Title: Investigating modal integration of public transport and non-motorised transport in the City of Johannesburg: A case of the Roodepoort CBD

Matshika Lindokuhle Prince

Student No.: 1440221

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Faculty of Engineering and Built Environment

School of Architecture and Planning

University of the Witwatersrand

Johannesburg

Supervisor: Professor Aly Karam

Declaration

I, Lindokuhle Prince Matshika hereby declare that this research report is my own work and any other work included in this report is referenced in the body and full references are provided at the end of the report. The report is submitted as a requirement for the Master of Urban studies in Urban Management to the Faculty of Engineering and Built Environment at the University of the Witwatersrand, Johannesburg and has not been submitted for any examination or degree at any other university.

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Abstract

This study explored the integration of non-motorized transport (NMT) with public transport in the City of Johannesburg, particularly the Roodepoort CBD. The research investigates the status of NMT infrastructure and public transport services in the city, identifying gaps and opportunities for integration. A comprehensive literature review was conducted to understand the factors influencing successful integration and to highlight best practices from other cities worldwide. The study examined the causes of transport fragmentation and emphasizes the importance of addressing these challenges to achieve seamless integration and analyses key enabling factors for successful integration, such as infrastructure planning and design, intermodal facilities, collaboration and coordination, policy, and regular support. Case studies of successful integration of public transport systems Globally are presented to gain practical insights for the implementation of integration strategies. Primary data was collected through interviews with key stakeholders and commuters and field observations were conducted to assess the existing NMT infrastructure and its integration with public transport. Convenience and purposive sampling methods were employed to select participants for the interviews and the data collected is analysed through thematic analysis, allowing for the identification of key themes and pattens relevant to the integration of NMT and public transport in the Roodepoort CBD. The findings of this study reveal that there is a possibility and opportunity for modal integration to occur within the Roodepoort CBD. However, there are various factors that need to be addressed such as the safety and security of pedestrians and the enforcement of regulations in terms of non-motorised transport facilities being used for other means such as street vending. The study concludes by providing recommendations to support the facilitation of this integration of NMT and public transport in the Roodepoort CBD.

Dedication

To my family and friends, for the consistent encouragement, love, and support throughout my academic journey. This is dedicated to you all!

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Firstly, I would like to thank the Almighty God for the strength and perseverance to pull through this academic journey. Through him, all things are possible.

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List of Acronyms

BRT – Bus Rapid Transit

CBD – Central Business District

COJ – City Of Johannesburg

GDS – Growth and Development Strategy

IDP – Integrated Development Plan

ITP – Integrated Transport Plan

NATMAP – National Master Transport Plan

NDP – National Development Plan

NMT – Non-Motorized Transport

NTP – National Transport Plan

NLSF – National Land Strategic Framework

RMTP – Roodepoort Transport Master Plan

SITPF – Strategic Integrated Transport Plan Framework

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Chapter 1 – Introduction and Background

1.1 Introduction

The past few decades have seen a rapid rise in the occupancy of cities. People are living in cities in ever-increasing numbers because of urbanization, and the trend is set to continue (Ravetz, Ferner, and Nielsen, 2013; Kehinde, 2019). This ongoing growth creates challenging urban environments and a variety of issues for local administrations and management (Guneralp, Lwasa, Masundire, Parnell and Seto, 2017). Cities are the primary drivers of economic growth worldwide, but the rapid growth has also let to the high dependency on motorized transportation to get around and take advantage of the many opportunities and activities the city has to offer (Risimati and Gumbo, 2019).

As a means of facilitating efficient, quicker, and seamless movement and enable access to places that are far from people, transportation networks have assumed a crucial role in urbanizing areas (Adewumni and Allopi, 2013). In South African cities, particularly the City of Johannesburg, numerous initiatives have been introduced, with varying degrees of intensity and support, such as the Bus Rapid Transit (Rea Vaya), to provide a transportation system that is effective, safe, and reliable to help people get around cities more quickly and efficiently (Chakwizira et al., 2011). This is a result of the increase in urbanization and the dependency on transportation. Most cities have turned to mass transit systems like bus rapid transit (BRT) as a response to their transportation problems (Gumbo and Moyo, 2020). These initiatives have been introduced with some hope to integrate the public transport system with non-motorized transport. Although it is acknowledged in policy pillars, integrating public transportation with non-motorized transportation has proven to be a challenging task (Selala and Musakwa, 2016; Gumbo and Moyo, 2020).

1.2 Background

Over the years, it has become a critical issue on the transportation agenda to develop an integrated, dependable, and efficient transportation system, that also caters for walking and cycling across cities (Risimati and Gumbo, 2019; Litman, 2017; Selala and Musakwa, 2016). This acknowledges the socioeconomic significance of transportation on those whose daily lives depend on it. A fragmentation of modes that are not connected to one another but rather compete with one another defines the South African public transportation system (Mthimkhulu, 2017). For a long time, the availability of motorized public transportation has been given precedence over non-motorized transportation (NMT). NMT is acknowledged as a mode of

transport and for its importance in the South African public transportation system in policies and legislative frameworks (Mbatha and Gumbo, 2020; Risimati and Gumbo, 2021). For instance, from the National sphere, the National Non-Motorised Transport policy (2008: 15) envisioned that "Non-Motorised Transport will be a sustainable and stimulant mode of transport for social and economic development within an integrated efficient transport system". The City of Johannesburg Strategic Integrated Transport Plan Framework (SITPF) of 2013, intends to connect individuals within a network of walking and cycling to reach close destinations, and into a network of affordable, high-quality public transportation to access distant destinations. They also acknowledge its advantages, including the reduction of parking and traffic congestion, the health benefits for users, and the infrastructure improvements that come from the inclusion of NMT facilities with public transportation services (Litman, 2017).

In South African cities, the combination of NMT with public transportation has long been desired (Litman, 2017; Risimati, Gumbo and Chakwizira, 2021). This integration would allow for seamless travelling for individuals who use public transportation. Risimati and Gumbo (2018) assert that the incorporation of NMT with public transportation infrastructure and services facilitates socioeconomic development and is essential to the critical realization of spatial integration. This integration is crucial to encouraging people to use public transit instead of private vehicles (Starkey and Hine, 2014). However, various challenges have been encountered in this move with regards to the safety of individuals who choose to walk and cycle in cities, availability of infrastructure such as walkways and cycle lanes, well-lit streets and crosswalks that permits the integration of NMT and public transportation and accessibility (Selala and Musakwa, 2016). The integration of public transport and NMT also rests on various factors, such as availability of funding and investments, political will, policy, and regulations that supports this integration.

1.3 Problem Statement

The absence of infrastructure needed to support and facilitate the use of NMT in cities in South Africa is a result of the country's preference for motorized transit over NMT (Risimati, Gumbo and Chakwizira, 2021). Where NMT is offered, it is dispersed and not included into the public transportation network (Litman, 2017). It is also discovered that the design criteria for ensuring ease and safety when utilizing the mode are not being considered in the creation of NMT facilities. The City of Johannesburg has produced various policies for the integration of public transport with NMT albeit with varying intensity and support, with plans to upgrade and integrate NMT facilities into the public transport system (Gauteng ITMP, 2013; CoJ IPTN,

2016; Risimati and Gumbo, 2019). However, a fragmentation of the modes is still prevalent in the City of Johannesburg.

Public transportation and NMT could be integrated in the Roodepoort CBD (Mbatha and Gumbo, 2020). Although the Roodepoort CBD is regarded as one of the municipal and transportation centers for the City of Johannesburg, it faces traffic problems, congestion, and an ineffective transportation system (RTPM, 2023).

1.4 Research aims and objectives

This section provides the aims and objectives that were employed to successfully carry out the study.

Aim of the Study

- The aim of the study was to investigate the extent of integration between public transportation with NMT in the Roodepoort CBD, City of Johannesburg.

Objectives of the study

- To investigate the causes of transport fragmentation in the Roodepoort CBD, City of Johannesburg.
- To assess the extent to which enabling factors are available for the Integration of Public Transport and NMT within the in the Roodepoort CBD, City of Johannesburg.
- To investigate the extent of infrastructure availability to allow for the integration of public transport and NMT in the Roodepoort CBD, City of Johannesburg.

1.5 Research Question and sub-questions

Research Question

- How can public transport be integrated with NMT in the Roodepoort CBD, City of Johannesburg?

Sub Questions

- What causes transport fragmentation in the Roodepoort CBD, City of Johannesburg?
- What enabling factors are available for the integration of public transport and NMT in the Roodepoort CBD, City of Johannesburg?
- How does the infrastructure available allow for the integration of public transport and NMT in the Roodepoort CBD, City of Johannesburg?

1.6 Research Rationale

The purpose of the study is to shed light on the degree of integration between the city of Johannesburg's non-motorized transportation network and public transportation system, as well as the enabling conditions that make this integration possible. As a result, this study will advance our understanding of the integration of NMT and public transport systems, particularly in South African cities. It seeks to inform existing gaps in transportation policy and legislation. The study also seeks to potentially present key findings that can be applied by planners, transportation experts, and city management to facilitate an all-encompassing integrated transport system more effectively within the City of Johannesburg.

1.7 Research Method

The study used the Roodepoort CBD in Johannesburg as a case study to investigate the integration of non-motorized transport (NMT) and public transportation. Data was collected through semi-structured interviews and field observations, with insights from consultants and commuters. Convenience and purposive sampling techniques were used to select participants, ensuring diverse perspectives. Thematic analysis was used to identify and categorize patterns within the qualitative data, coding and organizing data into themes to capture the complexity of NMT and public transportation integration in Johannesburg. Detailed research methods are discussed in chapter 3 of this study.

1.8 Ethical considerations

An ethics application was submitted for approval prior to conducting any interviews with either the municipal officials, external stakeholders, or commuters. Ethics approval was granted prior to the data collection process (Letter of approval is Annexure 1). The participants were informed of the purpose of the study, anonymity will be maintained by not disclosing their names or any details that could lead to them being identified. I ensured that all participants are over eighteen (18) years of age, and participants were informed about the research and that they can withdraw from the interview process whenever they feel the need to do so.

1.9 Chapters outline

Chapter two provides a review of literature on transport fragmentation, integration enabling factors and infrastructure availability. Furthermore, it provides a detailed literature on case studies from different cities, and policy and legislative frameworks from the South African context. Chapter three discuss the methods used to undertake the study and to answer the

research questions. The fourth chapter provides the results of the field study, analysis and discussions of the research findings. The fifth chapter concludes the study and provides recommendations and areas of further research.

Chapter 2 – Understanding the integration of Non-Motorised transport and Public transport

2. Introduction

Transportation is critical in defining the urban landscape and improving the quality of life for city people. It plays a critical role in determining where people live, work and play, and do shopping and this has an impact on their quality of life. However, many cities, including the City of Johannesburg, confront severe issues due to traffic congestion, air pollution, and restricted transportation options (Risimati and Gumbo, 2021). Modal integration has emerged as a possible way to improving urban transportation networks in response to these difficulties.

The seamless integration and coordination of various forms of transportation inside a city is referred to as modal integration (Chakwizira, 2020; Gumbo and Moyo, 2020). The integrating of public transportation modes like buses, trains, and taxis with non-motorized transport (NMT) modes like walking and cycling has an enormous potential for revolutionizing urban mobility (Lawrence, Gumbo and Jeeva, 2022; Makgata, 2022, Venter, 2020). This integration intends to increase accessibility, address the first and last mile difficulty, improve connection, and encourage environmentally friendly transportation behaviours (Lawrence et al., 2022).

The goal of this literature review is to review existing knowledge and research on modal integration of public transportation and NMT. This review intends to provide a review of the present state of modal integration efforts in cities, as well as highlight challenges and barriers to effective integration, by evaluating the findings and insights from past research.

2. 1 Defining key terms

This section provides the definitions of key terms as they are used in this dissertation. This is done to provide an understanding of how the researcher understands and draws from these definitions in this work.

Non-Motorized transport (NMT)

Non-motorized transport (NMT) refers to modes of transportation that use human or animal power rather than engines or motors. This includes walking, cycling, and using animal-drawn vehicles (Litman, 2012). For the purpose of this study, the notion of NMT is only limited to walking, cycling and wheelchair users. NMT is critical in supporting sustainable urban mobility because it is environmentally friendly, emitting no pollutants and greatly lowering the

carbon footprint connected with transportation (0biero,1995). These means of transportation are frequently aided by specialized infrastructure such as sidewalks, bike lanes, pedestrian crossings, and paths designated for animal-drawn vehicles. NMT is more than just a means of transportation; it is also an important component of urban design and planning aimed at making cities more livable, healthy, and sustainable (Lawrance, Gumbo and Jeeva, 2022).

Public transportation

Public transport, often known as public transportation or mass transit, refers to a wide range of transportation services offered to the general public, such as buses, trains, tramways, ferries, and subways (Lles, 2005). These services run on defined routes and timetables and are frequently supplied by government or municipal bodies, private enterprises, or a combination of the two (Horcher and Tirachini, 2021). Bus stops, rail stations, tram lines, ferry terminals, and subway systems are examples of public transportation infrastructure that is integrated to allow for smooth movement throughout a city or region. Public transportation networks are designed to efficiently move large numbers of people throughout cities and suburbs, providing a cost-effective and accessible alternative to private vehicle use (White, 2016).

Transport integration

Transportation integration is the process of constructing a coherent and efficient transportation network by connecting diverse modes of transportation, such as buses, trains, trams, ferries, cycling, and walking, into a single system (Preston, 2012; Hidalgo and King, 2014). Key components of transport integration include multimodal connectivity, where different transport modes are linked through well-designed intermodal hubs that facilitate easy transfers; coordinated timetables to ensure minimal waiting times and synchronized schedules; unified ticketing systems that allow passengers to use multiple modes of transport with a single ticket or payment method; and standardized information systems providing real-time updates about routes, schedule Intelligent transportation systems (ITS) and other advanced technologies play an important role in controlling and optimizing integrated transportation networks (Potter and Skinner, 2000).

Transport fragmentation

Transport fragmentation is defined as a lack of coordination and connectivity among various modes of transportation within a given network, resulting in an inefficient and disconnected system (Chakwizira (2020). Transport fragmentation is characterized by fragmented and poorly connected means of transportation, such as buses, trains, trams, and bicycle lanes, which run

independently without seamless transfers or coordinated schedules. Fragmentation can take the form of unconnected routes, uneven timetables, distinct ticketing systems requiring numerous payments, and insufficient infrastructure that does not facilitate smooth transitions between modes of transportation (O'Sullivan and Poter, 2004). This disintegration may result in longer travel times, increased discomfort, and higher total expenses for users.

Integrated transport system

An integrated transportation system is a well-coordinated and seamless network of diverse modes of transportation, such as buses, trains, trams, ferries, cycling, and walking, that work together effectively to provide convenient and dependable travel options (Hull, 2005). Key components of an integrated transportation system include multimodal connectivity, ensuring easy transfers between different transport modes through well-designed intermodal hubs; coordinated timetables to minimize waiting times and synchronize schedules; unified ticketing systems that allow passengers to use multiple modes of transport with a single ticket or payment method; and standardized information systems that provide real-time updates about routes, schedules, and Furthermore, infrastructure designed to enable the integration of diverse modes of transportation, such as dedicated bus lanes, bike-sharing stations, pedestrian walkways, and transit stations, is critical (Stokpa et al.,2015).

2. 2 Public transport

Public transport operates on fixed routes with scheduled stops, providing predictable and reliable service. Vehicles are shared among multiple passengers, maximizing space and resource use. Fare structures are designed to be within reach of the average citizen. Public transport networks cover extensive geographic areas, providing connectivity between different parts of a city or region. Government agencies often regulate and subsidize public transport systems to ensure they meet public needs and operate efficiently.

Benefits of public transport

A public transportation system provides economical, efficient, and accessible transportation options to inhabitants and visitors in urban and suburban locations. It is critical to promoting sustainable and inclusive mobility by offering accessible transportation options to a diverse spectrum of users, including those without private vehicles, those with mobility difficulties, or those unable to afford car ownership. Public transportation enhances accessibility by connecting individuals to numerous destinations such as workplaces, schools, healthcare facilities, shopping centers, and recreational sites (Bruun et al., 2015).

A well-developed and efficient public transportation system encourages people to take public transportation instead of driving, resulting in lower traffic volumes and smoother traffic flow (Litman, 2017). As a result, travel times are reduced, traffic congestion is reduced, and general road safety is improved. Public transportation is a more environmentally friendly means of transportation, as it reduces greenhouse gas emissions, air pollution, and energy usage. A transition to public transportation can help reduce climate change, improve air quality, and create more sustainable and liveable communities.

In general, public transportation is less expensive than owning, maintaining, and running private vehicles, with costs frequently being lower, especially for frequent commuters who can benefit from discounted passes or travel cards (Lawrence, Gumbo, and Jeeva, 2022). This makes it a viable alternative for a large number of people. It plays a role in the promotion of social inclusion by making transportation services available to all members of society, allowing them equal access to education, employment, healthcare, and social activities. It also helps to reduce transportation gaps and provide more equitable access to vital services.

Public transportation has an impact on land use patterns and urban development, promoting compact, transit-oriented development (Mbatha and Gumbo, 2019). Public transportation systems that are well-planned can guide urban expansion, reduce urban sprawl, and contribute to the establishment of vibrant, walkable, and sustainable urban environments (Kehinde, 2019). Walking or cycling to and from public transportation stops or stations promotes physical exercise, promoting better lives, cardiovascular fitness, and lowering the risk of chronic diseases. Furthermore, public transportation alleviates the stress associated with driving and parking, resulting in enhanced mental well-being for commuters.

Integration of public transportation

Transport integration involves coordinating different modes of transportation (such as buses, trains, subways, and bicycles) to create a seamless and efficient travel experience for users. The rapid rise in urbanization has led to increased population density in cities, necessitating efficient and effective transportation systems to manage the movement of people. An integrated transport systems can reduce reliance on private vehicles, thereby decreasing greenhouse gas emissions, and contributing to environmental sustainability. An efficient transportation system can reduce travel time and costs, improving productivity and economic output. Integrated transport can also enhance accessibility for all citizens, including those with disabilities and those without access to private vehicles, promoting social equity.

Integration of transportation systems improves user experience by connecting different modes of transportation, reducing transfer time and effort. This enhances public transport appeal and has the potential to reduce reliance on private cars, in turn, reduce traffic congestion in urban areas. Integrated systems also promote environmentally friendly modes like cycling, walking, among others, reducing pollution and carbon emissions. Coordinated services can lead to better resource utilization, operational costs, and potentially lower fares. An efficient transport system can boost economic activity by facilitating access to jobs, education, and services, and reducing vehicle usage. Additionally, well-integrated transport systems improve safety by reducing vehicle numbers and minimizing transfer needs in unsafe areas.

