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RESEARCH REPORT

Urban Transportation modes: Measuring self-reliance in Hatfield

Natasha Zwarts

Calayde Davey

Department of Architecture

Faculty of Engineering, the Built Environment and Information Technology

University of Pretoria

South Africa

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DECLARATION OF ORIGINALITY

I declare that the mini-dissertation, Urban Transportation modes: Measuring self-reliance in Hatfield, which has been submitted in fulfilment of part of the requirements for the module of DIT801, at the University of Pretoria, is my own work and has not previously been submitted by me for any degree at the University of Pretoria or any other tertiary institution.

I declare that I obtained the applicable research ethics approval in order to conduct the research that has been described in this dissertation.

I declare that I have observed the ethical standards required in terms of the University of Pretoria's ethic code for researchers and have followed the policy guidelines for responsible research.

Signature: N. Zwarts

Date: 24/07/2023

Table of Contents

Abstract

This research paper delves into the pressing issue of transportation in Hatfield, with a primary focus on assessing the degree of self-reliance across different transportation modes. With Pretoria's population projected to grow by 45% (CSIR, 2023), it is imperative to optimize and diversify the existing transportation system to accommodate the increasing demand for mobility driven by population growth.

The study concentrates on the Hatfield precinct, where three primary transport modes exist: private, public, and active transportation. The research methodology consists of two key steps: an extensive literature review and meticulous mapping techniques using Geographic Information System (GIS) to visualize and analyse the collected data and metrics. The principal objective of the study is to develop a comprehensive metrics table to gauge the level of self-reliance among commuters in Hatfield.

Through an in-depth literature review, it has been established that Hatfield is categorized as a low-walkable neighbourhood, indicating limited street connectivity and insufficient pedestrian and bike facilities, such as sidewalks, bike lanes, and intersection signage (Habitat Landscape Architects, 2020). Findings from the study reveal motor vehicles in accessing most locations within Hatfield, underscoring the dominance of private transportation even in the central core. However, certain areas, particularly around the University of Pretoria, prioritize active transportation, fostering a culture of self-reliant commuting. Notably, public transport emerges as the most self-reliant mode, with an average of 16/24 (66.7%), followed by active transportation at 15.7/24 (65.4%), and private transportation at the lowest self-reliance with an average of 11.5/24 (47.9%).

In conclusion, this study emphasizes the significance of critical factors such as infrastructure availability, safety, attractiveness, and sustainability. By acknowledging these insights, stakeholders can explore alternative transportation solutions, enhance public transportation systems, invest in pedestrian and cycling infrastructure, and promote sustainable modes of transportation. By addressing these aspects, a more self-reliant transportation culture can be nurtured, resulting in positive impacts on the environment, health, and safety of commuters in Hatfield. The findings of this research offer valuable guidance for future urban planning and policy-making aimed at fostering a well-integrated, efficient, and sustainable transportation network in the Hatfield area.

1. Introduction and background

The topic of self-reliance in transportation is of paramount importance in addressing the challenges associated with urban mobility. This research report aims to investigate the level of self-reliance in transportation modes among commuters within the Hatfield precinct in Pretoria, Gauteng, South Africa. Understanding self-reliance in transportation is crucial for establishing sustainable and efficient mobility systems capable of accommodating the projected population growth in Pretoria.

Currently, Hatfield relies heavily on motor vehicles as the dominant mode of transportation, prioritizing private vehicles over active modes of transport (Habitat Landscape Architects, 2020). This high level of dependence on motor vehicles gives rise to various issues that must be addressed. With Pretoria's population expected to grow by 45% (CSIR, 2023), relying solely on motor vehicles for commuting is neither self-reliant, sustainable, nor feasible in the long term. There is a pressing need to diversify and optimize the existing transportation system to meet the increasing demand for mobility.

Figure 1.1 Vehicles in Hilda St. (Zwarts, 2023)

This research report aims to fill the existing gap in knowledge by exploring the degree of self-reliance of transportation modes among commuters in Hatfield. In this study, self-reliance refers to the ability of individuals or communities to fulfil their mobility needs independently, without relying on external support. This includes utilizing easily accessible modes of transportation, such as *active transport* (which is defined as human-powered transport modes e.g., walking, cycling, skating), and public transport, which offers efficient, safe, and sustainable options for commuting. The commuters - includes any person moving in, around or through Hatfield during any time of the day - are the group of people that will be studied and observed.

By analysing transportation self-reliance, this study seeks to identify the factors that influence individuals' reliance on different transportation modes in Hatfield. The research methodology involves desk research, mapping, and grounded theory to develop research theories and gain insights into the determinants of self-reliant transportation in the study area. Understanding the level of self-reliance in transportation among commuters is crucial for formulating strategies and interventions that promote sustainable, accessible, and inclusive urban transportation systems in Hatfield.

Addressing the research problem of transportation self-reliance, this study aims to contribute to the broader global, national, and local discourse on urban transportation and its implications for sustainable development, quality of life, and equitable access to essential services.

Keywords: urban transportation, motor vehicle dependency, active transportation, urban networks and accessibility.

1.1 Background

The world's transportation systems are undergoing a rapid and interconnected transformation, with nearly every mature metropolitan city boasting a diverse network of transportation modes (Batlle, 2022; Steves, 2012). This shift, varying in pace across different regions, is unstoppable and impacts the vast, diverse, dynamic, and youthful global community. The ways in which transportation is evolving are unique and distinctive, shaping the transportation systems of cities worldwide. A combination of public transportation includes: subways, buses, trains and trams that ensures the safety of commuters (Batlle, 2022; Steves, 2012).

In South Africa, the transportation system is somewhat different to other developing and developed countries. Most mature metropolitan cities (i.e., London, Singapore, New York, Hong Kong, Berlin and Tokyo) implemented long term and incremental changes. South Africa experienced a failure in executing transportation system planning due to apartheid and government changes (Khosa, 1995). South African transportation problems are a result of apartheid cities, where workers lived outside of the city and had to travel as labourers to and from their workplace inside the city, on a daily basis (Khosa, 1995). Protests against the increasing fees and poor conditions of public transport was and is an indication of the importance of transportation issues faced by the majority of African working people (Khosa, 1995). The vision of attaining affordable, integrated, and safe transportation systems in South Africa remains unrealized (Khosa, 1995).

Figure 1.2 Hatfield from Gautrain parking lot (Zwarts, 2023)

South African streets are shaped by specific spaces, structures and surfaces that are of low pedestrian quality (Habitat Landscape Architects, 2020). From the mapping conducted it is evident that in Hatfield the roads are wide, with the sidewalks being narrow. The public spaces are few and the private spaces are plenty. The structures and buildings are fenced and access are restricted. There are few ground floor shops that are publicly accessible and informal traders make up the majority of venders. The surfaces are uneven and the sidewalks do not distinguish between cyclists and pedestrians. The current condition of Hatfield does not promote pedestrianisation (Habitat Landscape Architects, 2020).

Figure 1.3 Poor sidewalk, Park St. (Zwarts, 2023)

In the context of Hatfield's student population, creating an environment that promotes an active lifestyle and integrated infrastructure is crucial. Campus environments, as described by Liao et al. (2022), should provide amenities such as sidewalks, bicycle lanes, and pedestrian-friendly streets that encourage physical activity and lifelong health habits. However, pedestrianisation in Hatfield is not actively encouraged, despite the potential increase in pedestrian activity with the provision of safe and integrated infrastructure (Liao et al., 2022).

The "15-minute city" is an urban design concept that emphasizes convenient access to essential amenities within a 15-minute radius, promoting well-being and reducing reliance on private vehicles (Deloitte, 2022; Sisson, 2023). This study aims to fill knowledge gaps by exploring different transportation modes in terms of their distance coverage, sustainability, safety, efficiency, and accessibility (Deloitte, 2022; Sisson, 2023).

1.2 Research problem

This research paper aims to address the key issue of transportation in Hatfield by focusing on measuring the degree of self-reliance for different transportation modes. In Hatfield, like many neighbouring areas in the City of Tshwane, South Africa, signs of aging and a growing dominance of motorized vehicles have been observed (Sibanda, 2013). This aging population and increasing reliance on motor vehicles have significant consequences for transportation, which is further unpacked in this section.

Hatfield lacks an integrated infrastructure system to enable self-reliant transportation practices. There is a need to explore how an analysis of maps and data schemes of current transportation modes can contribute to advancing this understanding. By investigating these insights, the research conducted aims to bridge the knowledge gap and provide valuable references for promoting self-reliant transportation practices in Hatfield.

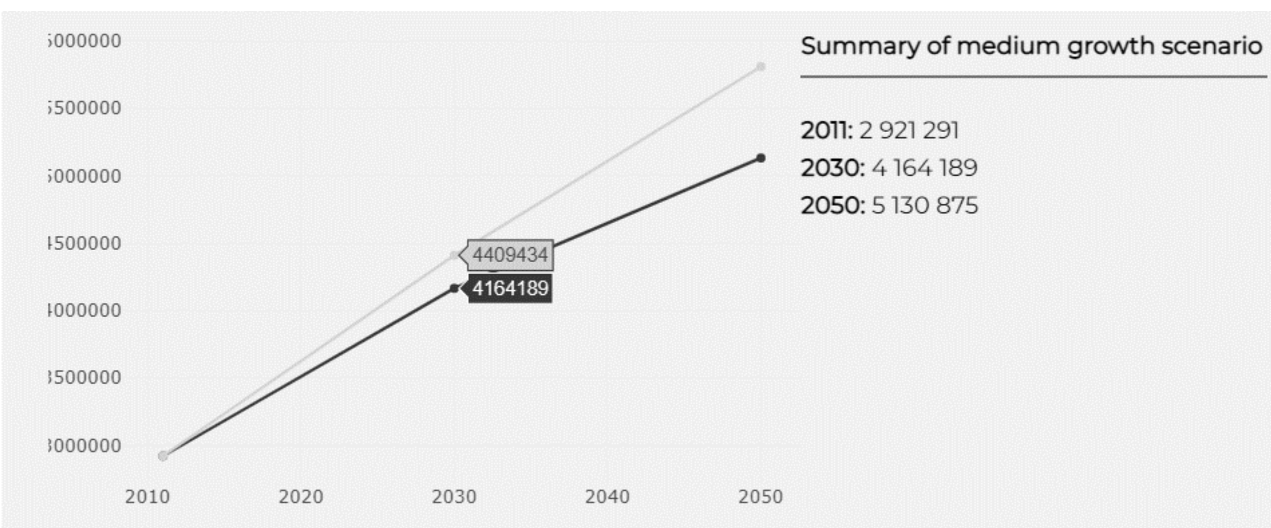

Figure 1.4 Pretoria population growth prediction (CSIR, 2023)

Figure 1.1 above shows that the predicted population for Pretoria in 2030 is over four million. In 2050, this figure grows to over five million. The data indicates that Pretoria's population is expected to grow by 45% (CSIR, 2023). Currently Hatfield is heavily reliant on motor vehicles as the main mode of transportation, subsequently, private vehicles are prioritized over active modes of transport (Habitat Landscape Architects, 2020). The dependence on motor vehicles for commuting is neither self-reliant, sustainable, nor feasible in the long term. This implies that there is a pressing need to diversify and optimize the existing transportation system in order to meet the increasing demand for mobility due to population growth.

Motor vehicles are commonly used in Hatfield, it is the cultural norm. Most students continue to use motor vehicles despite their proximity to campus, further perpetuating the motor-vehicle-culture. Furthermore, inadequate parking space on the main campus leads to vehicles being parked around Hatfield, often obstructing pedestrian routes (Sibanda, 2013). This is evident in the insufficient allocation of space for pedestrians, resulting in narrow sidewalks that do not provide an adequate environment for walking (Habitat Landscape Architects, 2020). The primary consequence of this congestion is the lack of consideration for other modes of transport. The current design of streets in Hatfield disregards the social and hierarchical functions, which further exacerbates the active transportation – or rather *lack* of active transportation - problem (Habitat Landscape Architects, 2020). The secondary consequence of this is that students studying at the University of Pretoria, although relatively safe on campus, face security risks such as vehicle crimes and muggings when they venture off campus (Sibanda, 2013). Further elaboration and discussion on the insufficient allocation and safe spaces for pedestrians will be address in the data scheme table later in the text.

Within the context of Hatfield's student population, creating an environment that promotes an active lifestyle and integrated transport infrastructure becomes crucial. Campus environments should provide features such as sidewalks, bicycle lanes, and pedestrian-friendly streets that encourage physical activity and healthy lifestyle habits (Liao et al., 2022). However, pedestrianization in Hatfield is not actively encouraged, despite the potential benefits of safe and integrated infrastructure.

The existing transportation infrastructure design in Hatfield contradicts the established hierarchy outlined in the Gauteng Spatial Development Framework 2030 (GSDF). The GSDF is a document that provides the spatial context and infrastructure-led planning for Gauteng. The GSDF consist of different topics including economy, ecology, social and culture aspects. It prioritizes pedestrians, followed by cyclists, buses, and lastly motor vehicles (Habitat Landscape Architects, 2020). Hatfield's current situation however demonstrates a reversal of this hierarchy, with streets primarily designed for motor vehicles. This neglects the needs and safety of pedestrians. This trend has direct implications for public safety, as vehicle-related crimes, such as smash-and-grab incidents and vehicle thefts, are prevalent in Hatfield (Sibanda, 2013).

To summarize, the prioritization of motor vehicles over other modes of transport in Hatfield leads to skewed resource allocations and exclusionary effects. The high costs associated with owning a motor vehicle further isolate certain users (Wagenbuur, 2019). With the population increase in Hatfield, it is essential to investigate and explore self-reliant transportation modes to address the challenges and implications associated with the current transportation situation.

1.3 Research questions

Given Hatfield's population growth and heavy reliance on privately owned vehicles. It is imperative to examine and pursue self-reliant transportation alternatives. In order to effectively tackle the challenges and consequences posed by the existing transportation system. The current reliance on private vehicles in Hatfield is unsustainable, inequitable, and detrimental to the community's well-being. Therefore, this study seeks to address the following question:

How can an analysis of maps and data schemes of current transportation modes in Hatfield contribute to a new understanding of self-reliant transportation practice in the community?

The following sub-questions are set up to support the main research question:

1. What are the current conditions of different transport modes in Hatfield?
2. How far can one travel, how sustainable is the transport mode, how safe is the user, how efficient is the transport mode and how accessible is the transport mode?
3. To what degree is private, public and active transportation self-reliant in Hatfield?
4. What barriers do the active transportation commuters face when travelling by foot or on a bicycle, what recommendations can address these barriers?

1.4 Research objectives

The research objectives of this study are as follows:

1. Identify relevant self-reliance metrics: The primary objective of this study is to identify suitable metrics that can effectively measure the degree of self-reliance in transportation within the urban community of Hatfield. By determining appropriate metrics, one can accurately assess the level of self-reliance and understand the transportation patterns in the area.
2. Explore factors influencing travel patterns: To achieve the aim of measuring self-reliance, it is crucial to explore and understand the factors that influence the current travel patterns in Hatfield. By examining these factors, such as infrastructure, accessibility, and mode preferences, one can gain insights into the existing conditions and dynamics of transportation.
3. Analyse maps and data schemes: The study aims to analyse maps and data schemes depicting the current transportation modes in Hatfield. Through a detailed examination of these sources, the author seeks to develop a comprehensive understanding of the self-reliant transportation practices within the community. This analysis will enable one to identify key factors, challenges, and opportunities associated with self-reliant transportation.
4. Provide recommendations and strategies: The ultimate goal of this study is to generate valuable knowledge and insights that can inform recommendations and strategies for promoting and supporting self-reliant transportation practices in Hatfield. The findings will be discussed in the discussion section, where the author will propose actionable recommendations to enhance the community's self-reliance in transportation.

By achieving these research objectives, the author aims to contribute to the existing body of knowledge on transportation planning and urban mobility, while also providing practical guidance for policymakers and stakeholders in Hatfield.

