islamabad.

This limited geographic scope may have resulted in an incomplete representation of the entire commuter experience within the twin cities, potentially overlooking specific challenges faced in unexamined areas. Furthermore, conducting a survey that focuses on the qualitative needs of transport users can improve inclusivity by gaining deeper insights into the specific requirements and preferences of various commuter groups. This approach would complement the quantitative data and provide a more comprehensive understanding of the transportation landscape.

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APPENDEX

A Questionnaire on Issues and Challenges Concerning First and Last Mile Travel in Twin Cities of Pakistan

Pakistan Institute of Development Economics (PIDE)

Department of Development Studies

(All the information provided here will be kept confidential and will only be used for research work)

Questionnaire No: _____

Interviewer location: _____ Home location: _____

Final destination: _____ No. of bikes: _____

Time: _____ No. of cars: _____

A. DEMOGRAPHIC AND ECONOMIC PROFILE

Table A1

Gender			Age	Education							Employment status					Household Type		Family Structure		Monthly Income					Physical Disability		Medical Condition						
1	2	3		1	2	3	4	5	6	7	1	2	3	4	5	1	2	1	2	1	2	3	4	5	1	2	1	2	3	4	5	6	7

Gender: male=1, female=2, transgender=3
Education: illiterate=1, primary=2, secondary=3, matric=4, intermediate=5, graduate=6, masters=7, other=8
Employment Status: employed=1, unemployed=2, student=3, housewife=4, retired=5, other=6
Household type: home owner=1, tenants=2
FaaHmily Structure: joint=1, nuclear=2, other__
Monthly income: <30,000=1, 30,000-50,000=2, 50,000-1, 00000=3, 1, 00000-1, 50,000=4, 1, 50,000>=5
Disability: yes=1, no=2
Medical Conditions: pregnancy=1, Arthritis/Gout=2, allergies=3, menstrual cycle=4, infections=5, mental health=6, chronic health conditions=7, other_____

B. TRAVEL BEHAVIOUS

Table B1

B11		B12				B13					B14							B15					B16		B17						
Do you regularly travel on this route?		What is your travel frequency?				What is the main purpose your trip?					How do you typically travel for your first/last mile of journey?							What factors you consider while choosing mode of transportation?					Have you ever denied transport services?		If yes, why?						
1	2	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	7	1	2	3	4	5	1	2	1	2	3	4	5	6	7

B11: yes=1, no=2
B12: daily=1, weekly=2, several times a month=3, rarely=4
B13: work=1, education=2, shopping trips=3, hospital visits=4, cultural trips=5
B14: walk=1, Bykea=2, personal vehicle=3, ride sharing=4, personal motorbike=5, uber/careem=6, rickshaw=7

B15: convenience=1, time efficiency=2, cost effectiveness=3, safety=4, comfort=5, other_____
B16: yes=1, no=2
B17: disability=1, safety=2, discrimination=3, harassment=4, affordability=5, age factor=6, medical conditions=7

Table B2: Commuter's location and mode choice

B21					B22					B23		B24				B25		B26				
How you describe your current location?					If you could choose your ideal location, where you would prefer to live?					Have you ever considered, re-locating to improve first and last mile travel?		If Yes, what are the main reasons for re-location?				Have you ever considered changing mode of transportation?		If you could choose your ideal mode, what you would prefer?				
1	2	3	4	5	1	2	3	4	5	1	2	1	2	3	4	1	2	1	2	3	4	5

B21& B22: city with a mix of offices, apartments and shops=1, city with more residential neighborhood=2, Sub-urban neighborhood with mix of houses, shops and business=3, sub-urban neighborhood with houses only=4, rural area where car is needed to get to amenities=5
B23 & 25: Yes=1, No=2
B24: limited transportation=1, travel cost=2, travel time=3, safety concerns=4, other_____
B24: yes=1, no=2
B26: Metro bus=1, Wagon=2, coaster=3, Suzuki=4, other_____

C. COST

Table C1: First Mile

C11	C12						C13	C14	C15	C16
Most frequently used mode	Alternative modes						Waiting time (minutes)	Travel time (min)	Travel cost (Rs)	Distance (km)
	1	2	3	4	5	6				

C12: Modes: walk=1, Rickshaw=2, Bykea=3, Taxi/Uber=4, personal Bike=5, Own car=6, other_____