Although the integration of public transport has benefits, it is not without disadvantages. The development of integrated transport systems often requires significant upfront investment in infrastructure, technology, and planning, which can be a challenge in cities that do not have the capacity to implement such projects. Integrating different modes of transport and coordinating between various stakeholders (such as government agencies, private companies, and the public) can be complex and challenging. Maintaining seamless integration in day-to-day operations can be difficult, especially in large cities with high demand and diverse transportation needs. Implementing new integrated systems may face resistance from various stakeholders, including private transport operators, and even some public transport users accustomed to existing systems. If not carefully planned, integrated transport systems may disproportionately benefit certain areas or populations, leading to inequalities in access and service quality. The integration of public transport often relies on advanced technologies for scheduling, ticketing, and real-time information sharing, which may be challenging to implement and maintain.

The integration of transport is a key aspect of a sustainable and efficient city and allows for easy travel into, out and within the city. Integration of transport systems provides an opportunity for traffic congestion reduction, improves mobility and traveller satisfaction (Risimati, et al., 2021). An integrated transport goes far wider than just an integration of public transport in terms of tariffs, infrastructure, ticketing, and operations between the modes, but goes beyond to include the integration of walking, cycling, private vehicles, and other modes of transportation (Stopka, Bartuska and Kampf, 2015). It also includes land use planning, spatial development, and environmental planning. The main purpose of an integrated transport system is to provide for an effective and efficient transport, where individuals are allowed choice of mode and can connect from one mode to another (ibid).

Transport integration promotes accessibility by enabling seamless links between various means of transportation, allowing people to effortlessly transfer from one mode to another. This lowers obstacles and provides accessible transfer places, enabling accessibility for all people, including those with mobility issues or limited access to private vehicles. It encourages efficient and sustainable movement patterns by minimizing wait times, trip distances, and wasteful route duplication. This results in better resource usage, less congestion, decreased greenhouse gas emissions, and overall system efficiency (Venter, 2020). It promotes multimodal travel by allowing people to select between walking or cycling to a nearby public transportation station, taking public transportation for longer distances, and taking non-motorized transportation for the final part of their journey. Mbatha and Gumbo (2021) argue that this adaptability improves the whole travel experience and provides additional options.

Transport integration also improves connectivity by integrating multiple modes of transportation smoothly, allowing for effective intermodal transfers and decreasing the need for complex and time-consuming transfers. This seamless transition between modes promotes the use of public transportation and non-motorized transportation, making the route more pleasant and dependable. Through the provision of appealing alternatives, effective transportation integration encourages a move away from the use of private vehicles. Integration minimizes the need for private vehicle ownership and usage by enhancing the accessibility, convenience, and dependability of public transportation and NMT modes, lowering traffic congestion, energy consumption, pollution, and environmental impacts.

Transportation integration improves inhabitants' quality of life by increasing mobility alternatives, lowering commute stress, and providing more sustainable and cost-effective transportation solutions. It increases social inclusion, boosts economic activity, and fosters dynamic and livable communities by delivering seamless and integrated transportation options.

Integrating public transport and NMT

Integration of public transportation and non-motorized transportation (NMT) entails the coordination and seamless linking of numerous modes of transportation, such as buses, trains, trams, and cycling or walking infrastructure (Gumbo and Mbatha, 2022). This integration attempts to improve the efficiency, accessibility, and convenience of urban transportation systems. Infrastructure development, multimodal connectivity, fare integration, information integration, planning and policy integration, and planning and policy frameworks are important parts of integrating public transportation with NMT (Risimati et al, 2021). Infrastructure

integration entails the installation of designated cycling lanes, pedestrian walkways, and safe crossings that connect to public transportation stops or stations. Integrating cycling infrastructure with bus or railway terminals allows for simple access and secure bicycle parking. A well-designed and integrated infrastructure supports the use of both public transportation and NMT modes, allowing for easy transfers and promoting environmentally friendly travel options (Risimati et al., 2021).

Intermodal connectivity focuses on making it easy to switch between modes of transportation, such as by developing transport hubs or interchange sites where NMT infrastructure is easily linked to public transportation stations. Integrating bike-sharing programs with bus or train services, for example, allows passengers to hire bicycles at one station and return them at another, giving a flexible and efficient last-mile connection to their destination (Litman, 2017). Fare integration strives to create a unified payment system that encompasses all types of transportation, including public transportation and NMT. This can be accomplished using smart cards or integrated ticketing systems, which allow passengers to use a single ticket or card for their whole voyage (Zuo et al., 2020).

Information integration entails delivering comprehensive and real-time information to travelers regarding public transportation services, schedules, and NMT infrastructure. This information allows travelers to successfully plan their journeys, make educated decisions, and navigate the transportation network. Integration of public transportation and NMT necessitates collaboration among numerous stakeholders, such as transportation authorities, urban planners, and policymakers. These integrations can improve the efficiency, accessibility, and convenience of urban transportation systems by aligning urban development plans with transportation infrastructure, promoting cycling and walking infrastructure, prioritizing pedestrian safety, and supporting the development of public transportation systems that cater to NMT connections.

Fragmentation of public transportation

Transport fragmentation is the inefficiency and inaccessibility of different modes of transport within a transportation system, resulting from disconnected networks, limited interoperability, and disjointed services (Chakwizira, 2020). It can occur at various levels, including physical infrastructure, operational aspects, fare systems, and information dissemination. Physical fragmentation involves insufficient infrastructure for transferring between modes, leading to longer travel times, inconvenience, and decreased usage of public transport and non-motorized

transport options (Ibid). Operational fragmentation occurs when different modes operate independently and lack coordination, leading to irregular services, inconsistent frequencies, and challenges in transferring between modes. Fare system fragmentation results in separate ticketing systems, different fare calculations, and limited options for transferring between modes without incurring additional costs (Jennings, 2015). Information fragmentation, on the other hand, is a lack of consistent, accurate, and easily accessible information about different modes of transport, making it difficult for commuters to make informed decisions, plan routes, and stay updated on service disruptions or changes.

Transport fragmentation can be attributed to historical planning approaches that prioritized private vehicle use and neglected the integration of different transport modes (Kehinde, 2019). This focus on private vehicles led to underinvestment in public transport systems, such as buses and trains, and inadequate coverage, unreliable services, and limited connectivity. Additionally, Wilkinsons (2010) argues that the presence of a significant informal transport sector, such as minibus taxis, has contributed to transport fragmentation.

Minibus taxis play a significant role in providing accessibility and mobility in areas where formal public transport may be limited (Wilkonsons, 2010). However, their informal nature poses challenges for integration and coordination (Booysen, Anderson, and Zeeman, 2013). The lack of standardized routes and schedules, as well as differing fare structures in the informal transport sector, can result in inconsistencies and challenges in integrating fare systems with other modes of transport (Bruun et al., 2015; Chakwizira et al., 2011).

Transport fragmentation is often exacerbated by the lack of sufficient infrastructure for non-motorized transport (NMT) modes such as walking and cycling (Chakwizira, 2020). The insufficient infrastructure can hinder the integration of NMT with public transport, leading to reduced accessibility, safety concerns, and limited connectivity within the transportation system. Efforts have been made to develop cycling infrastructure with varying intensities and support in many cities, such as implementing cycling lanes, creating shared bicycle paths, and integrating cycling facilities in urban development projects (Lawrence, Gumbo and Jeeva, 2022; Mbatha and Gumbo, 2022; Risimati, Gumbo and Chakwizira. 2021). These efforts aim to improve cycling safety, promote active mobility, and enhance connectivity between cycling and public transport networks.

Pedestrian infrastructure is crucial for enabling the integration of walking with public transport. Inadequate infrastructure can lead to unsafe walking conditions, limited accessibility to public

transport stops or stations, and fragmented pedestrian networks (Lawrence, Gumbo and Jeeva, 2022). Many cities have recognized the importance of pedestrian infrastructure and has taken steps to improve walkability, such as enhancing sidewalks, creating pedestrian-friendly zones, installing pedestrian crossings, and improving lighting and signage.

Intermodal facilities, such as transport hubs, terminals, and stations, are essential for seamless modal integration. The City of Johannesburg has undertaken projects to develop integrated transport hubs, such as bus and rail services at Gautrain stations and bus and taxi interchanges, to facilitate transfers between different modes of transport, enhance connectivity, and promote the use of public transport and NMT (Risimati, Gumbo and Chakwizira, 2021; Mbatha and Gumbo, 2022).

2. 3 Non – Motorized transport

Non-motorized transport (NMT) is a healthy and sustainable mode of transportation that does not rely on motorized vehicles such as automobiles, motorbikes, or buses. It generally refers to walking and cycling, but it can also refer to other human-powered modes of transportation such as skateboarding, rollerblading, or utilizing a wheelchair. Walking is the most basic type of NMT, but cycling is a faster and more efficient way of transportation for medium-distance excursions, and partaking in NMT has a variety of health benefits (Lawrence, Gumbo and Jeeva, 2022; Mbatha and Gumbo, 2022; Makgata, 2022). Walking is a simple activity that encourages physical activity, improves cardiovascular health, and lowers the risk of chronic diseases (Mbatha and Gumbo, 2022). It also improves pedestrian safety and urban life by encouraging social connections and community involvement. cycling, on the other hand, is a more efficient and speedier method of NMT for medium-distance trips, with dedicated bicycle lanes, bike-sharing networks, and secure parking facilities supporting its expansion.

NMT is environmentally sustainable, as it reduces the negative environmental implications of motorized transportation. NMT contributes to mitigating climate change, improving air quality, and lowering noise pollution, visual pollution, and parking space demand by reducing dependency on fossil fuels and minimizing greenhouse gas emissions, resulting in more livable and sustainable communities (Selala and Musakwa, 2016). NMT is cost-effective because it requires little capital investment. Walking is practically free, and cycling is affordable when compared to owning and operating motorized vehicles. due to its inexpensiveness, NMT is an accessible and equitable method of transportation for people of all income levels.

Promoting NMT is critical to urban planning and the design of livable cities (Lawrance et al., 2022). Designing cities and neighborhoods that prioritize walking and cycling infrastructure improves pedestrian and cyclist safety, encourages active lifestyles, and generates vibrant and inclusive public areas (Risimati and Gumbo, 2021). Well-planned NMT networks help to minimize traffic congestion, optimize land use, and create sustainable and resilient urban settings.

2. 4 Transit-Oriented Development (TOD)

Transit Oriented Development (TOD) is a cutting-edge urban planning technique that focuses development on high-quality public transit infrastructure to create dynamic, sustainable, and livable communities. This strategy aims to build high-density, mixed-use neighborhoods with a variety of residential, commercial, and recreational options within walking distance of transit stations. TOD highlights the need to design urban places that favor walkers and cyclists, integrate many modes of transportation, and lessen dependency on private vehicles. TOD strives to improve urban people' quality of life by promoting a symbiotic relationship between land use and transit infrastructure in order to enhance accessibility, lower environmental impacts and reduce traffic congestions.

TOD is a concept that promotes the creation of transit-oriented communities near transportation hubs. This technique maximizes land use efficiency while providing easy access to public transportation, resulting in compact, efficient urban areas that promote sustainable living (Ibraeva et al., 2020). High-density zones also promote vibrant, dynamic communities by bringing amenities, jobs, and services closer together, decreasing the need for long commutes and encouraging a more active lifestyle. Another pillar of TOD is mixed-use development, which combines diverse types of land uses in the same region, decreasing the need for long-distance travel and providing a more convenient urban experience. This strategy also improves the economic viability of transportation systems by ensuring a consistent flow of passengers throughout the day and week (Nasri and Zang, 2014).

TOD stresses the creation of safe, convenient, and appealing infrastructure for pedestrians and bicycles, such as wide sidewalks, pedestrian crossings, dedicated bike lanes, and secure bike parking. This infrastructure improves not only safety but also the general quality of urban life by encouraging physical activity, reducing traffic congestion, and lowering pollution levels. TOD's effectiveness depends on high-quality public places including parks, plazas, and community centers (Nasri and Zang, 2014; Carlton, 2009). They act as hubs for social

interaction, recreation, and cultural events, improving inhabitants' well-being and boosting local economies. TOD makes cities more livable and sustainable by including green spaces and public facilities into their design. TOD additionally discourages driving by reducing parking access, particularly for private vehicles, while boosting public transportation, walking, and cycling. This strategy not only decreases traffic congestion and environmental pollution, but it also frees up valuable urban property for other purposes such as parks, housing, and commercial buildings (Guthrie and Fan,2016; Ibraeva et al., 2020).

Transit Oriented Development (TOD) is a comprehensive urban planning strategy that encourages a smooth and efficient transportation network. It focuses on constructing high-density, mixed-use neighborhoods around transit stations, thereby creating focal centers for people to live, work, and play. TOD addresses the "first and last mile" problem by prioritizing pedestrian and cycling infrastructure, resulting in smooth transitions between modes of transportation. TOD fosters higher transit usage by locating both residential and commercial developments within walking distance of transit stations, resulting in less reliance on private vehicles and increased use of public transportation networks (Carlton, 2009). This multimodal approach improves the efficiency and efficacy of the transportation system, lowers reliance on private vehicles, and limits urban expansion. TOD boosts local economies by bringing businesses and investments to transit-rich regions, resulting in more foot traffic and job growth. High-quality public spaces, such as parks, plazas, and recreational areas, are included into transit-oriented developments to create lively, living communities. Concentrating development around transit nodes eliminates the need for extensive road networks and parking facilities, which saves towns revenue on infrastructure development and maintenance (Ibid). TOD is critical for transport system integration, as it promotes accessibility, increases public transportation use, supports environmental sustainability, and provides considerable economic and social benefits. It promotes a smooth and efficient transportation network that improves the overall quality of urban life by establishing high-density, mixed-use, and walkable neighborhoods focused on public transit.

2. 5 Enabling factors related to NMT

Several enabling factors contribute to the successful integration of NMT with public transportation networks. These elements contribute to the creation of an atmosphere that supports and facilitates seamless interactions between NMT and public transportation modes. These factors are supported by literature and theories such as the TOD theory as outlined in the previous section, and others such as the Sustainable Urban Mobility.

The notion of sustainable mobility emerged from the larger framework of sustainable development, which emphasizes the balance of economic growth, social equity, and environmental conservation. Gallo and Marinelli (2020) defined sustainable mobility as the endeavor "to ensure that our transport systems meet society's economic, social, and environmental needs while minimizing their undesirable impacts on the economy, society, and the environment." This definition emphasizes the importance of a comprehensive approach that goes beyond simply solving environmental issues. The literature emphasizes the importance of considering all three pillars of sustainability—economic viability, social inclusion, and environmental stewardship when establishing and implementing sustainable practices.

The Sustainable Urban Mobility (SUM) represents a comprehensive strategy to developing economically viable, socially inclusive, and environmentally sustainable transportation systems (Zegra, 2005). It addresses the challenge of urban mobility by advocating measures that improve citizens' quality of life while minimizing environmental effect. The approach focuses on affordability, economic productivity, social inclusion, equity, and safety. It focuses on creating transportation networks that are accessible by all individuals, including people with disabilities, the elderly, and those who do not have access to private vehicles (Doi and Kii, 2012).

Integrated transport planning is a key strategy for the SUM, which aims to create a cohesive network of multiple modes of transportation such as public transportation, non-motorized transportation (NMT), and private automobiles (Perra, 2016; Gallo and Marinelli, 2020). This encompasses land use and transportation planning, urban development, and transportation infrastructure.

Public transportation promotion entails improving reliability, regularity, and comfort while investing in modern, efficient, and easily accessible infrastructure. Non-motorized transportation (NMT) is fostered through safe and convenient walking and cycling infrastructure, as well as public awareness campaigns and educational initiatives that highlight the benefits of NMT.

This section presents some critical factors for the integration of NMT and public transportation as drawn from literature and theories.

Infrastructure planning and design

For the integration of NMT with public transportation, cities must provide bicycle and pedestrian infrastructure (Mbatha and Gumbo, 2020). This comprises bike lanes, bike-friendly intersections, traffic lights, and signs to improve safety and reduce conflicts. Pedestrian infrastructure should prioritize safety, provide appropriate walking space, and take disabled pedestrians' requirements into account (Risimati, Gumbo and Chakwizira, 2021). Connecting NMT to public transportation stops necessitates careful planning and design, which includes bike lanes, secure bicycle parking, and integrated transit interchange points. For seamless integration and sustainable travel options, safety considerations, universal accessibility, and continual network growth are critical.

Intermodal facilities and integration

Intermodal facilities, such as transport hubs and interchange points, are essential for integrating NMT with public transport (Litman, 2017). These facilities facilitate convenient transfers between NMT and public transport, allowing commuters to transition from walking or cycling to buses, trains, or other modes. Secure bicycle parking facilities, bike-sharing programs, and pedestrian connections are also crucial for promoting NMT and first-last mile connectivity. Makgata (2022) contends that, clear signage and wayfinding systems should guide NMT users to public transport stops or stations, providing clear directions for cyclists and pedestrians. Public transport operators should collaborate with NMT providers and stakeholders to ensure smooth integration, incorporating NMT considerations into planning and synchronizing schedules with NMT connections (Mohiuddin, 2021). By creating intermodal facilities and integrating NMT with public transport, cities can enhance accessibility, encourage sustainable travel choices, and create a well-connected and efficient transportation system (Moyo, Kibangou and Musakwa, 2021).

Collaboration and Coordination

Stakeholder engagement is crucial for successful integration of NMT and public transport (Starkey and Hine, 2014). It involves transport authorities, urban planners, public transport operators, cycling advocacy groups, pedestrian organizations, and community representatives in planning and decision-making processes. This approach ensures that diverse needs and perspectives are considered, and a shared understanding of the benefits and challenges of integrating NMT and public transport is built (Ibid). Integrated planning involves aligning NMT infrastructure development, public transport route planning, and urban development

strategies, ensuring strategic location, well-connectedness, and accessibility (Chakwizira, 2020). Policy frameworks should prioritize NMT investments, include cycling and walking as viable modes of transport, and establish guidelines for coordination and integration.

Data sharing then becomes essential for identifying patterns, monitoring usage, and evaluating the impact of NMT and public transport integration. Effective communication channels, such as meetings, workshops, forums, and online platforms, ensure stakeholder engagement and engagement in the integration process. Through the fostering of collaboration and coordination among stakeholders, cities can create a holistic and integrated approach to NMT and public transport, ensuring the diverse perspectives and needs of users are considered and resulting in a more user-centric and efficient integrated transport system.

Policy and regulatory support

Policy support is essential for prioritizing NMT infrastructure development in cities, encouraging mixed-use development, establishing safety standards, and incorporating NMT issues into public transportation planning (Walters, 2014). This creates a conducive environment for integration while also promoting sustainable and active transportation and vibrant, thriving communities. Incentives and subsidies can be offered to encourage the use of NMT, while continuous monitoring ensures that the system is adaptable to changing demands and circumstances. Governments may foster a supportive environment for sustainable urban transportation networks by prioritizing NMT infrastructure, encouraging mixed-use development, and enacting regulations that promote NMT infrastructure (Starkey and Hine, 2014).

Public awareness and education

Public awareness campaigns are critical for integrating NMT and public transportation, promoting sustainable transportation options, providing information about NMT infrastructure and facilities, educating on NMT safety and etiquette, engaging local communities, working with stakeholders, and sharing success stories. These ads urge people to make informed decisions, support integration projects, and take an active role in making cities more livable and linked. They support sustainable travel choices, reduce carbon emissions, conserve energy, and mitigate climate change by educating the public about the benefits of NMT and public transportation.