1.5 Limitations and delimitations of the study

Limitations

The study's limitations encompass the following aspects. Firstly, data reliability poses a potential limitation. The accuracy and dependability of the maps and data schemes utilized for analysis may vary, which can impact the validity of the findings. It is essential to acknowledge the potential limitations arising from any inconsistencies or inaccuracies in the data sources. This study is desktop study and primarily uses secondary data (such as maps, observations, data, precinct plans and other literature). The secondary data is supplemented by primary data in the forms of GIS maps. This will be explained in research design.

Secondly, external factors that influence self-reliant transportation practices may not be fully accounted for in the study. Variables such as cultural norms, socioeconomic conditions, and policy frameworks can significantly shape transportation behaviours and preferences. By not incorporating these external factors comprehensively, the generalizability of the findings may be limited to the specific context of Hatfield, restricting their applicability to other settings.

Acknowledging these limitations is crucial to ensure a balanced interpretation of the study's results. While the research provides valuable insights into self-reliant transportation practices, it is important to consider these constraints as they may impact the scope and implications of the findings. Future studies should aim to address these limitations to enhance the comprehensiveness and robustness of research in this field.

Delimitations

This study focuses on analysing maps and data schemes of current transportation modes in Hatfield to gain insights into self-reliant transportation practices. However, there are specific delimitations that shape the scope and limitations of the study.

Firstly, the availability and accessibility of maps and data schemes related to transportation modes in Hatfield may vary. This could impact the validity and reliability of the findings, and it is important to acknowledge any potential constraints in data collection or limitations in data quality.

Secondly, the study is delimited to a specific time frame, where possible data from the past ten years are used, to capture recent trends and developments in transportation modes. This ensures a comprehensive understanding of the current transportation landscape in Hatfield.

Thirdly, the study focuses on selected transportation modes, including public transportation, cycling infrastructure, walking paths, and motor vehicles. However, it excludes other modes like electric cars and electric scooters. This delimitation allows for a focused analysis while acknowledging the boundaries of the chosen modes.

Lastly, the study may prioritize the perspectives of specific stakeholders such as residents, local transportation authorities, and urban planners. While this provides a deeper understanding of self-reliant transportation practices, it may limit the inclusion of other perspectives. Efforts will be made to consider diverse viewpoints within the identified stakeholder groups.

These delimitations provide a clear framework for the study, establishing its boundaries and contextualizing its scope and limitations. By acknowledging these delimitations, the research can maintain transparency and enhance the rigor and validity of the findings.

2. Literature review

The literature review began by collecting data on transportation and self-reliance in similar communities to Hatfield. Specific keywords such as "Hatfield," "self-reliance," "transport," and "pedestrian" are used for this purpose. However, there is a lack of academic literature on transportation self-reliance in Hatfield. To find more relevant sources, alternative keywords are employed, such as urban transportation, motor vehicle dependency, active transportation, urban networks and accessibility. These adjustments yielded fruitful results, especially when exploring the concept of dependency on motor vehicles.

The scoping literature review is organised into four distinct sections: contextual history of urban transportation modes, current conditions of transportation modes, identified research gaps and theories and suggestions. Upon investigation, each of these sections can be organized into three sub-themes regarding urban transportation modes. These themes are consequences of motor vehicles dependency, urban transportation modes in South Africa, and active transportation in an urban context.

2.1 Contextual history of urban transportation modes

This section will discuss recent history that relates to urban transportation developments and transport modes. Three sub-divisions will be discussed namely, consequences of motor vehicles dependency, urban transportation modes in South Africa, and active transportation in an urban context. The literature shows how cities changed over the years.

Consequences of motor vehicles dependency

The history of the consequences of motor vehicles and the commuters’ dependency thereof, will be discussed in this sub-section.

During the era referred to as "the walking city," cities and towns were characterized by their compactness and the close proximity of residences and workplaces (Melosi, 2010). People had short commutes to work, regardless of their occupation, and the land use patterns were mixed. Additionally, the city centres were where the elite members of society resided (Melosi, 2010).

In *the industrial cities*, the core areas were concentrated with a focus on diverse business activities, commerce, trade, retail, hotels, and cultural pursuits. In contrast to the walking city, there is a noticeable separation between work and residential areas, particularly for the middle and upper classes (Melosi, 2010).

The automobile city witnessed significant changes in urban dynamics, including the weakening of the core as a centre for social and cultural life, as well as the dispersion of population into the suburbs (Melosi, 2010). With the emergence of automobiles, individuals and road builders played a pivotal role in shaping a more fluid and less rigid pattern of urban growth. This transformation has had a profound impact, particularly in cities like Los Angeles or Houston, where pedestrians have become an endangered species due to the dominance of car-centric infrastructure (Melosi, 2010).

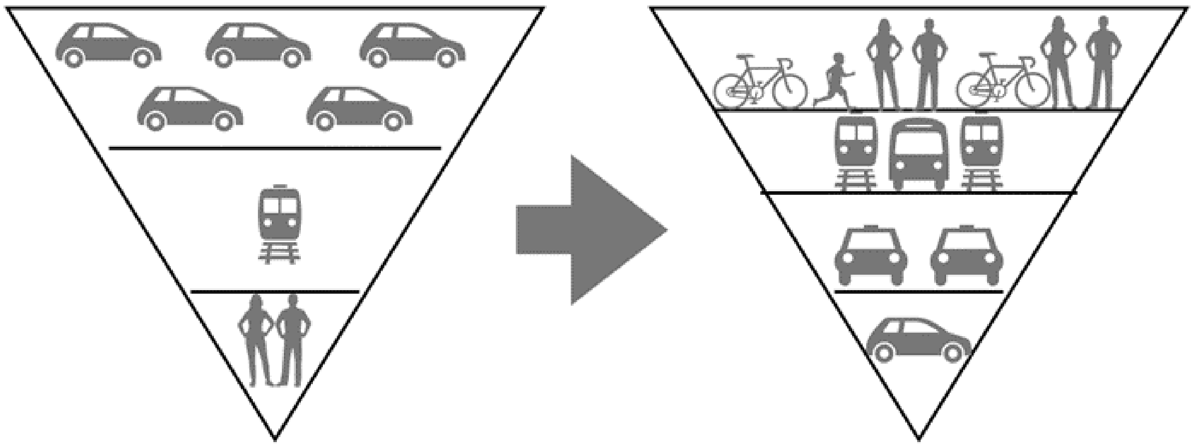

Figure 2.1 Motor vehicle shift to active transportation (Radwan and Morsi, 2019)

Recent developing cities move away from motor vehicles dependency and use more urban and public transportation modes and end up using mostly active transportation in the city centre. Hatfield unfortunately has not yet made a shift towards active transportation (Albers et al., 2010).

Conscious dependence serves as a notable illustration of the prevailing 'ABC' (attitude, behaviour, and choice) paradigm of climate change policy and research (Mattioli et al., 2016). This paradigm highlights that resistance to change stems from entrenched pro-motor-vehicle attitudes, which drive individuals to opt for motor vehicle usage in their behavioural choices, disregarding other factors such as the availability of alternative transportation options (Mattioli et al., 2016). In contrast, structural dependence relates to barriers that impede free choice, superseding the influence of individual attitudes (Mattioli et al., 2016). While some of these barriers may be linked to personal attributes like disabilities, they are predominantly contextual or external factors that contribute to this form of dependence. Barriers that are created by different transport conditions therefore does not allow a commuter to be self-reliant, as the commuters does not have the ability to fulfil their mobility needs independently, without relying on external support.

Urban transportation modes in South Africa

The history of urban transportation modes in South Africa, will be discussed in this sub-section.

South Africa renewed effort in public transportation improvements and implemented rapid bus systems in some bigger cities. Dedicated bus lanes and bus stops are implemented that result in moving more people around in a shorter time (Kings, 2016). However, this is not the case in Hatfield because many students are still using motor vehicles as their main transportation mode.

A case study done by Aropet and Venter (2017), examined the possibility to integrate the A Re Yeng buses and University of Pretoria transport. With the aim to ensure effective public transport systems. Mutual goals of different transport networks can be achieved with one integrated solution, this lead to improved transport systems (Aropet and Venter, 2017). Upgraded public transport services around institutions, demands motor vehicle useful considerations and investigations in terms of safety, cost and time effective solutions. This imply that institutions are making a shift away from motor vehicles towards public transportation (Aropet and Venter, 2017).

BRTs are becoming more popular in the context of Hatfield; unfortunately, motor vehicles are still one of the main transportation modes. An integrated public transport network is what Hatfield needs in order to move away from motor vehicles towards public transportation.

Active transportation in an urban context

The history of active transportation in an urban context, will be discussed in this sub-section. It will further explain the relevance thereof in the urban context of Hatfield.

Traditional neighbourhoods that are known for their active transportation are characterised by factors such as high population density, a diverse mix of land use, excellent connectivity, and well-designed pedestrian walkways and continuous bicycle infrastructure (Brunner et al., 2018; Global desiging cities initiative and NACTO, 2016; Plan H, 2023; Saelens et al., 2003). These neighbourhoods are contrasted with areas that have lower population density, predominantly residential land use, limited street connectivity, and insufficient pedestrian and bike facilities, such as a lack of sidewalks, bike lanes, or proper intersection signage (Brunner et al., 2018; Global desiging cities initiative and NACTO, 2016; Plan H, 2023; Saelens et al., 2003). These areas are considered to have low active transportation. Residents living in high-walkable neighbourhoods reported approximately twice as many weekly walking trips compared to residents in low-walkable neighbourhoods (Brunner et al., 2018; Global desiging cities initiative and NACTO, 2016; Plan H, 2023; Saelens et al., 2003)

Hatfield is a city with a medium population density, recently a diverse mix of land use, limited street connectivity, and insufficient pedestrian and bike facilities, such as a lack of sidewalks, bike lanes, or proper intersection signage (Habitat Landscape Architects, 2020). With this being said, Hatfield is classified as a city with low active transportation.

Pedestrian fatalities represent a substantial proportion, approximately 45%, of the overall deaths on South African roads (Albers et al., 2010). Yield control crossings (zebra crossings) were introduced in South Africa in 1952 to prioritise pedestrian safety (Albers et al., 2010). However, challenges persist in enforcing and educating people about their proper usage. Insufficient crossing facilities, walkways, and recreational spaces like cycling lanes may also contribute to pedestrian-motor vehicle collisions (Albers et al., 2010). This implies that the number of accidents and the number of sidewalks and cycling lanes can be a useful metric to determine self-reliance.

The National Department of Transport in South Africa acknowledges pedestrians as the most vulnerable road users (Department of transport, 1999). However, there is minimal focus on pedestrians or enhancing the pedestrian environment in the Moving South Africa Strategy (Albers et al., 2010). This imply that South Africa is aiming to shift focus to active transportation. The prioritization of motor vehicles arises some problems with the population increase expected in Hatfield. With the aim to shift the focus to active transportation modes, the challenges and implications associated with the current transportation situation might be reduced.

In the data analysis section, the maps and data schemes of current transportation modes in Hatfield will be analysed upon which, a new understanding of self-reliant transportation practice will be gained. Key factors are the result of researching the history of active transportation.

In summary, the key factors of interest in order to improve active transportation in Hatfield are to ensure densification and safety by increasing and improving crossing facilities, walkways, and recreational spaces like cycling lanes.

2.2 Current conditions of transportation modes

This section will discuss current urban transportation conditions. Three sub-divisions will be discussed, namely consequences of motor vehicles dependency, urban transportation modes in South Africa, and active transportation in an urban context.

Consequences of motor vehicles dependency

The consequences of motor vehicles and the commuters' dependency thereof, in the context of South Africa, will be discussed in this sub-section.

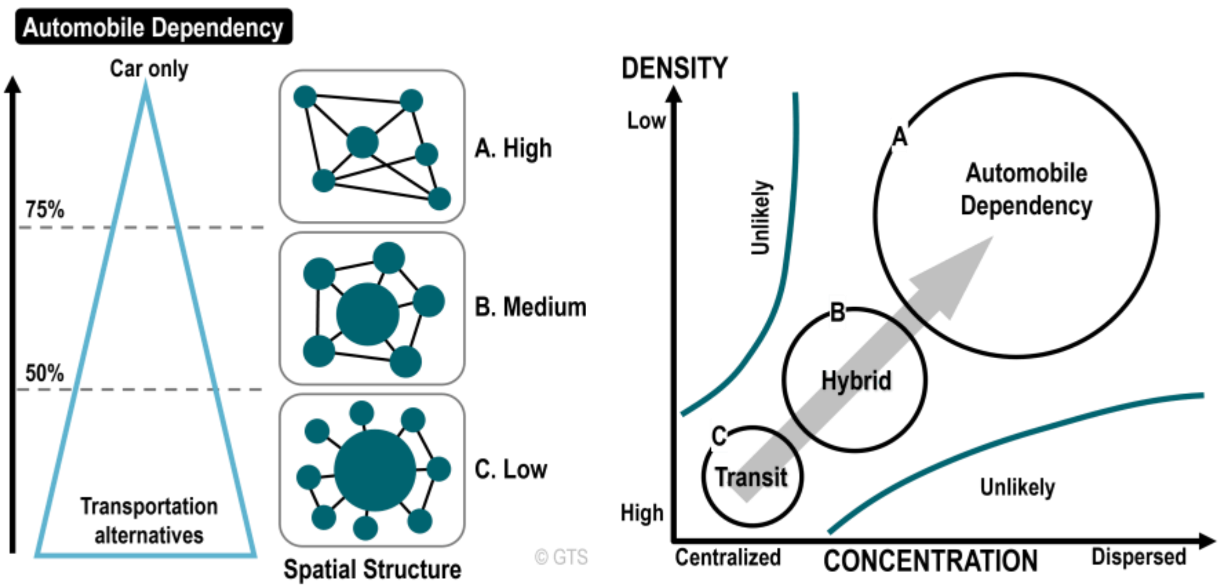

Figure 2.2 Motor vehicle dependence diagrams (Rodrigue, 2020).

In general terms, the extent of motor vehicles dependency varies, ranging from low levels where there are multiple transportation alternatives to high level dependency where there are less transportation alternatives, as seen in the diagram on the left (Figure 2.2).

In the diagram to the right side of Figure 2.2, transportation dependency is determined according to the density and the concentration of the city. The transit category refers to cities that are centrally concentrated and with a high density. Cities characterised by low levels of motor vehicles dependency tend to be centralised, with a high concentration of population and infrastructure (Rodrigue, 2020). On the opposite site of the spectrum is the low density cities with dispersed concentration (Rodrigue, 2020). Additionally, motor vehicles dependency is closely associated with the spatial structure of urban areas (Rodrigue, 2020). Cities with a high degree of motor vehicles dependency are more dispersed in nature (Rodrigue, 2020). Hence, there exists a reciprocal relationship between low population density and high reliance on motor vehicles (Rodrigue, 2020).

Hatfield fits somewhere between the Hybrid and the automobile dependency category. Despite the fact that Hatfield is a medium density and medium centralised concentrated city, plenty of commuters depend on motorised vehicles and BRT's (City of Tshwane district development, 2021; Habitat Landscape Architects, 2020).

In order to overcome the challenge of motor vehicle dependency, Chibuzo (2020) advocates for the path of self-reliance as a crucial aspect for urban African communities. Self-reliance entails the ability to meet one's own needs and make independent decision (Chibuzo, 2020; Rodrigue, 2020). It becomes particularly significant in the context of limited space within cities, where the availability of traffic and parking areas is constrained (Chibuzo, 2020). Recognizing these constraints, it becomes imperative to explore alternative transportation solutions that can foster self-reliance and address the challenges associated with limited urban space (Chibuzo, 2020).

The dependency on motor vehicles is not a self-reliant transportation solution, and so transportation alternatives can help cities move away from motor vehicle dependency. The following table creates a metric that can determine motor vehicle dependency, which is based on literature reviews.

Topic/Theme/Cluster	Metric	Description	Source
Motor vehicle dependency	City density	The amount of people staying in the area	(Rodrigue, 2020)
Motor vehicle dependency	City centralisation	The majority of urban activity in the city	(Rodrigue, 2020)
Motor vehicle dependency	Alternative transportation modes	Variety of transport options available	(Chibuzo, 2020)

Table 2.1 Motor vehicle dependency (Zwarts, 2023).

