AN EXPLORATION OF THE SUSTAINABILITY OF A PUBLIC TRANSPORTATION SYSTEM FOR A SMALLER METROPOLITAN AREA IN SOUTH AFRICA: A CASE STUDY OF MANGAUNG METROPOLITAN MUNICIPALITY

BY

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PROMOTER: PROF VERNA NEL

DECLARATION

I, Everardt Andrè Burger, declare that the thesis that I herewith submit for the Doctoral Degree in Urban and Regional Planning at the University of the Free State, is my independent work and that I have not previously submitted it for a qualification at another institution of higher education. I also declare that this document was language edited (please see the letter from my editor in Appendix D).

I also cede copyright of this thesis to the University of the Free State.

Everardt Andrè Burger

December 2019

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LIST OF ACRONYMS AND ABBREVIATIONS

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AI	Artificial Intelligence
BCMM	Buffalo City Metropolitan Municipality
BRT	Bus Rapid Transport
CBD	Central Business Districts
CNU	Congress for the New Urbanism
DFA	Development Facilitation Act
GDP	Gross Domestic Product
GHG	Global Greenhouse Gas
IPTN	Integrated Public Transport Network
ITS	Intelligent Transport Systems
IUDF	Integrated Urban Development Framework
MMM	Mangaung Metropolitan Municipality
MTSF	Medium-Term Strategic Framework
NDP	National Development Plan
NHTS	National Household Travel Survey
NMT	Non-Motorised Transport
NPC	National Planning Commission
OECD	The Organisation for Economic Co-operation and Development
PTNG	Public Transportation Network Grant
RMTC	Road Traffic Management Corporation
RSA	Republic of South Africa
SANRAL	South African National Road Agency
SANTACO	South African National Taxi Council
SD	Sustainable Development
SDG	Sustainable Development Goals
SPLUMA	Spatial and Land Use Management
Stats SA	Statistics South Africa
TOD	Transport Oriented Development
UN	United Nations
UNDP	United Nations Development Programme
VR	Virtual Reality

5.1 CLARIFICATION OF TERMINOLOGY

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Bus Rapid Transit systems (BRTs)	Bus Rapid Transport systems (BRTs) offer mass transportation for underserviced communities, especially in outlying areas of cities due to the problem of urban sprawl in South African cities (Chobokoane & Horn, 2015:79). In South Africa, the most common public transportation modes are conventional, commuter buses, and minibus taxis with limited use of Bus Rapid Transport systems (BRT) in only major metropolitans.
Greenhouse Gas Emissions (GHG)	Global greenhouse gas (GHG) emissions, which include CO_2 emissions, have grown more than 70% from 1970 to 2004 (IPCC, 2007:3), and have constantly increased over the past decade (i.e. 2007 - 2017) (Global Energy & CO_2 Status Report, 2017:3; Sharifi and Yamagata, 2016:1668). The importance of promoting responsible consumption and production through our daily choice of transportation method is of importance since the use of fossil fuels is one of the major contributing factors to the ever-increasing GHG emissions.
Mangaung Metropolitan Municipality (MMM)	Mangaung Metropolitan Municipality (MMM) is the metropolitan municipality with the smallest population and the lowest density of all the metropolitan municipalities within South Africa (Stats SA, 2012). MMM comprises Bloemfontein city, as well as the towns of Botshabelo, Thaba Nchu, Dewetsdorp and Wepner. In 2011 MMM has a population of approximately 750 000 people (Stats SA, 2012). MMM is located in the central province of the Free State in South Africa.
New Urbanism	The New Urbanism movement is an alternative approach to spatial planning in the postmodernism era (i.e. the era after the Second World War). This movement is also commonly referred to as neo-traditional (Ford, 1999:249) since it incorporates elements of modernism (i.e. the era before the Second World War) as well as postmodern elements (Hirt, 2009:249). The design

principles of this movement have been incorporated into various fields including sustainable development, Smart Growth, and transit, pedestrian and bicycle planning (Bohl, 2000:761; Garde, 2004:154), as well as most policies in the United States (Hirt, 2009:248).

Public Transport

Public transport internationally started with Hansom Cabs (i.e. a two-wheeled horse-drawn cab accommodating two inside, with the driver seated behind) in London which later expanded to the mass public transportation with horse drawn trams (Crank, 2011: online). With the invention of the motorised engine, public transportation also saw a transformation. In South Africa, trains and trams were commonly used, but public transportation for the masses started when taxi operators were forced to use sedan vehicles with fare meters during the twentieth century. In 1977 a legislation change allowed the use of minibus taxis which could transport fifteen passengers at a time (Ingle, 2009:72). Public transportation provides mobility to people that do not have access to personal motorised modes of transport due to their economic situation, social characteristics (e.g. age and disability), access to transportation and personal preference (e.g. reducing emissions by not using a personal vehicle).

Smart Growth

Smart Growth is a popular planning concept for managing traffic congestion and the ever-increasing development (sprawl) of the community (e.g. housing or commercial development). The ideal for Smart Growth is to halt urban sprawl by implementing policies that focus more on compact development (Kushner, 2002:48). Handy (2005:1) avers that a close relationship exists between the Smart Growth of a city and its ability to be sustainable. The aim is to have parallel support between Smart Growth of a community/neighbourhood and first-generation growth management (Kushner, 2002:48).

Sustainable Development (SD)

The notion of sustainable development (SD) is not a modern-day fad seeing as the concept has firm roots in ancient times (Du Pisani, 2006:87). Campbell (2016:389) highlights the three key considerations to achieve SD,

namely: economic development, environmental protection and social justice. The triangulation of these three key considerations is referred to as the planner's triangle (Campbell, 2016:389). SD has received more emphasis over the past few decades in the light of the world's ever-increasing population growth, consumption rates and limited available natural resources (Du Pisani, 2006:87), and is regarded as a wicked problem in the light of the several contradicting priorities or key considerations of the term and their resulting conflicts (Campbell, 2016:390). SD is not a constant state of harmony as a result from this compromise but should rather be seen as an ongoing process of change (Campbell, 2016:396; Dierwechter, 2014:692; United Nations World Commission on Environment and Development, 1987:17).

Transport Oriented Development (TOD)

A city with a high level of vehicle dependency is a big challenge for urban and transport planners in modern times (Ogra & Ndebele, 2015:539). The only way to reverse the effects of vehicle orientated development is to introduce TOD practices which can act as a central role or model for policy making (Ogra & Ndebele, 2015:539). TOD is defined as urban planning that links various land uses (e.g. residential, business and leisure) with the transit system of a city to promote SD practices, reduce vehicle dependency and limit urban sprawl (Doulet, Delpirou & Delaunay, 2017:1).

ABSTRACT

The South African public transportation system is often associated with words such as 'poor service delivery', 'unreliable', 'inaccessible', 'unsafe', 'unaffordable', and 'uncomfortable'. Mangaung Metropolitan Municipality currently has a state-subsidised transportation system which residents can use to travel between and within the various towns and cities of the metropolitan region (Chobokoane & Horn, 2015:81). Urban sprawl is a common phenomenon in South African cities, and Mangaung Metropolitan Municipality is no exception, which results in low density areas on the edges of the city that have limited access to basic services such as public transportation (Knaap & Talen, 2005:108). Although the Mangaung Metropolitan Municipality's Bus Rapid Transit project has many constraints (e.g. limited funding and expectations of high performance and quality) and is far behind on its original operation timeline, the value that this project may bring to the community is not doubted. This study aims to explore the factors that will promote a sustainable public transportation system for a medium size metropolitan area in South Africa such as MMM.

The four research objectives derived from the aim guide the empirical and non-empirical facets of this study. The first objective calls for the non-empirical exploration of the literature on spatial planning and transportation development guidelines which may influence the sustainability of public transportation systems. The theoretical foundation of the first objective informs the empirical investigation expressed in the second and third objectives. The second objective investigates the transportation needs of the population of the study area, whereas the third objective identifies the spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area. The fourth and final objective involves the convergence, synthesis and integration of the findings obtained through the investigations pertaining to the first three research objectives in order to propose plausible policy guidelines for the development of a sustainable public transportation system for the study area.

The research is conducted within the interpretivist paradigm with a single case-study approach. Although this study employed a mixed method research design, the interpretivist paradigm was chosen since the individual commuter's opinion is of particular value in this research study. Mangaung Metropolitan Municipality is the metropolitan municipality with the smallest population and the

lowest density of all the metropolitan municipalities within South Africa and has a population of approximately 750 000 people (Stats SA, 2012). A purposive sampling method was used to select the first round of research assistants in the study area as a starting point for a snowball sampling technique. The data collection tool of this study employed a self-administered, self-explanatory mixed method questionnaire which was informed by the literature. A total of 550 questionnaires were distributed, with 447 respondents completing and returning the questionnaires (81.24% response rate).

The contribution and significance of this study are the generation of new knowledge regarding sustainable public transportation systems for smaller cities and metropolitan areas on which there is limited published research, and to address the gap in knowledge between the areas of spatial, transportation and sustainable development practices in South Africa. The proposed plausible policy guidelines acknowledge the need to protect the environment, contribute to the economic development of the country and provide social justice to the residents of the area. Although the policy guidelines might be generalisable to other public transportation systems of other metropolitans or secondary cities such as George, Buffalo City, Ekurhuleni, Msunduzi and Polokwane, the purpose of this study was to investigate the specific transportation needs of the population of Mangaung Metropolitan Municipality.

Future research pertaining to the policy guidelines for the design of a sustainable public transportation system in smaller areas can be conducted through in-depth interviews with spatial and transportation planners to expand on the proposed guidelines derived from this study. If the proposed policy guidelines discussed in section 8.5 are implemented, it may open the way for the exploration of the feasibility and effectiveness of the application of these guidelines into the national policies of South Africa.

Key terms:
Transport Oriented Development, Bus Rapid Transit, Mangaung Metropolitan Municipality, Sustainable development; Public transportation

CHAPTER 1

ORIENTATION TO THE STUDY

1

1.1 INTRODUCTION

The South African public transportation landscape is sketched by the local news, social media and the commuters who use this service as unsustainable due to various spatial limitations (e.g. lack of accessibility to mode, transportation stops and urban sprawl), transportation factors (e.g. road safety, travel distance and unsafe travel modes), and sustainable development aspects such as an unequal society where the majority of South Africans cannot afford the fares, together with a high unemployment rate and the downgrading of the South African economy. This chapter provides the reader with an orientation to the study and serves as a guide to complete this research. This study explores how public transportation in smaller metropolitans in South Africa can be more sustainable by converging the themes of spatial planning, transportation and sustainable development. The various sections in this chapter, as outlined in Figure 1.1, reveal the problem and the resulting need for this study, the guiding aim and objectives, the rationale to undertake this study, the significance and contribution to the field of knowledge and a brief description of how this research was undertaken within the specific methodological approach and ethical considerations to uphold the trustworthiness of the contribution to the field of knowledge.