2. 6 Conceptual Framework

The framework below provides a summary of the key emergent themes in literature on the modal integration of public transport with non-motorised transport. While the framework summarizes the literature review, it also provides an emphasis that for an integrated transport system to be achieved with non-motorised public transport, there are various elements that need to be taken into consideration, such as the availability of infrastructure and the factors that enable this integration to occur. Policy and legislative frameworks play a critical role in the enabling of this integration to occur, and they ought to be aligned in all the spheres of government to ensure coordination and support.

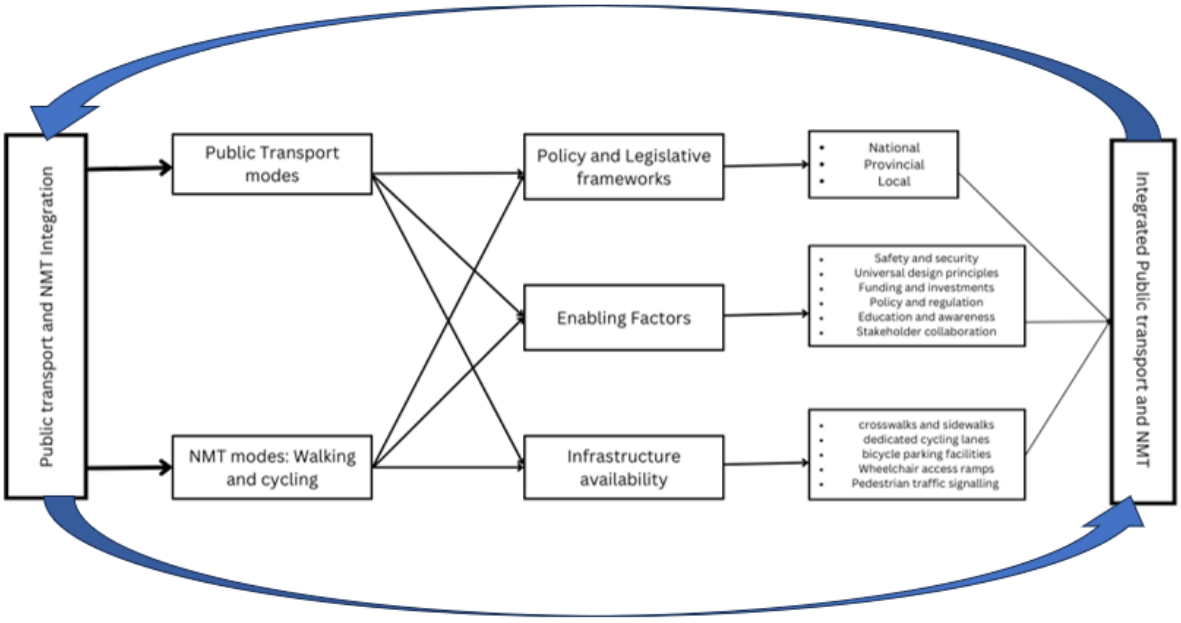

Figure 2.1: Conceptual Framework. Source: Author, 2023

2. 7 Case studies

One of the unique elements of this study strategy is the incorporation of case studies from several urban contexts, including a developing country, a transitioning country, and a developed country.

The study examines three case studies: a developing country case study, a transitioning country case study, and a developed country case study. The Transitioning Country Case Study identifies common hurdles and innovative solutions for rapid urbanization, while the Developed Country Case Study serves as a benchmark for successful integration. The research

seeks to identify best practices for the Roodepoort CBD integration efforts and provides a holistic understanding through multiple perspectives.

Case studies are effective tools for studying and learning from the experiences of cities all around the world in urban planning and transportation. The distinctive environment, challenges, and inventive solutions of each city provide significant insights into the complex issue of integrating non-motorized transportation (NMT) with public transportation networks. In this part, I look at case studies from around the world to highlight the approaches, triumphs, and challenges that cities confront as they attempt to build more sustainable, efficient, and inclusive urban transportation networks.

These case studies introduce us to cities with various levels of development, cultural origins, and geographical environments. Each city has its own tale of NMT integration, from the bustling streets of Bogotá, where imaginative design has altered transportation, to the historic districts of Curitiba, Brazil, where modern public transportation systems smoothly interact with cycling and pedestrian infrastructure.

Through these case studies, I seek to understand different practices, lessons gained, and current initiatives in the field of NMT and public transportation integration. The examples provided serve as inspiration and direction for urban planners, governments, and communities around the world as they strive to make cities more liveable, sustainable, and accessible to everyone. The following section discuses case studies on the integration of Non-motorised transport with public transport from Belin, Bogota and Curitiba.

Developed Country: Germany – Berlin

Berlin, Germany's capital, serves as a compelling case study for the integration of NMT and public transportation. Berlin, known for its rich history, vibrant culture, and efficient public transportation system, has made significant progress in encouraging sustainable mobility and reducing car dependency in the urban landscape (Sarker, Mailer, and Sikder, 2020). Berlin has a long history of investing in public transportation infrastructure. The city's large tram and U-Bahn (subway) networks date back to the late 1800s, establishing the groundwork for a robust and efficient public transportation system (Hesse, Welz, Assmann, Quentin and Waldner, 2009).

Berlin confronted enormous urban planning issues following Germany's reunification in 1990 (Reinholdand Kearney, 2018). To accommodate the rising population, the merging of two

independent transport networks, one in East Berlin and one in West Berlin, required careful coordination and expansion. Berlin has made great efforts to provide dedicated bike lanes around the city (Pebler, 2022). These lanes are physically segregated from motor vehicles traffic, increasing cycling safety. Commuters can rely on these lanes for daily travel because they provide a safe route. Aside from dedicated lanes, many Berlin roadways are planned with bikes in mind (ibid). This features broad shoulders and visible markings to denote cycling areas, ensuring that different road users coexist peacefully.

The city has comprehensive bike-sharing schemes in place, making it simple for residents and visitors to access bicycles for short trips (Hesse et al., 2009). For those who have no access to a bicycle, these programs provide flexibility and convenience. Several areas in Berlin have been declared as car-free zones, transforming them into lively pedestrian-friendly districts. Unter den Linden, a historic boulevard in Berlin, has been transformed into a vibrant pedestrian zone complete with outdoor cafes, street entertainment, and green areas (Ibid).

Berlin has invested in pedestrian safety measures such as well-marked crosswalks, pedestrian signals, and increased lighting to encourage people to walk. These improvements make it safer for pedestrians to navigate the city. Along with pedestrianization efforts, Berlin has boosted the city's quantity of green spaces and parks (Reinhold and Kearney, 2018). These locations are used for pleasure and to promote walking and leisurely strolls.

Berlin's public transportation system connects perfectly with NMT modes. Subway and train stations include bike racks and are easily accessible by foot (Pebler, 2022). This encourages commuters to use many modes of transportation for their trips. Berlin has implemented integrated ticketing systems that cover many modes of transportation, making it easy for travelers to switch between public transportation and NMT without having to purchase separate tickets (Neumann, Kevn, Leich and Nagel, 2022). The city has invested in navigational signage to assist passengers who are walking, cycling, or taking public transportation. This signage improves the overall commuting experience and encourages the usage of public transportation.

Berlin is addressing seasonal constraints by improving winter maintenance of cycling lanes and bridging infrastructure gaps in outer districts. The city is also promoting sustainable transportation through education, awareness campaigns, and incentives for NMT commuters. This multifaceted approach aims to bridge gaps and encourage widespread NMT use, despite the challenges posed by cold winters and inadequate cycling infrastructure. Berlin's commitment to sustainability and active transportation is evident in its ongoing initiatives.

Transitioning Country: Colombia – Bogota

Bogotá, Colombia's capital and largest city, has emerged as a global model for sustainable urban transportation, notably in its attempts to integrate non-motorized transport (NMT) with public transportation. Faced with rising urbanization and transportation issues, the city has pioneered creative solutions that favour non-motorized means of transportation such as cycling and walking. Like many quickly growing cities, Bogotá had traffic congestion, air pollution, and restricted mobility alternatives (Hildago and King, 2014). The city's reliance on private vehicles resulted in a slew of environmental and social issues. In response, Bogotá implemented the TransMilenio system, a Bus Rapid Transit (BRT) network that transformed public transportation, in 2000. This system laid the groundwork for a multimodal transportation strategy that actively promotes NMT (Hildago, Pereira, Estupinan, and Jimenez, 2013).

Bogotá's extraordinary efforts to integrate non-motorized transport (NMT) into its urban fabric have granted it a global leadership position in sustainable mobility. Ciclova, a project in Bogotá, is a highlight. Every Sunday and holiday, substantial portions of the city's streets are closed to motor vehicles and only open to cyclists, pedestrians, and rollerbladers (Sallis et al., 2015). This weekly event has come to represent Bogotá's dedication to promote healthy lifestyles and NMT. It encourages citizens of all ages to actively participate in the utilization of the city's public areas.

Bogotá has a vast network of dedicated bike lanes and trails that extend over hundreds of kilometers. These lanes are physically segregated from automotive traffic, assuring cycling safety (Guzman and Oviedo, 2018). Commuters can rely on these lanes for daily travel, making cycling a viable means of transportation. Bike racks and secure storage spaces are available at several TransMilenio stations and bus stops. This integration enables commuters to smoothly switch between cycling and public transportation, eliminating obstacles between different modes of transportation (Hildago and King, 2014).

The pedestrianization efforts in the historic La Candelaria area and Usaquén are excellent examples. Bogotá has developed vibrant, car-free zones where people can enjoy leisurely walks, investigate local shops, and participate with their communities by prohibiting vehicle access in certain places. Public plazas have been revitalized across the city to offer open areas where people can meet, relax, and participate in cultural and recreational events. These plazas serve as community gathering places and encourage people to walk about their areas (Vivenco, 2022).

The city launched BiciBogotá, a bike-sharing scheme that allows residents to rent bicycles for short trips at a low cost. Residents and visitors can readily rent bikes from several bike stations strategically situated across the city, thus increasing NMT use (Rosas-Satizabal and Rodriguez-Valencia (2019). Cycling is widely promoted as an environmentally friendly and effective means of transportation in Bogotá. Cycling benefits such as less pollution, increased health, and reduced traffic congestion are highlighted in public awareness campaigns. Furthermore, the city offers incentives, such as tax reductions, for acquiring bicycles (Ibid).

Bogotá is enhancing its NMT infrastructure by improving traffic enforcement and addressing traffic violations. The city is expanding its cycling and pedestrian network, particularly in underserved neighborhoods, to benefit a wider population. The city is also promoting cultural change and fostering community engagement to encourage a shift in mindset towards NMT as a practical choice. This holistic approach to urban mobility is setting an example for other cities.

Developing Country: Brazil – Curitiba

Curitiba, a city in southern Brazil, is well-known for its creative and efficient public transportation system, particularly its incorporation of non-motorized transit (NMT). Curitiba has built a model that prioritizes sustainability, lowers traffic congestion, and enhances the quality of life for its citizens over time. Curitiba began its journey toward sustainable urban transportation in the 1960s, when city leaders embraced visionary urban design principles (Rabinovitel, 1996). Their foresight and dedication to sustainable development paved the way for the city's transportation revolution. As the city grew in size, there was an urgent need to alleviate traffic congestion and pollution while improving mobility for all inhabitants.

Curitiba's pioneering BRT system, which debuted in 1974, has become a global model for efficient public transportation. It runs on designated bus lanes, providing locals with a quick and dependable form of transit (Fryszman, Carsterns and Da Cunha, 2019). Passengers can board and disembark fast using pre-paid fare systems, reducing travel times. The BRT system works in tandem with NMT modes. BRT stations are designed to make it easy for walkers and bicycles to get about (Tucker and Manaugh, 2018). They contain bike racks and pedestrian routes, allowing commuters to combine cycling, walking, and bus transport in one trip. Curitiba has a large network of dedicated bike lanes and trails that run across the city (Leite De Almeida et al., 2021). These lanes are physically segregated from automotive traffic, assuring cycling

safety. Commuters can rely on these lanes for daily travel with confidence and making cycling a practical and secure mode of transportation.

Curitiba has created a bike-sharing program to encourage NMT. This program provides residents and guests with access to bicycles for short trips (Tucker and Manaugh, 2018). Bike-sharing stations strategically positioned make it easy for people to hire bikes, encouraging NMT use even among those who do not own bicycles. Curitiba's downtown center has been significantly revitalized, with pedestrian-friendly zones and plazas created. Rua das Flores, for example, is a car-free street that demonstrates this method. It provides a lively environment for pedestrians to enjoy shopping, dining, and cultural activities (Alcides Rezende et al., 2021).

Curitiba is addressing its transportation infrastructure challenges as the city grows and urbanizes. It is expanding its cycling network and optimizing the BRT system to accommodate the growing population. However, the city needs to shift cultural norms away from car dependency, especially among younger generations. Public education and awareness campaigns are crucial for this transformation. Investing in bike lanes and pedestrian pathways is also essential for creating an inclusive and equitable transportation system. Curitiba's pioneering efforts in NMT integration serve as an inspiration for cities worldwide to improve their NMT and public transport integration efforts.

2. 8 Policy and legislative frameworks: South African Context

In this section, I discus the legislative frameworks that guide the planning and implementation of NMT and public transport and its integration in the South African context.

White Paper on National Transport Policy

The 2021 White Paper on National Transport Policy (NTP) is a revised policy document that expands on the previous National Transport Policy of 1996. The latter is widely regarded as a foundational blueprint which influenced the formation of numerous future national transportation plans. The overarching goal outlined in the 2017 White Paper on National Transport Policy is to create a transportation system that provides fair and dependable access to all while remaining economically and environmentally sustainable. This overarching goal is supported by the goal of promoting inclusive growth and increasing the country's competitiveness (NTP, 2021; 1).

The policy recognizes the importance of having a transportation system that not only provides access and mobility to various economic and social opportunities, but also emphasizes the

importance of providing transportation infrastructure and services that are responsive to the populace's diverse demands. To fulfill this vision, the White Paper emphasizes the importance of developing a transportation system that is accessible, reliable, timely, cost-effective, and committed to safety and security.

Furthermore, the White Paper on National Transport Policy recognizes a significant flaw in current transportation planning procedures, namely a lack of integration. To remedy this shortcoming, the strategy emphasizes the critical need of promoting transportation integration. The construction of a fully integrated transportation planning framework that actively supports the harmonious integration of various transportation modes is a critical component of this endeavor (NTP, 2021). Within this framework, special emphasis is placed on the creation of robust and integrated intermodal coordinating structures that support the delivery of high-quality intermodal services. Moreover, the policy emphasizes the importance of encouraging collaboration across diverse means of public transportation and emphasizes the importance of accelerating infrastructure development in order to allow seamless intermodal interchanges.

The document underlines the need of promoting and growing non-motorized transportation (NMT) as a means of lowering carbon emissions, encouraging a move to more sustainable modes, and providing low-cost mobility options. The NMT strategy acknowledges that the demands of rural and urban environments differ, particularly in terms of addressing pedestrian needs, promoting cycling, increasing road safety, and taking into account the needs of people with disabilities. It pushes for appropriate and sustainable funding, the integration of NMT into the formal transport system, and the creation of traffic regulations to support NMT as a key mode of transportation (NTP, 2021).

National Land Transport Strategic Framework (NLTSF 2023 – 2028)

The National Land Strategic Framework (NLSF, 2023) is a strategic framework that acts as a basic template for establishing strategic priorities in transportation planning. Its primary goal is to use transportation planning to achieve multidimensional goals covering social, health, economic, and environmental elements. The NLSF is linked to significant national and provincial strategic documents, most notably the National Development Plan (NDP) and National Master Transport Plan (NATMAP), as well as provincial transportation and spatial planning projects. Furthermore, it broadens its impact to include a broader range of strategies and plans developed at the local government level. The explicit delineation of strategic priorities and outcomes facilitates this interconnectedness.

The major goal of the NLSF is to provide a comprehensive five-year framework for the integration of land use and transportation planning. This integration is meticulously planned to comply with the broader objective outlined in the NDP 2030. The NLSF also serves as a compass, providing essential principles for the seamless integration of various modes of land transport. It finds harmonious alignment with the NDP's architectural design in this context. By doing so, the NLSF aims to establish a systematic framework that improves clarity and certainty in transportation planning while adhering to relevant national legislation and policy.

The National Land Transport Strategic Framework (NLTSF) 2023-2028 highlights non-motorized transport (NMT) as a crucial component of the larger objective of developing an integrated and efficient land transport system. NMT, which includes walking, cycling, and other non-motorized modes of transportation, is regarded as critical for encouraging sustainable urban settings and minimizing transport operations' environmental effect. The framework emphasizes the significance of boosting NMT to reduce greenhouse gas emissions, relieve traffic congestion, and promote public health through increased physical activity.

The document also emphasizes the importance of significant investment in NMT infrastructure to ensure the safety and accessibility of all users, especially vulnerable groups like those walking, cyclists, and people with disabilities. It pushes for the building of dedicated bicycle lanes, safe crossings, and secure parking, as well as the introduction of traffic calming measures in cities. The NLTSF advocates for the incorporation of NMT into land use and transportation planning at all levels of government, ensuring that NMT issues are taken into account when designing and developing urban places. Furthermore, the framework emphasizes the importance of NMT in fostering social inclusion by making mobility options affordable and accessible to all individuals, including those living in rural and neglected areas. It promotes collaboration among national, provincial, and municipal governments in developing and implementing policies that support NMT, ensuring that it remains a viable and appealing mode of transportation. The NLTSF sees NMT as a critical component in building a more equitable and sustainable transportation system that contributes to the general well-being of communities across South Africa.

The ultimate purpose of the NLSF is to provide an integrated and highly efficient transportation system. In accordance with the broader national objective, this system is committed to fostering a vibrant and healthy economy. It intends to accomplish this by supporting long-term economic growth, providing safe and accessible transportation options, developing social cohesion across

all geographical regions, and protecting the environment. The NLSF's strategic priorities are inherently aligned with these overarching goals, charting a comprehensive path toward a transportation system that boosts economic vitality, maintains safety and accessibility, fosters social integration, and ensures environmental sustainability.

National Development Plan (NDP) 2030

The National Development Plan (NDP) 2030 is a comprehensive national strategy framework that defines a visionary path for many sectors of society, all of which are aimed at achieving particular overall goals. The NDP (2012), which is based on the South African Constitution, projects a long-term perspective that is consistent with the constitutional mission. It essentially serves as a roadmap for the country's development efforts, with a focus on the aspirational aim of relieving poverty and eliminating inequities by 2030.

The recognition of the critical role that transportation systems play in society is central to the NDP's worldview. The NDP emphasizes the importance of channeling transportation investments toward the development of empowering transportation infrastructure. An infrastructure of this type is envisioned to improve society access to economic and social opportunities, bridging the current gap that divides individuals from these valued opportunities. Furthermore, the NDP pushes for a transportation system that is affordable, reliable, and safe, with the goal of creating diversity.