In summary, the dependency on motor vehicles is influenced by factors such as; the amount of alternative transportation modes available, densification and centralisation (Chibuzo, 2020; City of Tshwane district development, 2021; Rodrigue, 2020). Some of these metrices will be used to determine the degree of self-reliance for the different transportation modes in Hatfield.

Urban transportation modes in South Africa

The urban transportation modes in the context of South Africa, will be discussed in this sub-section. It will further explain the relevance thereof in the urban context of Hatfield.

A problem that Mthimkulu (2017) mentions is the geographical and political sprawling cities of South Africa. It remains a transportation challenge if new housing developments and perpetual planning is away from economic and activity nodes (Mthimkulu, 2017).

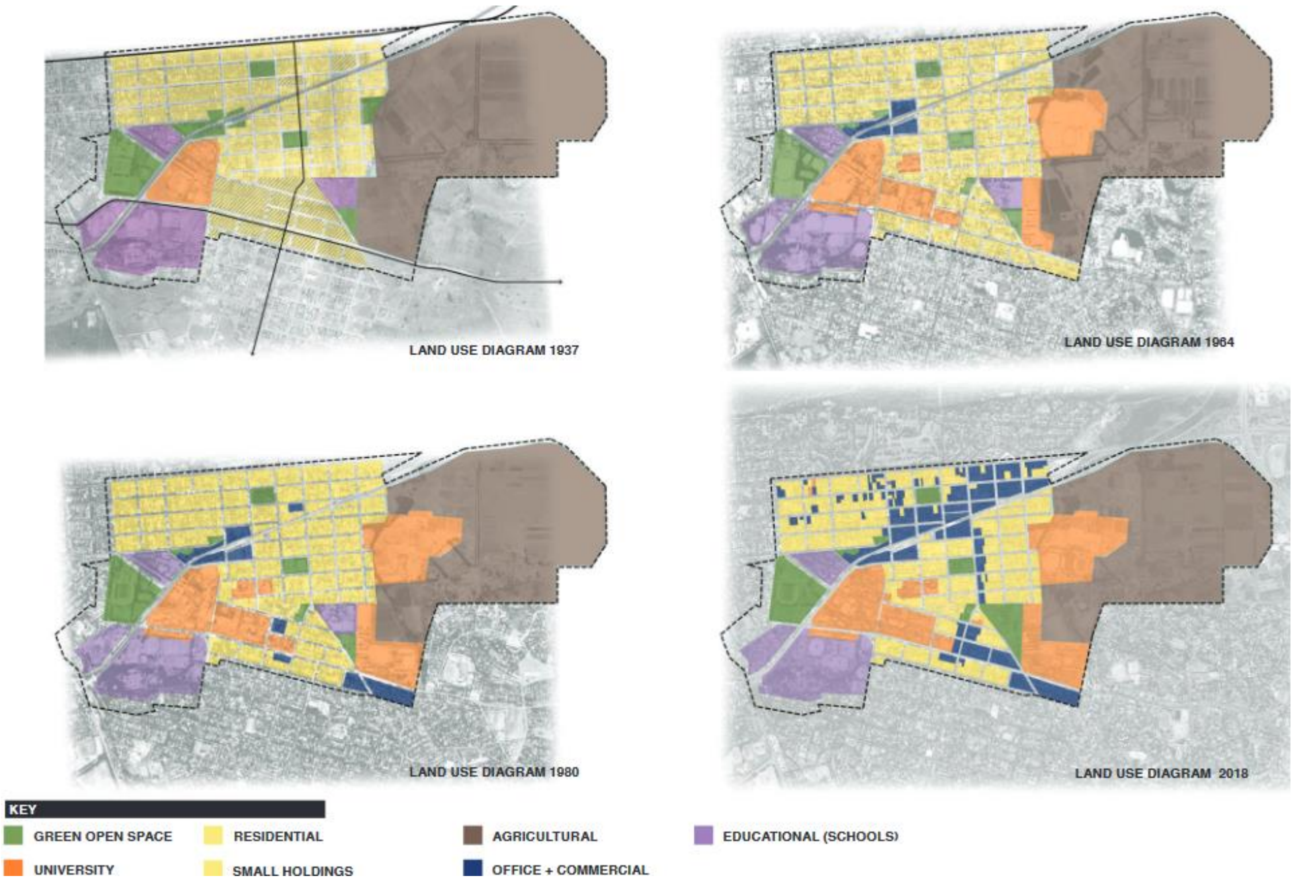

Figure 2.3 Hatfield land use diagram evolution 1937, 1964, 1980, 2018 (Habitat Landscape Architects, 2020).

As seen in the diagrams above, Hatfield is an example of a sprawling city with more recent development in the centre to allow for central concentration (Habitat Landscape Architects, 2020). Recently, office and commercial use are present in the centre and mix use is starting to become a big part of the land use area (Habitat Landscape Architects, 2020).

Mini Bus Taxis (MBT), transport most of the industry's commuters (70%) (Mthimkulu, 2017). Unfortunately, the state does not subsidise the MBT's and unsafe habits of drivers are triggered by the competitive need to obtain more customers. Mthimkulu (2017), stated in his research paper that this negative behaviour might be positively influenced by subsidies.

The main objectives for South African citizens in terms of transport is affordability, safety and availability (Mthimkulu, 2017). The initial implementation of BRT (Bus Rapid Transit) systems provoked tension as the MBT felt that it was reducing their customer base (Mthimkulu, 2017). The public transportation issues cannot be addressed in isolation and will not be mitigated when working independently (Mthimkulu, 2017).

Various factors, such as the cost of travel, the quality of the environment, and convenience-related aspects like the availability of parking, are also likely to have a significant impact (Saelens et al., 2003). The proximity factor relates to the distance between the starting point and the destination of a trip. It is determined by two essential elements of land use. The first element is density, which refers to the degree of compactness of land utilisation (Brunner et al., 2018; Global desiging cities initiative and NACTO, 2016; Plan H, 2023; Saelens et al., 2003). The second aspect of proximity is the land use mix, which pertains to the distance or integration between different types of land usage, such as residential and commercial areas (Brunner et al., 2018; Global desiging cities initiative and NACTO, 2016; Plan H, 2023; Saelens et al., 2003). In contemporary suburban areas, intentional segregation of land uses often makes it practically unfeasible to walk from one's residence to the nearest shopping centre or workplace (Brunner et al., 2018; Global desiging cities initiative and NACTO, 2016; Plan H, 2023; Saelens et al., 2003).

Topic	Metric	Description	Source
Urban transport modes	Proximity	The distance you travel to a destination	(Brunner et al., 2018; Saelens et al., 2003)
Urban transport modes	Connectivity	The directness of travel	(Brunner et al., 2018; Saelens et al., 2003)
Urban transport modes	Affordability	The cost to travel	(Mthimkulu, 2017)
Urban transport modes	Safety	Protection of life and belongings	(Mthimkulu, 2017)

Table 2.2 Urban transport modes (Zwarts, 2023).

In the data analysis section, the maps and data schemes of current transportation conditions in Hatfield will be analysed, upon which a new understanding of self-reliant transportation practice will be gained, in order to answer the research question successfully.

In summary, the selection of motorised or active transport is influenced by key factors related to land use, primarily cantered around two fundamental aspects: (a) proximity (distance) and (b) connectivity (directness of travel), other factors include the affordability and the safety (Brunner et al., 2018; Frank, 2000; Saelens et al., 2003). These metrices will be used to determine the degree of self-reliance for the different transportation modes in Hatfield.

Active transportation in an urban context

The active transportation modes in the general urban context, will be discussed in this sub-section. It will further explain the relevance thereof in the urban context of Hatfield.

The mixture of land uses, particularly the close proximity of shopping, work, and other non-residential areas to housing, appears to be linked to higher engagement in active transportation among residents (Albers et al., 2010; Kitamura et al., 1997; Saelens et al., 2003). Another study has also highlighted the connection between neighbourhood walkability characteristics, such as diverse land use mix, connectivity, and aesthetics, and the experience of walking (Liao et al., 2022). In addition to promoting physical activity, walking has been shown to enhance social capital, foster a sense of community, encourage social interaction, and contribute to a greater sense of safety. These factors collectively contribute to the liveability of a neighbourhood and positively impact the mental health of its residents (Liao et al., 2022).

The assessment of infrastructure supporting active transportation, such as the presence of dedicated bike paths and continuous sidewalks, has been conducted infrequently in relation to transport choice. However, some empirical evidence suggests that the availability of sidewalks and bicycle paths contributes to an increase in the number of trips made using active transportation (Kitamura et al., 1997; Saelens et al., 2003). According to Albers, the most crucial factors identified for walking in Tshwane were personal safety, attractiveness, and the presence of a destination. On the other hand, for cycling, the key considerations were having a continuous route and ensuring traffic safety (Albers et al., 2010).

According to the study conducted by Cervero and Kockelman (1997), improved pedestrian infrastructure, such as well-maintained sidewalks and effective street lighting, was found to be associated with an increased usage of active transportation modes, especially for nonwork trips starting from residential areas (Cervero and Kockelman, 1997; Saelens et al., 2003). Besides the physical infrastructure, there are other objective environmental factors that may have a connection to active transportation and physical activity, such as crime rates and weather conditions (Saelens et al., 2003).

There is a rising concern among policy experts, urban planners, and transportation specialists that communities have been designed in a way that makes active transportation difficult and, in many cases, unsafe (Saelens et al., 2003). As a result, physical activity has been inadvertently reduced from our daily lives, leading to an increasing awareness of the impact of our environment on a more inactive lifestyle (Jackson and Kochtitzky, 2002; Saelens et al., 2003).

Topic	Metric	Description	Source
Active transportation	Infrastructure conditions	Continuous and maintained sidewalks and cycling lanes	(Albers et al., 2010; Kitamura et al., 1997; Liao et al., 2022; Saelens et al., 2003)
Active transportation	Weather conditions	Moderate temperatures	(Saelens et al., 2003)
Active transportation	Crime rates	Protection of life and belongings	(Albers et al., 2010; Saelens et al., 2003)
Active transportation	Proximity	Distance to locations	(Albers et al., 2010; Kitamura et al., 1997; Saelens et al., 2003)

Table 2.3 Active transportation (Zwarts, 2023).

In this report the definition for self-reliant transportation refers to the ability of individuals or communities to fulfil their mobility needs independently, without relying on external support. When looking at active transportation the definition is any human-powered transport modes (Plan H, 2023). To conclude, the active commuter is using only his own power to commute, without relying on any external energy from other people, by only referring to definitions, active transportation is classified as self-reliant. In the data analysis it would be further unpacked if and how active transportation is seen as self-reliant transportation.

2.3 Identified researched gaps

This section will discuss identified research gaps that relates to urban transportation. Three sub-divisions will be discussed, namely, consequences of motor vehicles dependency, urban transportation modes in South Africa, and active transportation in an urban context.

Consequences of motor vehicles dependency

There are two research gaps identified in terms of motor vehicle dependency. Firstly, insufficient consideration of the various factors contributing to commuter dependency. Further research is needed to explore the different categories that influence commuters' reliance on specific modes of transportation, including factors such as distance covered, sustainability, safety, efficiency, and accessibility. Secondly, there is limited examination of strategies to promote alternative travel options and reduce dependency on motor vehicles in Hatfield. Additional research is required to explore effective measures and policies that prioritise walking, cycling and public transport as viable alternatives to motor vehicle usage in Hatfield (Samsonova, 2021).

In summary, by addressing these research gaps, a more comprehensive understanding of transportation dependence and the potential for self-reliant and sustainable transport systems can be achieved (Samsonova, 2021). Therefore, by analysing maps and data schemes of motor vehicles dependency in Hatfield, it can contribute to new understanding and strategies of self-reliant transportation practice that can be implemented in Hatfield.

Urban transportation modes in South Africa

There are two gaps identified in the literature reviews concerning the transportation sector. Firstly, the transportation challenges in sprawling cities: The geographical and political sprawl of cities presents a transportation challenge, especially when housing developments and activity nodes are located far apart. Further research is needed to explore effective transportation solutions for such cities, taking into account factors like accessibility, connectivity, and affordability. Secondly public transportation integration: The literature highlights that public transportation issues cannot be addressed in isolation and require collaboration among different transportation modes. Research is needed to explore effective strategies for integrating various modes of public transportation, such as Mini Bus Taxis, BRT systems, and other alternatives, to ensure better overall transportation service for commuters.

In summary by addressing these research gaps, policymakers and transportation planners can develop more effective strategies to improve the affordability, safety, and availability of public transportation in South Africa, taking into account the unique challenges of the Mini Bus Taxi industry and the urban environment. Therefore, by analysing maps and data schemes of current urban transportation modes in Hatfield it can contribute to new understanding and strategies of self-reliant transportation practice that can be implemented in Hatfield.

Active transportation in an urban context

The two gaps identified through literature review, in terms of active transportation include firstly, designing communities for active transportation: There is a growing concern among experts about how communities are designed, making active transportation difficult and unsafe. Research should focus on understanding the impact of community design factors, such as population density, land use mix, connectivity, and pedestrian and bike infrastructure, on promoting active transportation. Secondly, pedestrian infrastructure and safety: The effectiveness of pedestrian infrastructure, including well-maintained sidewalks and effective street lighting, in promoting active transportation and ensuring pedestrian safety, needs further examination. Research should explore the relationship between infrastructure improvements and the usage of active transportation modes, particularly for non-work trips.

In summary by addressing these research gaps, it can inform the development of effective strategies and interventions to promote active transportation, enhance pedestrian safety, and improve the overall pedestrian environment in communities. Therefore, by analysing maps and data schemes of current active transportation modes in Hatfield it can contribute to new understanding and strategies of self-reliant transportation practice that can be implemented in Hatfield.

2.4 Theories and suggestions

This section will discuss theories and suggestions that relates to urban transportation. Three sub-divisions will be discussed, namely, consequences of motor vehicles dependency, urban transportation modes in South Africa, and active transportation in an urban context.

Consequences of motor vehicles dependency

The concept of the "15-minute city", is widely known and implemented, it encompasses an urban design strategy that strives to enhance the overall well-being of residents by establishing cities where all essential amenities are conveniently accessible within a 15-minute radius, either by walking, cycling, or utilizing public transportation (Deloitte, 2022; Sisson, 2023). Notably, this comprehensive lifestyle can be achieved without the dependency on private vehicles (Deloitte, 2022; Sisson, 2023).

The different categories that contribute to the commuter's dependency include: the distance that can be covered in 15 minutes, the sustainability (petrol usage, transport mode capacity, asking if the capacity is optimal and placing the transport mode in a category), safety (personal item theft, transport mode theft and accidents), efficiency (space on street edge and speed) and accessibility (in terms of cost, age groups and disability).

To promote a sufficient level of accessibility and a self-reliant community that does not rely on motor vehicles, it is important to prioritise such as public transport, cycling and walking (Samsonova, 2021). In the data analysis section, the maps and data schemes of current transportation conditions in Hatfield will be analysed upon which, alternative travel options will be analysed, in order to answer the research question successfully, in the results section.

Urban transportation modes in South Africa

A holistic approach is needed for transportation systems to function effectively (Global designing cities initiative, 2016; Kings, 2016). The ideal commuting system is linked to a public transport system, where the users cycle to the bus station, leave the bicycle there, take the bus to the closest stop from work and walk the last bit (Kings, 2016). Creating inclusive designs that cater to various mobility choices is crucial, with a focus on promoting active and sustainable modes of transportation. By ensuring safe, efficient, and comfortable experiences for pedestrians, cyclists, and transit riders, accessibility to essential services and destinations is enhanced. Moreover, these design considerations also contribute to increasing the overall capacity and functionality of the street (Global designing cities initiative, 2016; Kings, 2016).

In the data analysis section, the maps and data schemes of current transportation conditions in Hatfield will be better understood by analysing safety, efficiency, and accessibility to essential services and destinations, in order to answer the research question successfully.