Table C2: Mid Journey

C21	C22					C23	C24	C25	C26
Last Stop	Alternative modes					Waiting time (minutes)	Travel time (min)	Travel cost (Rs)	Distance (km)
	1	2	3	4	5				

C22: Modes: Bykea=1, Public van =2, Taxi/Uber=3, personal Bike=4, Own car=5, other_____

Table C3: LAST MILE

C31	C32						C33	C34	C35	C36
Most frequently used mode	Alternative modes						Waiting time (minutes)	Travel time (min)	Travel cost (Rs)	Distance (km)
	1	2	3	4	5	6				

C32: Modes: walk=1, Rickshaw=2, Bykea=3, Taxi/Uber=4, Bike=5, Own car=6, other_____

D. PUBLIC PERCEPTION

Table B1: People attitude toward first and last mile travel
Codes: Strongly Disagree=1, Disagree=2, neither Agree nor Disagree=3, Agree=4, Strongly Agree=5

D11	I am willing to walk or cycle for first/last mile if infrastructure is well-designed	1	2	3	4	5
D12	I feel safe while waiting and walking to bus	1	2	3	4	5
D13	I am using public transport because it offers convenient routes and schedules	1	2	3	4	5

D14	I am willing to use new transportation options (electric scooters, bike sharing)	1	2	3	4	5
D15	Cost is an influential factor in my choice of transportation for first/last mile travel	1	2	3	4	5
D16	I am using public transport due to recent increase in petrol prices	1	2	3	4	5
D17	I am familiar with concept of park and ride service	1	2	3	4	5
D18	The cost of using park and ride affect your decision to use it	1	2	3	4	5
D19	I am willing to pay Rs 100 for park and ride service	1	2	3	4	5
D110	Park and ride help reduce traffic congestion	1	2	3	4	5

Table B2: Public perception toward first and last mile travel

Codes: Strongly Disagree=1, Disagree=2, neither Agree nor Disagree=3, Agree=4, Strongly Agree=5

D21	Improve in public transit can help reduce traffic congestion	1	2	3	4	5
D22	Public transit provides good travel choice modes	1	2	3	4	5
D23	Transit stops are within walking distance	1	2	3	4	5
D24	Public transport is safe choice to use	1	2	3	4	5
D25	Public transport is easily assessable	1	2	3	4	5
D26	Clean and well-maintained public transport encourage me to use them	1	2	3	4	5
D27	Public transport is cost efficient/budget friendly	1	2	3	4	5
D28	Improving safety measures can prevent potential crimes	1	2	3	4	5
D29	I use my own cars because of inefficient public transit system	1	2	3	4	5
D210	I can use park and ride services, because petrol prices are very high now a days	1	2	3	4	5
D211	Park-and-ride facility is much better than other modes of transportation?	1	2	3	4	5

Table B3: Barriers toward first and last mile travel

Codes: Strongly Disagree=1, Disagree=2, neither Agree nor Disagree=3, Agree=4, Strongly Agree=5

D31	Insufficient and unsafe pedestrian walks discourage me from first/last mile travel	1	2	3	4	5
D32	Absence of designed pickup/drop-off areas at first/last mile is major barrier	1	2	3	4	5
D33	There are no proper ramps and elevator facilities for people (elders, disabilities)	1	2	3	4	5
D34	Absence of street lights is significant barrier for me	1	2	3	4	5
D35	Distance between public transportation stops to final destination is time consuming	1	2	3	4	5
D36	The public transport is always crowded and makes me uncomfortable	1	2	3	4	5
D37	Poor maintenance and lack of side-walks influences my choice to use public transport	1	2	3	4	5
D38	Lack of available seats on public transport effects my comfort and convenience	1	2	3	4	5
D39	There are no proper waiting shelters	1	2	3	4	5
D10	Park and ride locations are not safe	1	2	3	4	5

Table D4: Policy responses toward first and last mile travel

Codes: Strongly Disagree=1, Disagree=2, neither Agree nor Disagree=3, Agree=4, Strongly Agree=5

D41	The current government policies are effective in addressing the challenges related to first and last mile travel	1	2	3	4	5
D42	The government policies should prioritize investment in improving first and last mile travel options	1	2	3	4	5
D43	The government policies should ensure the safety and security of first and last mile travelers	1	2	3	4	5
D44	The partnerships between government agencies, private companies, and community organizations is essential in improving first/last travel	1	2	3	4	5
D45	The government should provide park-and-ride facilities that would enhance the overall travel experience	1	2	3	4	5