In keeping with its forward-thinking approach, the NDP 2030 emphasizes the importance of promoting more mobility. It advocates for transportation solutions that not only improve mobility but also align with sustainability goals, reducing their environmental impact (NDP, 2012). As a result, the NDP 2030 provides a strategic and visionary framework for South Africa's socioeconomic development. It lays forth a comprehensive agenda centered on transportation systems' critical role in furthering the nation's well-being, social equality, and environmental sustainability.

The National Development Plan (NDP) 2030 stresses Non-Motorised Transport (NMT) as part of a larger vision for South Africa's inclusive and sustainable transportation system. It recognizes NMT's contribution in improving the quality of life by offering inexpensive, accessible, and environmentally friendly transportation options. The New Democratic Party emphasizes the importance of creating safe, widely accessible neighborhoods that encourage walking and cycling, hence reducing dependency on motor vehicles. It argues for major expenditures in NMT infrastructure, such as sidewalks, bike lanes, and pedestrian-friendly

urban designs, to help with the transition to a low-carbon economy and promote public health. Furthermore, the NDP advocates for the integration of NMT in public transportation networks to enable seamless connectivity and promote social inclusion.

National Land Transport Act

The National Land Transport Act, with the reference number No. 5 of 2009, is a legal enactment that specifies the procedures for the reconfiguration and transformation of terrestrial transportation systems, as well as all associated and interconnected aspects. This legislative framework operates with the goal of putting the national policy agenda into action, with a primary focus on the merger and rationalization of land transport functions. Furthermore, it strives to guarantee that these duties are located within the appropriate jurisdictional sphere of government, as stipulated by governance principles (National Land Transport Act, 2009).

This legislative act is based on an understanding of the critical need of harmonizing land use planning processes as well as the necessity of integrating transportation networks. It is specifically intended to provide regulatory control over intermodal transportation efforts, such as Bus Rapid Transit (BRT) networks and minibus taxis. It seeks to develop and preserve a comprehensive and integrated transportation network operating within metropolitan regions through such regulation. The act is strategically aligned with the goal of establishing a comprehensive and well-coordinated transportation ecosystem inside cities.

National Policy on Non-Motorised Transport

The fundamental goal of the Non-Motorized Transport (NMT) Policy is to elevate the function of NMT to a prominent position within the transportation spectrum. It accomplishes this by establishing NMT as an essential component of public transportation and ensuring the availability of secure NMT infrastructure. This initiative is complemented by a pledge to seek and sustain funding for the development and promotion of NMT (Department of Transport, 2008).

The NMT Policy aims to promote the recognition and integration of Non-Motorized Transport (NMT) modes into the transport system, enhance traffic legislation, establish infrastructure and maintenance standards, promote NMT as a feeder system, empower marginalized groups, and position NMT as reliable, healthy, affordable, accessible, and safe. It also emphasizes the need for adequate and sustainable funding to support NMT promotion and development, encourages research and innovation to enhance NMT performance, and reduce traffic fatalities for

vulnerable non-motorized road users. The policy emphasizes the importance of sustainability, inclusivity, and safety in the broader transport landscape. The policy's ambitious agenda aims to strengthen NMT's role and status within the transport landscape.

Policy context

In this section, I discus the policies that guide the planning and implementation of NMT and public transport and its integration.

CoJ's Integrated Development Plan (IDP 2021 – 2026)

The City of Johannesburg's (CoJ) Integrated Development Plan (IDP) for the years 2021 to 2026 represents a comprehensive five-year strategy. Its primary goal is to steer the city toward the fulfillment of a visionary future that includes becoming a "world-class African city." This vision includes a lively, equitable, and varied urban core dedicated to improving inhabitants' quality of life. Furthermore, it wants to ensure sustainability for all of its residents, which supports the city's goal to transitioning into a resilient and adaptive society (IDP, 2021; 3).

Significantly, the IDP works in tandem with the larger national development strategy while remaining focused on the local level. To attain these lofty goals, the IDP has developed a set of strategic objectives, which include, but are not limited to:

- Good Governance
- Financial Sustainability
- Integrated Human Settlements
- Sustainable Service Delivery
- Job Opportunity and Creation Safer City
- Active and Engaged Citizenry
- Economic Development
- Sustainable Development
- Smart City
- Minimizing the Impact of COVID and Future Pandemics

Transportation is recognized as a critical component of the city's economic development strategy and commitment to giving access to varied socioeconomic possibilities. As a result, the city is committed to creating a reliable and efficient public transportation infrastructure. This system includes a variety of means of transportation, such as battery-powered cars, cycling, walking, and low-emission vehicles. Furthermore, the city is aggressively attempting to integrate current modes of transportation, such as minibus taxis, the BRT system, and metrobuses. It also aims to leverage Intelligent Transportation Systems and smart technology to improve customer satisfaction by promoting higher efficiency, dependability, safety, and environmental sustainability in these integrated transportation modes (IDP, 2021).

CoJ Growth and Development Strategy

In 2006, the City of Johannesburg unveiled its first Growth and Development Strategy (GDS), which served as the foundational articulation of the city's long-term economic trajectory. This comprehensive approach also serves as the conceptual framework for the city's five-year Integrated Development Plan. The concept of 'eco-mobility' is central to the strategic goal articulated in the Joburg 2040 GDS. This term represents a dedication to ecologically friendly and socially inclusive types of local transportation. This concept combines non-motorized transportation (NMT) options including walking, cycling, and wheeling with public transportation and the use of light electric cars fueled by renewable energy sources.

The city's Transport Department has specifically stated that its two long-term outcomes would be the promotion of public transportation, walking and cycling, and the improvement of transportation infrastructure and movement. The GDS 2040 envisions a city defined by social inclusion and increased social cohesiveness, which will be realized through widespread use of public transportation. The National Development Plan also emphasizes the transformative potential of public transportation and NMT modes, arguing that they can accelerate a shift in societal norms by encouraging social engagement, healthful behaviors, and street-level activity. These interactions help to create a sense of place and social inclusion, which is in line with South Africa's broader societal requirements.

In line with this goal, the GDS emphasizes that transportation hubs should be regarded as critical zones for local economic growth. This understanding extends to urban design, which should take into account economic development aspects as well as the interests of prospective investors. Furthermore, the Joburg 2040 GDS emphasizes spatial reconfiguration as a foundation for the city's more efficient operation. It believes that bringing individuals closer to

employment opportunities, markets, social networks, and other opportunities demands not only increased mobility but also an approach based on integration. This entails the building of mixed-use villages as well as spaces meant to promote social interaction.

Roodepoort Transport Masterplan (RTPM, 2023)

The Roodepoort Transport Master Plan, adopted in 2023 is a strategic plan aimed at improving the transportation needs of Roodepoort. The plan includes aims at enhancing road networks, upgrading existing roads, expanding public transportation services, and integrating various modes of public transport for efficient travel. The MasterPlan identifies Roodepoort as a Regional node and economic hub within the city of Johannesburg that promotes the development of viable public environment and a mixed-use development. It also emphasizes the need for the development of infrastructure for non-motorized transport (NMT), including walking and cycling. The plans strategic values include creating safe pedestrian pathways, dedicated cycling lanes, and traffic calming measures to protect NMT users, creating NMT routes that are integrated with public transport hubs, ensuring easy access to buses, taxis, and other forms of public transportation. The plan denotes that safety can be enhanced through better lighting, signage, and crossing facilities, making these routes accessible for all, including the elderly and disabled. Furthermore, it stresses the need for intermodal facilities that allow for easy transfer between different transport modes, and integrated ticketing systems that allow passengers to switch between different modes without multiple tickets. The plan also aims to improve coordination between public transport services, minimizing wait times and enhancing overall transport network efficiency. It supports local economic development by improving access to jobs, education, and essential services through better transport connectivity.

CoJ Strategic Integrated Transport Plan (SITPF, 2013)

The Strategic Integrated Transport Plan (SITPF, 2013) serves as a comprehensive framework for providing an in-depth study of an urban area's existing transportation networks. It provides a complete assessment of the existing situation, including both flaws and ongoing developments. The framework defines a set of goals aimed at improving the performance and effectiveness of transportation networks. Furthermore, it explains the precise techniques that have been developed and implemented to achieve these goals. The discovery and elaboration of indicators, outputs, and outcomes that are useful in measuring the city's success is an important part of the SITPF. These metrics assess the city's adherence to the national standards

in terms of transportation infrastructure and public transportation service provision, contributing to a comprehensive assessment of the city's transportation ecosystem.

CoJ Integrated Transport Plan (2013)

The City of Johannesburg developed its Integrated Transport Plan (ITP) in August 2013, with the primary goal of outlining the anticipated development trajectory of public transportation infrastructure and services within the municipal boundaries (Letaifa, 2015). Notably, the Integrated Transportation Plan was instrumental in arguing for the establishment of the city's Strategic Public Transportation Network (SPTN). This entire network, which includes operational concepts as well as network architecture, was created with the explicit knowledge of the need for robust public transportation integrations.

The fundamental goal of the Strategic Public Transportation Network was to promote the development of a multi-nodal urban layout and the achievement of a compact city paradigm. To do this, it established an organized, high-frequency public mobility "grid" that linked critical high-density hubs with densely inhabited residential regions. The public transportation system was methodically constructed within this grid-like framework to ensure inclusive, continuous integration, hence simplifying access to all key destinations via the public mobility system. This was accomplished by establishing an integrated network of public transportation routes, which served as the backbone of this comprehensive architecture.

The strategy recognizes NMT's role in offering alternative transportation options, promoting healthy lives, reducing traffic congestion, and minimizing the environmental impacts of motorized vehicles. It promotes the creation of safe, well-connected, and accessible infrastructure for pedestrians and cyclists, with the goal of improving the entire urban environment and encouraging more sustainable modes of transportation. In addition, the plan emphasizes the importance of integrated planning that incorporates NMT infrastructure into the city's transportation network. Its goal is to provide a comprehensive transportation system that meets the demands of pedestrians and bicycles while also ensuring their safety, convenience, and seamless integration with other modes of transportation in the City of Johannesburg.

2. 9 Chapter conclusion

This chapter evaluated current literature and provided insights into the integration of public transit and non-motorized transportation (NMT). The analysis emphasizes that successful

integration of multiple modes of transportation is dependent on the creation and maintenance of comprehensive infrastructure. Although infrastructure alone does not encourage users to use NMT and public transport, it plays an important role towards encouraging the use of these services. Dedicated cycling lanes, well-designed pedestrian routes, and facilities that smoothly connect NMT options to public transportation services are all critical components of this infrastructure. Furthermore, the provision of intermodal infrastructure such as transport hubs and interchange points are critical to the integration of NMT and public transportation, allowing for seamless transitions between modes. Infrastructure is important for more than just physical building; it also includes safety, comfort, and accessibility aspects that provide a positive user experience. For example, well-lit, secure, and clearly indicated pathways and transit hubs are critical for universal accessibility, as they accommodate the needs of all people, including those with disabilities. Cities may promote active and sustainable transportation by prioritizing and investing in such infrastructure. This method not only improves the efficiency and appeal of public transportation and NMT choices, but it also reduces reliance on personal vehicles. Furthermore, a well-integrated transportation system promotes a more connected and sustainable metropolitan environment, fostering an ecologically conscious and inclusive mobility culture.

The case studies section and the policy and legislative framework section both highlight the need for sustainable urban mobility. The case studies showcase the practical application of diverse strategies and initiatives to transform urban mobility, highlighting the power of public transport, the vibrancy of Non-Motorized Transport (NMT), and the vitality of integrated transport systems. These examples affirm that sustainable urban mobility is achievable, tailored to each city's unique needs and aspirations.

The policy and legislative framework section provides the foundation for sustainable urban mobility, focusing on national and local policies, legislative enactments, and strategic planning documents. The inclusion of NMT in these frameworks exemplifies a commitment to greener, healthier, and more accessible cities. These frameworks aim for equitable access, social inclusion, and economic vitality, ensuring no one is left behind.

The collective narrative emphasizes the importance of translating visionary strategies into tangible actions on the ground. Cities are blending vision and implementation, building a brighter urban future through visionary policies and real-world practices. The path to

sustainable urban mobility is a collective endeavor that spans the globe, encompassing cities of varying sizes, cultures, and contexts united by a shared commitment to better urban living.

Chapter 3: Research Method

3. Introduction

The methodology chapter gives a detailed review of the research methods, data collection methods, and data analysis methodologies that will be used in this study. The purpose of this chapter is to give a solid and methodical approach to researching the integration of non-motorized transport (NMT) and public transportation in the City of Johannesburg, particularly in the Rooodepoort CBD.

3.1 Research Method: Case study

To focus the investigation, this study used Roodepoort CBD in the City of Johannesburg, Region C, as a case study. The study is descriptive qualitative research. This will help to examine a phenomenon in its social context and try to determine why and how it happens (Sogunro, 2002; Noor, 2008). It generates qualitative data that the researcher can interpret using rigorous and systemic transcription, coding, and theme analysis (Patten and Newhart, 2017), This approach provided a comprehensive understanding of the obstacles, successes, and underlying variables impacting integration through open-ended interviews and rigorous case study analysis (Mohajan, 2018).

Case studies allow for an in-depth examination of a phenomenon, circumstance, in a specific setting (Yin, 2009). Researchers strive to present a full portrayal of the issue under examination in a descriptive study. The case study technique provides for a thorough assessment of the case's complexities, allowing researchers to capture the phenomenon's richness and complexity (Yin, 2009). A case study research design, according to Yin (2009), entails an in-depth assessment of a single occurrence or a limited number of cases, known as "cases," with the goal of comprehending the complexities and nuances of the phenomenon being examined. Case study designs encourage a comprehensive examination of the case, considering all important features, dimensions, and relationships. This entails investigating several viewpoints and views to generate a holistic picture.

3.2 Data collection methods

To properly examine the subject and respond to the research questions, this study used primary data. Ajayi (2017) defines primary data as original data that is collected for the first time by the researcher in real-time. I collected primary data using semi-structured interviews with key informants who were chosen through convenience and purposive sampling. Field observations were also carried out. Schensul and LeCompte (1991: 91) define field observation as "a process of learning through exposure to or the involvement in the day-to-day routine activities of the research setting". This will allow for an observation of various factors that have the potential to enable or inhibit modal integration in the site of study.

Semi-structured interviews

In this qualitative study, semi-structured interviews are an important part of the primary data collection method. These interviews provided a forum for in-depth discussions with key stakeholders who have unique insights into the integration of non-motorized transport (NMT) and public transportation. The interviews were semi-structured to strike a balance between a predetermined set of questions and the freedom to explore emergent themes (Jamshed, 2014). The interview guide included open-ended questions that allow participants to express their NMT integration experiences, thoughts, and recommendations. The interview questions are included as appendix 3 of the study.

The study initially aimed to interview officials from the transport department in the City of Johannesburg. However, after multiple attempts through emails and phone calls, the selected informants from the city could not be interviewed. The officials were initially approached in September after obtaining permission from the city to conduct the study (Permission letter attached as annexure 2). Some of the officials initially agreed to participate in the study but did not show up for the interviews when they were supposed to take place. I followed up with the officials telephonically and visited their offices from October to November after receiving ethics clearance but could not get an interview with them. I opted for the option of having the interview online to save time for the participants, but I still could not secure the interviews with the city officials. Officials often face time constraints due to their demanding roles and responsibilities, such as managing daily operations, attending meetings, addressing emergencies, liaising with stakeholders, and making critical decisions. At the point of the data collection, the city had experienced fires in some of its buildings, which resulted in them being closed and they systems were down, with officials working from home (Luvhengo, 2023). This

emergency was stated as one of the excuses that some officials could not sit down for an interview at that point. These positions often result in packed schedules, leaving little room for additional engagements, such as research interviews. Officials, especially those in leadership roles, often have back-to-back meetings, tight deadlines, and a variety of responsibilities that consume their working hours. As such, some of the officials noted that although they had agreed to the interview before, they simply do not have time to engage because their schedules are packed. Finding available slots for interviews can be challenging due to these time constraints. Therefore, the study proceeded without the interviews from the city officials.

The Key informants that were interviewed for the study are consultants with the City of Johannesburg for their transport MasterPlans. These key informants provided valuable insights and sufficient information to proceed with the study. The two consultants were a Civil Engineer (Male) and a Town Planner (Female). They both fall within the age category of 33 to 39 years of age. Twenty (20) commuters were interviewed within the Roodepoort CBD of these commuters, twelve (12) were males and eight (8) were females. These commuters were approached as they went to board a public transport, or as they got off one. With these interviews, two (2) of the commuters did not feel comfortable with signing the consent form, and another one could not finish the interview as she was rushing to an uber. These interviews were marked as incomplete and could not be used for the study.

Field Observations

Field observations are an important part of the basic data collection procedure. These observations will provide a personal understanding of Johannesburg's existing non-motorized transportation (NMT) infrastructure and its integration with public transportation (Westbrook, 1994). Observation locations were carefully chosen to represent a variety of mobility centres, key public transportation corridors, and areas with considerable NMT infrastructure (Sullivan and Sargeant, 2011). These sites offered insights into the practical issues of integration as well as the interaction between NMT and public transportation. I visited the selected observation sites at various times of the day to document varied usage patterns and scenarios. The emphasis is on documenting the physical connectivity between NMT amenities (such as bike lanes and pedestrian walkways) and public transportation stops or stations.

3.3 Sampling techniques

In this study, I used both convenience and purposive sampling techniques. Participants were chosen through purposeful sampling based on their specialization, aptitude, and familiarity

with the subject matter of the study. Therefore, I utilized purposive sampling to select external stakeholders who were interviewed for the study. The study also used convenience sampling to select key informants. This sampling technique was useful in the selection of key informants who are readily available and easily accessible to participate in the study. Therefore, this sampling technique was used to sample commuters and pedestrians from the Roodepoort CBD.

Convenience Sampling is a non-probability sampling strategy that is used to select participants based on their accessibility and willingness to participate in the study (Shaheen and Pradhan, 2019). This strategy is useful when resources, time, or access to a certain population are limited. Convenience sampling is appropriate given the study's focus on gathering insights from key stakeholders involved in non-motorized mobility (NMT) and public transportation integration in Johannesburg. This strategy enables the researcher to reach out to volunteers who are readily available and have direct knowledge or competence in the topic. Convenience sampling in this study entailed approaching commuters who are participating in or are impacted integration efforts. The selection is based on these stakeholders' accessibility and potential contribution to the research objectives.

Purposive sampling, also known as judgmental or selective sampling, is the deliberate selection of participants with specified characteristics or information relevant to the research aims. The goal to get in-depth and contextually rich insights motivates this method (Etikan, Musa, and Alkassim, 2016). This technique assures that the consultants who are chosen have direct engagement, competence, or influence in NMT and public transportation integration projects.

The researcher can use purposive sampling to carefully pick individuals based on their positions and experiences. Transit authorities, for example, can provide policy insights, public transit operators can provide operational perspectives, and city planners can provide urban planning insights. Purposive sampling improves the chances of acquiring in-depth and specialized insights from individuals with unique knowledge. The participants chosen are closely aligned with the research objectives, ensuring that the data acquired directly addresses the study's focus. This strategy allows the researcher to collect a variety of viewpoints that, when combined, provide a thorough insight of the integration process.