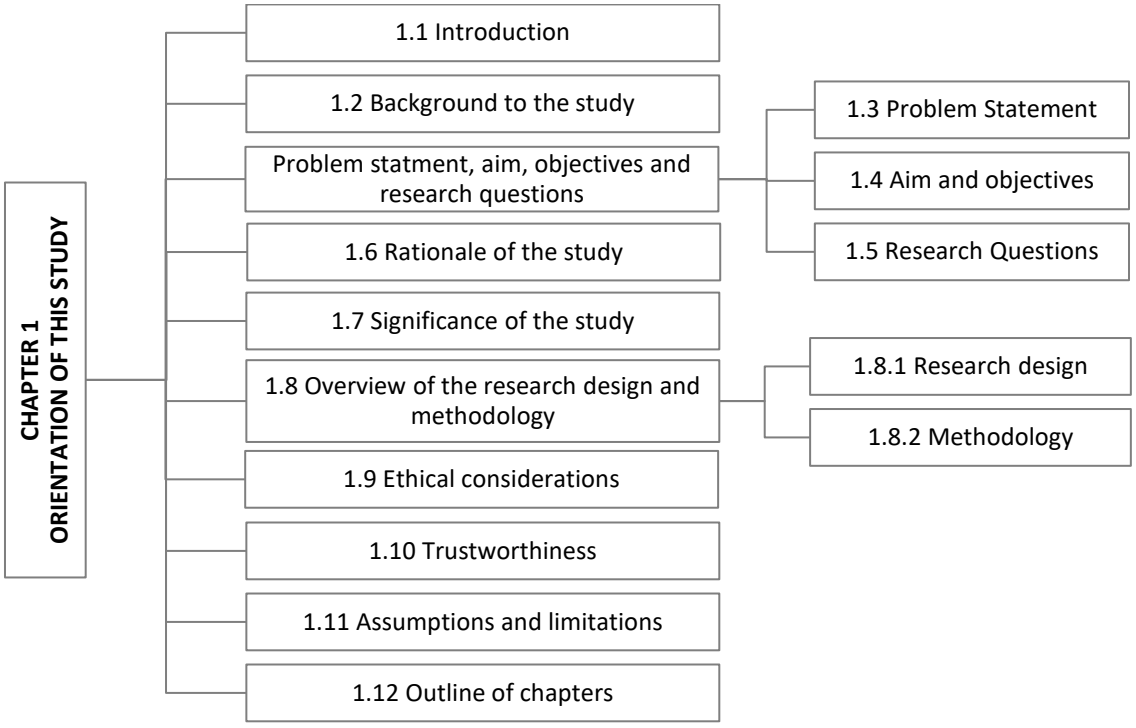


Figure 1.1: Outline of Chapter 1

1.2 BACKGROUND TO THE STUDY

In 1987, the United Nations first introduced the concept of Sustainable Development (SD) in the Brundtland Commission (UN World Commission on Environment and Development, 1987) to raise awareness of the need to reduce the consumption rate of the world's natural resources and environment protection with the ever increase in the world's population (Du Pisani, 2006:94). During the UN+20 summit in Brazil, 17 Sustainable Development Goals (SDGs) were created by world governments to promote sustainable practices to conserve the world for future generations (Griggs, Stafford-Smit, Gaffney, Rockström, Öhman, Shyamsundar, et al., 2013:305). The UN (United Nations Development Programme [UNDP], 2017:6) identifies three core elements for sustainable development, namely: economic growth, social inclusion and environmental protection.

One of the 2030 SDGs is the promotion of sustainable cities and communities which speaks to the global increase of people moving to cities. If one considers that cities only occupy about 2% of the land on the planet but house over half of the world's population, it is clear why this is listed as one of the 2030 SDGs (Matter, 2016:1; UNDP, 2017:14). The importance of sustainable development in cities is stressed further by the UN's estimation that by 2050 approximately two-thirds of the world's population will live in cities (UNDP, 2017:14). This urbanisation will result in new urban management and planning problems which planners have not addressed before (Watson, 2009:2263).

Watson (2009:2263) forecasts that a large proportion of the population growth in cities will take place in cities of the Global South. The Integrated Urban Development Framework (IUDF) of South Africa projects that 71.3% of the country's population will live in cities by 2030 (RSA, Cooperative Governance and Traditional Affairs [COGTA], 2016:7), which is higher than the global urbanisation forecast of the UN that estimates that by 2050 approximately two-thirds of the world's population will live in cities (UNDP, 2017:14). Spatial inequalities are one of the major concerns identified in South African cities which are renowned for their segregated spatial planning between different culture groups (Maylam, 1995:15), which results in a large proportion of the population living on the edges of the city with limited access to basic services. This phenomenon is referred to as urban sprawl and formally defined as unplanned development which results in low density and higher vehicle dependency (Knaap & Talen, 2005:108).

Suburbs with low density and vehicle dependency as a result of urban sprawl are likely to have limited access to public transportation, greater travel distances and restricted walking and cycling opportunities (Ogra & Ndebele, 2015:539; De Vos, Van Acker & Witlox, 2014:326). Transportation plays an important role in the development and shaping of the economy of the world (since it is part

of humans' daily life (Filipczyk, 2015:117). A lack of personal mobility or access to transportation hinders the economic and social development of a society (Lee, Sener & Jones, 2017:211). The economic stance of individual commuters is an important aspect to consider creating sustainable transportation, especially in a country such as South Africa which has more than 15 million people that are unemployed (Statistics South Africa [Stats SA], 2018: online). The Integrated Urban Development-Framework (RSA, COGTA, 2016:52) of South Africa acknowledges that an integrated transportation system that encourages mobility should promote social development, be more affordable to commuters and provide linkages between the urban and rural areas of a city.

Buses form an important part of public transportation systems in many global cities (Babalik-Sutcliffe & Cengiz, 2015:792). Bus Rapid Transport (BRT) systems are a bus-based system which is used for mass transit in developing cities (Mallqui & Pojani, 2017:254; Venter, Jennings, Hidalgo & Valderrama Pineda, 2018:149; Deng & Nelson, 2012:108). In the light of the need to address the spatial inequalities in South African cities, a public transport network grant was offered by the South African government to implement BRT systems in many metropolitan municipalities (Van Ryneveld, 2018:2), including the Mangaung Metropolitan Municipality (hereafter referred to as MMM) which is one of the smaller metropolitan cities in the country. The metropolitan municipality consists of Bloemfontein, Botshabelo, Thaba Nchu and various other small towns linked together with a state-subsidised transportation system (Chobokoane & Horn, 2015:81).

The Republic of South Africa's Department of Transportation (2019: online) indicates that MMM should have completed their public transport network development planning and service contract designs during 2013/14 and started with the network development in 2014/15. In a meeting held in 2017 on the progress, challenges, and risks faced by cities to roll out the BRT systems, MMM reported that their go-live date is during the financial year of 2019/20 for Phase 1 which includes the areas of Bloemfontein CBD, Freedom Square, Rocklands, and Waaihoek (MMM, 2017:8). The project steering committee cites very limited funding and expectations of high performance and quality as the main challenges that this project faces (MMM, 2017:41).

Todes (2011:116, 120, 128) notes that spatial planning in this century promotes sustainability, inclusiveness (social justice) and liveability in growing cities. Sustainability also aligns with other prominent themes of planning of this century (e.g. New Urbanism and Smart Growth), such as limiting urban sprawl, creating compact cities, transport orientated development and walkable urbanism (Campbell, 2013:88). Transport Orientated Development is a key consideration to address spatial inequalities in South Africa through the promotion of high-density developments with restricted

parking, mixed land uses and access to public transportation to counter vehicle dependency and urban sprawl (Chatman, 2013:17).

Within the MMM the most significant concern is the skewed spatial patterns that are created by the apartheid regime, which poses a challenge to develop their communities (MMM, 2018:44). This created low economical activities in the townships and residents are required to travel long distances for proper economic events (MMM, 2018:44). The spatial planning of the area provides a disadvantage to the poorer people in the townships that need to travel a great length for employment or services (MMM, 2018:44). The current transit situation assists the challenge of poverty and unemployment. MMM aims to embrace human settlement, environmental management, and increase economic activities through a spatial development framework (MMM, 2018:44).

1.3 PROBLEM STATEMENT

The South African public transportation system is often associated with words such as 'poor service delivery', 'unreliable', 'inaccessible', 'unsafe', 'unaffordable', and 'uncomfortable'. MMM currently has a state-subsidised transportation system which residents can use to travel between and within the various towns and cities of the metropolitan region (Chobokoane & Horn, 2015:81). These issues are the antithesis of sustainable transportation. In this respect, South Africa experiences similar problems as other countries of the Global South when it comes to moving towards sustainable development. Urban sprawl is a common phenomenon in South African cities, with MMM no exception, which results in low density areas on the edges of the city that have limited access to basic services such as public transportation (Knaap & Talen, 2005:108). Although the MMM BRT project has many constraints (e.g. limited funding and expectations of high performance and quality) and is far behind on its original operation timeline, the value that this project may bring to the community is not doubted. Goal 11 of the United Nations' seventeen sustainable development goals includes safe, affordable, accessible and sustainable transport systems for all. Sadly, South Africa is slow with its implementation of sustainable development in national policies (Swilling, 2011:24), including sustainable and affordable transportation. Therefore, this research explores the sustainability of a public transportation system for a smaller metropolitan area such as MMM.

1.4 AIM AND OBJECTIVES

The aim of this study is to explore the promotion of a sustainable public transportation system for a small or medium size metropolitan area in South Africa. Four objectives guide the exploration of this study, namely:

1 Explore spatial planning and transportation development guidelines which may influence the sustainability of public transportation systems (see Chapters 2, 3 and 4).
2 Investigate the transportation needs of the population of the study area (see Chapters 6 and 7).
3 Identify the spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area (see Chapter 7).
4 Propose plausible policy guidelines for the development of a sustainable public transportation system for the study area (see Chapter 7).

1.5 RESEARCH QUESTIONS

The primary research question of this study is how to promote the development of a sustainable public transportation system for a smaller metropolitan area in South Africa. Four secondary research questions were derived to answer the primary research question, namely:

1 What are the spatial planning and transportation development guidelines which may influence the sustainability of public transportation systems?
2 What are the transportation needs of the population of the study area?
3 What are the spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area?
4 What policy guidelines can be proposed to develop a sustainable public transportation system for the study area?

1.6 RATIONALE OF THE STUDY

South Africa is no different from any of the world's other developing countries which need to address the mandated SDGs by 2030. South Africa was quite slow with its inclusion of sustainable development (SD) in national policies with most policies being updated only a few years ago (Swilling, 2011:24) [see RSA National Development Plan (NDP), 2012; The Integrated Urban Development Framework (RSA IUDF), 2016; RSA The Spatial and Land Use Management (SPLUMA), 2013]. The three pillars of SD are currently in a dire state in South Africa due to the downgrading of the country's economy to junk status by two of the major investment agencies, the ever increasing population of the country that needs access to basic services (e.g. water, electricity, basic sanitation and transportation), the unequal society with a high unemployment rate and the increasing pressure on the natural environment. Equity is a problem that has long been discussed in the social sciences and amongst decision makers, however, the contribution of transportation to this problem is often overlooked (Zakowska & Pulawska, 2014:68). Due to a lack of public transportation systems in most developing countries such

as South Africa, many people are obliged to make use of their own private vehicles to commute daily which increases the use of scarce fossil fuels and vehicular emissions. However, South Africans who do not own private vehicles must make use of other transportation options which impacts on their mobility.

There is a need to explore how the public transportation system for MMM can be sustained in the light of the limited published research on MMM, especially in respect of transportation and the specific needs of the sample population. The economic situation of MMM's BRT project, as well as the economic state of the country, emphasises the need for research that specifically focusses on this metropolitan region's requirements to create a sustainable public transportation system and not broader, more generalisable requirements, although it is possible to do so.

1.7 SIGNIFICANCE OF THE STUDY

As noted in the problem statement of this study, the Department of Transportation's (2019: online) expansion of the BRT programmes have been severely delayed due to a number of challenges as reported to the Parliamentary Monitoring Group in 2017. The original aim of the BRT programmes was to ensure that all city residents are not more than 500 meters away from a BRT system by 2020. The achievement of this aim is currently outside the reach of South Africa's Department of Transportation with only a short time left on the calendar before the start of the 2020 year. The MMM reported that they envision to go live with Phase 1 of the BRT system in the financial year of 2019/20; however, little progress has been made. The current state of the rollout of the programme accentuates the importance of this research because when it is eventually implemented, it should be sustainable even within the financial limitations of the municipality in order to address the other two SD pillars, namely environmental protection and social justice. This study attempts to address the gap in knowledge between the three knowledge areas of spatial, transportation and sustainable development to propose plausible policy guidelines for the development of a sustainable public transportation system in the study area that acknowledges the need to protect the environment, contribute to the economic development of the country and provide social justice to the residents of the area. Although the policy guidelines might be generalisable to other public transportation systems of other metropolitans or secondary cities such as George, Buffalo City, Ekurhuleni, Msunduzi and Polokwane, the purpose of this study is to investigate the specific transportation needs of the population of MMM.