Active transportation in an urban context

The highest indices in scenario balance are achieved by human-powered modes of transport (walking and cycling) (Brunner et al., 2018). Small vehicles are also seen as efficient, but the action radius for walking, cycling and scooters/ mini vehicles are limited (Brunner et al., 2018). The best outcome is to use public transport in combination with active transport (Brunner et al., 2018). This will solve first-mile and last-mile issues introduced by public transport (Brunner et al., 2018).

By incorporating multiple modes of transportation, multimodal streets have the capacity to accommodate a higher volume of people. When street space is repurposed to prioritise more efficient travel modes, it not only increases the overall capacity of the street but also reduces reliance on personal motorised vehicles (Global designing cities initiative, 2016).

In the data analysis section, the maps and data schemes of current transportation conditions in Hatfield will be better understood by measuring active transportation with key factors such as, infrastructure conditions, safety and proximity amongst others, in order to answer the research question successfully.

In conclusion, to study the research question, it is important to acknowledge the context, conditions, gaps, and theories from literature to help generate useful metrics for further study. The literature review revealed key important metrics that will be discussed in detail in the research design section to follow. This can be seen in Table 2.4 below. Careful considerations are made to ensure these metrics can be used to measure self-reliance in Hatfield, therefore not all of these metrices are used. The column on the right indicates if the metrics are used or not.

Topic	Metric	Description	Source	Used
Motor vehicle dependency	City density	The amount of people staying in the area	(Rodrigue, 2020)	No
Motor vehicle dependency	City centralisation	The majority of urban activity in the city	(Rodrigue, 2020)	No
Motor vehicle dependency	Alternative transportation modes	Variety of transport options available	(Chibuzo, 2020)	Yes
Urban transport modes	Proximity	The distance you travel to a destination	(Brunner et al., 2018; Saelens et al., 2003)	Yes
Urban transport modes	Connectivity	The directness of travel	(Brunner et al., 2018; Saelens et al., 2003)	Yes
Urban transport modes	Affordability	The cost to travel	(Mthimkulu, 2017)	Yes
Urban transport modes	Safety	Protection of life and belongings	(Mthimkulu, 2017)	Yes
Active transportation	Infrastructure conditions	Continuous and maintained sidewalks and cycling lanes	(Albers et al., 2010; Kitamura et al., 1997; Liao et al., 2022; Saelens et al., 2003)	Yes
Active transportation	Weather conditions	Moderate temperatures	(Saelens et al., 2003)	No
Active transportation	Crime rates	Protection of life and belongings	(Albers et al., 2010; Saelens et al., 2003)	Yes
Active transportation	Proximity	Distance to locations	(Albers et al., 2010; Kitamura et al., 1997; Saelens et al., 2003)	Yes

Table 2.4 Metrics (Zwarts, 2023).

3. Research design

The study focuses on the commuting behaviour within the Hatfield precinct in Pretoria, Gauteng, South Africa. The research aims to examine the diverse range of individuals who traverse Hatfield throughout the day, referred to collectively as "commuters." The following sections will explain the study area and context, research strategy, research methodology, research instruments, data collection and lastly data analysis.

3.1 Study area and context

The study area and context refer to a geographical area, including boundaries that is used to define the extent of the analysis throughout the research report. The study area used for this report is the Hatfield precinct, shown in the figure below.

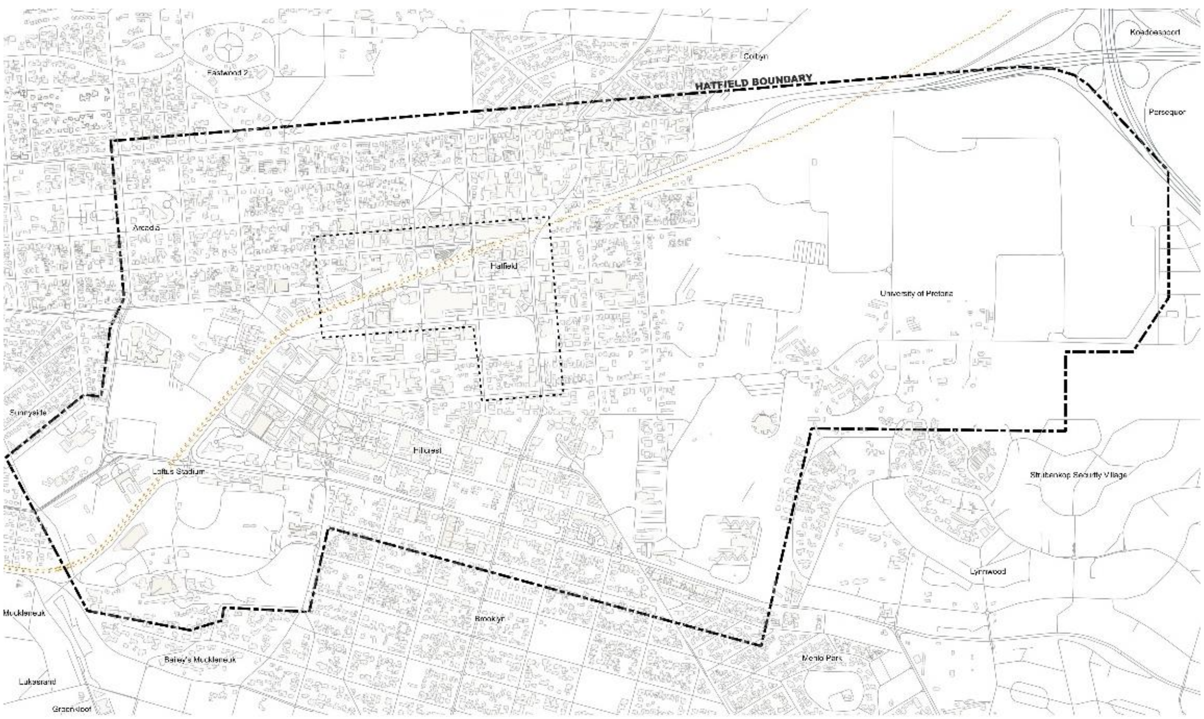

Figure 3.1 Hatfield boundary (Zwarts, 2023).

The Hatfield precinct is a vibrant urban community comprising approximately 100,000 individuals, including residents from nearby neighbourhoods and various stakeholders (Habitat Landscape Architects, 2020). As seen in the map above, Hatfield is west of the N1 freeway. The dotted box in the centre of the Hatfield precinct indicates the core and central focus of Hatfield.

There are three existing transport modes in Hatfield: Private, public and active.

Private transport refers to motor vehicles and scooters, a private owned transportation method that is used by the commuter. Most used transport in Hatfield is the motor vehicles that is part of the private transport. Most trips to main campus are done by means of a motor vehicle, despite the proximity of most students staying within 2km from campus (Habitat Landscape Architects, 2020).

Public transport systems in Hatfield include: Tshwane and A Re Yeng bus services (Bus Rapid Transport (BRT) systems), University of Pretoria (UP) bus services (student transportation between different UP campuses), Taxi services (informal mini bus), Gautrain buses and Gautrain and Metro Rail.

Active transport includes commuters walking, cycling or skating to educational facilities, food stores or any other destination. Active transportation is not very popular in Hatfield. The mobility needs of the commuters, referred to in the definition of self-reliant transportation, refer to the requirements that ensure the travellers have the ability to move freely and easily (Rodrigue, 2020).

The main campus of the University of Pretoria is situated in Hatfield. About 15 000 students are educated there. Solutions for student parking is needed because of the increased traffic in Hatfield (Aropet and Venter, 2017). There is a need for a transportation system that connects the complex existing transportation networks (Aropet and Venter, 2017). The survey done by Aropet and Venter in 2017, found that 39% of trips to UP campus is done by means of a motor vehicle. Additionally, 25% of motor vehicles park outside of campus on the street, blocking pedestrian routes (Aropet and Venter, 2017). These numbers have only increased in recent years. The increase in the use of private transportation is a direct result of population growth without improving the infrastructure of public transportation (CSIR, 2023). Maps and diagrams will be unpacked in the data collection section.

To enhance the depth of understanding, this research paper will specifically investigate individuals who commute from locations outside Hatfield, as well as those travelling through or inside the precinct. The primary demographic group targeted by this study consists of students, given the presence of the University of Pretoria's main campus in Hatfield. Importantly, this research will adopt an inclusive approach, making no distinctions based on gender, culture, income group or language.

By refining the study area and expanding the scope of analysis to encompass a broader range of commuters, this research aims to provide comprehensive insights into the commuting patterns, experiences, and needs within the Hatfield precinct.

Current transportation conditions in Hatfield will be best understood by adapting an inclusive approach and documenting all commuters, in order to answer the research question successfully. The findings will contribute to a better understanding of the unique challenges and opportunities associated with commuting in this dynamic urban environment.

3.2 Research strategy

The research strategy employed in this study encompassed two main steps to investigate the degree of self-reliance in transportation within the Hatfield community.

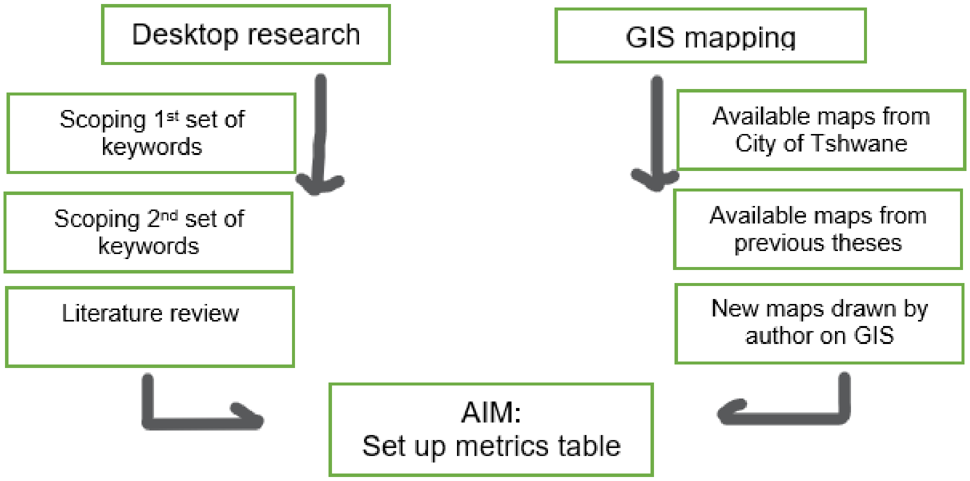

Figure 3.2 Research strategy diagram (Zwarts, 2023).

The first step involved conducting extensive desktop research to gather public or institutional data on transportation and self-reliance within communities of similar size to Hatfield. This initial stage focused on reviewing the scope of results using specific keywords such as "Hatfield," "self-reliance," "transport," and "pedestrian."

During the second stage, it became evident that there is a scarcity of academic literature specifically addressing transportation self-reliance in Hatfield. To expand the scope of the literature, alternative keywords are employed to identify more suitable academic writings. The inclusion of the concept of "dependency" and the exclusion of any specific location obtained more pertinent academic sources that align with the topic at hand. This adjustment proved to be more conducive, as it allows for the discovery of sources that are more closely related to the subject matter. Specifically, exploring the concept of dependency on motor vehicles yielded more relevant findings. The keywords that ultimately yielded the most fruitful results includes urban transportation, motor vehicle dependency, active transportation, urban networks and accessibility.

In the second step, Geographic Information System (GIS) mapping techniques are employed to visualize and represent the collected data and metrics. The primary objective is to develop a self-reliance metrics table (as shown in Figure 3.2), which would serve as a tool for determining the level of self-reliance among commuters in Hatfield. This step is undertaken with the aim of gaining insights into the baseline and extent of self-reliance transportation practices within the Hatfield community. The metrics is set up with the help of the transportation self-reliance definition as well as literature reviews. The themes discussed in literature that are used to set up the metrics include: distance, sustainability, safety, efficiency and accessibility. The literature will focus on these themes as their importance were discussed in previous literature and in the previous literature review section, the metrics were discussed and motivated. These themes are searched and graded in terms of in terms of different transportation modes that are available in Hatfield. Refer to the metrics Table 2.4 in Section 2.4 of this report.

By combining the comprehensive desktop research and GIS mapping techniques, this research strategy aimed to provide a holistic understanding of self-reliance in transportation in Hatfield. It sought to explore the available data, review relevant academic literature, and create a metrics table (later discussed as Table 3.2) that would contribute to the assessment of self-reliance among Hatfield commuters.

3.3 Research methodology

The research methodology utilized in this study is of a hybrid approach that combines both qualitative and quantitative research methods. This hybrid method allows for a comprehensive exploration of the topic of self-reliance in transportation within Hatfield by incorporating both qualitative and quantitative data.

The research paradigm underlying this report is positivism, which highlights the pursuit of factual data and true findings. The report is written in an objective manner, avoiding any subjective opinions, with the aim of identifying abstract and universal practices pertaining to the current state of self-reliance in transportation within Hatfield.

To maintain focus and coherence, the report concentrates on a single research problem, thereby ensuring that the review remains focus around the specific central question. The qualitative component of the research involves conducting a scoping literature review. This involves searching for relevant literature, reports, documents, and online databases to gather information about self-reliance in transportation. The study also relies on quantitative data, particularly GIS data and observations. These quantitative measures provide a more objective and empirical foundation for analysing and interpreting the degree of self-reliance in transport within the Hatfield community. The quantitative nature of the data, including GIS data and observations, strengthens the objectivity and empirical foundation of the report's findings and analysis. The quantitative data complements the qualitative findings and allows for a more comprehensive understanding of the topic.

By employing a scoping literature review and adopting a positivist research paradigm, this methodology enables the study to systematically gather and evaluate existing knowledge and data related to self-reliance in transportation.

3.4 Research instruments

The grounded theory methodology for this research report involves several key steps: data collection, theoretical sampling, and theoretical integration. The data collection process begins with the acquisition of large and diverse samples, encompassing various sources of information related to motor vehicle dependency, public transportation and active transportation. Through iterative analysis, the sample is progressively narrowed down to focus specifically on literature directly relevant to self-reliance.

Theme	Source	Instruments
Self-reliance and transportation	Literature review	Google scholar and online libraries
Self-reliance and transportation	Grey literature	Web-based and videos
Mapping	Hatfield field data	QGIS application

Table 3.1 Data Sources table (Zwarts 2023).

In addition to traditional academic sources, the study also incorporated grey literature, which encompasses non-peer-reviewed materials, such as videos and web-based references. This inclusion aimed to capture a broader range of perspectives and insights related to self-reliant transportation in Hatfield that is used to set up the data scheme for the self-reliance metrics.

This research report also incorporated mapping as a key component. Data collection was conducted from field sources, and the Geographic Information System (GIS) is utilized as the primary tool for data analysis and visualization. This integration of mapping into the research methodology facilitates the capture and examination of spatial information, which provides valuable insights for addressing the research question on self-reliance in transportation within Hatfield.

By employing grounded theory methodology, utilising GIS, and incorporating a diverse range of sources including grey literature, this study aims to ensure a comprehensive and rigorous exploration of self-reliant transportation in Hatfield. These research instruments contribute to the reliability, accuracy, and inclusiveness of the study's findings.

3.5 Data collection (and Sampling)

In this section a data scheme table is set up with the metrics that was discussed in the literature review section. The data scheme will help to answer some of the research sub-questions. These questions are how far can one travel, how sustainable is the transport mode, how safe is the user, how efficient is the transport mode and how accessible is the transport mode.

By grounding these sub-questions, they aid in guiding the analysis and presenting a comprehensive understanding of the research topic in order to understand how maps and data schemes can contribute to a new perception of self-reliant transportation practice in the community of Hatfield.

3.5.1 Primary Data Collection

A diverse range of data is collected for the data scheme table, the following primary data collection section will explain and calculate the raw data, in order to set up data scheme Table 3.2. The data scheme table will further be discussed in the data analysis section.