While convenience and purposeful sampling offer benefits, the researcher recognizes the value of diversity and representativeness. To capture a well-rounded image of NMT and public transportation integration in the Roodepoort CBD, efforts will be made to engage people from all sectors, backgrounds, and perspectives.

The convenience selection and purposive sample strategies will be used to select participants based on practical accessibility and agreement with the research objectives. While convenience sampling facilitates the collection of information rapidly, purposive sampling assures a purposeful selection of participants who can contribute in-depth and contextually relevant information, boosting the richness and depth of the study's conclusions.

3.4 Data Analysis

In this qualitative study, thematic analysis is the foundation of the data analysis process. It entails identifying, analyzing, and reporting patterns (themes) within qualitative data in a systematic manner. This method allowed the research to extract useful insights from the massive amount of qualitative data gathered through interviews and case study documentation (Lochmiller, 2021). The procedure begins with data coding, which involves methodically reviewing and segmenting the obtained qualitative data, such as transcribed interviews and case study materials, into meaningful units. These units, or codes, indicate distinct ideas, concepts, or attitudes conveyed or mentioned in case study materials (Ibid). The initial codes are formed by carefully reading through the material and looking for reoccurring phrases, ideas, or patterns. These codes serve as the foundation for later investigation (Terry, Hayfield, Clarke and Braun, 2017).

Based on their commonalities and patterns, the generated codes were then classified into probable themes. Themes are broad notions that arise from data and represent key characteristics of the research topic. These topics capture the essence of the data and provide a deeper understanding of NMT and public transportation integration in Johannesburg. Themes are created and refined by constantly comparing, contrasting, and organizing the codes associated with each theme. This ongoing procedure guarantees that the themes appropriately reflect the data's diversity and complexity. The research matrix below (table 3.4) outlines the matrix for the research. For each of the objectives of the research, it shows who was the informant, how data was collected, analysed and presented.

*Table 3.4: Research Matrix (*Source: Author, 2023)

Objective	Sub-Question	Informant	Data collection	Data analysis and presentation

To investigate the causes of transport fragmentation in the Roodepoort CBD, City of Johannesburg.	What causes transport fragmentation in the Roodepoort CBD, City of Johannesburg?	Key Informants	Interviews, Observations	Thematic analysis
To assess the extent to which enabling factors are available for the Integration of Public Transport and NMT within the in the Roodepoort CBD, City of Johannesburg.	What enabling factors are available for the integration of public transport and NMT in the Roodepoort CBD, City of Johannesburg?	Key informants, Commuters	Interviews, Observations	Thematic analysis
To investigate the extent of infrastructure availability to allow for the integration of public transport and NMT in the Roodepoort CBD, City of Johannesburg	To what extent is the infrastructure available to allow for the integration of public transport and NMT in the Roodepoort CBD, City of Johannesburg?	Key informants, Commuters	Interviews, Observations	Thematic analysis

3.5 Study Area: Roodepoort CBD

The Roodepoort Central Business District (CBD) in the City of Johannesburg offers a unique case study for exploring the integration of non-motorized transport (NMT) and public transportation. As an urban centre that is faced with its own challenges, and opportunities, Roodepoort CBD is a focus of economic, commercial, and social activity (RTPM, 2023). The convergence of multiple transportation flows, such as residents traveling to work, shoppers visiting commercial districts, and those seeking services, requires a comprehensive understanding of these dynamics.

Roodepoort, located in the West Rand, Region C of the City of Johannesburg, Gauteng, South Africa, (See Figure 3.5 Below) has a long history dating back to the late nineteenth century. The growth of the area began with the discovery of gold in the Witwatersrand, which sparked

a gold rush in the late 1880s. This resulted in the formation of mining enterprises and, as a result, the region's urbanization. Roodepoort developed around the Roodepoort Gold Mine. The name "Roodepoort" comes from the Afrikaans words "roode," which means "red," and "poort," which means "gate or pass." It is thought to have been named from the area's red soil and rocky environment.

The discovery of gold in the late nineteenth century in the Witwatersrand region, particularly in Johannesburg, had a huge impact on the growth of Roodepoort. The discovery of gold on Wilgespruit sparked a gold rush, driving prospectors, miners, and fortune-seekers to the area. The Roodepoort Gold Mine was instrumental in the foundation of the town. The gold rush converted the region into a bustling metropolitan center, attracting people from all walks of life and propelling infrastructural development and urbanization. The town's diverse mining operations, including the West Rand Consolidated Mine, Durban Roodepoort Deep Mine, and Roodepoort United Main Reef, attracted a diverse workforce from South Africa and abroad. This led to the establishment of mining camps and communities, shaping the social fabric and fostering cultural diversity. The mining industry also supported ancillary industries like engineering, manufacturing, and services, contributing to infrastructure development. Despite its success, the industry faced fluctuations due to gold prices, labor disputes, and decline in reserves. Today, Roodepoort has diversified its economy, incorporated various industries, commercial enterprises, and residential developments while preserving its mining heritage in its cultural and historical landscape.

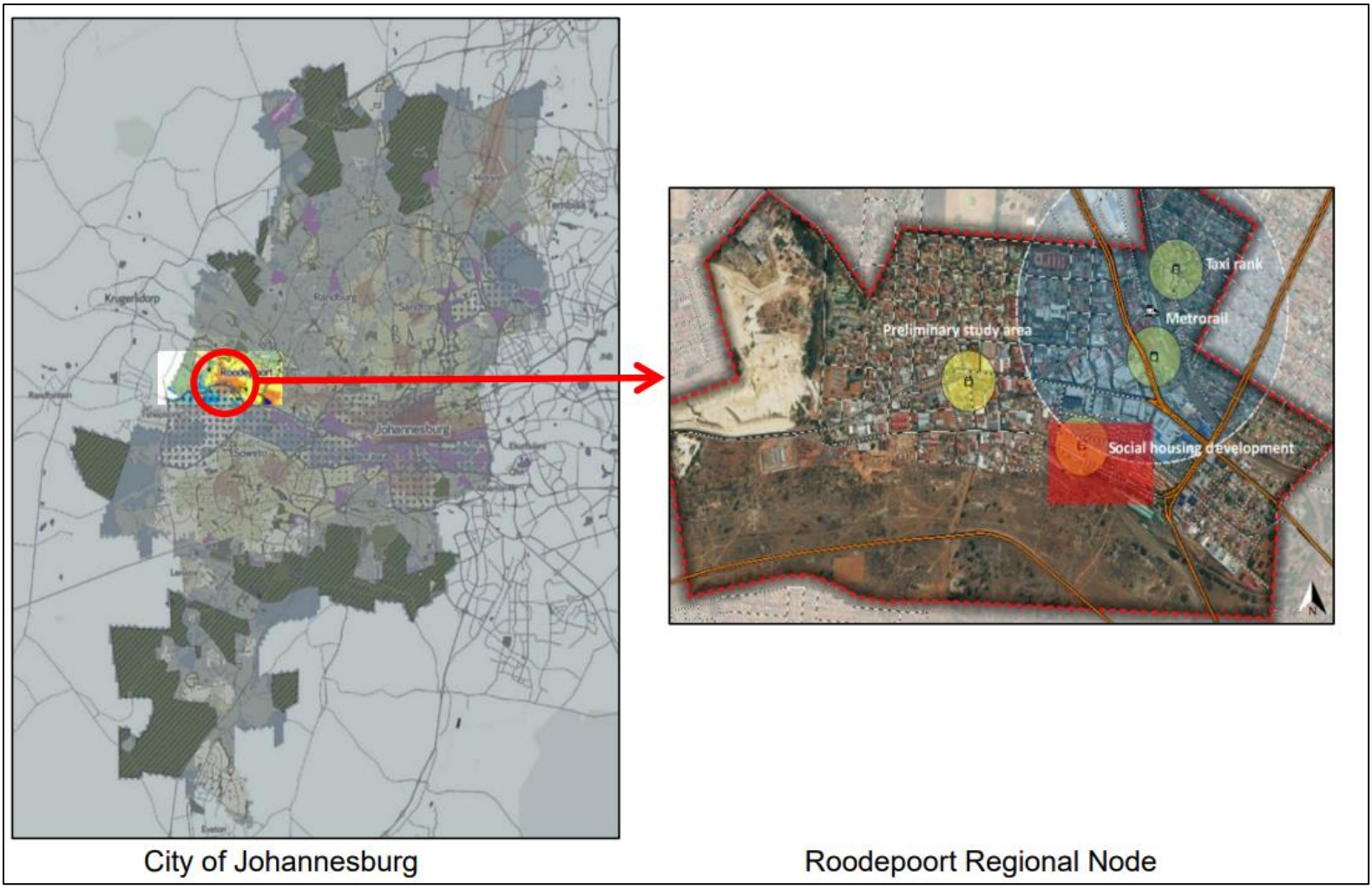

Figure 3.5: Map showing location of Roodepoort within the City of Johannesburg. Source: (Khoza and Behrens, 2023)

Roodepoort's establishment of municipal status in 1904 marked a significant milestone in its development within the City of Johannesburg. This move granted the town autonomy and administrative independence, allowing it to manage its affairs, make decisions on local issues, and provide essential services to its residents. The creation of a municipal government allowed the town to establish administrative structures, including a town council, to govern local affairs, enact bylaws, and manage municipal services. The transition to municipal status was closely linked to the town's economic growth and population expansion due to the thriving mining industry. The increased population and the need for improved infrastructure, services, and urban planning necessitated the transition to municipal status. Roodepoort gained autonomy in decision-making processes related to local governance, urban planning, and economic development, allowing it to establish policies and initiatives tailored to its community's needs. The attainment of municipal status also positioned Roodepoort as a significant player within the broader municipal landscape of Johannesburg, enabling it to collaborate with other municipalities, participate in regional development initiatives, and contribute to the overall development and governance of the greater metropolitan area.

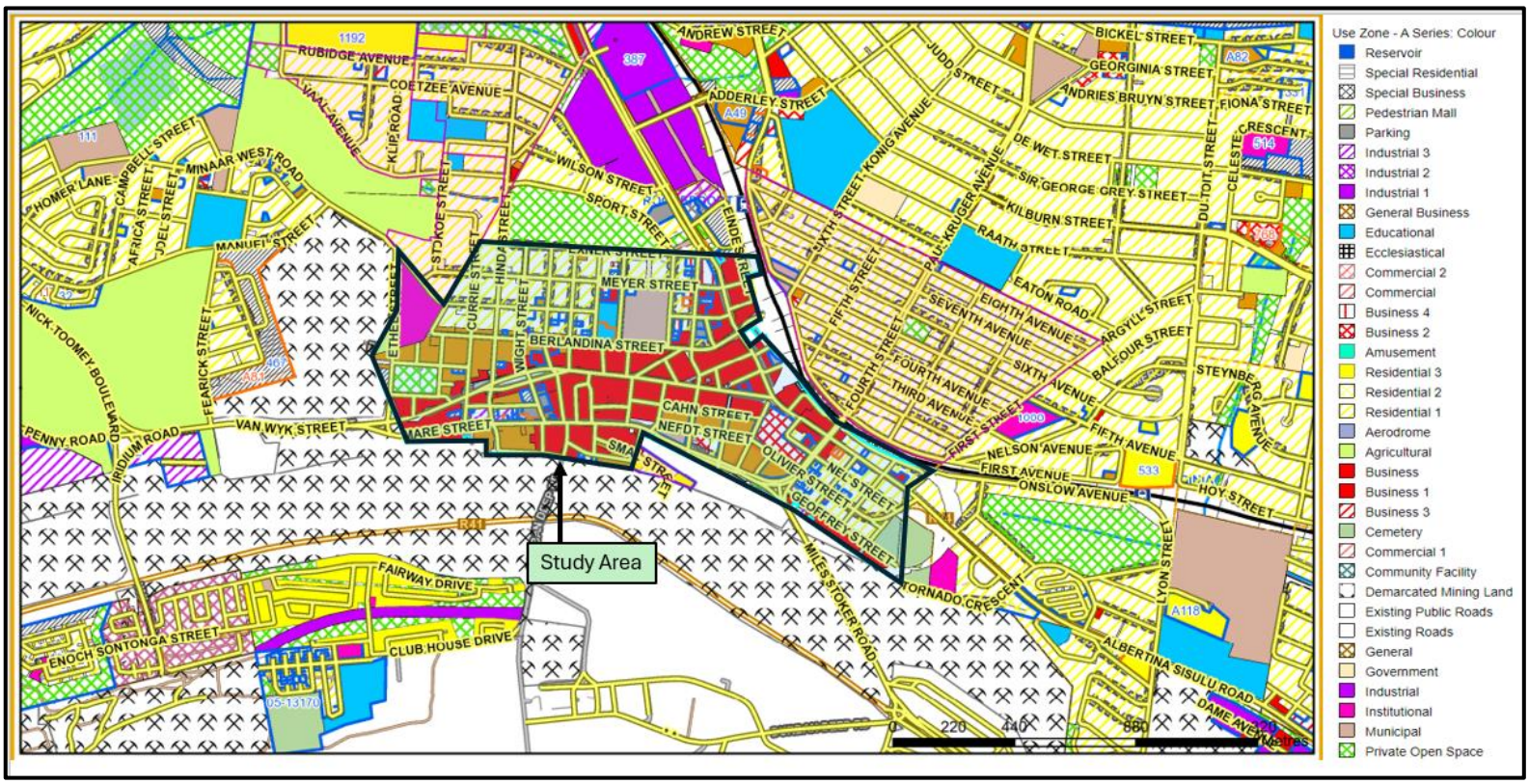

Figure 3.6: Study Area. Source: Authors construct, 2023

According to the Roodepoort Transport MasterPlan (RTPM, 2023), the Roodepoort CBD faces issues such as traffic congestion, lack of parking space, and environmental concerns. The integration of NMT options like bike lanes and pedestrian paths with public transportation could provide a realistic approach for reducing traffic congestion and promoting sustainable commuting options (Mbatha and Gumbo, 2022). reveals opportunities for enhancing accessibility through integration (RTPM, 2023).

The layout and infrastructure of Roodepoort CBD determine the possibility of this linkage, and analysing how successfully NMT choices connect residential areas to public transportation nodes The urban form and infrastructure of Roodepoort CBD are critical to the success of NMT integration. The provision of bike lanes, pedestrian-friendly walkways, and dedicated public transportation stops all impact the convenience and safety of combining NMT and public transportation (Risimati, Gumbo and Chakwizira, 2021).

The selection of Roodepoort CBD as a case study adds dimension to the study by providing a detailed evaluation of NMT and public transportation integration within a specific metropolitan zone. The knowledge gathered from this case study setting will improve the research's ability to influence urban planning decisions and policy recommendations for Roodepoort and Johannesburg's larger urban landscape. The lessons that will be acquired from Roodepoort's integration efforts can help build measures that can be applied to other districts of Johannesburg that face similar transportation issues.

3.6 Status Quo Analysis of the study Area

This section provides a status quo analysis and context of the Roodepoort study area

Socio-economic profile and economic activity

Roodepoort CBD is a hub of economic activity that includes industrial, retail, and informal trading sectors. The industrial edge north of Albertina Sisulu Street, as well as the huge retail anchors, provide a substantial contribution to the local economy. Informal traders are clustered in high-traffic areas, especially near transportation hubs and social amenities. Informal trading is prevalent around transportation, retail, and social services. This trading is mostly driven by heavy foot activity.

Figure 3.7: Image showing informal trading on pavements at Station Street. Source: (RTPM, 2023)

However, there is a lack of appropriate infrastructure for informal traders, resulting in public health risks and interruptions. The CBD's residential density is from 2500 to 5000 people per square kilometer, while the job density ranges from 500 to 1250 people per square kilometer (RTPM. 2023). Approximately 47% of the population works in either the formal or informal sectors, with a significant proportion engaging in informal jobs. Education levels are relatively high, with 53% achieving Grade 12 or better. However, there is a considerable gap in economic potential due to insufficient infrastructure and high rates of crime (RTPM. 2023).

Land Use

The land use in Roodepoort CBD is a combination of commercial, residential, and civic areas. Key routes like Van Wyk Street and Albertina Sisulu Road are business zones, with many mixed-use buildings. Current land use frequently deviates from permitted zoning, as depicted in figure 3.6 above, resulting in an excess of educational and religious facilities that have an impact on the urban landscape and demand for infrastructure. There is widespread urban deterioration, with many outdated and physically hazardous structures. Combining this with crime has an impact on pedestrian activity and safety. The area has poor public and urban infrastructure, such as broken public facilities, damaged bins, and unmaintained pavements. These factors offer barriers to non-motorized transportation and universal access.

Transport systems and road networks

Ontdekkers Road is one of the main arterial roadways that connects Roodepoort to Johannesburg and the neighboring districts. It is extensively trafficked, particularly during peak hours. The N1 Freeway serves as a crucial link for lengthier travels, connecting Roodepoort to other major cities and areas. Access to the N1 is critical for Central Business District residents and enterprises.

The local street network in the CBD is a combination of main and side streets. Many of these streets are congested, especially during business hours, due to heavy traffic and limited road capacity. Potholes and uneven surfaces degrade driving quality and contribute to traffic delays, raising concerns about road maintenance. Minibus taxis are the most popular kind of public transportation in Roodepoort CBD. Many residents benefit from their economical and accessible mode of transportation. The Roodepoort precinct implementation framework (2018) noted that 38% of all the trips in Roodepoort are done with a taxi. However, the system is informal, with irregular scheduling and congestion being major difficulties. These are being run by private individuals and fall under various associations which regulate the routes.

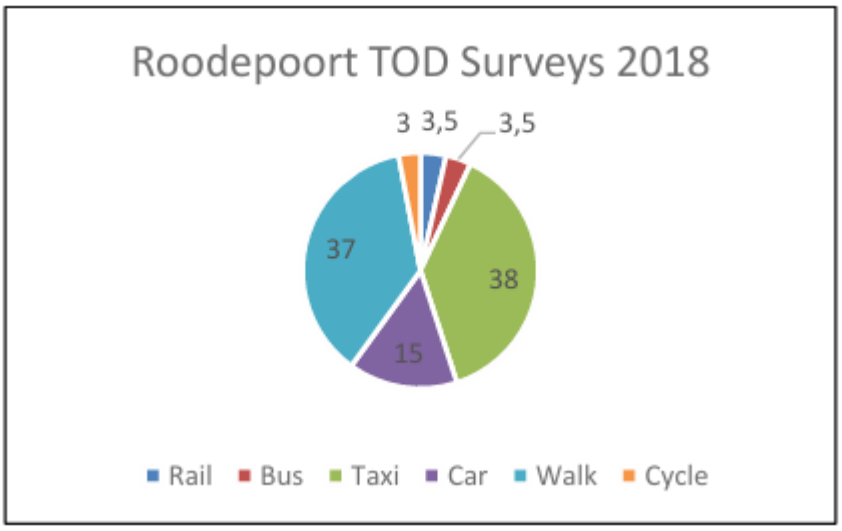

Figure 3.8: Roodepoort TOD Surveys, 2018. Source: RTPM, 2023

Metrobus and other companies such as Putco run bus services that connect the Roodepoort CBD to Johannesburg and other parts of the Greater Johannesburg area and according to the TOD Surveys as depicted in figure 3.7 above, they account for 3.5% of the commutes in the Roodepoort CBD. Buses have a more regimented schedule than minibus taxis, although they also experience traffic congestion and delays, they are also very limited within the study area and do not serve a large population like minibus taxis. The Metro buses are being run by the City of Johannesburg while the other buses are from private companies.