1.8 OVERVIEW OF THE RESEARCH DESIGN AND METHODOLOGY

1.8.1 Research Design

The research is conducted within the interpretivist paradigm with a single case-study approach. Although this study employed a mixed method research design, the interpretivist paradigm was chosen since the individual commuter's opinion is of particular value in this research study. A case-study approach is employed since the research has set parameters within which it is completed. The qualitative research component is used as an explanatory element in the research design to shed light on the findings of the quantitative dataset.

1.8.2 Methodology

The methodology of this research is described in the sections to follow, namely: the study area, data collection tool, sampling technique, response rate and data analysis.

1.8.2.1 Study area

Mangaung Metropolitan Municipality (MMM) is the metropolitan municipality with the smallest population and the lowest density of all the metropolitan municipalities within South Africa (Stats SA, 2012). MMM comprises of Bloemfontein city, as well as the towns of Botshabelo and Thaba Nchu. In 2011 MMM has a population of approximately 750 000 people and is similar in size to the Buffalo City Metropolitan Municipality (BCMM) located in the Eastern Cape province of South Africa, which has a total number of 755 200 residents (Stats SA, 2012). The low population of MMM is accentuated when compared with the Johannesburg Metropolitan Municipality (population: 4 434 827 people), Cape Town Metropolitan Municipality (population: 3 740 026 people) and Tshwane Metropolitan Municipality (population: 2 921 488 people) (Stats SA, 2012). Larger metropolitan municipalities in South Africa have an extended infrastructure for public transportation (i.e. Bus Rapid Transport systems (BRT) used in the Gauteng province and Cape Town city region). However, smaller metropolitan municipalities' public transportation systems, such as BCMM are only used by the people that cannot afford their own vehicles (Buffalo City Integrated Development Plan, 2014:209). Reference is made to BCMM; however, this finding is applicable to MMM as well since they are similar in population size and density. MMM, in particular the city of Bloemfontein, will be used as the study area for this research to investigate whether it is feasible to improve the public transportation system's infrastructure in smaller metropolitan municipalities. The motivation for selecting this metropolitan municipality is that the researcher has lived in the city of Bloemfontein for the past decade and has knowledge of its public transportation system and a working relationship with the municipality.

1.8.2.2 Data collection tool

The data collection tool of this study employed a self-administered, self-explanatory mixed method questionnaire that is informed by the literature. The questionnaire was divided into four sections, namely Section A: Demographic (including social economical aspects) and psychographic information of respondents; Section B: Private transportation users; Section C: Public transportation users, and Section D: Non-motorised transportation users. Respondents were asked to complete all the sections relevant to them together with Section A which was compulsory. The questionnaire employed a five-point Likert scale to derive quantitative data (closed-ended), and the open-ended questions at the end of each section in the questionnaire produced the explanatory qualitative data. The data collection tool was piloted with ten respondents before it was distributed to contribute to the trustworthiness of this study. The completed pilot questionnaires were excluded from the final data analysis.

1.8.2.3 Sampling technique and response rate

The study started with a purposive sampling method to select the first round of respondents as a starting point for a snowball sampling technique. Five research assistants, known to the researcher that reside in different residential areas of the metropolitan area, were purposively chosen. These five research assistants were each given 100 printed questionnaires and informed consent letters to distribute to their network of known and unknown respondents. The researcher also personally distributed a further 50 questionnaires to known and unknown respondents. A total of 550 questionnaires were distributed, with 447 respondents completing and returning the questionnaires (81.24% response rate).

1.8.2.4 Analysis of the quantitative and qualitative data

The quantitative data was analysed according to the steps set out by Fouché and Bartley (2015:257-258) by firstly entering it into a Microsoft Excel sheet. The nominal and ordinal variables of the demographic and psychographic information of the questionnaire were captured to determine if the sampled data has specific groups or specific ranks. The quantitative data measured with the Likert scale was awarded a value of between 1 to 5, with non-responses marked as 0. The quantitative data analysis was limited to frequencies and standard deviation calculations.

The qualitative data obtained from the qualitative components of the questionnaire were analysed according to the process suggested by Schurink, Fouché and De Vos (2011:403-404), namely by coding and fine-coding the data, refining categories, and identifying emerging themes by using a computer programme such as Microsoft Excel. In addition, the literature findings assisted in analysing the data and gleaning appropriate meaning from the way respondents' individual remarks were formulated. The biographical data of the questionnaire was used to categorise the data in the discussion section (Chapter 7) of this research.

1.9 ETHICAL CONSIDERATIONS

A brief overview of the ethical considerations is given in this section (see 5.6 for a detailed description). The sample population of this study were aged between 18 and 65 years of age to exclude any at-risk groups. Respondents were provided with an informed written consent form which they had to sign prior to completing the data collection tool. To ensure confidentiality, anonymity, and privacy of the respondents, no personal details were captured during this research. Respondents had the right to withdraw at any stage of the research and participation was completely voluntary. The hard-copy questionnaires are locked away in a safe to which only the researcher has a key, and the soft-copy data is password protected. Respondents were not deceived in any manner, no harm came to them, and there were no benefits received for participating in this study.

1.10 TRUSTWORTHINESS

The trustworthiness measures of the study are discussed in detail in section 5.5. This study employed the quantitative trustworthiness measures of validity, reliability and objectivity together with the qualitative trustworthiness measures of credibility, transferability, dependability and confirmability.

1.11 ASSUMPTIONS AND LIMITATIONS

The study area consists of MMM situated in the Free State, South Africa. Some assumptions and limitations of this study are:

- The respondents that completed the questionnaire were familiar with their surroundings and the basic knowledge of their mode of public transportation (Assumption).
- Non-responsiveness from respondents in the questionnaire was due to a lack of transport experience and not to a lack of understanding of the questions (Assumption).
- The researcher aimed to distribute the questionnaire to all parts of the study area. The researcher assumed that all areas of the study area were reached with the questionnaire (Assumption).
- The study area of MMM was selected on the basis of its size and the researcher was restricted to this metropolitan only within his time and financial constraints (Limitation).
- The data analysis was restricted on the basis of the objectives of the study. Further analysis beyond the objectives of this study was also restricted due to time constraints (Limitation).
- Limited generalisability of the findings due to the research design and methodology of this study (Limitation).

1.12 OUTLINE OF CHAPTERS

An outline of the eight chapters of this research is provided in the figure on the next page. The literature review encompasses three chapters (see Chapters 2, 3 and 4). In these three chapters the focus is based on spatial planning (Chapter 2), transportation development (Chapter 3) and

sustainable development (Chapter 4). These chapters provide a background into achieving objective 1 of the study. This is followed by the research design and methodology (see Chapter 5) to assist the reader's understanding of the different procedures followed for the completion of the study. The following chapters are the interpretation, findings and discussion of the data (see Chapters 6 and 7). Chapter 6 is more based on the profile of the respondents and Chapter 7 focuses on the interpretation, findings and discussion of the data. These chapters address the remainder of the objectives of the study. The last chapter is a conclusion that reflects on the research by answering the posed research questions in section 1.5 together with a discussion on the limitations of this research and future recommendations (see Chapter 8).

OVERVIEW OF THE CHAPTERS OF THIS STUDY

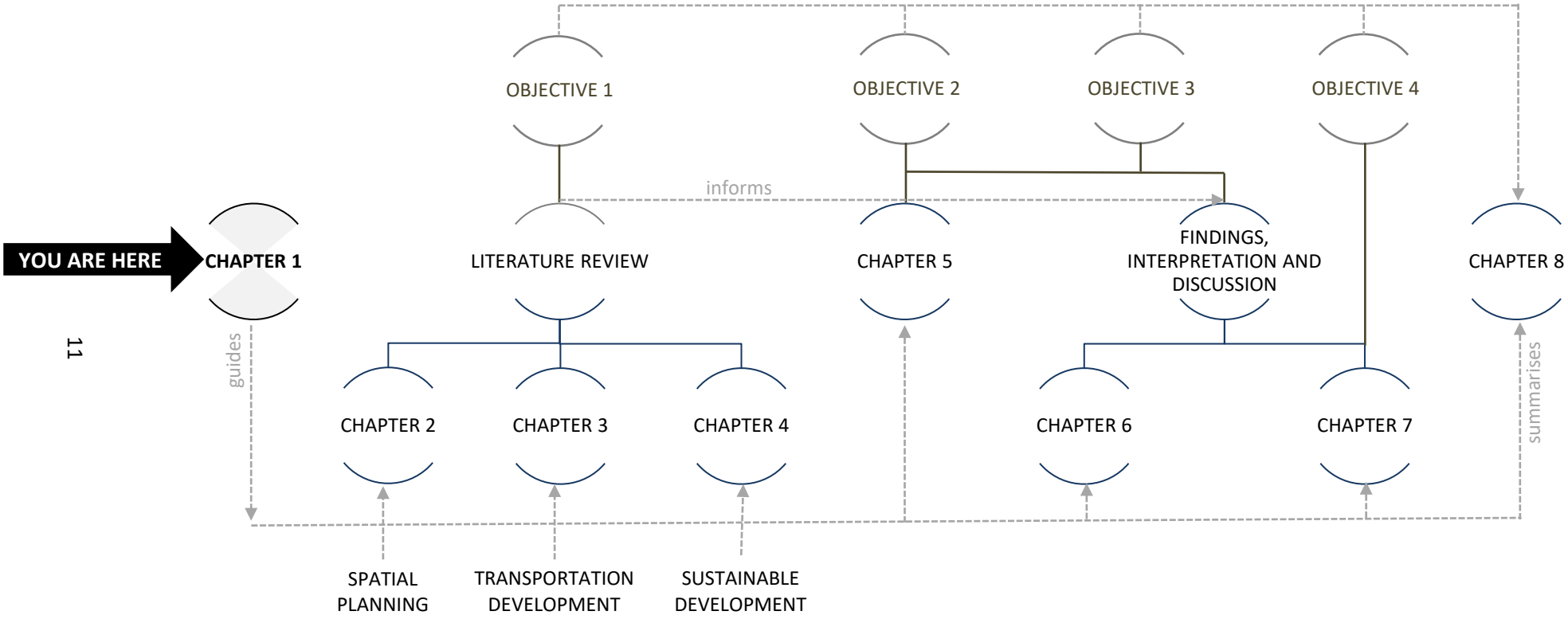


Figure 1.A: Overview of Chapter 1

OVERVIEW OF LITERATURE CHAPTERS

The first objective of this study calls for the exploration of spatial planning and transportation development guidelines which may influence the sustainable development of public transportation systems. The figure below provides a broad overview of the study and highlights the objective that the literature review chapters address.