Data Scheme for commuters traveling in Hatfield													
			Sustainability			Safety			Efficiency		Accessibility		
Mode	Type	Distance (km) in 15min	Petrol consumption	Utility	Transport mode capacity catogary	Personal item theft	Transport mode theft	Accidents	Space on street edge	Speed	Cost	All ages	Disability
Walking	Active	1.2	Excellent	100%	Excellent	Yes	No	Yes	Low	Slow	Low	Yes	Some
Cycling	Active	4.25	Excellent	100%	Excellent	No	Yes	Yes	Low	Medium	Low	No	Some
Skating	Active	2.75	Excellent	100&	Excellent	No	No	Yes	Low	Medium	Low	No	Some
Busses	Public	3	High	80%	Medium	No	No	Yes	Medium	Medium	Medium	Yes	All
Taxi's	Public	7	High	100%	Excellent	No	No	Yes	Medium	Fast	High	Yes	All
Trains	Public	6	High	80%	Medium	No	No	Yes	Medium	Fast	Low	Yes	All
Motor vehicle	Private	9	Medium	20%	Low	Yes	Yes	Yes	High	Fast	High	No	Some
Scooters	Private	5.5	Medium	100%	Excellent	No	No	Yes	Low	Fast	Medium	No	Some

Table 3.2 Data scheme table (Zwarts, 2023).

The primary data for this research report includes the information gathered for the data scheme table. The data scheme table grades the different transportation modes in three different colours. Green, representing categories with desired results (for example cheap and safe). Orange representing categories with results than can be improved (for example 80% utilised). And finally red, representing categories with results that need attention (for example high cost and low utilisation). Desired results are based on the literature reviews. The information for this table was retrieved from various online web-based articles, platforms and websites.

The first column seen in Table 3.2 Data scheme table, provides information on the distance that can be covered within a 15-minute timeframe. The subsequent maps present graphical representations depicting the distances covered within a 15-minute timeframe (Travel Time, 2023).

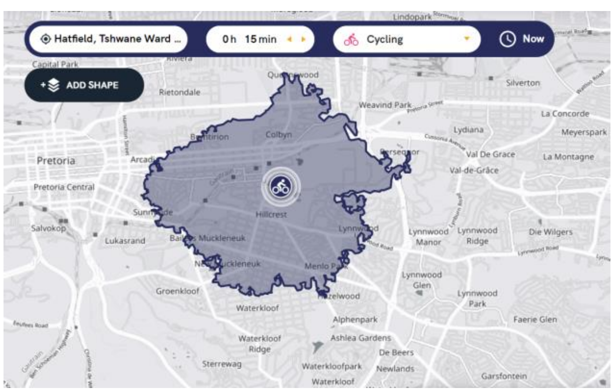

Figure 3.3 15 minutes by Cycling (Travel Time, 2023).

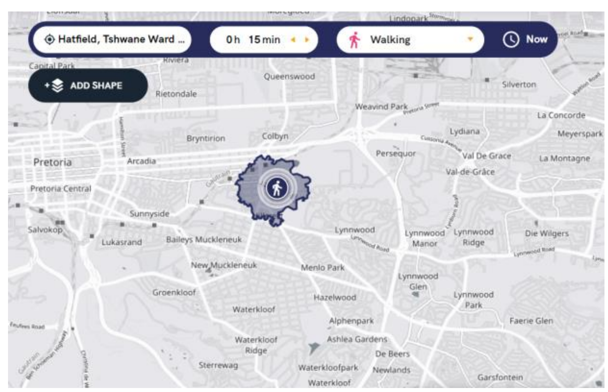

Figure 3.4 15 minutes by walking (Travel Time, 2023).

Figure 3.5 15 minutes via motor vehicle (Travel Time, 2023).

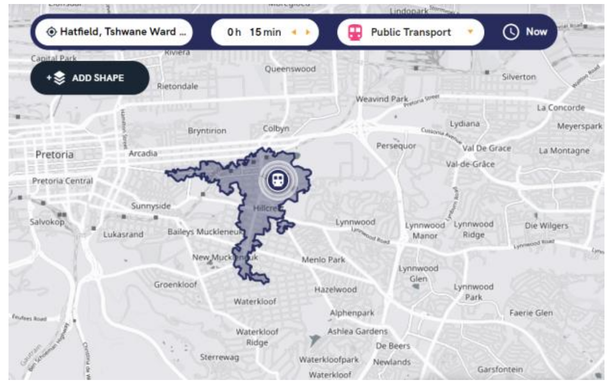

Figure 3.6 15 minutes via public transport (Travel Time, 2023).

Mode	Speed (km/h)	Distance (km) in 15 min	Source
Walking	5	1.2	(Travel Time, 2023)
Cycling	17	4.25	(Travel Time, 2023)
Skating	11	2.75	(Riding boards, 2023)
Buses	12	3	(Travel Time, 2023)
Taxis	28	7	(Travel Time, 2023)
Trains	24	6	(Metrorail, 2023)
Motor vehicles	36	9	(Tomtom traffic index, 2022)
Scooters	22	5.5	(Tomtom traffic index, 2022)

Table 3.3 Traveling distances (Zwarts, 2023).

- According to Cronkleton, 2019, 1.37 meter/second is the average walking pace.
  Distance = Speed x Time
  Distance = 1.37 m/s x (15 min x 60 s/min) = 1,233 km
  Therefore, with an average speed of 1.37 meters per second, you can walk approximately 1,2 km in 15 minutes.
- In 2022, the average bicycle cycled 17km/h in Pretoria (Tomtom traffic index, 2022).
  Distance = Speed x Time
  Distance = 17 km/h x (15 min / 60) = 4.25 km
  Therefore, a bicycle travelling at 17 km/h can cover approximately 4.25 km in 15 minutes in Pretoria.

- A skater can average a cruising speed of 11 km/h (Riding boards, 2023).
  Distance = Speed x Time
  Distance = 11 km/h x (15 min / 60) = 2.75 km
  Therefore, with an average cruising speed of 11 km/h, you can skate approximately 2.75 km in 15 minutes.
- A bus can average a speed of 12 km/h in Hatfield (Travel Time, 2023).
  Distance = Speed x Time
  Distance = 12 km/h x (15 min / 60) = 3 km
  Therefore, with an average speed of 12 km/h, you can drive approximately 3 km with a bus in 15 minutes, in Hatfield.
- A taxi can average a speed of 28 km/h in a city (Travel Time, 2023).
  Distance = Speed x Time
  Distance = 28 km/h x (15 min / 60) = 7 km
  Therefore, with an average speed of 28 km/h, you can drive approximately 7 km with a taxi in 15 minutes, in Hatfield.
- The Metro in Hatfield takes 10min from Pretoria station to Rissik station, 6km. When the stops are included the Metro train average on 6km in 15 minutes (Metrorail, 2023).
- In 2022, the average time it took to drive a motor vehicle 10km in Pretoria was 16 minutes (Tomtom traffic index, 2022).
  Speed = Distance / Time
  Speed = 10 km / 16 min = 0.625 km/min
  Distance = 0.625 km/min x 15 min = 9.375 km
  On average, drivers travelled approximately 9 km in 15 minutes during that year.
- In 2022, the average scooter travelled 22km/h in Pretoria (Tomtom traffic index, 2022).
  Distance = Speed x Time
  Distance = 22 km/h x (15 min / 60) = 5.5 km
  Therefore, an electric scooter in Pretoria travelling at 22 km/h can cover a distance of approximately 5.5 km in 15 minutes.

The second column seen in Table 3.2 Data scheme table, assesses petrol consumption, categorizing it as excellent if non-existent, medium if between 1-20 litres per 100 km, and high if exceeding 20 litres per 100 km.

- All active transport modes are human powered and do not use petrol.
- The average fuel consumption for buses are 28 litres per 100km (Reut, 2023).
- The average fuel consumption for taxis (kombi's) are 9 litres per 100km (Reut, 2023).
- The average fuel consumption for trains are 80 litres per 100km (Reut, 2023).
- The average fuel consumption for motor vehicle are 10 litres per 100km (Reut, 2023).
- The average fuel consumption for a scooter is 4 litres per 100km (Reut, 2023).

The third and fourth columns seen in Table 3.2 Data scheme table, pertain to utilisation, showcasing the percentage of average utilisation for each transportation mode. Excellent utilisation (green) is indicated by 100%, while medium utilisation (orange) falls within the 50-99% range, and low utilisation (red) encompasses anything below 50%.

- Active transport modes (walking, cycling and skating) are individual ways of commuting, which are always 100%.
- Buses in Centurion are 80% utilised (Pienaar, 2007).
- Taxis in Pretoria are transporting on average 16people per trip, 100% utilised (Africa check, 2021).
- Trains in Centurion are 80% utilised (Pienaar, 2007).
- Motor vehicles carry 1-5 commuters per car, that means it is 20% utilised (Albers et al., 2010).
- Scooters are 100% utilised if there is at least one person per scooter, as this is always the case (Pienaar, 2007).

The fifth column seen in Table 3.2 Data scheme table, focuses on personal item theft safety, particularly incidents of smash and grab involving items such as laptops, cash, and cell phones. A red block denotes "yes" in case of theft, while a green block signifies "no" when there is no personal item theft. There are often news articles published that states personal item theft while walking, waiting next to the road and sitting in a motor vehicle (Mahope, 2022; Sibanda, 2013; Van der Westhuizen, 2012; Venter, 2020). In comparison, there are insignificant amounts of personal item thefts documented while using any of the other transportation modes. Other theft incidents relating to trains are infrastructure and cable theft (African news agency, 2018).

The sixth column seen in Table 3.2 Data scheme table, relates to transportation mode theft, indicating whether certain transport modes are prone to being stolen in Hatfield. A red block represents "yes," while a green block indicates "no." The only transportation modes that are documented to be stolen in Hatfield are motor vehicles (Sibanda, 2013) and bicycles (Van der Westhuizen, 2012).

The seventh column seen in Table 3.2 Data scheme table, examines accident safety, highlighting instances where accident is present with a “yes” and a red block. All the transportation modes experience accidents in Hatfield (Chawane, 2016).

The eighth column seen in Table 3.2 Data scheme table, measures transportation method efficiency concerning the space occupied when stationary, typically observed as being parked near the street edge. If the space that is occupied by the transportation mode is less than three times the space a pedestrian occupies, in this report, it is seen as low space demand (green). If the transportation mode takes up more than three times but less than 10 times, the space a pedestrian, in this report, it is seen as medium space demand (orange). If the transportation mode takes up more than 10 times the space a pedestrian, in this report, it is seen as high space demand (red).

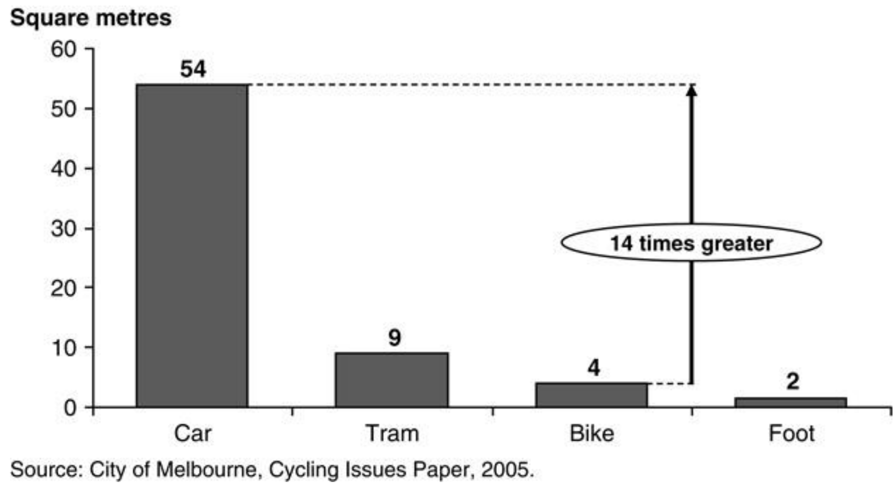

Figure 3.7 Transport space occupied (March, 2010).

The bar chart shows the space per square meter that the representative transportation modes take up in comparison to the amount of passengers per transportation method (March, 2010).

The ninth column seen in Table 3.2 Data scheme table, assesses transportation method efficiency based on the average speed at which it can travel. For this study a red block denotes a slow speed below 5 km/h, an orange block represents a medium speed between 5-20 km/h, and a green block indicates a fast travelling pace above 20 km/h in the city.

The tenth column seen in Table 3.2 Data scheme table, evaluates accessibility in terms of cost and affordability. For this study a green block signifies affordability when transport costs range from R0-R4 per 5km trip, an orange block denotes medium cost between R5-R10 per 5km trip, and a red block represents high-cost exceeding R10 per 5km trip.

- All active transport modes are once off payments and does not use petrol – Low cost.
- The average cost for buses are R10 per 5km (Lombard, 2022)
- The average cost for taxis (kombi's) are R20 per 5km (Lombard, 2022).
- The average cost for metro rail trains are R1,25 for 5km (Metrorail, 2023).
- The average cost for motor vehicle are R21 for 5km (AA rates, 2023).
- The average cost for a scooter is R5 for R5km (AA rates, 2023).

The eleventh column seen in Table 3.2 Data scheme table, explores accessibility in terms of availability to different age groups. A green block indicates inclusivity where all age groups can utilise the transport method, while a red block signifies exclusion. Four transportation modes are used by all age groups, walking and the three public transportation modes; trains, taxis and buses (Basarić et al., 2016). The other transportation modes are excluding mostly younger and older age groups (Basarić et al., 2016).

The twelfth column seen in Table 3.2 Data scheme table, addresses accessibility for individuals with disabilities. A green block indicates inclusivity for all disabilities, an orange block represents inclusivity for some disabilities, and a red block signifies exclusion for all disabilities. All public transportation modes are inclusive to all disabilities (Mackett, 2021).The other transportation modes are including only some of the disabilities (Mackett, 2021).

3.5.2 Secondary Data Collection

The secondary data consisted of maps, observations, data, precinct plans and other literature. Mapping and observing transportation and movement patterns in Hatfield contributed to the data. The data collected for this report is in the form of GIS maps, and programs like ArcGIS and QGIS are used. The Hatfield precinct plan is used to understand the history and the future plans for Hatfield.

The changes that Hatfield underwent the last few decades, is big. There are plenty existing plans and construction for a new Hatfield. That includes transportation systems, road networks, economy, business profiles, residential and commercial areas etc. (Habitat Landscape Architects, 2020). The hierarchy in the spatial development framework stated that pedestrians are the main priority followed by cyclists, buses and lastly motor vehicles (Habitat Landscape Architects, 2020). Regrettably, this hierarchy is reversed in most parts of Gauteng (Habitat Landscape Architects, 2020). Currently streets in Hatfield prioritise motor vehicles with pedestrians being accommodated for in the 'left over' space (Habitat Landscape Architects, 2020). According to Habitat Landscape Architects (2020), Hatfield aims to have liveable streets that operate as a network. In order to ensure safe access for all users including active and transit commuters.

Private and public transportation modes currently dominate Hatfield, there is some exceptions of active transportation.