The Roodepoort Train Station, which is part of the Metrorail network, serves Johannesburg as well as other destinations. Train service is an important mode of transportation for commuters. However, during the study, trains had not been operational in the area since before the Covid-19 Pandemic. Sidewalks and pedestrian crossings exist; however, they are frequently improperly maintained. Poor lighting and uneven surfaces make walking difficult, especially

at night. More pedestrian-friendly zones and safer walking paths are needed to promote walking as a means of transportation. Cycling infrastructure is sparse, with few dedicated bike lanes and trails. The scarcity of safe cycling routes prevents residents from utilizing bicycles to commute.

Traffic congestion is a major issue in the Roodepoort CBD, especially during morning and evening peak hours. The high volume of vehicles, combined with inadequate road capacity, causes delays and longer travel times. According to the Roodepoort Transport Master Plan (2023), the current network lacks sufficient capacity to meet projected traffic increase, necessitating network upgrades. Intersections are typically functioning at unsatisfactory levels of service, especially during peak traffic periods. This causes substantial delays and congestion.

3.7 Ethical considerations

Ethical considerations are critical in safeguarding the research process's integrity, respect, and anonymity. Interactions with participants, data handling, and distribution of findings are all guided by ethical norms. All participants in the study, including those who take part in interviews, were asked to provide informed consent. The participants were given thorough information about the study's objectives, research procedures, potential risks, benefits, and participant rights. They were assured that their participation is completely voluntary, and they have the option to decline participation or withdraw from the study at any time.

Ethical approvals were obtained for the study to proceed (See Annexure 1). The identities of participants are kept private during the research procedure. The personal information gathered from participants is treated with the highest care and to protect the privacy of participants, personal identifiers are removed from transcripts and reports. Participants are guaranteed that their information will be used just for research purposes and will not be shared or broadcast without their prior permission.

The researcher maintained a courteous and professional interaction with participants throughout the study process. To ensure fair data collection and analysis, any prejudices, preconceptions, or personal beliefs were set aside. If assistance is required, participants are given resources and contacts. Participants were told about the research's objective, procedures, and intended use of the findings. Any potential conflicts of interest or study limitations are disclosed.

3.8 Limitations of the study

Every research project has limits, and this study is no exception. These constraints give critical context for interpreting the findings and comprehending the scope of the investigation.

The use of convenience and purposeful sampling methods may introduce bias into the sample. These methodologies may not adequately represent the broad spectrum of stakeholders or opinions relevant to NMT and public transportation integration. The study may not reflect the opinions of underprivileged communities or persons who have limited interaction with official transportation planning processes due to participant availability and accessibility limits. The qualitative research method involves interpretation, and these interpretations can differ between researchers. Despite best efforts, researcher subjectivity may influence the analysis and findings.

The study employed a small sample size and focuses on a specific group or situation. In the case of Key informant interviews, the results may only represent a subset of individuals inside a given company, department, or governmental entity. As a result, the findings may not be generalizable to different contexts or groups. The perspectives, behaviours, and decisions of officials in one context may not be representative of those in other organizational cultures, geographic regions, or political environments, and the insights and perspectives gathered from key informants may be subjective or biased based on their personal experiences, opinions, or agendas, making it difficult to generalize these viewpoints to a larger population.

Time constraints also limited the scope and depth of the investigation. The researcher only had ten (10) months to carry out the study and a much lesser time to conduct interviews and this had an impact on the scope of data collection, the number of participants, and the thoroughness of case study analysis.

Recognizing and admitting the study's limitations is critical for a balanced assessment of the findings. While efforts were taken to reduce these limits by rigorous research design and methodological choices, the study's findings should be viewed considering these constraints.

3.9 Chapter conclusion

The methods chapter outlines a comprehensive and rigorous study on the integration of non-motorized transport (NMT) and public transport in Johannesburg. The chosen research approach, data collection methods, and ethical considerations shape the study's foundation, providing insights into the challenges, successes, and policy implications of NMT and public

transport integration in Johannesburg's context. The qualitative research approach, anchored in in-depth interviews, field observations, and case study analysis, aims to uncover the multifaceted dynamics of NMT and public transport integration. Data collection methods, such as semi-structured interviews and field observations, offer both stakeholder perspectives and practical realities of integration. Ethical considerations are prioritized, ensuring participant rights, data privacy, and research integrity.

However, the study's limitations, such as sample bias, qualitative subjectivity, and contextual differences, are essential to understanding the scope and applicability of the findings. The methodology chapter lays the groundwork for an in-depth exploration of NMT and public transport integration in Johannesburg, aiming to contribute valuable insights that can inform sustainable and effective transportation integration strategies.

Chapter 4 – Presentation, Analysis, and discussion of research findings

4. Introduction

In this chapter, I present and discus the empirical findings of the fieldwork conducted. This chapter presents the findings of the research and begins to answer the research questions of the causes of transport fragmentation, the enabling factors available for the integration of public transport and NMT, and the extent of infrastructure available to allow for this integration in the City of Johannesburg, Roodepoort CBD. The findings presented are from the semi-structured interviews held with commuters within the Roodepoort CBD along with participant observations as they commute around the CBD, and interviews with two key stakeholders who are consultants with the City of Johannesburg (Interview questions attached as Annexure 3). The semi-structured interview questions were a critical instrument in the data collection process as they allowed me to ask follow up questions in to probing issues as the interview proceeded. The interview questions were tested prior to the initial data collection and adjusted accordingly. Participants observations were also carried out within the Roodepoort CBD. The data gathered was analysed using thematic analysis and grouped into themes identified from the participants responses to the interviews.

Initially, the study's focus on NMT was limited to pedestrians, cyclists, and disabled individuals (using a wheelchair). However, during the data collection process, I did not come across any individual who was cycling in the Roodepoort CBD or who was Wheelchair user. Hence, the individuals who were interviewed were pedestrians who were walking in the study area. The individuals were approached as they off-boarded public transport, heading towards different destinations, and some as they were walking towards a public transport. This was done to ensure that the participants of the study are individuals who either utilize the NMT facilities, public transport, or both within the Roodepoort CBD.

4.1 Delineating the transport fragmentation in the Roodepoort CBD

The delineation of transport fragmentation within the Roodepoort Central Business District (CBD) provides a vital lens through which to examine the complexities and challenges of people within the CBD. This section will evaluate and dissect the numerous factors that contribute to transportation fragmentation in the Roodepoort CBD, shining light on the multifaceted difficulties that impede seamless movement and connection in this urban setting.

Historical Planning practices

The study revealed that South Africa's historical urban planning policies have had a considerable impact on the current level of transportation fragmentation inside its cities. The legacy of apartheid is perhaps the most important historical aspect influencing urban transit in South Africa. Apartheid was a highly restrictive and segregated urban planning regime that lasted from 1948 until the early 1990s. The Group areas Act of 1950 made racial segregation in cities a legal requirement, resulting in racially delineated residential areas where people of different races were expected to live apart (Newton and Schuermans, 2013). Cities were separated into racially segregated zones, with people of color relocated to the outskirts, often disconnected from economic possibilities and services. This spatial distribution exacerbated the need for expanded transportation networks and contributed to the underdevelopment of non-white communities (Emdon, 2014). to substantiate this, a key Consultant confirms that:

> *"The legacy of apartheid is one that cannot be ignored when we speak of fragmentation in our cities, the Roodepoort CBD included. The racial segregation that came with the apartheid system saw black people being moved to the peripheries and being subjected to long hours of commuting to reach places of employment in central areas. Their only way to access these areas was through long hours of travelling in buses"* (Consultant 1 Interview, November 2023).

The Bantu Authorities Act, another key piece of legislation, established "homelands" or "Bantustans" for several Black ethnic groups. These apparently self-governing zones were frequently impoverished and located distant from urban centers. Long commutes for persons who needed to access work or services in cities were exacerbated by this legislation (Monana et al., 2022). Apartheid's demise in the early 1990s triggered a tremendous surge of urbanization as previously oppressed people sought better economic opportunities in cities. As the urban population grew, the burden on already-fragmented transportation infrastructure increased. A key Stakeholder further mentions that:

> *"When apartheid came to an end, and people started having opportunities that allowed them to move closer to places of employment, there was a huge influx of people from different areas around the country, and this caused strains to the transport system as it was not planned for the numbers it now had to carry"* (Key Stakeholder 2 Interview, November 2023).

It was also observed during the study that the Roodepoort CBD, like many other cities throughout the world, has a history of car-centric urban planning. Urban planners frequently prioritized the convenience of private car travel during the mid-twentieth century, resulting in the building of large roads, highways, and vast parking facilities. This approach reflected the widespread confidence in the freedom and flexibility provided by private automobiles.

Historically, the emphasis on car-centric planning resulted in inefficient land use. A substantial percentage of Roodepoort CBD's urban space is allocated to roadways and parking lots, restricting space for alternate mobility choices, green spaces, and mixed-use buildings. This inefficiency adds to urban sprawl, increased travel distances, and a greater reliance on automobiles. These historical development decisions frequently overlooked the provision of safe and accessible pedestrian and bicycle infrastructure. The lack of sidewalks, bike lanes, and pedestrian-friendly crossings makes it difficult to promote walking and cycling as viable modes of transit.

Infrastructure and planning – The "Legacy Infrastructure"

Transport system fragmentation has resulted from a lack of crucial link, and this has resulted in isolated communities and a dependency on longer, less direct routes, which can discourage walking, cycling, or taking public transportation. The preference for motor vehicles, particularly private cars, over alternative types of transportation has also resulted in fragmentation. This is due to cities frequently prioritizing road infrastructure for motor vehicles over other types of transportation. This development bias has resulted in the construction of massive road networks that emphasize cars over pedestrians, bikes, and public transportation. Wide, high-speed roads with few pedestrian crossings and bike lanes separate communities and discourage people from utilizing sustainable means of transportation. Significant impediments to NMT modes are created by a lack of safe and well-maintained pedestrian and bike infrastructure. Incomplete sidewalks, lacking bike lanes, and hazardous pedestrian crossings restrict walking and cycling, contributing to private vehicle dominance. To substantiate this, a key Consultant notes that:

> *"Because we have infrastructure that is already built, the plans that are created to try and undo the effects of the apartheid era have to be planned around the existing infrastructure. This is a disadvantage because even with new plans, there comes the issue of budget constraints to build new infrastructure, so we have to do with the legacy infrastructure"* (Key Stakeholder 1 Interview, November 2023).

Transport fragmentation is also influenced by spatial planning and land-use decisions. When residential neighborhoods are separated from workplaces, commercial hubs, and important services, individuals are forced to rely extensively on motorized transportation to get to these sites. This distance adds to longer commuting times, increased traffic congestion, and pollution. Urban sprawl, characterized by low-density development and a lack of mixed land uses, increases reliance on private cars. As cities grow in size, services and amenities become separated, making it difficult for inhabitants to use NMT or public transportation effectively.

Socio-economic factors

Transport fragmentation is linked to socioeconomic inequalities and issues that affect accessibility and mobility for different parts of the population. The Interviews with commuters have also revealed that transport fragmentation is a manifestation of socioeconomic inequality, with marginalized communities and individuals having less access to dependable and efficient transportation options. When asked about what determined which mode of transport they used, 65% of the commuters noted money as part of those factors. Low-income communities may lack access to public transportation, NMT infrastructure, or well-kept roads. This creates a transportation divide in which individuals with fewer resources have fewer mobility options. One of the commuters notes that:

> *"The availability of funds determines the kind of transportation I use to go to certain places. Sometimes I choose to walk to certain places not because I want to, but because I do not have the money to catch a taxi"* (Commuter Interview 4, October 2023).

Another commuter alluded that:

> *"I always use a taxi to come here because I stay far away"* (Commuter Interview 7, October 2023).

The commuter's comment addresses the larger issue of transportation equity. People in low-income neighborhoods are frequently pushed to choose the cheapest alternative over convenience, safety, or efficiency due to a lack of financial means. For many, this can entail traveling lengthy distances, taking occasional or unreliable public transportation, or being unable to access certain regions entirely. It demonstrates how closely linked transportation choices are to financial resources, particularly in low-income communities. It highlights the critical need for legislation and infrastructure improvements that enable fair access to transportation for all, regardless of financial level.

Socioeconomic factors can contribute to spatial disparities in transportation service access. Low-income communities are frequently located in places with limited access to jobs, education, healthcare, and social services. Such disparities can worsen transportation fragmentation by forcing citizens to travel longer distances to access important services. These leaves them with only the choice of mode that they can afford and gets them to their desired destination. For people and families with low financial resources, the expense of transportation, including public transportation fees, car ownership, and fuel, can be a substantial obstacle. The commuters of the study seem to agree that affordability of transportation options influences mode choice and access to opportunities, which influences the extent of transportation fragmentation within a city.

Informal Transport – The minibus taxi industry

South Africa's minibus taxi industry has its roots in the informal transport sector. It emerged mostly in response to a lack of easily accessible, affordable, and efficient public transportation, particularly during the apartheid era. During this time, many Black South Africans had limited access to public transportation that served the locations they were on. During apartheid, the minibus taxi sector functioned informally and was frequently regarded by the government as unlawful. However, it does play an important role in providing mobility to disadvantaged Black areas (Sebola, 2014). The minibus taxi industry fills significant service shortages in numerous places, including Roodepoort CBD. This is especially true in underserved places where alternative modes of public transportation may be unavailable (Lomme, 2008).

Figure 4.1: Taxi rank in Roodepoort CBD

The National Taxi Task Team developed the Taxi Recapitalisation Programme (TRP) in 1996 to help the taxi industry in replacing its aging fleet with minibus taxis designed in South Africa

(Lomme, 2008). The government intended to offer scrapping allowances to minibus taxi operators to be used as deposits for new cars, with the goal of introducing safe, effective, accessible, and affordable public transportation vehicles. The policy's goals included mandating minibus taxi operators to register as taxable corporations, offering financial aid, training and technical assistance, and demanding an operational license. The policy also aspired to establish a self-regulated minibus taxi business, with associations engaging in the formalization process and adhering to the standards of governmental authorities. The initiative also attempted to strengthen labour standards by assuring driver and other workers' compliance with sectoral labour legislation, as well as minimum salary and working hours. Despite efforts, the initiative has met with opposition and has never been fully implemented. However, up to this point, it is not clear on the status of formalizing the minibus taxi industry into a formal public transport mode (Kerr, 2018).

The study reveals that unregulated and unformalized nature of the taxi industry also contributes to the transport fragmentation. A Consultant notes that:

> *"Although the minibus taxi industry serves a majority of our communities and is a crucial mode of transport within our cities, it is not run by government, and this makes integrating it with other modes of transport or regulating it a difficult task".* (Key Consultant 2 Interview, November 2023)

Minibus taxis are more flexible and can provide point-to-point services, which can be very useful for those who have limited transit options. The sector has several obstacles, including safety concerns, overcrowding, and competition among taxi Associations These difficulties have occasionally resulted in disagreements and concerns about the industry's operation. Thus, the taxi industry operates in silos. However, 90% of the study participants noted that they use both walking and public transport to reach their destinations. One of the commuters alluded that:

> *"I walk to catch a taxi at the rank because it is closer, then I walk to where I work when I get of the taxi"* (Commuter Interview 1, November 2023).

It was also observed within the Roodepoort CBD that commuters walk to different destinations from when they off-board taxis. This shows that there is a use of the combination of the use of public transport and NMT to reach various destinations. This also shows that NMT plays an important task in the first and last mile connectivity for commuters heading to various destinations.

Cultural and Behavioural factors

Transport fragmentation is influenced by cultural and behavioural factors. Cultural norms, habits, and community preferences can all impact the development of integrated urban transportation systems. There is a highly embedded vehicle culture in many societies, where private car ownership is typically considered as a status symbol or a representation of personal freedom. Individual choices are influenced by car culture, which in turn influences government policies and investment in infrastructure (Javaid et al., 2020). Prioritizing personal vehicles in planning has resulted in car-centric urban landscapes, which contribute to fragmentation.

Individual behaviors and preferences for specific means of transportation can be strongly rooted (Javaid et al., 2020). People prefer to use modes of transportation with which they are familiar and comfortable with. For example, a preference for driving a car, even for short trips, can perpetuate car dependency and discourage the use of public transportation or NMT. Changing established patterns can be difficult. Change resistance, which is typically affected by cultural norms, may hinder efforts to shift toward more sustainable and integrated forms of transportation. People may be hesitant to adopt new, unfamiliar modes of transportation. Cultural elements can, in some situations, contribute to community identity and connection to a particular form of transportation. Communities with a strong cycling culture, for example, were community members cycle to work in the morning and back home in the evenings, may be reluctant to infrastructure modifications that promote other modes, even if such changes result in better integration.

4.2 Enabling factors for integration

The successful integration of multiple modes of transportation within an urban landscape is a complex endeavour that necessitates a detailed understanding of the various elements that influence mobility patterns and choices. These enablers are critical in building an integrated transportation system that is efficient, sustainable, and responsive to the different requirements of metropolitan areas. In the following section, we will look at major factors that act as enablers for modal integration. Each component, from infrastructure and legal frameworks to community engagement, contributes to the harmonious cohabitation of public transportation and non-motorized transportation (NMT). The goal as we travel through these components is to reveal the interrelated web of elements that, when managed harmoniously, create the framework for a robust and integrated urban mobility landscape.

Safety and security

Safety and security emerge as crucial enablers in the aim of smoothly integrating multiple means of transportation inside the Roodepoort CBD. The perceived safety and security of the area can either promote or discourage people from taking public transportation or walking in the area. When asked of the elements that determine they mode of transport, all the commuters' noted safety as part of the elements that determine their transport choice. One commuter comments that:

> "*the streets are not safe, so I am scared to walk when I go to work*" (Commuter Interview 13, October 2023)

Another commuter further alludes that:

> *"... I just don't feel safe walking around this area"* (Commuter Interview 11, October 2023).

The commuters' statements underline how important safety and security issues are in choosing transit choices. People's mobility is compromised in unsafe situations, confining them to the most secure modes of transit rather than the most convenient or efficient. Safety concerns also act as a deterrent to promoting active transportation, such as walking or cycling, which are frequently promoted for their health and environmental benefits. Individuals are unlikely to choose these activities if they do not feel secure doing so, particularly in particular areas or at certain times of day, even if they are otherwise eager or interested. Furthermore, this supports the RTMP (2023) in that certain areas within the Roodepoort CBD are crime hotspots, as shown in the figure 4.2 below. This can increase dependency on motorized modes of transportation, contributing to traffic congestion and pollution.