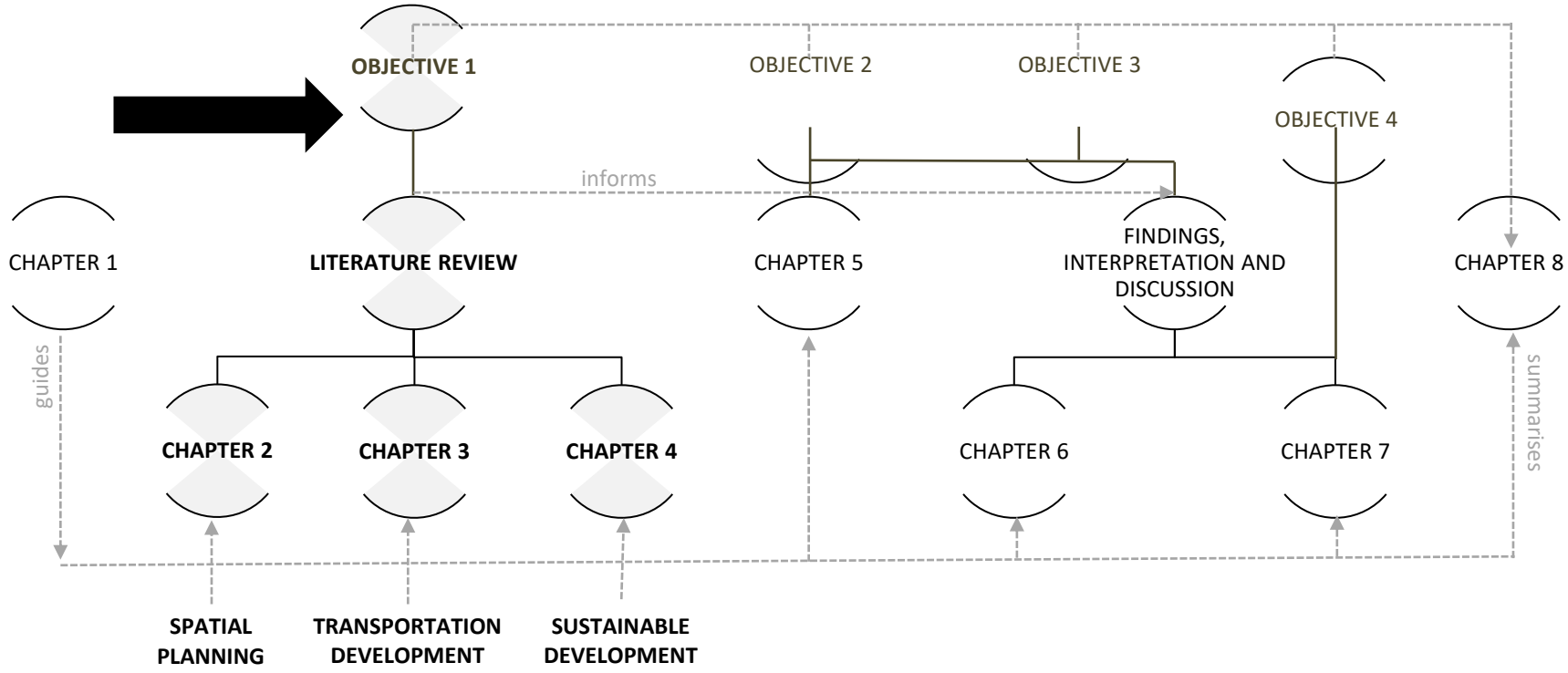


Figure 2.A: Overview of literature chapter

CHAPTER 2

SPATIAL PLANNING

2

2.1 INTRODUCTION

The history of spatial planning may date back as early as the founding of the first formal cities about 6 000 years ago (Reba, Reitsma & Seto, 2016: online). Spatial planning is defined as a broad activity concerning various aspects of land development for either a municipality or a metropolitan area (Albrechts, 2004:743). Spatial planning and land use planning are often used synonymously for each other (Barton, 2009:116), but spatial planning also governs the development patterns of specific territorial spaces (Nadin & Stead, 2008:35). The (natural) region around a town, city, municipality, or metropolitan area is also regarded as part of spatial planning (Hall, 2014:6).

Within the spatial planning system, the concepts of values, approaches and processes are often used to explain, assist or add a new dimension for strategic planning because there is no single or best way of designing an effective planning system (Albrechts, 2004:743). Campbell (2002:272) points out that the activity of planning is generally about making decisions or judgements with and for others (e.g. residents of the specific community), regarding what makes a good place/town/city. Planners need to make their decisions or judgements concerning the (ethical) value of their actions for the good and inclusive deliberation with stakeholders (Campbell, 2002:274, 278). As a result, factors such as sustainability and globalisation have started to play a role in planning activities (Nadin & Stead, 2008:35) as is evident from the key considerations in regard to spatial planning discussed in this chapter (see 2.4).

Throughout history, countries, as well as specific regions and/or cities, have adopted their own approach towards spatial planning (cf. Hirt, 2013; Nadin & Stead, 2008). The socio-economic, political and cultural aspects of the specific country, region or city mainly contribute to the approach of the spatial planning selected (Albrechts, 2004:744; Nadin & Stead, 2008:35; Hall, 2014:5). Swilling (2011:79) points out that cities have a dynamic mix of these interactions (e.g. socio-political, cultural, institutional and technical), and between material resources, people and their cultural practices, energy and information networks. Therefore, spatial planning is complex with various factors/aspects that the planner needs to take note of.

Spatial planning in South Africa is built according to the apartheid spatial planning model, which restricted access for residents that use formal public transportation services (Cooke, Behrens & Zuidgeest, 2018:374). The urban areas are developed in such a way that the patterns appear to create spatial divisions (Treasury, 2018:7). These spatial divisions influence the convenience of the journey, the length of the trip, and lastly, the cost of the trip (Treasury, 2018:7; Ryneveld, 2018:24). This hampers the Transport Orientated Development (TOD) approach for accessibility for public transportation users and the financial viability from a planning approach (Cooke et al., 2018:374). Apartheid land use planning created a land use environment that provided financial distress and an income inequality that influences the trips and demand pattern on the public transportation patterns (Cooke et al., 2018:368). This causes the residents to pay more for public transportation due to spatial planning and also provides a connection between spatial planning and public transit from the apartheid era.

This chapter provides a review of three Ideal City models (see 2.2), discusses spatial planning in the twenty-first century (see section 2.3), identifies some of the key considerations that spatial planners need to take into consideration (see section 2.4), and provides an overview of spatial planning in South Africa (2.5). Figure 2.1 presents an outline of this chapter.

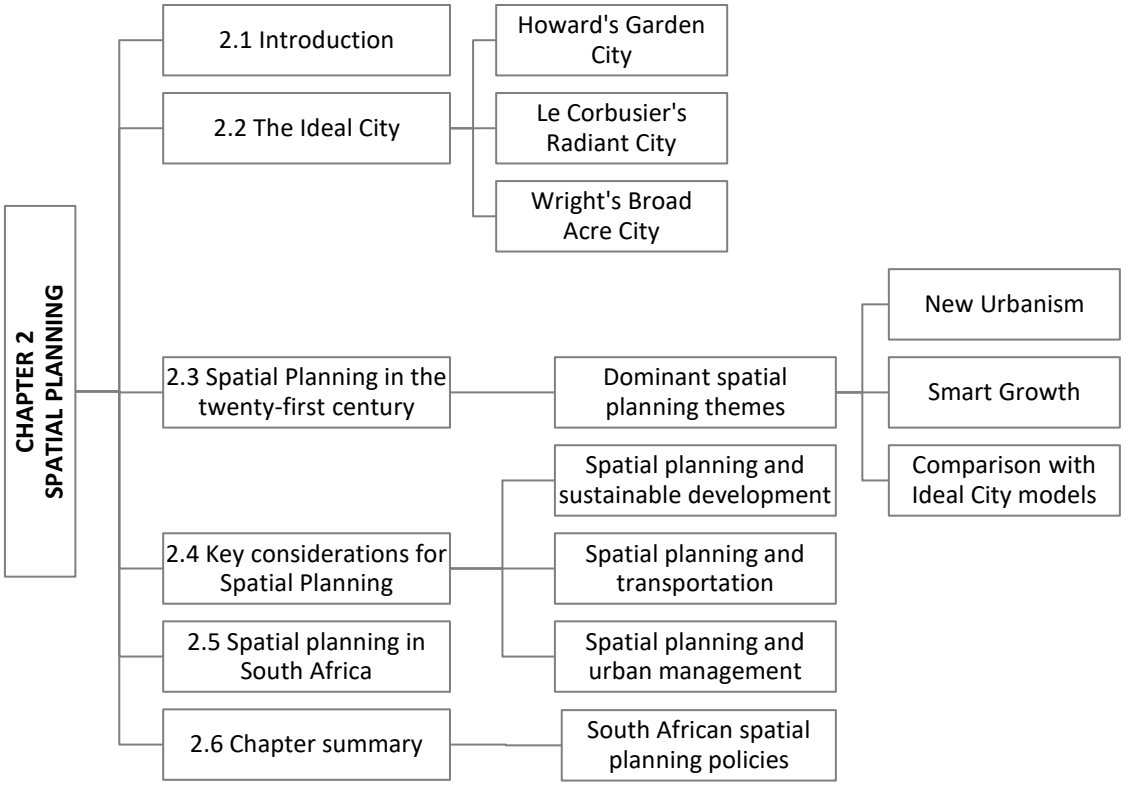


Figure 2.1: Outline of Chapter 2: Spatial Planning

2.2 THE IDEAL CITY

In the years preceding the Second World War, several factors influenced the ways of thinking about urban patterns such as the development of large-scale factories, the implementation of zoning regulations and the Great Depression. Many neighbourhoods degenerated into slums with a low level of services and a high number of occupants as a result of high demand for affordable accommodation, and no building regulations (LeGates & Stout, 2000:299).

This led to an urban reform crisis with several planners, or "visionaries" as Hall (2014:2) refers to them, stepping in and introducing ideas for the ideal city. Liscombe (2006:15) describes the ideal city as a harmonious place to live where imagination and experiences interconnect to overcome present day frustrations and conventions across all boundaries. Most of the ideas for the improvement of cities rest on the connection between the religious values of care, compassion, equality and love (Oranje, 2014:2), as well as the judgement of (ethical) values (Campbell, 2002:274). The most well-known ideal city planners are Howard, Le Corbusier and Wright. Table 2.1 documents the main aspects of these planners' Ideal City models through a content analysis of historic illustrations and writings of these models.

- Ebenezer Howard's ideal Garden City specified green space surrounding the city with the ideology of a social city in mind (LeGates & Stout, 2000:302). His Garden City concept is regarded as the most important response to the slums of the Victorian city (Hall, 2014:8). This model is concerned with three dominant themes (or magnets), namely: town, country, and town-country. Towns draw people from the country since they offer higher wages, employment opportunities and social interactions but living in towns is expensive. Countrysides offer fresh air, access to nature and cheaper living, but as a direct result also lower wages, fewer employment opportunities and limited social interactions. The town-country magnet of Howard's Garden City model aims to provide the best-of-both for residents. This model, proposed in the early 1900s, made provision for people to travel between town and country by means of various rapid transportation modes (Howard, 1902:16, 17, 130).

- Le Corbusier, in his many utopian plans, believed that a city should have a total of three million people with a city centre with undecorated high skyscrapers and evenly spaced parks. His ideas contradicted the Garden City of Howard's (Hall, 2014:9; LeGates & Stout, 2000:304). Liscombe describes the Ideal City in relation to Le Corbusier's utopia which is focused on the twentieth-century Modern Movement. Le Corbusier was a visionary that incorporated transportation means in his utopia that provide quick and efficient transit in the Radiant City (Liscombe, 2006:18). He

incorporated various traffic intersections to promote traffic circulation in his ideal city (Le Corbusier, 1933:163).

- Frank Lloyd Wright supported the middle class and suggested the Broadacre City model which suggested that each household should be allocated a minimum of one acre of land with a small house and a carport so that they could still practise some agriculture (LeGates & Stout, 2000:305). Wright was another visionary that made provision for transportation but did not foresee the congestion and pollution that it would create in his ideal city (Liscombe, 2006:18). Wright's idea regarding planning was that a city needs to be built by its own citizens rather than corporations (Hall, 2014:9). This links to the community design movement in the United States and Britain after the Second World War (Hall, 2014:10).

Table 2.1: Content analysis of the Ideal City models of Howard, Le Corbusier and Wright.