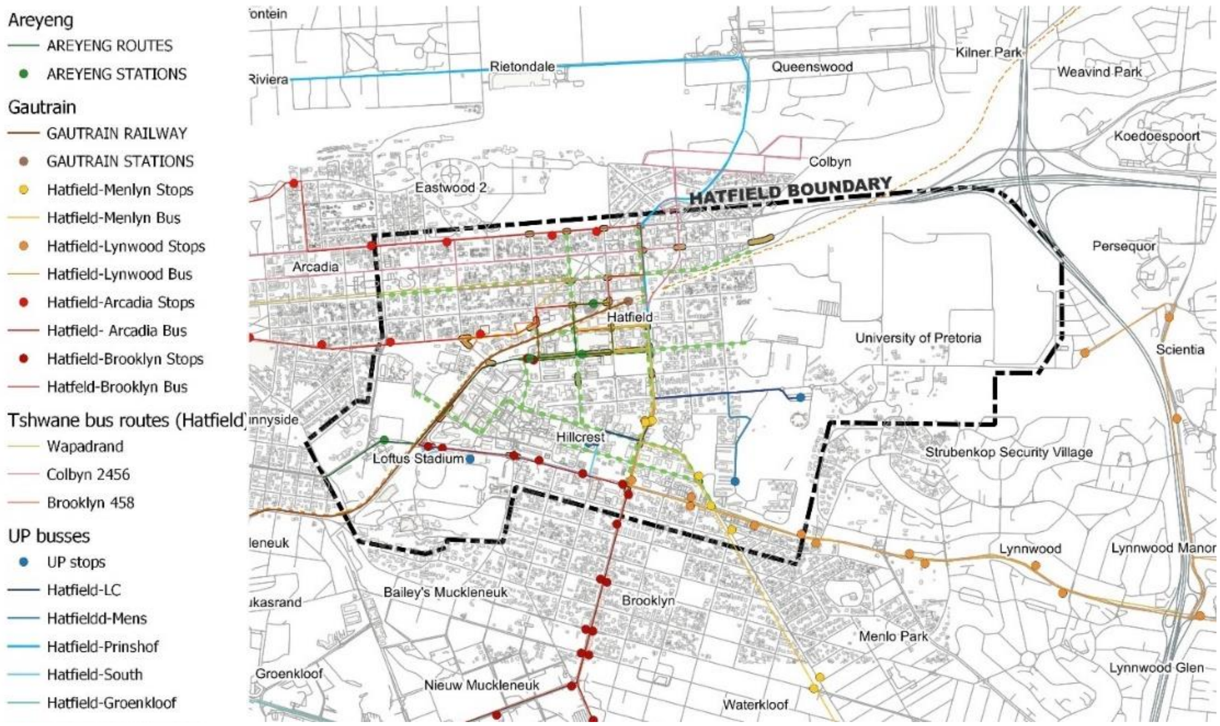

Figure 3.8 Public transportation systems in Hatfield (Zwarts, 2023).

The map indicates the different public transportation systems available in Hatfield. The different colour lines are where the respected buses travel (see legend for specific information on where the buses start and end). The dots indicate the drop off and pick up locations, the colours of the dots correlate with the respected colours of the routes. From the map it can be concluded that there are numerous public transport options available in Hatfield, specifically in the centre of Hatfield. It is also evident that there are many pick up and drop off locations, however most of these stops are only used by one of the bus lines. It can be concluded that these bus systems are not integrated. There are few nodes where two or more bus routes share pick up and drop off locations.

The **public transportation** available in Hatfield is not entirely part of a higher order system. Recently the City of Tshwane improved the transport system by ensuring the new A Re Yeng buses share pic up and drop off locations. There are also benches and shading available at these respective stops for the benefit of the commuters (Habitat Landscape Architects, 2020). The public transport available in Hatfield include: A Re Yeng and Tshwane bus services (part of the Bus Rapid Transport (BRT) system), UP bus services (transporting students between different campuses), Taxi services (informal mini bus public transportation), Gautrain buses and Gautrain and Metro Rail.

Integrated public transport networks ensures that mutual goals are aligned in solutions, and thus the outcome is improved transportation systems (Aropet and Venter, 2017). These integrated networks also ensures convenience-related aspects like effective and time efficient commuting patterns (Saelens et al., 2003). These integrated and effective commuting patterns can contribute to a more self-reliant society, which will be discussed in the data analysis section.

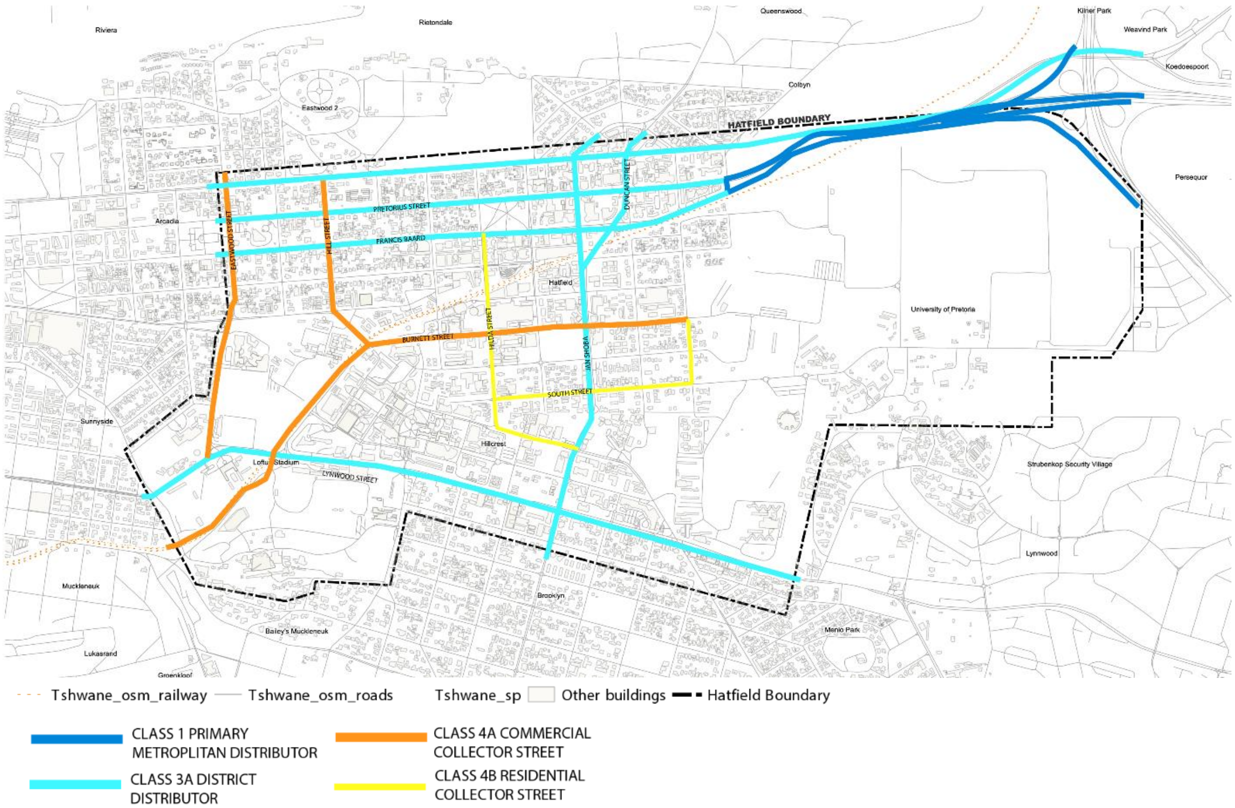

Figure 3.9 Motor vehicle roads in Hatfield (Zwarts, 2023).

The map shows the different roads available for motor vehicles in Hatfield. The roads are classified according to different uses. The dark blue represents primary metropolitan distributors, these roads are connections between different suburbs in Pretoria. The light blue represents district distributers, these roads connect the Hatfield precinct. The orange represents commercial collector streets, these streets are connections between different companies and business areas within Hatfield. The yellow represents residential collector streets, these streets connect the residential areas to the district distributers.

The **private transportation** is one of the most prevelant forms of transportation in Hatfield (Habitat Landscape Architects, 2020). Plenty of students drive with motor vehicles to campus and block the little existing pedestrian sidewalks. This map does not show all the smaller in between streets with colour, but it indicates the importance of private transportation in the Hatfield precinct. Most streets in Hatfield are designed for motor vehicles. Different to other cities, most locations in Hatfield can be reached with a motor vehicle, this is an indication of the dominance of motor vehicles, even in the central core of Hatfield. Other than the University of Pretoria there is no street where active transportation is the priority.

The concept of the "15-minute city" is based on either walking, cycling, or utilizing public transportation (Deloitte, 2022; Sisson, 2023). Notably, a comprehensive lifestyle can be achieved without the dependency on private vehicles (Deloitte, 2022; Sisson, 2023). If private vehicles are the priority, then a sufficient level of accessibility and a self-reliant community is not achieved (Samsonova, 2021). Alternative travel options will be analysed, in order to answer the research question successfully.

Figure 3.10 Green spaces in Hatfield (Zwarts, 2023).

The map indicates the three different green spaces in Hatfield. Public, Semi-public and private. In this research paper Public green spaces (dark green colour) are defined as parks or other natural spaces that are open to any person at any time of the day, no fees charged to use the space (for example the park in Park Street). Semi-public green spaces (medium green colour) are defined as parks, sport grounds or any other natural space that are accessed by payment, joining a club or a specific group of people (for example LC de Villiers sport grounds are only accessible by University of Pretoria students). Private green spaces (light green colour) are defined as any green space that are privately owned (for example office lawn or residential lawn).

According to Saelens et al. (2003), the quality of the environment is also likely to have a significant impact for commuters to decide what transportation mode to use. If the sidewalks continue past private and semi-public green spaces the commuters are likely to not enjoy active transportation modes. If the sidewalks travel past active public parks, commuters are more likely to enjoy walking or cycling in the city (Saelens et al., 2003).

The functionality of streets depends on factors such as safety, efficiency and comfortable experiences for pedestrians. These factors can be ensured with active public parks. Creating inclusive designs that cater to various mobility choices is crucial, with a focus on promoting active and self-reliant modes of transportation (Global designing cities initiative, 2016; Kings, 2016).

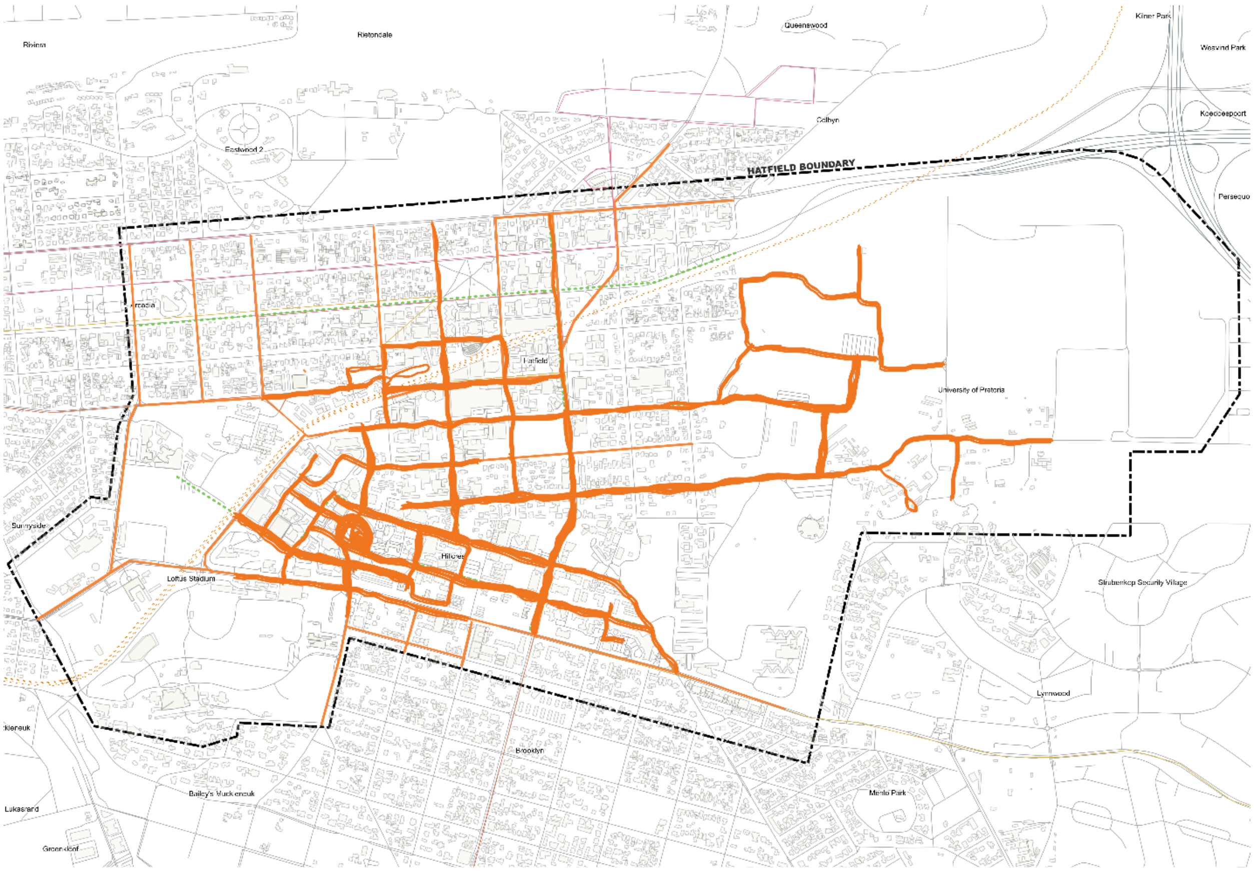

Figure 3.11 Pedestrian activity in Hatfield (Zwarts, 2023).

The map shows the pedestrian activity in Hatfield with an orange colour. A thicker line indicates a higher concentration of pedestrians. **Active transportation** refers to commuters walking, cycling, jogging, skating or any other means of human-powered transportation. North is to the top of this picture, to the South West of the Hatfield precinct is the University of Pretoria. It is evident that there is plenty of pedestrian activity on campus. As discussed in Figure 3.9, the University of Pretoria campus is the only area in Hatfield where streets prioritise active transportation above private and public transportation. In this map it is evident that pedestrians are concentrated on campus. This is a result of prioritisation, safety, accessibility and comfortable experiences.

To conclude, the active commuter is concentrated in areas where they are prioritised. This is a good way to encourage self-reliant transportation. In the data analysis it would be further unpacked if and how active transportation is seen as self-reliant transportation.

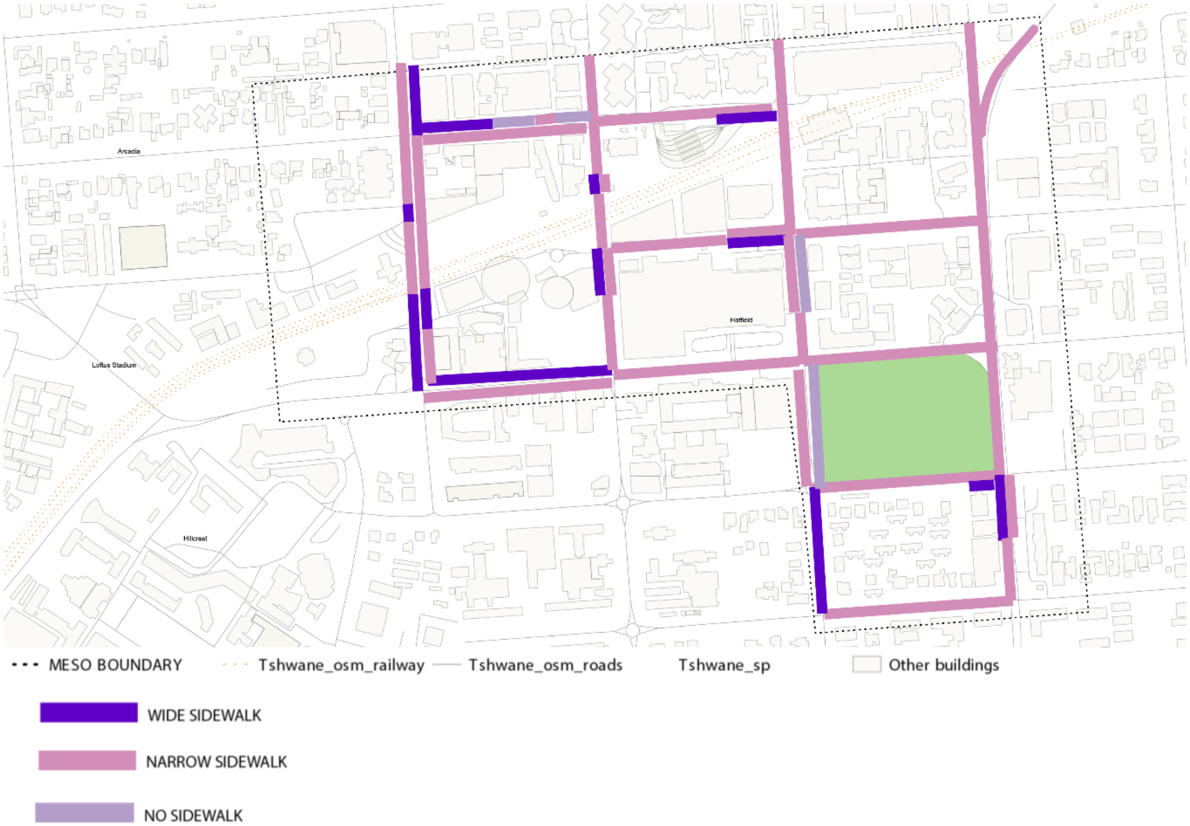

Figure 3.12 Pedestrian activity in central Hatfield (Zwarts, 2023).