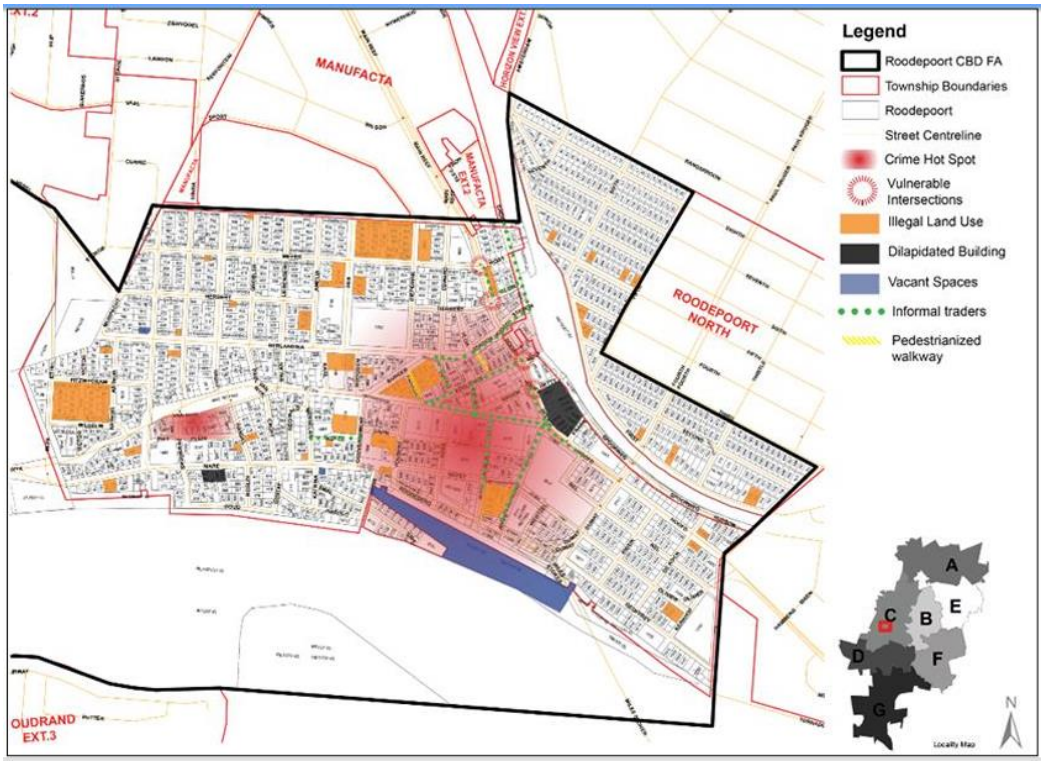

Figure 4.2: crime hotspots in the Roodepoort CBD (RTMP, 2023)

Effective street lighting is essential for pedestrian safety, especially at night. Well-lit streets provide a sense of security, making it easier for pedestrians to walk at night. Adequate illumination not only discourages criminal activity, but it also increases visibility for both pedestrians and automobiles, lowering the likelihood of accidents. Streetlights strategically placed along sidewalks, crosswalks, and pedestrian walkways provide to a safer walking environment.

Traffic calming methods are intended to reduce vehicle speeds and make pedestrians safer. Speed bumps, elevated crosswalks, and textured pavements encourage automobiles to slow down in places where pedestrian activity is strong. These interventions help to a pedestrian-friendly urban environment by lowering the likelihood of accidents and establishing areas where pedestrians can walk without fear of being run down by a car. It was also observed during the study that commuters do not only fear to walk because of crime, but also due to the way private vehicle drivers and minibus taxis drive, particularly during peak hours, where they seldom obey the traffic lights leaving the pedestrians vulnerable and fearing to cross the street.

Clear and visible signage, as well as well-marked crosswalks, are required to guide both pedestrians and automobiles. Pedestrians benefit from clear signs indicating safe crossing sites, while cars are made aware of the presence of pedestrian crossings. This clarity promotes a more

fluid interaction between people and automobiles at junctions, hence improving overall safety. It was observed during the study that pedestrians cross the roads at any point in the street. This might be due to a lack of crosswalks around the area, or they are just ignorance of the ones that are available and choose to cross the road when they feel it is safe to do so.

The establishment of pedestrian zones or areas dedicated entirely for pedestrians improves safety dramatically. Pedestrian-only areas, which are commonly found in city centers or shopping districts, reduce the threat of automotive traffic, creating situations in which people can wander freely without fear of being hit by a vehicle. These areas improve safety while also encouraging a pedestrian-friendly environment. The Consultant speaks to this and says that:

> *"... look at cities like London. They have taken initiative to create pedestrian zones, with certain streets being closed to car traffic and only being utilized for walking. They also have programs where on certain days the community comes out to participate in walking activities. This raises awareness and shows that it can be done"* (Key Consultant 2 Interview, November 2023).

This further supports the case study of Berlin and Bogota as described in the literature, with the establishment of the Unter den Linden, La Candelaria area and Usaquén, a complete pedestrian zone coupled with supporting amenities and infrastructure, cafes and shops and the creation of a culture that encourages people to walk in these areas.

Visible security measures, such as community policing and safety patrols, contribute to pedestrians' overall perception of safety. The presence of law enforcement or community safety professionals in public places deters criminal activity and gives pedestrians with reassurance. Collaborative efforts between law enforcement agencies and local communities improve pedestrian route security.

Policy, regulation, and enforcement

The intricate balance of policy frameworks, regulatory structures, and enforcement mechanisms defines the character of urban mobility, determining how residents travel and interact within the urban environment. The regulations developed by urban planners and policymakers, the laws that govern the building of infrastructure and the enforcement systems that ensure compliance all interact collaboratively to shape the contours of a city's transportation landscape.

Parking on pavements, also referred to as sidewalks, has a wide range of consequences for urban environment. While the causes for this conduct range, from a lack of parking spaces to driving convenience, a critical examination reveals both the bad and, in some cases, the beneficial sides of this habit. Cars parked on sidewalks obstruct pedestrian paths, endangering people who must navigate around the vehicles (Box, 2004). This is especially dangerous for people with disabilities, the elderly, or parents using strollers. Pedestrians forced onto the road due to restricted footpaths are more likely to be hit by moving vehicles. This jeopardizes their safety and well-being, especially in congested places. It was observed during the study that pedestrians are at some points forced to move between walking on the sidewalks, to walking on the street, while there is incoming traffic, and going back to walking on the sidewalk because there is a car that is parked on the sidewalk, and they cannot walk there.

Parked cars on sidewalks add to visual clutter and detract from the aesthetic appeal of urban areas (Ibrahim, 2017). This is especially true in neighbourhoods with well-designed sidewalks and landscaping. Parking on sidewalks can hinder efforts to build dynamic, walkable urban places. It contradicts urban development ideas that favor pedestrian-friendly areas. The weight of parked cars can cause sidewalk deterioration, resulting in cracks, uneven surfaces, and higher maintenance costs. This adds to the deterioration of municipal infrastructure over time. Sidewalks are intended to provide pedestrians with a safe and accessible walkway. This accessibility is weakened when used for parking, undercutting the basic function of walkways in urban planning.

Pavement parking may be viewed as a practical solution to the shortage of parking places in areas where parking is rare (*ibid*). It enables drivers to find parking close to their destinations. Pavement parking might be considered as a useful choice for drivers who are having difficulty finding standard parking spaces. This is especially true in densely crowded cities. In some cases, inadequate parking enforcement adds to the popularity of pavement parking. There is minimal deterrent for this practice when regulations are not strictly enforced. Ambiguous or inconsistent pavement parking restrictions can cause confusion among drivers and law enforcement, making it difficult to manage the issue effectively.

Parking cars on pavements is a complicated problem. The negative consequences for pedestrian safety, urban aesthetics, and infrastructure integrity are significant. To address this issue, a multifaceted approach is required, including effective regulation, urban planning techniques, and the promotion of alternative, sustainable transportation options. The requirement for

convenient parking must be balanced against the need to produce safe, accessible, and visually pleasant urban areas.

Education and awareness

Education and awareness are critical in promoting modal integration, particularly in public transportation and non-motorized transportation (NMT) systems. These elements all contribute considerably to the development of a culture of sustainable and integrated transportation.

The study has revealed that promoting modal integration requires educational activities aimed at stakeholders involved in urban planning and transportation management. Policymakers, urban planners, and transportation operators must have a thorough understanding of the benefits and drawbacks of combining public transportation and non-motorized transportation (NMT) systems.

> *"… We as the stakeholders, planners and officials need to go out to the streets and walk. We need to get a real-life experience of the environment, to understand the challenges and opportunities that are present on the ground to ensure that we are talking about something that we have really experienced"* (Key Consultant 2 Interview, November 2023).

The Key Consultant's statement emphasizes the value of experiential learning for stakeholders involved in urban planning and transportation management. It implies that for effective planning and decision-making, stakeholders must go beyond theoretical understanding and interact directly with the environments they are planning and administering. This strategy can result in more informed and compassionate decisions that reflect the realities of the communities they serve. The consultant's urge to "walk the streets" implies that decisions made behind a desk, without real-world context, can result in incorrect policies or investments. Engaging with the physical environment allows stakeholders to get vital insights that help them predict possible problems, discover possibilities for change, and make decisions that are more anchored in the lived experiences of the environment itself.

Workshops, seminars, and training programs can be conducted to enhance knowledge exchange and guarantee that decision-makers are well-versed in modal integration principles and practices. Communication tactics should emphasize the synergies between public transportation and NMT. For example, public transportation hubs can be constructed to connect smoothly with pedestrian routes. Brochures and online tools, for example, can clearly explain how various modes might function together efficiently. A great educational tool is highlighting

successful case studies of cities that have successfully integrated public transportation and NMT. Analysing and publishing information about projects that have improved urban mobility and reduced congestion may instill trust in stakeholders while also demonstrating the feasibility and benefits of modal integration. A key stakeholder further elaborates on this and notes that:

> *"When the Project of the Rea Vaya was initiated back in the years, several individuals were sent to countries best known for the implementation of the system to go observe and learn and come back with the information. This was crucial because we were doing something that we had not done before, and we needed to ensure that we are learning from best practices"* (Key Consultant 2 Interview, November 2023).

The above statement substantiates the importance of learning from best practices. These practices are effective in enhancing efficiency, resulting in cost savings, and avoiding trial-and-error approaches. They also encourage innovation and adaptation, reducing risks associated with untested strategies. Optimized decision-making is achieved by examining successful examples, aligning data-driven decisions with specific needs and goals. Best practices prioritize sustainability, considering environmental, social, and economic factors. Studying successful models fosters capacity building and knowledge transfer among professionals and stakeholders, improving overall expertise. Implementing proven best practices can also enhance public trust and engagement, demonstrating a commitment to evidence-based decision-making and community-oriented development. However, it is essential to adapt these practices to local contexts, as blindly copying without considering unique conditions may not yield optimal results. Thus, Continuous improvement is necessary, requiring continuous monitoring, evaluation, and refinement to adapt and evolve these practices over time.

Collaboration and partnerships

Collaboration between multiple levels of government is critical for policy formation and implementation. It ensures that transportation plans are consistent and coherent with broader development strategies and regulatory frameworks, fostering consistency and coherence in infrastructure development. Coordination across various government agencies, such as transportation, urban planning, environmental affairs, and infrastructure, is critical. Aligning these entities policies and initiatives ensures a coherent approach to integrated transportation planning and development.

> *'The disconnect between different departments and the levels of government sometimes hinder progress in the implementation of projects. The different levels of government*

sometimes have different priorities, and this can have an impact on how a project is run to completion" (Key Consultant2 Interview, November 2023).

The Key Consultant emphasizes the substantial challenge of a lack of alignment and coordination among multiple government departments and levels of government. This gap can result in inefficiencies, delays, and even project failures, undermining attempts to develop integrated and effective transportation networks. Transportation planning and development often involve a wide range of stakeholders from several levels of government, as well as departments within those levels. Each of these entities may have their own set of priorities. A municipal government, for example, may emphasize enhancing public transportation access in a particular neighborhood, but a regional government may focus on building highway infrastructure to improve regional connections. When these priorities overlap or do not align, it can cause major barriers to the successful implementation of plans.

Collaboration between different government spheres is essential for effective governance, policy implementation, and holistic development. It allows for optimal resource allocation, comprehensive problem-solving, enhanced policy integration, improved service delivery, holistic urban development, and effective infrastructure development. Collaboration allows for pooling resources from different government levels, optimizing budget allocation, and preventing duplication of efforts. It also facilitates the integration of policies, ensuring alignment and coherence in addressing interconnected issues. Collaboration also facilitates the execution and maintenance of critical infrastructure projects, reducing inequalities and promoting inclusive development. It also fosters participatory decision-making processes, enhancing transparency and accountability. However, challenges such as differing priorities, intergovernmental conflicts, or bureaucratic hurdles can sometimes hinder effective collaboration.

The consultants of the study agree that engaging people and communities in collaboration and partnership efforts is crucial for ensuring the relevance of policies and initiatives. A community-centered approach involves aligning policies and projects with their needs, aspirations, and lived experiences, shifting the focus from top-down to bottom-up. This supports the point made by the stakeholder above that stakeholders and city officials need to gain real-life experience of the places that they are planning for. It was further observed in the study that commuters have preferred points on the roads where they cross, and preferred routes they take to reach certain destinations to reach some areas. This might be due to their perceived

safety along those places. Engaging with the communities when planning for the provision of NMT facilities will ensure that the provided infrastructure is used to its fullest potential.

Local knowledge and expertise from communities can be leveraged to develop innovative solutions and improve intervention effectiveness. These fosters trust and participation, leading to increased ownership of projects and better compliance. Social cohesion and inclusivity can be promoted through the involvement of diverse community voices, addressing underlying social disparities, and fostering a sense of belonging in projects. One of the study participants supported this by stating that:

> *"Community involvement is important when undertaking projects. Remember that whatever you are planning, you are doing it for them. Community involvement offers great insights into the project, and you might also get critical feedback on issues that you might have not been aware of"* (Key Consultant 1 Interview, November 2023).

The above statement shows that an increased program efficacy can achieved by identifying overlooked problems and innovative solutions through community participation, and conflict resolution and mitigation are also achieved through dialogue and understanding diverse perspectives. This can lead to capacity building and empowerment, fostered through training, education, and participation in decision-making.

There are challenges faced in community engagement such as varying interests, power dynamics, and limited resources. Stakeholder 1 denotes that:

> *"The extent to which community engagement is undertaken depends on the budget allocated to the project*" (Key consultant 1 Interview, November 2023)

Consultant 2 further elaborates that:

> *"Sometimes community engagements do not go as planned. People nowadays consider meetings to engage them on various projects as a box-ticking activity, and not really as a way to get their inputs on the projects…"* (Key Consultant 2 Interview, November 2023).

The remarks of Key Consultants 1 and 2 offer light on the complexities and challenges of community engagement in urban planning and development initiatives. Community engagement is critical to ensure that projects fulfill the needs and goals of those they are intended to serve. However, the process is plagued with difficulties, including competing

interests, power dynamics, and the restrictions of limited resources. Key Consultant 1's observation that the level of community engagement is determined by the project's funding highlights a key restriction in the practice of public consultation. Community engagement is frequently viewed as an add-on rather as an essential component of the planning process, leaving it vulnerable to budget cuts or limits. When a project's budget is restricted, expenditures for comprehensive, meaningful community engagement may be the first to be cut. This can result in superficial engagement with projects that do not adequately address the community's needs, concerns, or ideas.

Consultant 2's statement reflects a rising dissatisfaction with the community engagement process, with stakeholders viewing it as a "box-ticking activity" rather than a genuine attempt to involve them in decision-making. This view can occur when engagement initiatives are carried out in a haphazard manner, frequently motivated by the need to comply with legal or regulatory obligations rather than a genuine desire to acquire and incorporate community opinion.

When communities believe that their participation is purely symbolic, their trust in the process dwindles. This might result in decreased attendance at meetings, a reluctance to engage in surveys or focus groups, and an overall sense of apathy or cynicism about the project. Over time, this can weaken planner-community relationships, making future meaningful collaboration more difficult.

4.3 Overcoming barriers to NMT implementation

This section provides a discussion of the barriers that were identified during the study to successfully implement NMT in the Roodepoort CBD.

The NMT infrastructure conditions and Maintenance

Well-maintained infrastructure plays a crucial role in promoting the use of non-motorized transportation (NMT) as it contributes to users' perception of safety, user experience, sustainability, accessibility, and behavioural impact. Regular maintenance practices, such as fixing damaged surfaces, ensuring proper lighting, and removing obstacles, create a safe environment that encourages individuals to choose NMT options. A seamless and pleasant experience is essential for encouraging NMT use, as it improves the overall appeal of the environment. It was observed that there is a lack of infrastructure, particularly benches and shelter where commuters catch taxis. As such, commuters are subjected to standing as they wait for taxis (See figure 4.1 for illustration of Taxi rank). On one of the days when participant

observations were undertaken, it was raining and because there is no shelter, participants who did not have umbrellas were subjected to standing in the rain while they waited for the taxi.

NMT environments that are well-maintained often align with sustainable principles, such as safety, green spaces, well-tended landscapes, and clean pathways. This aesthetic appeal can positively influence individuals to choose NMT options. The green spaces around the study area were observed to lack regular maintenance, which ended up looking like bushes and commuters were keeping away from walking in their path. This shows that the up-keep and maintenance of infrastructure plays a crucial role in encouraging individuals to use NMT. It was also observed during the study that some of the NMT infrastructure in the Roodepoort CBD is also used as a sleeping area by homeless individuals. This further exacerbates safety concerns with walking in the area.

Figure 4.3: Unmaintained walkways within the study area.

Alternative uses of Infrastructure: Street vendors on sidewalks

Street vendors on pavements are a common element in urban areas around the world. While street vending can benefit local economies, give entrepreneurial opportunities, and supply consumers with a varied range of goods, a thorough examination reveals a multifaceted picture with both positive and negative aspects. Street vending is frequently used as a source of income

for people who do not have access to regular work. It encourages entrepreneurship and provides a platform for the growth of small businesses. Street vending can help microenterprises develop by allowing vendors to start and run their operations with little overhead costs.

Pavement street vending can restrict pedestrian paths, causing congestion and safety problems. This is especially problematic in congested metropolitan settings. It can also impair pedestrian and driver visibility, increasing the chance of accidents and jeopardizing overall pedestrian safety. The visual clutter caused by a large number of vendors on the streets may have an impact on the aesthetic appeal of urban settings.

Figure 4.4: salons located on pavements

This is especially important in regions with historic or well-designed architecture. Inadequate waste disposal and unregulated street vending practices may contribute to environmental deterioration, reducing the cleanliness and attractiveness of public spaces. One participant note that:

> *"... We end up walking on the streets because the aunties are selling on the pavement. They need to find a place for them to sell their stuff"* (Commuter Interview 16, October 2023).

Another Commuter further elaborates that:

> *"There are many people here because this is where they get off taxis, and some are going to the mall. So, this is a good place for them to sell and they get support"* (Commuter interview 2. October 2023).