CRITERIA	HOWARD (Howard, 1902:16, 22-23, 128-129)	LE CORBUSIER (Marmot, 1978:82-85; 158)	WRIGHT (Wright, 1932:17-45)
Ideal City Model	Garden City.	Radiant City.	Broadacre City.
Goals of the Ideal City	• Combine city and country living.	• Effective means of communication. • Abundance of green spaces. • Access to sunlight. • Reduce urban traffic.	• Create a family focused living to create a more stable community. • Focused on the individual.
City created as a solution to the specific problem	Depopulation of rural areas which resulted in overcrowding and pollution in cities.	Chaotic and inefficient cities which are over-congested.	Cities which are run like factories that do not focus on the person and family.
Spatial planning characteristics of proposed Ideal City model	• Structured organically. • Central city includes city hall, hospitals, libraries, museums, etc. • Smaller towns are connected with avenues to the central city. • Smaller towns are connected to each other via the municipal channel and rail and high roads. • Central city and town have their own water resource and reservoirs. • Six broad main boulevards around the central city (e.g. green areas with recreation activities, residential areas, industrial areas, green spaces for agricultural and animal use).	• Geometric. • Skyscrapers made from steel, glass and concrete rising from parks and gardens resting on pilotis. • Roads raised 5 m above the ground. • Entire ground level for pedestrians. • Focused on the well-being (i.e. psycho-physical needs) of the people living in cities. • Block system built against the sidewalk. • Limited street access. • Residential housing is at the core of the radiant city. • Zones for specific land uses.	• Geometrically spaced (one acre) but forms part of the landscape (evenly distributed). • Entitled to as much land as you can use (minimum of one acre). • Self-supporting. • Focused on man and nature's relationship with one another. • Spacious landscaped highways which are of high grade. • Highways used to unite and separate public-private and private-private land. • Access to public spaces within a 240 km radius such as small schools, markets, factories, etc.
Space distribution within the model	Sprawling nature with greenbelts in between the smaller communities with vast open spaces which are planned and structured.	Vertical space that allows for more land allocation to parks and gardens.	Sprawling nature where dwellings are part of nature.
Land uses	Indicated land uses around the city with combined land use within each town.	Clearly indicated blocks for different uses (e.g. residential and industrial are separated).	Combined land use on one acre of land.
Transportation modes	Land, rail and water transportation methods.	Land: High speed freeways with interchanges to promote traffic circulation.	Land and air transportation methods.

Table 2.1 highlights the similarities and differences of the utopias of Howard, Le Corbusier and Wright. Although all three Ideal City models propose a structured and planned spatial layout with specific land uses, Howard's Garden City model is more organic, compared to the geometric Radiant and Broadacre City models. These models offered solutions, some more viable than others, to the busy, overcrowded and congested cities of the early 1900s which had little consideration for the people living in them. Le Corbusier's model differentiates itself from the other Ideal City models with its futuristic designs of today's skyscrapers of steel, glass and concrete. Wright's Broadacre City model propagates decentralisation which is in contrast with the other two utopian models. Although these three Ideal City models offer alternative approaches, they are not necessarily better than the traditional approach for spatial planning. An alternative approach merely allows the planner or designer to solve the problem at hand using other skills and principles since a single problem can have multiple solutions (De Roo, 2012:145, 146).

2.3 SPATIAL PLANNING IN THE TWENTY-FIRST CENTURY

In the twenty-first century, spatial planning leans more towards alternative approaches and the concept of the Ideal City than in previous eras, due to the increase of globalisation, the creation of megacities and more diverse populations (e.g. class, ethnicity, gender, race and religion of individuals). Healey (2010:1) stresses the intense struggles that exist in planning spatially for a diverse group of people with different cultures and values, such as South Africa, which is known as a rainbow nation. Spatial planning should express and contribute to the quality of life of the people who use such spaces and remind them (i.e. the users) that they need to co-exist with other people in these spaces (Healey, 2010:8-9). The increasing diversity of the population inspired civil rights movements that led to the shift of focus from economic growth to environmental sustainability (e.g. New Urbanism movement) (Hall, 2014:10; Healey, 2010:11). Environmental sustainability is important for city planners in the light of global climate change and resource depletion in specific regions (e.g. the water and electricity crisis in South Africa), particularly since most of the world's population now live in cities (Watson, 2009:2259) (see 2.4.1).

Spatial planning in this century furthermore includes the objective of addressing the impact of urban expansion of the previous century (Healey, 2010:13). One example is the destruction of environmental areas that impacts the number of green spaces and public spaces (i.e. parks and recreational areas) as well as the quality of the infrastructure because of inadequate urban planning systems in the previous Soviet Union (Harrison & Todes, 2015:153) or even in townships in South Africa. Watson (2009:2259)

notes that there is a rapid expansion of urban dwellers in poorer regions of the Global South during the twenty-first century and that it is faced with certain challenges.

In attempts to address the issue of urban growth, spatial planners and governments have responded with the zoning of land, improving housing and living conditions for the poorest people, and an improved understanding of the relationship between humans and the environment (Healey, 2010:14-15). Land allocation maps set out broad land use infrastructure patterns that detail land use infrastructure and zonings assigned to a local authority for its specific zoning layouts (Albrechts, 2004:744). However, Watson (2009:2263) believes new forms of spatial planning are needed to respond to these concerns since most of the planning forms used by the majority of poorer countries are unable to respond to their rapid, unpredictable urban growth where service delivery is not provided mainly by the government and may be unaffordable to residents. Albrechts (2004:75) supports the need for an alternative process to spatial planning in order to deliver viable solutions to the complex problems that planners face on a daily basis. A pro-poor planning approach is recommended to balance the "rationality of governing" and the "rationality of survival" in poorer cities and/or regions to ensure the inclusion of all residents in the adopted planning approach (Watson, 2009:2268) (see 2.4.1). In order to create viable alternative solutions, planners will need to build their strategic planning capacity (Albrechts, 2004:75).

Beyond postmodernism, the film industry depicts future cities with high-tech transportation yet degrading urban buildings and infrastructure (e.g. The Fifth Element, Metropolis, Judge Dredd and Blade Runner) (Hall, 2014:129) which projects the reality of urban spaces without sustainable planning practices (see 2.4.3). Although spatial planning themes such as New Urbanism (see 2.3.1) and Smart Growth (see 2.3.2) are dominant spatial themes currently, Hall (2014:141) reminds planners that technological change is a major unknown factor that guides future growth and planning.

In response, many new spatial planning themes have emerged over the past few decades such as New Urbanism and Smart Growth. These spatial planning themes have several similarities with the Ideal City concept proposed by Howard, Le Corbusier and Wright which are discussed in section 2.3.1.

2.3.1 Dominant spatial planning themes of the twenty-first century

Social, political and ecological criteria became dominant themes in spatial planning during the 1990s to promote the economic transformation of cities. Mayer's article on *the Right to the City* emphasises the public's claim to decide what kind of city they want to live in as well as which stakeholders (e.g.

residents, government, etc.) should benefit from the city (Mayer, 2009:365-367). However, he believes that the slogan 'the right to the city' is based on the principles of justice, ethics, virtue and the good, rather than a legal claim of sorts according to the definitions of Marcuse and Harvey (Mayer, 2009:365-367).

Harrison and Todes (2015:153) discuss the developments occurring within spatial planning which relates to multiple factors such as edge city development, gated communities, privatised open spaces, upmarket tenements and luxury retail and entertainment hubs. The material claims of residents to have a 'right to the city' they live in has transformed cities by building invisible barriers (e.g. gated communities) which result in access restriction to amenities and city infrastructures (Mayer, 2009:367). According to De Roo (2012:159-160), an adaptive planning approach with a focus on sustainability and destructive-creative revolution is a more suitable model for the complex spatial planning of this era. Such an approach should also offer social and economic diversity within cities to accommodate the diverse population of a city (e.g. race, gender, age, occupation, etc.) (Talen, 2006:233). Although alternative approaches, such as New Urbanism, promote diversity, they are often not implemented in meaningful ways (Talen, 2006:233). New spatial theories, such as New Urbanism and Smart Growth (Grant, 2009:13), emerged to guide spatial planners in addressing these problems. These two spatial planning theories are discussed in the two subsections that follow.

2.3.1.1 New Urbanism

The New Urbanism movement is an alternative approach to spatial planning in the postmodernist era (i.e. the era after the Second World War). This movement is also commonly referred to as neo-traditional (Ford, 1999:249) since it incorporates elements of modernism (i.e. the era before the Second World War) as well as postmodern (Hirt, 2009:249). The design principles of this movement have been incorporated into various fields including sustainable development, smart growth, and transit, pedestrian and bicycle planning (Bohl, 2000:761; Garde, 2004:154), as well as most policies in the United States (Hirt, 2009:248).

The Congress of New Urbanism (hereafter referred to as CNU) drafted a charter for the movement that identifies principles for public policy, development practice, urban planning, and design (CNU, 2009: online). These principles include a focus on the relationship between humans and the environment for sustainability as advocated by Healey (2010:14-15), as well as the sprawling nature of South African city suburbs as noted by Chobokoane and Horn (2015:79). Urban sprawl is defined by Knaap and Talen (2005:108) as low density, mainly unplanned urban development that results in

dependence on automobiles. The ideals of the movement are spatial planning that promotes defined edges (to counter sprawling), pedestrian movement, mixed land use, and sensitivity towards build forms to only name a few (Bohl, 2000:762; Hirt, 2009:248, 251). Ford (1999:252-253) lists several benefits in defence of the critics of the approach such as the inclusion of a variety of housing types to accommodate people from various income groups; the design of aesthetically pleasing and inviting neighbourhoods with doors and windows visible from the street; the elimination of previous neighbourhood problems when creating new communities; designing specific lifestyle zones for people with similar tastes; and walkable sidewalks that encourage socialisation in neighbourhoods. However, Bohl (2000:791-792) warns designers and policy makers not to regard New Urbanism as an economic development, housing, or social service programme.

Two distinctive strategies exist within New Urbanism, namely urban in-fill or new communities (Ford, 1999:249). Bohl (2000:767) notes the application of the principles of the New Urbanism movement to a housing programme in the United States that transformed existing neighbourhoods into holistic communities by redesigning and/or demolishing barracks-style and high-rise projects. This is an example of urban in-fill. However, the rehabilitation or redesign of existing buildings and infrastructure is a better option rather than the demolition of these buildings (slum clearance) (Bohl, 2000:768). An example of new communities is Disney's Celebration near Orlando, Florida which created a more sociable environment with less dependency on private motor vehicles (Ford, 1999:251). A negative aspect of new communities is that commercial areas develop slower than the residential areas since there is no pre-existing population to support trading, retailing and/or services rendered (Ford, 1999:252). Therefore, residents will initially have to travel to other suburbs for commercial purposes.

The CNU (2009:1, 3-4) stipulates 27 principles that are categorised under the interconnected and interdependent scales of the region, the neighbourhood and the building that provides guidance for planners and designers. Table 2.2 summarises the principles under the three scales of the charter. The light grey cells of the table highlight the eight principles of the charter that relates to transport oriented development which is the prominent theme of this study.