This is the central core block in Hatfield, where most activity takes place because of mixed land use. Therefore, it is essential to examine the sidewalk conditions to determine if these conditions promote active transportation modes.

The map in Figure 3.12 shows the different pedestrian sidewalks in Hatfield. The wide sidewalks are indicated with the dark purple, the narrow sidewalks are indicated with the pink colour and where there is a lack of sidewalks, it is indicated with the lavender-grey colour.

From the literature, it is important to incorporate multiple modes of transportation as multimodal streets have the capacity to accommodate a higher volume of people (Global designing cities initiative, 2016). When street space is repurposed to prioritise more efficient travel modes, it not only increases the overall capacity of the street but also reduces reliance on personal motorised vehicles (Global designing cities initiative, 2016). From this it can be concluded that more pedestrian activity can be promoted by improved pedestrian infrastructure, such as well-maintained sidewalks (Cervero and Kockelman, 1997; Saelens et al., 2003).

3.6 Data analysis

The data analysis section explains how the table is set up. The data scheme of current transportation modes in Hatfield will also be analysed. Data collected in the previous section will be analysed in order to determine the degree of self-reliance for different transportation modes in Hatfield. This analysis will help to formulate a new understanding of self-reliant transportation practice, that will be explained in the results section.

Data Scheme for commuters traveling in Hatfield													
			Sustainability			Safety			Efficiency		Accessibility		
Mode	Type	Distance (km) in 15min	Petrol consumption	Utility	Transport mode capacity catogary	Personal item theft	Transport mode theft	Accidents	Space on street edge	Speed	Cost	All ages	Disability
Walking	Active	1.2	Excellent	100%	Excellent	Yes	No	Yes	Low	Slow	Low	Yes	Some
Cycling	Active	4.25	Excellent	100%	Excellent	No	Yes	Yes	Low	Medium	Low	No	Some
Skating	Active	2.75	Excellent	100&	Excellent	No	No	Yes	Low	Medium	Low	No	Some
Busses	Public	3	High	80%	Medium	No	No	Yes	Medium	Medium	Medium	Yes	All
Taxi's	Public	7	High	100%	Excellent	No	No	Yes	Medium	Fast	High	Yes	All
Trains	Public	6	High	80%	Medium	No	No	Yes	Medium	Fast	Low	Yes	All
Motor vehicle	Private	9	Medium	20%	Low	Yes	Yes	Yes	High	Fast	High	No	Some
Scooters	Private	5.5	Medium	100%	Excellent	No	No	Yes	Low	Fast	Medium	No	Some

Table 3.2 Data scheme transportation mode table (Zwarts, 2023).

Self-reliant in terms of transportation modes in this study is defined as *the ability of individuals or communities to fulfil their mobility needs, independently, without relying on external support.* This is to be achieved in the most efficient, safe and sustainable way. The concept of self-reliant transportation aims to minimize dependence on external support, and instead prioritize independent and autonomous means of meeting mobility requirements. The table therefore measure the transportation modes according to distance, sustainability, safety, efficiency and accessibility. These measurables are used to measure self-reliance, as they are important measurements used in previous studies, seen in the literature review section.

The following table explain each index and measurement.

Index	Detail	Unit of measurement	Range Red	Orange	Green
			Bad	Average	Good
Distance	Travel in 15 minutes	Kilometres	<2 km	2-5 km	>5 km
Sustainability	Petrol consumed by transport mode	Liters per 100km	>20 l	0-20 l	0 l
Sustainability	Utilisation, to use the mode effectively, to its full capacity	Average people per mode / capacity *100 = Percentage	<50%	50-99%	100%
Sustainability	Capacity according to the utilisation	Range according to percentage	Low	Medium	Excellent
Safety	Personal item theft	Is theft present?	Yes	n.a.	No
Safety	Transport mode theft	Is theft present?	Yes	n.a.	No
Safety	Accidents for specific mode	Are there accidents?	Yes	n.a.	No
Efficiency	The space when parked, compared to pedestrian space	Compared to pedestrians that takes up 2sqm.	>10 times	3-10 times	<3
Efficiency	Speed the mode travels in the city.	Kilometres per hour	<5 km/h	5-20 km/h	>20 km/h
Accessibility	Cost that includes all users.	Rand per 5km trip	>R10	R5-R10	<R5
Accessibility	Availability to different age groups	Inclusive to all the age groups?	No	n.a.	Yes
Accessibility	Available to people with disabilities	Inclusive to people with disabilities?	No, none	Only some	Yes, all

Table 3.3 Index table (Zwarts, 2023).

The data presented in the table represents a scheme illustrating commuter satisfaction levels for different modes of transportation in Hatfield. The Hatfield analysis utilises color-coded blocks to signify the satisfaction levels of various factors. The satisfaction threshold is based on the desired state, to travel as fast as possible, minimum cost, as safe as possible and as sustainable as possible. These themes are further explained in depth in the literature review section. Green blocks represent a desirable state, indicating a high level of satisfaction. Orange blocks represent medium satisfaction, while red blocks represent a very poor level of satisfaction.

Each mode of transport in Hatfield is assigned a score out of 24, with green blocks scoring two points, orange blocks scoring one point, and red blocks scoring no points. There are 12 columns and the highest possible score is two, therefore the highest possible total score in this metrics is (12x2) 24. This scoring system is employed to assess the success of transportation modes in Hatfield, with higher scores indicating greater self-reliance in transportation.

Conducting a Hatfield analysis allows for the identification of factors that influence active transportation in the area. This impacts the self-reliance of transportation modes directly, as explained previously, active transportation is dependent on personal and human power only.

4. Results

The results section will be discussed in sub-headings according to the four different research sub-questions. The sub-sections will address the research sub-questions.

4.1 What are the current conditions of different transport modes in Hatfield?

The data collected for this study involved the application of specific mobility-related criteria, which are used to establish parameters. Upon analysing the data, it was found that motor vehicles obtained the lowest self-reliant score, amounting to six out of 24 (or 25%). On the other hand, the most self-reliant modes of transport in Hatfield are identified as, skating (longboard or skateboard), taxis, trains, and scooters, scoring 17 out of 24 (71%) as seen in Table 3.2 This observation suggests that commuters in Hatfield generally express higher levels of satisfaction with the distance, sustainability, safety, efficiency, and accessibility offered by these transport modes. In simple terms, these transportation modes fulfil the majority of the commuters needs and expectations, as set up from the literature review. When looking at the measurables, these transportation modes should be the most used transport modes, if every factor had an equal contribution in determining what mode is being used.

Presently, private vehicles dominate the transportation landscape in Hatfield (Figure 3.9). Commuters who lack access to private vehicles are constrained in their commuting patterns. Table 3.2 shows that motor vehicles are amongst the most expensive transport modes in Hatfield. The high cost of motor vehicles, combined with average petrol consumption, leads to unsatisfactory sustainability outcomes. Additionally, the data (Table 3.2) reveals safety concerns for drivers, including incidents of personal item theft, accidents endangering lives, and motor vehicle theft. Moreover, motor vehicles are not accessible to everyone due to their expense and limited usage to individuals aged 18 and above. Additionally, motor vehicles are inaccessible for certain disabled individuals. Analysis of the road maps (Figure 3.9) demonstrates that commuters who drive *private motor vehicles* or scooters can access nearly any location in the area. The 15-minute motor vehicle map Figure 3.5 reveals that using a motor vehicle is the fastest mode of commuting for longer distances. However, the data in Table 3.2 highlights the significant shortcomings of motor vehicles in terms of sustainability, safety, and accessibility. Red is the colour used to present most of the date for the motor vehicles. This indicates that most commuting needs and expectations are not fulfilled while using motor vehicles.

The results obtained from the analysis of pedestrian maps indicate a scarcity of sidewalks and bicycle paths. Specifically, the 15-minute walking map revealed that *walking* is the slowest form of transportation. Moreover, when considering the distances that can be covered by *bicycles*, they are found to be the fourth slowest means of commuting (Tomtom traffic index, 2022). The absence of dedicated bicycle paths compounds the issue, leading to increased commuting times. When you overlay traveling distance in 15 minutes for pedestrians (Figure 3.4), sidewalks (Figure 3.12) and pedestrian activity (Figure 3.11) on each other they reveal patterns of increased commuting times. The data scheme (Table 3.2) further reveals that active transportation commuters face safety concerns, such as incidents of personal item theft, accidents that endanger lives, and bicycle theft.

4.2 How far can one travel, how sustainable is the transport mode, how safe is the user, how efficient is the transport mode and how accessible is the transport mode?

These five questions are different factors that are measured in the data scheme.

The same grading system, explained in the data analysis, is used to score these five factors. Green indicates a satisfied experience (scoring two), orange indicates average satisfaction (scoring one) and red indicates unsatisfied results (scoring zero).

The distance that one can travel depending on the mode of transport is indicated in Table 3.2.

The sustainability is measured according to three categories. These categories are petrol consumption, utility and capacity (which is influenced by the utility). The sustainability for each mode is scored out of six (2points x 3columns = 6) as seen in Table 3.2. All three active transportation modes scored six out of six (6/6), being the most sustainable way of commuting. The second most sustainable mode of transport is scooters (5/6). The third most sustainable transportation mode is taxis (4/6). Buses and trains are relatively unsustainable and scored two out of six (2/6). The least sustainable way of transporting in Hatfield is motor vehicles (1/6).

The safety is also measured according to three categories. These categories are personal item theft, transport mode theft and accident safety. The safety for each mode is scored out of six (2points x 3columns = 6) as seen in Table 3.2. All modes scored zero in terms of accident safety, the safest mode of transports scored four out of six (4/6), these include skating, buses, taxis, trains and scooters. Walking and cycling are unsafe, scoring two out of six (2/6) and motor vehicles scored zero, most unsafe mode of commuting in Hatfield.

The efficiency is measured according to two categories, namely the space it takes up on the street edge compared to the space a pedestrian occupies, and the speed it can travel in the city. The efficiency for each mode is scored out of four (2points x 2columns = 4) as seen in Table 3.2. Scooters are scored as the most efficient transport mode (4/4) as they take up little space and due to the fact that they can travel relatively quickly, averaging at 22km/h. Most modes of transport are relatively efficient and scored three out of four (3/4). This includes cycling, skating, buses, taxis and trains. The least efficient modes of transport are walking (because of the slow speed) and motor vehicles (because of the space a motor vehicle occupies on the side of the street).

The accessibility is once again measured according to three categories. That is cost, age and disabilities. The accessibility for each mode is scored out of six (2points x 3columns = 6) as seen in Table 3.2. Trains are the most accessible mode of transport in Hatfield (6/6) as it is a cheap and inclusive transport mode. Buses and walking are the second most inclusive transport mode (5/6). Taxis are accessible to all ages and disabilities, but because of the high cost (R20 per 5km), it is not as accessible as trains, scoring four out of six (4/6). Cycling and skating scores three out of six (3/6) for accessibility, it's fairly cheap transport but, excludes some age groups and some people with disabilities. Motor vehicles and scooters both scores below three out of six (3/6).

4.3 To what degree is private, public and active transportation self-reliant in Hatfield?

The total self-reliance scores for each mode of transport, considering all five factors, in Hatfield are as follows: Skating (17), Taxis (17), Trains (17), Scooters (17), Walking (15), Cycling (15), Buses (14) and lastly Motor vehicles (6).

Active transportation	(15+15+17) /3	Average 15.7
Walking	15	
Cycling	15	
Skating	17	
Public transportation	(14+17+17) /3	Average 16
Buses	14	
Trains	17	
Taxis	17	
Private transportation	(17+6) /2	Average 11.5
Motor vehicles	6	
Scooters	17	

Table 4.1 Research strategy diagram (Zwarts, 2023).

From the table above the averages for each transportation type (active, public and private) are calculated. In Hatfield, public transport is currently the most self-reliant with an average of 16/24 (66.7%). Active transportation is the second most self-reliant in Hatfield with an average of 15.7/24 (65.4%). Private vehicles are the least self-reliant in Hatfield with an average of 11.5/24 (47.9%).

4.4 What barriers do the active transportation commuters face when travelling by foot or on a bicycle, what recommendations can address these barriers?

The primary and secondary data collectively suggest that Hatfield is characterised as a low walkable city, which aids in explaining the low number of active transportation commuters. On campus, where pedestrians are the priority, the active transportation are energetic (seen in Figure

3.11). Unfortunately, just outside campus these individuals face various barriers that hinder their ability to walk, cycle, or skate effectively, which will be discussed in this section.

Regarding walking in Tshwane, key factors such as personal safety and accidents (revealed in Table 3.2) as well as attractiveness, referring to public parks (revealed in Figure 3.10) are not adequately addressed by Hatfield's sidewalks. Table 3.2 shows that the commuters' needs with regards to personal safety and accidents are not met (red block) whilst walking in Hatfield. Active commuters risk their phones, and in some instances even their lives whilst walking in Hatfield. An area of particular concern is the strip on Lynnwood Road (Mahope, 2022; Venter, 2020). These factors are crucial for encouraging a higher utilisation of active transportation, as highlighted in existing literature. Regrettably, the essential factors that may influence individuals' decision to walk instead of opting for alternative modes of transportation (such as bicycles) are not met in Hatfield.

Similarly, for cycling, Albers (2010) stresses the significance of having a continuous route and ensuring traffic safety. However, these considerations are once again not met in Hatfield, as indicated by the low safety levels and the presence of only one cycling lane, spanning less than 4.25km, which is the average distance travelled in 15 minutes by bike. The factors that typically influence individuals to choose cycling over alternative transportation options are likewise not met within the Hatfield area.

Examining the green spaces map, it becomes apparent that there is a dearth of public green spaces and parks accessible to the general population (Figure 10). Most green spaces are semi-public areas owned by the University of Pretoria and other educational institutions. This scarcity contributes to the limited attractiveness of the area and reflects the absence of diverse destinations, as there is only one public park available.

In summary, the Hatfield area faces significant challenges in meeting crucial factors such as the availability of sidewalks and bicycle paths, personal safety, attractiveness, continuous route, and traffic safety. These factors are important aspects to consider for fostering a more active transportation culture in the region.

5. Discussion

The discussion will delve into the meaning, importance and relevance of the results, by referring to literature. The discussion section is divided in sub-headings according to the four different research sub-questions. The significance of the results will tie back to the research question.

5.1 What are the current conditions of different transport modes in Hatfield?

Upon analysing the data, it was seen that motor vehicles obtained a self-reliance percentage of 25%. This observation suggests that commuters in Hatfield should generally experience low levels of satisfaction with the sustainability, safety, efficiency, and accessibility offered by motor vehicles. Despite the significant shortcomings of motor vehicles, shown in Table 3.2. which indicates that most commuting needs and expectations are not fulfilled while using motor vehicles, motor vehicles are still one of the most dominant means of commuting in Hatfield.

It is interesting to see that in Rodrigue's (2020) diagram (Figure 2.2), automobile dependency is a result of disperse and low density cities, Hatfield is a medium density and medium concentrated space. This is in spite of the fact that plenty of commuters depend on motorised vehicles and BRT's (City of Tshwane district development, 2021; Habitat Landscape Architects, 2020). This is likely the case as Rodrigue (2020) suggests, due to a lack of well designed, alternative transportation modes. Therefore it becomes imperative to explore alternative transportation solutions that can foster self-reliance as well as address the challenges associated with limited urban space (Chibuzo, 2020).