Although the street vendors are operating illegally on the crosswalks, they have identified areas that can provide an opportunity for them to sustain their livelihoods and provide services where needed. It was observed that the street vendors can function alongside the NMT facilities if they are planned for, and proper infrastructure is provided. Designated spaces should be provided along sidewalks or intersections to prevent encroachment on NMT lanes or pathways. Clear signage can be used to delineate these lanes and prevent vendors from setting up stalls within them. It was also noted that the stalls which are used by the vendors are flexible stalls, which they disassemble at the end of day and go home with them.

Figure 4.3: Street vendors occupying sidewalks

Community engagement is essential to understand the needs and concerns of both vendors and NMT users, incorporating their input into the design and regulation processes. Clear signage and communication can help create awareness and compliance. This is needed to ensure that there is a limited number of street vendors at a certain place to avoid overcrowding. Regular enforcement and monitoring are necessary to maintain designated areas and keep NMT paths clear. Infrastructure improvements, such as widened sidewalks or additional space, can help maintain a safe and organized environment. Collaboration among city departments, urban planners, vendors' associations, and NMT user groups is crucial to find mutually beneficial solutions.

The E-hailing services

The study has revealed that the e-hailing services (i.e., Uber, bolt/taxify) has become an alternative for commuters who feel unsafe when walking around the Roodepoort CBD for their last-mile connectivity. This was observed when one lady was approached for an interview as

she was standing after off boarding a taxi. As I approached the participant and explained to her why I had approached her and my intention to interview her, she says that:

> *"We can proceed with the interview quickly as my uber is on its way".*

As I approached the lady, I observed that she was feeling unsafe and started looking at her surroundings. However, after a brief explanation, she was calm and explains to me that:

> *"I catch a taxi from the inner city coming this side and when I get here, I request an uber to take me straight to work because I do not feel safe walking around this area".*

Her requested ride swiftly arrived in about two minutes, and she got into the car and was on her way to work. This was an interesting observation that revealed that due to safety concerns, individuals are opting to using e-hailing services for their last mile connectivity instead of walking to the destination.

The e-hailing services have emerged as alternate transportation options in cities, trying to solve safety concerns connected with walking (Teo et al., 2018). E-hailing services provide door-to-door transportation, reducing the amount of time spent walking in potentially dangerous or poorly lighted locations. Users can request rides from certain areas, which eliminates the need to walk unknown or perceived unsafe routes. They provide rapid replies and are available on-demand, which can be useful in instances requiring immediate transport, limiting potential exposure to hazardous conditions (Giddy, 2019). However, the use of e-hailing services instead of walking to closer destinations continues to add on car traffic on the roads and discourages the use of NMT infrastructure. The e-hailing services also comes with cost implications, and it is not everyone who can afford them. This shows that to enhance the walkability of the Roodepoort CBD and further encourage pedestrians to use NMT, there is a need to address the safety concerns around the area.

4.4 Chapter conclusion

This chapter presented an analysis of the results of the study, through themes identified, the objectives of the study that were addressed are what are the causes of transport fragmentation in the Roodepoort CBD, what enabling factors are available for the integration of NMT and public transport within the Roodepoort CBD and to what extent is infrastructure available to allow for this integration. the following chapter provides a summary of the findings, conclusions and recommendations drawn from the results of the study.

Chapter 5: Summary of findings, Conclusion and Recommendations

5 Introduction

A nuanced grasp of the issues surrounding urban transportation has been revealed throughout this detailed investigation of transport fragmentation, enabling factors, infrastructure availability and mobility challenges within the Roodepoort (CBD). Through this study, it becomes clear that the issue of transport fragmentation is more than just a matter of infrastructure or connectivity, but rather an intricate interplay of various socioeconomic, infrastructural, and planning factors that have a significant impact on movement and accessibility within the CBD. This final chapter serves as a summary of the detailed study performed, with the goal of distilling key insights to answer the research questions of the study. It begins with a reflection of the methods used to undertake the study, synthesizes the findings from the transportation fragmentation delineation, enabling factors for the integration of NMT and public transport, and the infrastructure challenges faced by the Roodepoort CBD. Furthermore, the chapter provides concluding remarks for the study, recommendations and areas of further research that emerged during the study.

5.1 Reflection on the research methods undertaken for the study

This study adopted a case study approach and collected qualitative data. The presentation of several other cities provided real-world examples of transportation integration successes and challenges. The study was enriched by conducting semi-structured interviews with important stakeholders and community residents. They provided varied viewpoints and direct experiences linked to transportation fragmentation and urban mobility within the Roodepoort CBD. Although municipal officials could not be interviewed for the study. The respondents of the study provided sufficient information to conclude the study. The use of direct field observations enabled the validation of theoretical conclusions, identification of on-the-ground issues, and comprehension of the built environment's impact on transportation.

5.2 Summary of finding

The following section provides a summary of findings in accordance with the research questions of the study.

What are the causes of transport fragmentation in the Roodepoort CBD?

South Africa's urban planning strategies, particularly those implemented during apartheid, have greatly contributed to transportation dispersion in its cities. The Group Areas Act of 1950 required racial segregation, resulting in fragmented areas and lengthy commutes for many.

Similarly, the Bantu Authorities Act established "homelands" for Black ethnic groups, which exacerbated urban development and increased travel times. Car-centric urban planning in the Roodepoort CBD has prioritized private car use, resulting in inefficient land use, sprawling urban development, long travel distances, and a heavy reliance on automobiles. The fragmentation of the transportation system can be attributed to a lack of critical connections, which isolate communities and force them to rely on longer, less direct routes. The preference for motor vehicles, particularly private cars, has further exacerbated the separation. Wide, high-speed roads with few pedestrian crossings or bike lanes physically divide communities, limiting the viability of sustainable transportation solutions.

Spatial planning and land-use decisions have had a further impact on fragmentation. When residential neighborhoods are located distant from workplaces, commercial centers, and important services, residents are forced to rely extensively on motorized transportation. This reliance leads to longer commuting times, increased traffic congestion, and higher pollution levels. Urban sprawl exacerbates the situation by increasing reliance on personal vehicles. Transportation fragmentation is also linked to socioeconomic disparities, as marginalized communities frequently have limited access to dependable and efficient transportation options. Low-income communities usually lack adequate public transportation, non-motorized transport (NMT) infrastructure, and well-maintained roadways, resulting in a considerable transportation gap. The Taxi Recapitalisation Programme (TRP), which was established in 1996 to update the taxi industry's fleet with cars suitable for public transportation, has experienced strong criticism and is only partially implemented. This has reduced its effectiveness in combating transportation fragmentation. Cultural and behavioural factors, such as a firmly embedded motor vehicle culture and unwillingness to change, have reinforced South African cities' car-centric nature. These characteristics make it difficult to adopt more sustainable and integrated transportation solutions, sustaining the current system's fragmentation.

Enabling factors for the integration of NMT and public transport

The study emphasizes the importance of safety and security in integrating different transportation methods in Roodepoort's CBD. Key findings suggest the need for effective street lighting, traffic calming measures, clear signage, and pedestrian-only zones to enhance safety. Streetlights along sidewalks and crosswalks create a safer walking environment, while speed bumps and raised crosswalks slow down traffic in busy pedestrian areas. Clear signs and marked crosswalks guide pedestrians and drivers, improving traffic flow. Pedestrian-only areas

reduce vehicle risks and make walking safer. Community policing and safety patrols reassure pedestrians and improve their perception of safety. Collaboration between law enforcement and local communities boosts security on pedestrian routes. Parking on sidewalks can help with parking shortages but also blocks pedestrian paths, especially for people with disabilities, the elderly, or those with strollers. To balance parking with safe, accessible, and attractive urban spaces, a mix of effective regulation, good urban planning, and promotion of alternative transportation options is necessary. Promoting public transport and non-motorized transportation systems (NMT) requires educating stakeholders through workshops, seminars, and training. Effective communication about the benefits of combining public transport with NMT can build trust and encourage collaboration between different levels of government for better policy development and implementation. Involving communities in the planning process ensures that policies and projects reflect local needs and experiences.

Infrastructure available to allow for the integration of NMT and public transport

The study reveals that Roodepoort CBD lacks adequate infrastructure for integrating non-motorized transportation (NMT) with public transport. While some NMT infrastructure is present, it is not sufficient to support effective integration. Regular maintenance is crucial for promoting NMT use, as it impacts safety, user experience, sustainability, and accessibility. However, the CBD lacks amenities like benches and shelters, which can inconvenience commuters. Some NMT infrastructure is also used as sleeping areas by homeless individuals, raising safety concerns. Street vendors on pavements offer economic benefits but can obstruct pedestrian paths, create congestion, and reduce visibility, increasing the risk of accidents. Poor waste disposal and unregulated vending practices can harm the environment and public spaces. To address these issues, community engagement, clear signage, and collaboration between city departments, urban planners, vendors' associations, and NMT user groups are needed. Proper infrastructure can accommodate illegal vendors on crosswalks, with designated areas along sidewalks and intersections. Regular enforcement and monitoring are necessary to maintain NMT paths. Infrastructure improvements, such as wider sidewalks, can ensure a safe environment. E-hailing services like Uber are popular alternatives to NMT in Roodepoort CBD, but they contribute to increased road traffic and discourage NMT use. Addressing safety concerns is essential for improving walkability and encouraging NMT use.

5.3 Concluding remarks

Based on the findings of the study, there is a possibility of integrating NMT and public transport in the Roodepoort CBD. However, there are various factors that need to be addressed such as

safety and infrastructure provision. The investigation of modal integration of NMT and public transport in the Roodepoort CBD reveals a complex interplay of factors influencing urban mobility. The research investigated the difficulties of integrating non-motorized transportation (NMT) with public transit, shining light on the consequences for accessibility, efficiency, and sustainability in the urban setting. Addressing transportation fragmentation and its causes clearly necessitates a multidimensional approach that includes legislative frameworks, infrastructure improvements, community participation, and coordinated efforts among stakeholders. A paradigm shift in urban design toward inclusive, sustainable, and linked transportation networks is required to achieve seamless integration of multiple forms of transportation. Furthermore, the study emphasizes the significance of prioritizing pedestrian safety, encouraging public transportation use, and creating an atmosphere appropriate to NMT and addressing issues of infrastructure within the study area. Adopting creative solutions, such as mixed-use developments and comprehensive transportation planning frameworks, can considerably help to overcome integration difficulties. As the Roodepoort CBD evolves, it is critical to implement long-term visions that promote accessibility, inclusion, and environmental sustainability in transportation planning. To create a more connected, liveable, and resilient urban environment, it will be critical to engage with communities, raise public awareness, and evaluate solutions. Moving forward, concerted efforts, collaboration among various stakeholders, and a commitment to creative solutions will be critical in creating seamless mobility and overcoming transportation fragmentation concerns inside the Roodepoort CBD, thus addressing the enabling factors for the integration of public transport and NMT. The vision of an integrated and sustainable transportation system can be fulfilled through collective action and strategic initiatives, improving the quality of life for both residents and visitors alike. The above points answer to the objectives of the study, addressing the fragmentation of transport, honing on the factors that enable integration and addressing the issues being faced by the city with infrastructure. With all the above been taken into consideration, it is how integrating NMT and public transport can be achieved.

5.4 Recommendations

The findings of the study revealed safety and security as a major factor that influences and impacts on the modal integration within the CBD. Here I propose the need for interventions such as community patrol forums within the Roodepoort CBD to ensure that there is visibility of patrol officers. This requires interdepartmental collaborations, where city officials and planners involves other departments such as the police and traffic wardens into their forums to

discuss these issues and collaborate towards a way forward. This would increase the perception of safety within the area and in turn, enable walkability within the area. The street vendors in the Roodepoort CBD are a crucial part of the community and provide necessities to residents and commuters. I propose that there be regulations and infrastructure provisions being made for the street vendors to occupy the space without hindering or obstructing pedestrians who are walking within the area. This could be done though identification of areas that have enough space to accommodate them while still allowing space for walking and cycling.

The minibus taxis remain one of the most used modes of transportation within the city and they transport most individuals on daily basis. I propose that there needs to be work done to formalize and regulate the minibus taxi sector to increase integration with other types of public transportation while also ensuring safety and reliability. Create systems to improve coordination between minibus taxis and other kinds of public transportation, such as buses and trains. This may include coordinated schedules, integrated ticketing systems, and designated transfer points. City planners can also introduce a proposal where taxis play the role of feeder systems. For instance, taxis could people from surrounding areas of the city and converge in one area of the CBD where all the individuals will be transferred into a bus that will take them to a certain location. Upon arrival at that point, another fleet of feeders can then come in and transport these individuals to their desired locations. There is a need to designate and build transportation hubs where minibus taxis can easily connect to other modes of public transportation. These hubs should be equipped with facilities that allow passengers to quickly switch between modes of transportation.

5.5 Areas of further research

This study was limited to the Roodepoort CBD in the City of Johannesburg. Further research could be undertaken on other nodes within the city and a comparison of the extent to which there is modal integrations within different nodes could be undertaken to understand and find out where it is working best. The study could also be undertaken in other municipalities such as the City of Ekurhuleni and the City of Tshwane to understand the extent of modal integration within our cities. A study can be undertaken to try and understand the infrastructure requirements in cities that would allow for NMT to co-exist in the same space with street vendors.

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Appendix 1: Ethics Approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | SCHOOL OF ARCHITECTURE PLANNING

20 October 2023

Dear Lindokuhle Matshika (1440221)

This letter confirms that your clearance/waiver application has been approved. Your protocol/clearance number is: SOAP090/07/2023

Yours sincerely

Lerato Nkosi

Lerato Nkosi

School of Architecture and Planning, Faculty of Engineering and Built Environment, John Moffat Building, Wits, 2050, South Africa
Tel: +27 11 717 7692 Email: lerato.nkosi2@wits.ac.za | **www.wits.ac.za**

Appendix 2: Permission Letter from City of Johannesburg

City of Johannesburg
Department of Corporate & Shared Services
Office of the Group Head: Group Human Capital Management

6th Floor, B Block
Metropolitan Centre
158 Civic Boulevard
Braamfontein

PO Box 1049
Johannesburg
South Africa
2000

Tel +27(0) 11 407 8926
Fax +27(0) 11 339 1878

www.joburg.org.za

07 September 2023
Lindokuhle Matshika
Master of Urban Studies: Urban Management
University of the Witwatersrand

Ref: Permission to conduct research study

This letter serves to acknowledge receiving the letter requesting permission to conduct research in the City of Johannesburg under the title: **"INVESTIGATING MODAL INTEGRATION OF PUBLIC TRANSPORT AND NON-MOTORIZED TRANSPORT IN THE CITY OF JOHANNESBURG: A CASE OF ROODEPOORT CBD."** I am aware that the study entails the collection of information from the City, city officials and participants from communities through semi-structured interviews, questionnaires, observation participation and other fora of the city.

The research study is promoted by the City of Johannesburg because it helps both students and practitioners to gain an understanding of the sociology of the City, as it evolves and contributes towards the building of developmental local government.

I, Tersia Johanna Groenewald, as delegated authority of the City of Johannesburg Municipality (the City), hereby give permission to the primary researcher, Lindokuhle Matshika. The following:

To collect and publish information about the City is publically not available, for the research project titled: **"INVESTIGATING MODAL INTEGRATION OF PUBLIC TRANSPORT AND NON-MOTORIZED TRANSPORT IN THE CITY OF JOHANNESBURG: A CASE OF ROODEPOORT CBD."**

- This authorisation is based on mutual understanding that the City's name can be revealed in her/his project; and
- The researcher contacts the relevant department for arrangements pertaining to the research; and
- The information provided by the employees or any other means (such as company's archived documents or reports) of the City is purely for academic purposes and cannot be used for any other purpose.

Please note that on completion of the study, a copy of the research report should be submitted to the City of Johannesburg in honour of your commitment.

I urge you to present this letter of permission whenever you come across officials and participants in the research study. I thank you for choosing the City of Johannesburg to conduct the study.

Kind Regards

Ntsodi

Dithope Ntsodi (on behalf of Tersia Groenewald)
Acting Manager: Human Resource Development
Tel: (011) 407- 7172
Email: Dithopen@joburg.org.za

Appendix 3: Research Questions

Interview Questions- Commuters

Demographics

1. What Age category do your fall under?

18 - 25	26 - 32	33 - 39	40 - 46	47 – 53	54 – 60	61 - 65

2. Gender

Male	Female	Other

3. How would you describe your employment Situation?

Employed	Self-Employed	Unemployed	Retired	Student

Main Questions

1. How frequently do you use walking or cycling and public transportation for your daily commute?

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2. What key elements determine whether you choose walking, cycling or public transportation?

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3. Have you ever encountered difficulties or impediments when attempting to combine multiple forms of transportation, such as going from a bus to a bike or walking?

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4. Are you aware of any initiatives or programs in the city that support the integration of walking or cycling and public transportation? If yes, what are your opinions of them?

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5. What changes could be made, in your opinion, to better incorporate non-motorized transportation into the city's transportation system?

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6. Have you ever used a combination of non-motorized and public transportation and seen any positive effects, such as cost savings, shortened travel times, or enhanced health?

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7. Do you think there is a need for better infrastructure, such as bike lanes or dedicated pedestrian pathways, to facilitate the integration between public transport and non-motorized transport? Why or why not?

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8. What aspects could be improved?

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9. Are there any specific areas or routes in the Roodepoort CBD where you feel the integration between public transport and non-motorized transport is particularly effective or ineffective? Why?

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10. In comparison to relying primarily on private vehicles, how do you think employing both public transportation and non-motorized transportation would affect the environment?

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11. What actions, in your opinion, can people take to actively support the integration of non-motorized and public transportation?

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Interview Questions – Consultants

1. What are the main causes of transport fragmentation?

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2. In your opinion, what are the main obstacles to achieving successful modal integration between public transportation and non-motorized transportation?

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3. What strategies or approaches have you observed or implemented in the past to successfully promote modal integration in urban areas?

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4. How do you prioritize the allocation of resources between public transport and non-motorized transport infrastructure projects when working on urban planning or transportation initiatives?

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5. What role do you believe infrastructure plays in facilitating the integration of public transport and non-motorized transport? Are there any specific infrastructure improvements you consider essential for achieving this integration?

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6. What factors do you take into account while designing or changing the infrastructure for non-motorized transportation and public transportation systems to improve their integration?

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7. How important is the involvement of various stakeholders, such as community members, advocacy groups, and transportation companies, in achieving modal integration? Have you encountered any successful examples of collaboration between these stakeholders?

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8. Are there any specific policy or regulatory measures that you believe can effectively promote and support modal integration? Have you seen any notable policy examples in action?

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9. How do you address concerns regarding safety and security for pedestrians and cyclists in areas where modal integration is emphasized, particularly in relation to shared spaces or mixed traffic environments?

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10. In your opinion, what steps can cities take to encourage modal shift from private vehicles to public transport and non-motorized modes? Are there any successful case studies that you can share?

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11. How do you envision the future of modal integration between public transport and non-motorized transport? What emerging trends or developments do you think will shape this integration in the coming years?

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12. Considering your expertise, what recommendations or advice would you offer to cities that aim to improve modal integration between public transport and non-motorized transport?

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