Table 2.2: Summary of the principles of the Charter of New Urbanism (CNU, 2009:3-4)

	THE REGION: METROPOLIS, CITY AND TOWN	THE NEIGHBOURHOOD, THE DISTRICT AND THE CORRIDOR	THE BLOCK, THE STREET, AND THE BUILDING
PRINCIPLE 1	• Metropolis is constrained by its geographic boundaries (e.g. topography, watershed, coastlines, farmlands, regional parks and river basins). • Consists of multi centres of cities, towns and villages, with identifiable centres and edges.	• Essential to the development and redevelopment of the metropolis. • Encourages the community's responsibility for the maintaining and development of this scale.	• Physically define streets and public spaces as places of shared use.
PRINCIPLE 2	• Metropolis should be a fundamental economic unit of the contemporary world. • Government cooperation, public policy, physical planning and economic strategies must reflect this.	• Compact and pedestrian friendly neighbourhoods with mixed uses. • Single use districts according to the principles of neighbourhood design (if possible). • Corridors (e.g. boulevards, rail lines, rivers, parkways, etc.) connect neighbourhoods and districts.	• Link architectural projects to their surroundings over the style of the project.
PRINCIPLE 3	• Environmental, economic and cultural relationship to its natural landscape. • Farmland and nature are very important.	• Promote the independence of young and old to walk to their daily activities. • Interconnected network of streets should encourage walking, reduce automobile trips (e.g. number and length of trips), and save energy.	• Promote the safety and security of streets but not at the expense of accessibility and openness. • This supports the renewing of urban places.
PRINCIPLE 4	• Edges of the metropolis should not be blurred or eliminated. • Encourage the reclaiming of marginal and abandoned areas rather than new development. • Conserve environmental resources, economic investment and social fabric with in-fill development in existing cities, towns and villages.	• Include a variety of housing types and prices in a neighbourhood to attract a diverse community.	• Accommodate (adequately) automobiles, pedestrians and the form of the public space in the development of a contemporary metropolis.

	THE REGION: METROPOLIS, CITY AND TOWN	THE NEIGHBOURHOOD, THE DISTRICT AND THE CORRIDOR	THE BLOCK, THE STREET, AND THE BUILDING
PRINCIPLE 5	• Organise contiguous development as neighbourhoods and districts of the existing urban pattern (if appropriate). • Organise non-contiguous development as towns and villages with defined urban edges with an appropriate job/housing balance.	• Properly planned and coordinated transit corridors organise metropolitan structures and renew urban centres. • Highway corridors should not draw investment away from existing centres.	• Safe, comfortable and interesting streets and squares to promote walking. • This supports the protection of communities (e.g. neighbourhood watches).
PRINCIPLE 6	• Respect historical patterns, precedents and boundaries.	• Promote public transit by ensuring that building densities and land uses are within walking distance of transit stops.	• Local climate, topography, history and building practice should inform design in this scale.
PRINCIPLE 7	• Include a wide variety of public and private uses that benefit people of all incomes to support the economy of the region. • Do not cluster affordable housing in the region to avoid concentrations of poverty.	• Embed civic, institutional and commercial activities in neighbourhoods. • Situate schools (with appropriate size capacity) in the neighbourhood for children to walk or bicycle to.	• Build civic buildings and public gathering places on important sites to promote the identity of the community and the culture of democracy.
PRINCIPLE 8	• Transport alternatives (e.g. transit, pedestrian and bicycle systems) to maximise access and mobility of the physical organisation of the region. • Reduce dependence on the automobile.	• Use graphic urban design codes as a guide for the future economic health and harmonious evolution of this scale.	• Use (where possible) natural methods of heating and cooling. • Buildings should provide a clear sense of location, weather and time of day to their inhabitants.
PRINCIPLE 9	• Share revenues and resources among municipalities and centres within regions. • Promote the sharing of transportation, recreation, public services, housing and community institutions within the region.	• Distribute a variety of parks in the neighbourhood. • Use conservation areas and open lands to connect neighbourhoods and districts.	• Preserve and renew historic buildings, districts and landscapes to support the continuous evolution of urban society.

Bohl (2000:790) notes the relationship that exists between residential location and cost of living. Newly developed neighbourhoods often promote urban sprawl since these new neighbourhoods are designed on the edges of a metropolitan area, city or town (where land is cheaper) (Garde, 2004:162). This results in increased transportation costs for residents since travel distances are increased (Echenique, Hargreaves, Mitchell & Namdeo, 2012:123; cf. RSA NDP, 2012:119). Such neighbourhoods force residents to use their own private motor vehicles since access to these neighbourhoods is mostly by motorway and/or arterial highway construction with no alternatives (Dixon & Dupuis, 2003:353). Wide roads with several lanes encourage commuters to use their own transport instead of public transportation which contributes to congestion (De Roo, 2012:140). One of the goals of the movement is to reduce the number of motor vehicle trips and the length of each trip (Garde, 2004:162). On the other side of the coin is ruralopolitanism which promotes urban sprawl into the countryside around a city or small towns near cities (Watson, 2009:2265). This is a result of low-income households who work in the city but need access to affordable land within a reasonable travel distance from the city (Watson, 2009:2265). Thus, it can be argued that transport cost is a determining factor for the density of residential locations (Echenique et al., 2012:124).

New Urbanism planners encourage the use of street networks (i.e. grid layout of streets) in the hope of promoting residents to use public transportation to reduce car dependency. However, this is dependent on commuters' transportation behaviours such as wanting to use their own private motor vehicle (Cozens & Hiller, 2008:61). Street networks may also decrease traffic safety since commuters may travel at excessive speeds since some may use the network as a thoroughfare (Cozens & Hiller, 2008:61; Ford, 1999:256).

Cozens and Hiller (2008:51) note that crime prevention and planning concerning the effectiveness and sustainability of suburban housing is important. Although New Urbanism promotes the use of open street networks, cul-de-sacs give residents control of their space and protect the community from outsiders (Ford, 1999:256). The three major threats to safety in cities are urban crime and violence (e.g. domestic violence, gun crime, murder and rape); insecurity of occupancy and forced eviction, and natural and human-made disasters (United Nations Habitat, 2007:vi). The importance of safety within cities is emphasised by high global crime rates in most countries (cf. Crime Stats South Africa, 2015: online). South Africa is regarded as a country that has high intentional homicide rates (i.e. unlawful death purposefully inflicted) according to the United Nation's (UN) office on drugs and crime (Crime Stats South Africa, 2015: online). Urban safety is one of the issues noted in the Integrated Urban Development Framework (RSA IUDF) that needs attention in South Africa in order to create spaces

where residents feel safe (COGTA, 2016:21-22). Prosperous and liveable cities are urban spaces where citizens feel safe from violence and crime. New Urbanism also links to Smart Growth principles (Garde, 2004:161-162). Several goals of Smart Growth are similar to those of New Urbanism, namely:

- building compact communities that are walkable;
- designing aesthetically pleasing and inviting communities;
- participation of all stakeholders in the decision-making process to promote predictable, fair and cost-effective decision;
- preserving environmental areas (i.e. open spaces, farmland, etc.);
- providing a variety of transportation choices;
- providing a variety of housing types to accommodate people from a variety of income levels;
- strengthening and directing development towards existing communities (i.e. in-fill development);
- using a variety of land uses.

  (Garde, 2004:161-162)

New Urbanism aims to provide an alternative to suburban sprawl (Bohl, 2000:762). This may, in turn, promote the spatial sustainability of an area since the limiting of urban sprawl is one of the spatial planning goals of South Africa (RSA Spatial Planning and Land Use Management Act No. 16, 2013:14-17). Compaction of cities (i.e. limiting urban sprawl) reduces vehicle travel, increases social diversity and promotes urban vitality (Echenique et al., 2012:123). Cozens and Hiller (2008:51) note that there is a debate regarding the effectiveness and sustainability of developing suburban housing according to New Urbanism principles in the United Kingdom, North America and Australia. New Urbanism promotes spatial sustainability by decreasing land consumption by limiting (urban) sprawl and using smart growth principles (see 2.3.1.1). However, there are vast differences between theory and practice as highlighted by Grant's (2009) article on the implementation of New Urbanism, Smart Growth and sustainability within spatial planning. Market restraints, government or municipal support and the private sector are three factors which may influence the differences that exist between the theory and practice of applying the principles of New Urbanism (Grant, 2009:30).

Researchers have critiqued the movement. Such critiques include traffic-related problems, the impact on the environment, and the alignment of the movement with regional planning, to only name a few (Ellis, 2002:283). Ford (1999:252) lists five major critiques of New Urbanism, namely: the design of New Urbanism neighbourhoods is not really different from standard developments; the layout of the neighbourhoods are often unauthentic and/or unsuitable; these neighbourhoods are physically disconnected from existing communities (which may result in public transportation problems); the

design contributes to the segregation of urban populations, and the movement makes use of an architectural style for a society of the past. Hirt (2009:251-252) critiques the movement's claim of addressing issues of the present (e.g. sustainability, compact cities, etc.) since it draws its inspiration from modernism that adhered to planning according to the Fordist economic and technological conditions of mass manufacture of the time. Hirt (2009:249) refers to this approach as "forward-into-the-past". Ellis (2002:284) argues that most of the critiques of the movement contradict each other since various groups (e.g. planners, architects, economists, etc.) focus on different aspects. The New Urbanism Charter 3.10 (CNU, 2009:3) argues that the theory is too often misinterpreted as only evoking the past, as is evident from Hirt's critique above.

2.3.1.2 Smart Growth

The growth or development of a city is influenced by factors such as mixed land use, transport orientated development, integrated housing and a connected street network that has been adopted by many cities (Grant, 2009:11). The ideal for Smart Growth is to halt urban sprawl by implementing a policy that focuses more on compact development (Kushner, 2002:48). This is also one of the principles of New Urbanism (see 2.3.1.1). Handy (2005:1) avers that a close relationship exists between the Smart Growth of a city and its ability to be sustainable.

Smart Growth is a popular concept for public officials and the general public due to their concern for traffic congestion and the ever-increasing development of the community (e.g. housing or commercial development). The aim is to have parallel support between Smart Growth of a community/ neighbourhood and first-generation growth management (Kushner 2002:48). Smart Growth can affect three different groups of people, namely:

- Real estate developers that want to develop outwards as far as possible (i.e. on the edges of the metropolitan, city and/or town).
- City officials that are keener to redevelop existing and older areas plus repairing decaying infrastructure.
- Environmentalists and planners that accept both real estate developers and the city officials' goals as long as there is a reduction in the number of motor vehicle trips and an increase in public transit.

  (Downs, 2005:368)

According to Downs (2005:368) and Knaap and Talen (2005:108), everyone has their own idea of what Smart Growth is and this is always related to their own perspective. Nine Smart Growth principles are noted below that promote planners and/or designers to move away from any ill-advised planning methods to promote a suitable Smart Growth planning environment, namely:

- Create a greater diversity of housing, including more affordable housing options (Downs, 2005:368; Knaap & Talen, 2005:108).
- Implement more diverse rules concerning aesthetics, street layouts, and design (Downs, 2005:368).
- Increase public costs for new developments/new communities via impact fees (Downs, 2005:368).
- Increase residential densities (Downs, 2005:368; Knaap & Talen, 2005:108).
- Limit new developments (Handy, 2005:1).
- Promote the use of public transit by offering a variety of transportation choices (Downs, 2005:368; Handy 2005:1; Knaap & Talen, 2005:108; Kushner, 2002:48).
- Promote public participation (Knaap & Talen, 2005:108).
- Provide more mixed land uses which include pedestrian facilities (walkable neighbourhoods) (Downs, 2005:368; Knaap & Talen, 2005:108).
- Reduce obstacles to developer entitlement (Downs, 2005:368; Knaap & Talen, 2005:108).
- Renovate or redesign older neighbourhoods (i.e. in-fill development) (Downs, 2005:368; Handy, 2005:1).

One of the most prominent principles of Smart Growth, as well as New Urbanism, is combating urban sprawl. Urban sprawl links to two elements of this study, namely transportation and land use (Handy, 2002:147; Knaap & Talen, 2005:108). Development patterns have a tendency to stretch next to highway corridors as land becomes available for development (e.g. shopping malls, new freeways, filling stations and commercial development) (Handy, 2002:147). As a result, as more highways are built, the number of low-density residential areas increases, and consequently, motor vehicle usage also increases since public transportation options are limited in such areas (Handy, 2002:147; Knaap & Talen, 2005:108). Planners and designers are therefore encouraged to use New Urbanism design principles (see 2.3.1.1) to reduce transport orientated problems and urban sprawl (see 2.4) (Handy, 2005:3). Handy (2005:3) advocates for investment in light rail transit as a solution to combat urban sprawl since this transportation option may increase urban densities.