When looking at the measurables in Table 3.2, public and active transportation modes should be the most relied upon transport modes if every factor had an equal contribution in determining what mode is being used. It is interesting to see from the mapping that this is not the case. This is probably not the case because the availability of sidewalks and bicycle paths in Hatfield is severely limited (as seen in Figure 3.12). This inadequacy poses a significant challenge to promote active transportation within the area. Thus, as Albers (2010) suggests, it is perhaps a good idea to invest in public green spaces, sidewalks, continuous cycling lanes and safety.

An analysis of maps and data schemes of current transportation modes in Hatfield contributes to a new understanding of self-reliant transportation practice in the community. By revealing the dominant use of motor vehicles, low satisfaction levels in sustainability, safety, efficiency, and accessibility, and other factors driving automobile dependency. Additionally, it highlights infrastructure gaps such as limited sidewalks and bicycle paths, posing challenges to active transportation. By recognizing these insights, stakeholders can explore alternative transportation solutions, including improving public transportation systems and investing in pedestrian and cycling infrastructure. In order to foster self-reliance and address the challenges associated with limited urban space in Hatfield.

5.2 How far can one travel, how sustainable is the transport mode, how safe is the user, how efficient is the transport mode and how accessible is the transport mode?

It is evident that the distances that can be covered is directly proportional to the infrastructure used by the different transportation modes, seen in the data collection section. Walking is the only mode that scored a zero, cycling, skating and buses all score one out of two (Table 3.2). This is perhaps an indication that infrastructure for the sidewalks, bicycle lanes and buses should be improved.

It is interesting that all three active transportation modes scored six out of six (6/6) for sustainability (Table 3.2), but is still not the transport modes most actively used. This might be because commuters in Hatfield are unaware or unbothered with sustainability factors.

Active transportation is not as commonly used, due in part to safety concerns, scoring two out of six (2/6) (Table 3.2). Safety is a key factor whether commuters use active transportation or not.

Table 3.2 indicates that scooters are the most efficient transport mode, however an in-depth study on scooters fell outside the scope of this report. For future reports it would be useful to include scooter usage in the research. It is interesting to note that the majority of transport modes are either quick but use excessive space, or are slow and utilize less space. As Chibuzo (2020) suggests, it becomes imperative to explore alternative transportation solutions that can address both self-reliance and the challenges associated with limited urban space whilst satisfying the needs of time effective traveling.

It is interesting that the two most expensive travel modes, taxis and motor vehicles, are quite popular in Hatfield. The only corresponding green blocks for taxis and motor vehicles are the speeds and the distances travelled in 15 minutes. This might be an indication that commuters using motor vehicles and taxis in Hatfield are concerned most with time and speed, by looking at the data scheme (Table 3.2).

An analysis of maps and data schemes of current transportation modes in Hatfield contributes to a new understanding of self-reliant transportation practice in the community. By emphasizing the need to improve infrastructure for active transportation modes, addressing concerns about safety, and exploring alternative solutions that balance self-reliance and time-effective travel within limited urban space. The analysis also highlights the popularity of taxis and motor vehicles, indicating a prioritization of speed and time by commuters. By considering these insights, stakeholders can develop strategies to promote sustainable modes of transportation, enhance infrastructure, and raise awareness about the benefits of self-reliant transportation options in Hatfield.

5.3 To what degree is private, public and active transportation self-reliant in Hatfield?

It is important to note that private vehicles (motor vehicles and scooters) are the least self-reliant transportation mode in Hatfield with an average of 11.5/24 (47.9%) however, most of the streets in Hatfield prioritise private vehicles. This is an indication why there is a rising concern among policy experts, urban planners, and transportation specialists that communities have been designed in such a way that makes active transportation difficult and, in many cases, unsafe (Saelens et al., 2003). As a result, physical activity in Hatfield has been inadvertently reduced from commuters' daily lives, leading to an increased awareness of the impact of our environment on a less active lifestyle (Jackson and Kochtitzky, 2002; Saelens et al., 2003). By taking action and designing for active commuters, an increase in active transportation can not only improve the environment but also the health and safety of commuters. Factors like safety, sustainability and accessibility directly increases the self-reliance.

An analysis of maps and data schemes of current transportation modes in Hatfield contributes to a new understanding of self-reliant transportation practice in the community. By highlighting the disconnection between the low self-reliance of private vehicles and the prioritization thereof in the streets of Hatfield. This reveals the challenges faced by active transportation and the need for improved infrastructure to promote safety, sustainability, and accessibility. By designing for active commuters and addressing these factors, the analysis can help increase active transportation, leading to positive impacts on the environment, health, and safety of commuters in Hatfield.

5.4 What barriers do the active transportation commuters face when travelling by foot or on a bicycle, what recommendations can address these barriers?

It should be noted that Table 3.2 indicates the active commuters' needs with regards to personal safety and accidents are not met within the streets of Hatfield. Lower population density, predominantly residential land use, limited street connectivity, and insufficient pedestrian and bike facilities, such as a lack of sidewalks, bike lanes, or proper intersection signage are factors that describe Hatfield as a low-walkable neighbourhood (Brunner et al., 2018; Global desiging cities initiative and NACTO, 2016; Plan H, 2023; Saelens et al., 2003). This helps explain the low number of active transportation commuters in Hatfield.

By increasing the number of public green spaces, it may expunge some of the barriers that active commuters face in Tshwane, for example, attractiveness (referring to public parks , revealed in Figure 3.10), and the presence of a destination (Albers et al., 2010). These factors are important aspects to consider for fostering a more active transportation culture in the region.

Additionally, the literature shows how developing cities move away from motor vehicle dependency and utilize more urban and public transportation modes. These developing cities end up using mostly active transportation in the city centre. In South Africa this is not yet the case, as the barriers South Africa face is partly because of undesigned active transportation infrastructure, but it is also a direct result of a sprawling city. Unfortunately, this research report did not explore sprawling cities in sufficient depth to make any informed conclusions, as it fell outside the scope for this report. For future reports it would be of use to include sprawling cities in the research.

Analysing maps and data schemes of current transportation modes in Hatfield can contribute to a new understanding of self-reliant transportation practices in the community. It helps identify gaps in infrastructure, assess safety concerns, evaluate land use patterns, identify public green spaces, and inform policy and planning decisions. By addressing these aspects, such analysis enables the prioritization of infrastructure development, the improvement of safety measures, the promotion of mixed-use development, the creation of public green spaces, and the alignment of policies and planning decisions with the needs of active commuters. Ultimately, this fosters a more self-reliant transportation culture in Hatfield.

6. Conclusion

In conclusion, the comprehensive analysis of maps and data schemes in Hatfield, coupled with insights from the literature review, research design, results, and discussion sections, provides invaluable perspectives on the challenges and opportunities for cultivating a self-reliant transportation culture in the community. The study underscores the importance of prioritizing accessible transportation modes, as highlighted in the literature review, with an emphasis on public transport, cycling, and walking for a self-reliant community (Samsonova, 2021). The subsequent data analysis delves into safety, efficiency, and accessibility in Hatfield's current transportation landscape, shedding light on critical factors that influence self-reliance.

This research incorporates primary data from a data scheme table, evaluating transportation modes based on key criteria gathered from reputable online sources. Self-reliant transportation, defined as independent and efficient mobility, is assessed through metrics like cost, utilization, and safety. The scoring system enables a clear evaluation of transportation success, with higher scores indicating greater self-reliance.

The Hatfield analysis uncovers influential factors in active transportation, directly impacting self-reliance. Understanding these dynamics, particularly human-powered transportation modes, lays the groundwork for strategies to enhance self-reliance in the community.

The findings reveal a significant deficiency in pedestrian and cycling infrastructure, particularly in sidewalks and bicycle paths, as outlined in the results section. Walking and cycling are identified as comparatively slower modes of transportation due to these limitations. This emphasizes the pressing need for targeted improvements.

The discussion section further highlights the dominance of motor vehicles, indicating a preference for speed and time efficiency by commuters. The study advocates for investments in pedestrian and cycling infrastructure, along with enhancements in public transportation systems, to address these challenges and promote self-reliance.

Acknowledging the study's limitations in terms of data reliability and potential external influences, future research should aim to address these constraints for a more nuanced understanding of self-reliant transportation practices in the Hatfield community. Overall, this comprehensive analysis establishes a sturdy foundation for enhancing self-reliance and accessibility in Hatfield's transportation system, ultimately contributing to a more sustainable, efficient, and secure commuting environment for all residents.

The report's thorough examination of transportation modes and its emphasis on accessibility, safety, efficiency, and sustainability have shed light on crucial factors influencing self-reliant mobility. While recognizing the potential constraints in data reliability and external influences, it is important to note that the structured evaluation provided by the data scheme table offers valuable insights, albeit representing a specific point in time. Looking ahead, addressing these limitations and exploring evolving urban dynamics and emerging technologies will further refine our approach towards fostering self-reliance, accessibility, and sustainability in Hatfield's transportation landscape.

7. References

AA rates, 2023. Vehicle rates calculator. URL https://aa.co.za/vehicle-rates-calculator/

Africa check, 2021. Taxi industry transports majority of South Africa's public commuters, but exact number of passengers unclear. URL https://www.polity.org.za/article/taxi-industry-transports-majority-of-south-africas-public-commuters-but-exact-number-of-passengers-unclear-2021-02-03#:~:text=South%20Africa's%20national%20land%20transport,16%20people%2C%20including%20the%20driver.

African news agency, 2018. Cable theft puts brakes on Pretoria-Joburg Metrorail trains. IOL news. URL https://www.iol.co.za/news/south-africa/gauteng/cable-theft-puts-brakes-on-pretoria-joburg-metrorail-trains-17137848

Albers, P.N., Wright, C., Olwoch, J., 2010. Developing a South African pedestrian environment assessment tool: Tshwane case study. S Afr J Sci 106, 8 pages. https://doi.org/10.4102/sajs.v106i9/10.187

Basarić, V., Vujičić, A., Simić, J.M., Bogdanović, V., Saulić, N., 2016. Gender and Age Differences in the Travel Behavior – A Novi Sad Case Study. Transportation Research Procedia 14, 4324–4333. https://doi.org/10.1016/j.trpro.2016.05.354

Batlle, L., 2022. Interconnected public transport systems are key to a smart city. URL https://www.thenationalnews.com/opinion/interconnected-public-transport-systems-are-key-to-a-smart-city-1.3503 (accessed 11.7.23).

Brunner, H., Hirz, M., Hirschberg, W., Fallast, K., 2018. Evaluation of various means of transport for urban areas. Energ Sustain Soc 8, 9. https://doi.org/10.1186/s13705-018-0149-0

Cervero, R., Kockelman, K., 1997. Travel demand and the 3Ds: Density, diversity, and design.

Chawane, G., 2016. Man dies after bus crash into Gautrain tracks. Rekord Pretoria. URL https://rekord.co.za/90419/newsflash-man-dies-after-bus-crash-into-gautrain-tracks/

Chibuzo, N., 2020. Rethinking the idea of independent development and self-reliance in Africa | African Review of Economics and Finance [WWW Document]. URL https://www.ajol.info/index.php/aref/article/view/232421 (accessed 5.18.23).

City of Tshwane district development, 2021. Metro IGR plan: City of Tshwane.

CSIR, 2023. Greenbook. City of Tshwane risk profile. URL https://riskprofiles.greenbook.co.za/

Deloitte, 2022. 15-Minute City | Deloitte Global [WWW Document]. URL https://www.deloitte.com/global/en/Industries/government-public/perspectives/urban-future-with-a-purpose/15-minute-city.html (accessed 5.18.23).

Department of transport, 1999. Moving South Africa.

Frank, L., 2000. Land use and transportation interaction - Implications on public health and quality of life.

Global designing cities initiative, NACTO, 2016. Global street design guide.

Global street design guide.pdf, n.d.

Habitat Landscape Architects, 2020. Hatfield metropolitan node precinct plan.

Jackson, R., Kochtitzky, C., 2002. Creating a Healthy Environment 2.

Khosa, M.M., 1995. Transport and popular struggles in South Africa. Antipode 27, 167–188. https://doi.org/10.1111/j.1467-8330.1995.tb00271.x

Kings, S., 2016. A changing world means urban areas must be self-reliant [WWW Document]. URL https://mg.co.za/article/2016-05-31-a-changing-world-means-urban-areas-must-be-self-reliant/ (accessed 5.18.23).

Kitamura, R., Mokhtarian, P.L., Laidet, L., 1997. A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area.

Liao, B., Xu, Y., Li, X., Li, J., 2022. Association between Campus Walkability and Affective Walking Experience, and the Mediating Role of Walking Attitude. IJERPH 19, 14519. https://doi.org/10.3390/ijerph192114519

Lombard, H., 2022. Tshwane Bus Routes [WWW Document]. Bus route map. URL http://www.tshwane-busroutes.co.za/map.php (accessed 5.18.23).

Mackett, R.L., 2021. Transport Modes and People with Limited Mobility, in: International Encyclopedia of Transportation. Elsevier, pp. 85–91. https://doi.org/10.1016/B978-0-08-102671-7.10410-5

Mahope, R., 2022. Crime still big problem in Hatfield, says recently robbed UP student. URL https://rekord.co.za/434906/crime-still-big-problem-in-hatfield-says-recently-robbed-up-student/

March, A., 2010. Recognising the economic role of bikes: Sharing parking in Lygon Street, Carlton.

Mattioli, G., Anable, J., Vrotsou, K., 2016. Car dependent practices: Findings from a sequence pattern mining study of UK time use data. Transportation Research Part A: Policy and Practice 89, 56–72. https://doi.org/10.1016/j.tra.2016.04.010

Melosi, M.V., 2010. The Automobile Shapes The City. URL http://autolife.umd.umich.edu/Environment/E_Casestudy/E_casestudy3.htm

Metrorail, 2023. Metrorail. URL http://www.metrorail.co.za/Timetables.html

Mthimkulu, N., 2017. Southern African solutions to public transport challenges.

Pienaar, P.A., 2007. Considerations with Regard to a BRT for Tshwane.

Plan H, 2023. Active transportation. URL https://planh.ca/take-action/healthy-environments/built-environments/page/active-transportation

Radwan, A.H., Morsi, A.A.G., 2019. The Human Scale in Public Spaces. An Analytical Study of New Cairo Settlements. SSRN Journal. https://doi.org/10.2139/ssrn.3449795

Reut, V., 2023. Technoton. URL https://jv-technoton.com/cases/eco-driving-quality-system-for-city-and-intercity-buses/#:~:text=Average%20fuel%20consumption%20of%20the,30%20liters%20per%20100%20km.

Riding boards, 2023. Average Skateboard Speed: How Fast Do We Ride? URL https://www.ridingboards.com/average-skateboard-speed/

Rodrigue, J.-P., 2020. The geography of transport systems. Urban transport challenges. URL https://transportgeography.org/contents/chapter8/urban-transport-challenges/

Saelens, B.E., Sallis, J.F., Frank, L.D., 2003. Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. ann. behav. med. 25, 80–91. https://doi.org/10.1207/S15324796ABM2502_03

Samsonova, T., 2021. Reversing car dependency: Summary and Conclusions.

Sibanda, L., 2013. Tuks student risk crime.

Sisson, P., 2023. What is a 15-minute city? URL https://citymonitor.ai/neighbourhoods/what-is-a-15-minute-city

Steves, R., 2012. Europe made easy on public transport. URL https://www.seattletimes.com/life/travel/europe-made-easy-on-public-transport/

Van der Westhuizen, F., 2012. Series of thefts on campus – Tuks bicycle thief gets 18 months. Pdby media. URL https://pdby.co.za/series-of-thefts-on-campus-tuks-bicycle-thief-gets-18-months/

Venter, O., 2020. Hatfield is a hotspot for cellphone theft – police. Rekord Pretoria. URL https://rekord.co.za/360425/hatfield-is-a-hotspot-for-cellphone-theft-police/

Wagenbuur, M., 2019. Dutch Cycling [WWW Document]. Bicycle Dutch. URL https://bicycledutch.wordpress.com/ (accessed 5.18.23).