Although Smart Growth principles motivate for greater diversity in housing types to accommodate a diverse population, such as the population of South Africa, the integration of these principles are often only superficially implemented (Talen, 2006:236). To create a greater diversity of housing and including more affordable housing options (Downs, 2005:368; Knaap & Talen, 2005:108), the planner can use Talen's (2006:236) definition of place diversity (i.e. place vitality, economic health, social equity and sustainability) (see 2.4). However, the spatial planner should acknowledge all the different factors which play a role in urban growth and urban sprawl (e.g. population growth, economic growth, living and property cost, lack of affordable housing, transportation, lack of proper planning policies, etc.) (Bhatta, 2010:18).

2.3.1.3 Comparison between dominant spatial planning themes of the twenty-first century and the Ideal City models

The two dominant spatial themes of this century (i.e. New Urbanism and Smart Growth) have several parallels with the Ideal City models of Howard, Le Corbusier and Wright (see 2.2). Table 2.3 provides a comparison between these themes and models regarding their spatial planning, transportation and sustainable development characteristics.

The spatial planning characteristics included space distribution, layout characteristics, land use/zoning and building characteristics. The space distribution of the New Urbanism and Smart Growth principles counters sprawling cities, similar to the Garden City and Radiant City. Howard's Garden City model defines the city centre and surrounding town edges but is considered as planned and structured sprawl. The two spatial planning themes of this century also promote in-fill development as part of their spatial distribution, something which not one of the Ideal City models considered. The layout characteristics of the two spatial planning themes of this century do not identify a geometric or vertical layout such as in the Ideal City models since the principles are more concerned with in-fill development (i.e. working with what you have rather than creating new). Wrights' Broadacre City's mixed land uses are incorporated into both spatial themes with a prominent mention of including a variety of housing types. The building characteristics of New Urbanism and Smart Growth have similarities with Le Corbusier and Wright's Ideal City models.

Table 2.3: Spatial Planning comparison of the Ideal City models, New Urbanism and Smart Growth

CRITERIA	NEW URBANISM (CNU, 2009: 3-4)	SMART GROWTH (Downs, 2005:368; Knaap & Talen, 2005:108)	HOWARD (Howard, 1902: 16, 22-23, 128-129)	LE CORBUSIER (Marmot, 1978: 82-85, 158)	WRIGHT (Wright, 1932: 17-45)
SPATIAL PLANNING CHARACTERISTICS					
Space distribution					
Sprawling nature			x		x
Defined edges	x	x	x	x	
Promotes in-fill development	x	x			
Layout characteristics					
Geometric layout			x		x
Vertical layout				x	
Centralised public spaces			x		x
Diverse aesthetics, street layouts, and design		x			
Land use/Zoning					
Mixed land use	x	x			x
Zoned land use			x	x	
Integrated housing options	x	x			
Building characteristics					
Consideration of style of building with its environment	x				x
Inviting buildings/communities with entry from the sidewalk	x	x		x	
Limited street access to promote safety and walkability	x			x	

CRITERIA	NEW URBANISM (CNU, 2009: 3-4)	SMART GROWTH (Downs, 2005:368; Knaap & Talen, 2005:108)	HOWARD (Howard, 1902: 16, 22-23, 128-129)	LE CORBUSIER (Marmot, 1978: 82-85, 158)	WRIGHT (Wright, 1932: 17-45)
TRANSPORTATION CHARACTERISTICS					
Transportation modes and transit corridors					
Pedestrian	x	x		x	
Bicycle	x				
Public transportation	x	x			
Private transportation			x	x	x
Air transportation			x		x
Rail transportation	x		x		
Water transportation			x		
SUSTAINABLE DEVELOPMENT CHARACTERISTICS (see 2.4.1)					
Elimination of poverty					x
No hunger					x
Good health and well-being			x	x	x
Access to water			x		x
Energy usage	x				
Industry infrastructure			x	x	
Decent work and economic growth					
Reduced inequalities	x	x			
Sustainable cities and communities	x	x			x
Responsible consumption and production	x				x
Climate action	x	x			

Only one of three Ideal City models (Howard's Garden City) specifically mentions the use of public transportation, but rail, air and water transportation modes are mostly public transportation (Moughtin & Shirley, 2005:146). However, New Urbanism and Smart Growth principles specifically promote the use of public transportation to reduce the use of private vehicles. Le Corbusier's Radiant City model allocated the entire ground level of the city for pedestrians which promotes walkability. New Urbanism and Smart Growth both advocate for more walkable neighbourhoods with wide sidewalks (see 2.3.1.1 and 2.3.1.2). The New Urbanism charter also mentions the use of bicycles as a transportation means for children from and to school daily (see Table 2.2).

Sustainable development characteristics are more limited in the Ideal City models since all the models were created to promote an alternative to congested and overcrowded cities to encourage the overall well-being and health of people. On the other hand, the two spatial planning themes of this century were designed to enforce climate action and design/redesign of sustainable cities and communities. The only ideal city which considered sustainable communities was Wright's Broadacre City model where every family had to be self-sustainable with their one acre of land, which also links to responsible consumption and production.

2.4 KEY CONSIDERATIONS FOR SPATIAL PLANNING

Handy (2002:146-147) starts her discussion on Smart Growth (see 2.3.1.2) and the "transportation–land use connection" by pointing out that spatial planning, land use and transportation (see 2.4.2) are closely related concepts. An internet search highlights the vast amount of research regarding transportation and land use (cf. Cervero, 2006; Lubus, Isnaeni & Nurjaya, 2003; Kiggundu & Mukiibi, 2012; Lai, Davies & Cheung, 2011; Rabinovitch, 1996). However, spatial planning and land use also go hand in hand since the spatial planning of a town, city or region needs to provide specific land uses within the specific area (cf. RSA Spatial Planning and Land Use Management Act No. 16, 2013). All three concepts (i.e. transportation, spatial planning and land use) are governed by land use and urban management policies and legislation. Sustainable development, transportation and land use/urban management are discussed in the following sections in regard to spatial planning.

2.4.1 Spatial planning and sustainable development

Sustainable development is broadly defined by the UN Documents World Commission on Environment and Development (1987:16) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development originally consisted of two broad concepts, namely ecological sustainability as well as economic and social development (Burns, Audion & Weaver, 2006:379; Du Pisani, 2006:94). This concept was already regarded as a key theory of good practice within spatial planning education more than a decade ago

(Gunder, 2006:218) since it integrates with spatial planning's dominant themes (e.g. New Urbanism and Smart Growth) and key considerations (e.g. transport oriented development) (Campbell, 2016:394). Campbell (2013:87-88) notes the evolving nature of the definition of sustainable development makes it a complex challenge to implement into the theme of spatial planning, but it also provides many opportunities due to its changing nature.

In more recent years, sustainable development is referred to in terms of the triple or quadruple bottom-line. The triple bottom-line was originally an accounting framework used to stress the comprehensive investment results of an organisation regarding their social (people), environmental (planet) and financial (profit) goals (Slaper & Hall, 2014:4). On the other hand, the UN (2017:6) identifies the three core elements for sustainable development as economic growth, social inclusion and environmental protection. However, Lawler (2014: online) points out that organisations need to be held accountable for quadruple bottom-line performance standards. The definition of the fourth aspect of the quadruple bottom-line differs among authors (cf. Cambridge Leadership Development, 2013: online; Lawler, 2014: online; Sood & Tulchin, [n.d.]:2) but in essence, it focuses on the organisation's goal(s) for sustainable development.

In support of the concepts of the triple and quadruple bottom-line of sustainable development, the UNDP (2017:4-13) identified 17 sustainable development goals (SDGs) which need to be adopted by all countries by 2030 (see Table 2.4). In line with these 2030 SDGs, sustainable development is defined as: "[The] promotion of sustainable, inclusive and equitable economic growth, creating greater opportunities for all, reducing inequalities, raising basic standards of living, fostering equitable social development and inclusion, and promoting integrated and sustainable management of natural resources and ecosystems" (UNDP, 2017: online). Sustainable development within this new definition seems to be quite demanding.

Table 2.4: 2030 Sustainable Development Goals (UNDP, 2017:4-13)

1. No poverty	10. Reduced inequalities
2. Zero hunger	11. Sustainable cities and communities
3. Good health and well-being	12. Responsible consumption and production
4. Quality education	13. Climate action
5. Gender equality	14. Life below water
6. Clean water and sanitation	15. Life on land
7. Affordable and clean energy	16. Peace, justice and strong institutions
8. Decent work and economic growth	17. Partnerships for the goals
9. Industry innovation and infrastructure	

How does sustainable development relate to spatial planning? If one considers that cities only occupy about 2% of the land on the planet but house over half of the world's population, the relationship is clear as to why it is necessary to transform these urban spaces (Matter, 2016:1; UNDP, 2017:14). The importance of sustainable development in cities is stressed further by the UN's estimation that by 2050 approximately two-thirds of the world's population will live in cities (UNDP, 2017:14). This urbanisation will result in new urban management and planning problems which planners have not addressed before (Watson, 2009:2263). Todes (2011:116, 120, 128) notes that spatial planning in this century promotes sustainability, inclusiveness (social justice) and liveability in growing cities. Sustainability also aligns with other prominent themes of planning of this century such as limiting urban sprawl, creating compact cities, transport orientated development and walkable urbanism (Campbell, 2013:88). As a result, the 11th 2030 sustainable development goal is dedicated to sustainable cities and communities.

On another note, the rapid growth of cities in the developing world often goes together with extreme poverty in concentrated urban slums (LeGates & Stout, 2000:299; UNDP, 2017:14; Watson, 2009:2263). This is evident in Sub-Saharan Africa where 45% of the population live in extreme poverty (Burns et al., 2006:379). According to Matter (2006:2), urban slums are one of the costs of unplanned or at best, poorly planned urbanisation which also results in lower life expectancy and economic growth. Hall (2014:528) dedicates an entire chapter in his book to the permanent underclass living in cities who appear to be excluded from the rest of the city. Although the article by Rydin (1995:373) was written more than two decades ago, her work still has merit in the current debate regarding the inequality of society partially as a result of the actions of planning and its impact on sustainable development (i.e. poverty generates environmentally unsustainable practices). As the number of people living in urban slums within cities increases, so does the gap between the ideals of planning and the realities of everyday life for the underclass in the cities (Watson, 2009:2263). Greater focus needs to be placed on efficient and effective spatial planning in cities in order to grow their economy (Eggenberger & Partidário, 2000:203). One of the objectives of SDG 11 – sustainable cities – is to upgrade slum settlements (UNDP, 2017:14). This may in turn address the first SDG of eradicating poverty. Conversely, there are shrinking cities that result in a vast amount of vacant land. Burkholder (2012:1166-1168) recommends that such spaces be transformed into ecological solutions for sustainable development of land as well as to promote the health and well-being of residents.

The question now is what kind of infrastructure needs to be designed and built to make cities more sustainable (Swilling, 2011:78). Campbell (2013:87) notes that the challenge is not to implement sustainable development to make cities more sustainable, but rather defining, measuring, negotiating and implementing sustainable practices. The UN 2030 sustainable development goal regarding sustainable cities identifies the following aspects:

- Access to safe and affordable housing;
- Investment in public transportation (see 2.4.3);
- Creating green public spaces;
- Participatory and inclusive urban planning and management.

  (UNDP, 2017:14; UN, 2018a:24-25)

Designing and building more sustainable cities may provide a decent quality of life for all citizens (even the poorest) as well as result in increased economic growth and social stability (Matter, 2006:2). However, the skill-sets and capacities of planners need to be revised on a continuous basis for planners to meet the requirements needed for sustainable development (UN Habitat, 2010:38), since the concept of sustainability is ever changing (Campbell, 2013:88). This, in turn, means that higher education institutions that produce graduates specialising in urban planning or similar fields need to ensure that their curriculum includes new forms of planning and approaches (including participatory approaches) in response to the sustainable development agenda of the UN (UN Habitat, 2010:38). Campbell (2016:393) cautions planners not to attempt to solve the sustainability of cities by means of traditional planning thinking regarding sustainable development. Such thinking includes attempts to redefine the concept of social development, focusing solely on environmental protection, and disregarding the other key considerations of sustainability (see 4.4); developing and evaluating sustainability measures rather than focusing on implementation tactics and strategies, as well as focussing on the aspirations of design visionaries (see 2.2) rather than the scientific and social analysis of sustainable development.

Good health and well-being is another 2030 sustainable development goal (see Table 2.4) (UNDP, 2017:6). Barton (2009:121) defines the dynamic interaction between the various aspects (e.g. human social and economic activity, development patterns, planning and environmental policy) that promotes good health and well-being (i.e. a healthy environment) as a wicked problem since these aspects are in constant flux with each other. A walkable neighbourhood that promotes physical activity (and as a result, lower obesity) is one of the core areas of future research on residents' lifestyles (Barton, 2009:121). One study by Christian, Bull, Middleton, Knuiman, Divitini, Hooper et al. (2011) reports on the correlation between walkability and mixed land uses. The designing of walkable neighbourhoods to promote residents' health is a core principle of both New Urbanism (see 2.3.1.1) and Smart Growth (see 2.3.1.2).

The New Urban Agenda (NUA) also links to discussions regarding spatial planning and sustainability. The NUA was the core focus of the Housing and Sustainable Urban Development (Habitat III) conference in Ecuador during 2016 (cf. UN, 2017d). The previous Urban Agenda promoted sustainable

villages, towns, cities, and regions (i.e. human settlements) which provide satisfactory shelter for all (Citiscope, [n.d.]: online). The NUA has a broader purpose than the previous agendas since it promotes equal rights and access for all residents to the benefits and opportunities available in their specific city (UN, 2017d:iv). The implementation of the NUA requires:

- Stakeholders to adhere to urban rules and regulations according to the "standards and principles for planning construction, development, management and improvement of urban areas".
- Efficient urban/spatial planning and design for common goods (e.g. streets, open spaces, etc.).
- Financial support for good management and maintenance of cities.
  (UN, 2017d:i; UNDP, 2017:14; UN, 2018a:24-25)

2.4.2 Spatial planning and transportation

The existing link between spatial planning and transportation-related matters is noted in the literature (e.g. increased level of CO_2 emissions that results from travel patterns due to a lack of public transportation infrastructure) (Jaiswal, Rathore & Jain 2012:60; Rydin, 1995:370, 372; Reisi, Aye, Rajabifard & Ngo, 2016:252). Most transportation issues (e.g. traffic congestion and green-house emissions) (Jaiswal et al., 2012:60; Matter, 2006:2; Reisi et al., 2016:252) are closely related to the discussion on sustainable development and spatial planning in section 2.4.1.

Williams (2005:1) reports that the issue which attracts the most attention both academically and in practice is the impact of a city's urban form on transport and mobility. The streets of most early cities were often the determining factor of their urban form (Blumenfeld, 1949:10). The most influential streets that dominated a city's urban form were those streets with a spiritual connection (e.g. the streets that lead up to temples or places of worship) (Blumenfeld, 1949:11). Mobility is often decreased in cities due to traffic congestion as a result of poor spatial planning (Jaiswal et al., 2012:60; Matter, 2006:2). Density is another aspect which influences mobility if there is an inadequate public transportation system (Newman, 2014:125). Morel, Lima, Martell-Flores and Hissel (2013) point out that transportation and mobility (movement of people) are critical to sustain a working-class level of tourism, politics and economy. Therefore, it is important to address these and other transportation issues to promote sustainable cities (Fu & Zhang; 2017:117) which is the 11th 2030 sustainable development goal identified by the UN (UNDP, 2017:14; UN, 2018a:24-25).

Another transportation-related matter that arises due to poor spatial planning is the sprawling nature of cities (Jaiswal et al., 2012:60; Matter, 2006:2). Urban sprawl is applicable to almost all cities, even South African city suburbs as reported by Chobokoane and Horn (2015:79). Countering of urban

sprawl is one of the main purposes of the New Urbanism movement (see 2.3.1.1) (Bohl, 2000:762; Hirt, 2009:248, 251) as well as Smart Growth (see 2.3.1.2) (Handy, 2002:147). Garde (2004:162) points out that urban sprawl is often extended by new neighbourhoods developed on the edges of a metropolitan area, city or town which in turn promotes the use of private motor vehicles since there is often a lack of public transport (Dixon & Dupuis, 2003:353). Adequate investment in public transport is needed in order to address these matters as well as to create sustainable cities and communities (see 2.4.1) (Rydin, 1995:373; UNDP, 2017:14; UN, 2018a:24-25). Newman (2014:128) avers that sustainable transportation is the politically tougher choice for planners since it means not building freeways. This may, in turn, motivate commuters to shift away from private motor vehicles towards public transportation which is the ideal (Eggenberger & Partidário, 2000:203; Rydin, 1995:372). Jaiswal et al. (2012:60) propose the incorporation of rail and bus transit as part of the overall public transportation planning process to improve accessibility and transit efficiency.

Low-density suburban developments encourage residents to use their private motor vehicles as transportation means (Handy, 2002:147). This mode of transportation is the only available choice in most low-density areas for commuters to reach their destinations within a reasonable time frame (Newman, 2014:124). Densities in cities are generally increasing (cf. UNDP, 2017:14; UN, 2018a:24-25) which may support the investment in adequate public transportation. However, land development patterns and land use policies influence transportation investments (Handy, 2002:163-164; cf. Waddell, Ulfarsson, Franklin & Lobb, 2007). Commuters' socio-demographic characteristics and their attitudes and behaviours are another set of factors that needs to be taken into consideration (Eggenberger & Partidário, 2000:203; Handy, 2002:147). Transportation-related matters to sustainability, land use and spatial planning are discussed in more depth in Chapter 3 since these concepts are intertwined as discussed in section 2.4.3.

2.4.3 Spatial planning and urban management

The implementation of land use and urban management policies are important to meet the goals for future spatial planning of towns, cities and regions (Le Roux & Augustijn, 2017:49). Strong leadership is a critical factor for the successful implementation of policies and regulations, such as the National Development Plan (NDP) of 2030 of South Africa (cf. RSA NDP, 2012:59). For example, the spatial policy has the ability to strengthen relations between neighbouring states to promote cross-border infrastructure connections (e.g. the Katse Dam Lesotho highlands water project) (RSA NDP, 2012:278).

Land zoning was implemented as an attempt to address urban growth since the Second World War (Healey, 2010:14-15). More formal planning legislation was originally established to organise the

development of land use planning across Europe and later on in the US (i.e. the allocation of specific land areas [zoning] for residential, commercial and/or industrial uses) (Hirt, 2013:293). Such planning legislation was implemented with the hope of reducing fire and work-related accidents, creating healthier living conditions for residents and improving transportation-related problems (e.g. traffic jams) (Hirt, 2013:301).

It is important to identify each region's specific purpose and the applicable rules and regulations before starting with any spatial planning since these aspects should be used as a guideline during the decision-making process (Stefanović, Danilović-Hristić & Milijić, 2015:67). However, decision makers often find it hard to justify or quantify their decisions as well as the resulting implications thereof (Le Roux & Augustijn, 2017:30). An example is a change within an ecosystem (e.g. habitat of species, water quality, soil erosion, etc.) when land uses shift from one use to another (e.g. agricultural to commercial) (Ekbia & Evans, 2009:330). Land use change models (e.g. Dyna-CLUE model) may be used as tools to support decisions taken by the spatial planner (Le Roux & Augustijn, 2017:30). However, such decisions should not only defend the implications of a specific location or zone but also on a regional level (Ekbia & Evans, 2009:330). Urban management policies need to include a stronger sustainable development focus (Pearsall & Pierce, 2010:579) to address the various issues the concept touches on such as the interlinking concepts of the economy, environment and social justice (see 4.3).

Mixed land use is promoted through the New Urbanism (see 2.3.1.1) and Smart Growth (see 2.3.1.2) movements which are leading spatial planning themes currently. Mixed land use means that a specific location/area has several compatible land uses in close proximity to each other (Du Plessis, 2014:219). High levels of mixed land use are commonly found around the Central Business Districts (CBD) of cities. Mixed land use within a specific area can be promoted by improving the accessibility of the location, the visibility of the location from major routes and related benefits (Du Plessis, 2014:230).

2.5 STANCE OF SPATIAL PLANNING IN SOUTH AFRICA

The IUDF of South Africa projects that 71.3% of the country's population will live in cities by 2030 (2016:7). This is higher than the statistics reported in section 2.4.1, which estimates that by 2050 approximately two-thirds of the world's population will live in cities (UNDP, 2017:14). This growth pattern is in alignment with Watson's (2009:2263) study that forecasts that a large proportion of the population growth in cities will take place in cities of the Global South. Therefore, it is important for South African spatial planners to pay more attention to future spatial development patterns since poor urban design decisions today impacts the social, economic and climate costs for decades to come (RSA IUDF, 2016:36).

A few years ago, Oranje (2014:1) reported that the planning profession was in a good state in South Africa and contributes to the transformation of South African cities in the post-apartheid era, but later on Oranje mentions the inability of planners to assist the people they are supposed to serve (Oranje, 2014:17). However, Du Plessis and Boonzaaier (2015:88) use the words distorted (spatial patterns), underdeveloped (public transportation) and unequal access (to economic and social opportunities) to describe spatial development in South Africa. These are not the words used in the spatial planning themes of this century of more resilient cities (see 2.3.1). The IUDF (2016:30) identifies several challenges which play a role in the current stance of spatial development in South Africa, such as the lack of effective use of spatial planning tools, the tension between government and traditional leaders, poor infrastructure, stagnation of the economy and weak partnerships. The private sector plays a too large role in the overall spatial development pattern of South Africa due to weak spatial governance (RSA NDP, 2012:275). Harrison and Todes (2015:47) point out that innovation is lacking in the field of spatial planning and land management in South Africa, possibly because South African planners lack passion for their profession and commitment to the role that they (the planners) can play as transformers in the post-apartheid society (Oranje, 2014:7-8). The NDP also notes that another reason for the slow transformation in South Africa can be contributed to the fragmentation of spatial planning responsibilities across various government departments (RSA NDP, 2012:276).

The New Urbanism Charter (2016:198) advocates that access to basic services makes more resilient cities which is in alignment with the 2030 SDGs. The transformation Oranje (2014:7-9) writes about also calls for transformation towards a more sustainable South Africa in regard to global initiatives (e.g. 2030 sustainable development goals). South African households spend approximately 30% (or even more) of their income, energy and time on transportation (RSA NDP, 2012:233). This is mostly as a result of an inadequate public transportation system in the country (ArriveAlive, 2018: online; Du Plessis & Boonzaaier, 2015:88) which is one of the key aspects of the 11th 2030 sustainable development goal (i.e. sustainable cities and communities). There are several transportation options available in South Africa, such as domestic flights, rail (e.g. Gautrain, Metrorail), bus, and motor vehicle travel that includes taxis (e.g. car rental and minibuses) (South African Tourism, 2018: online). The reality is, however, that poor South Africans (the majority of South Africa's population) are dependent on minibus taxis as means of transportation which are often an unsafe transportation option (ArriveAlive, 2018: online). Although R18 billion was received to implement Bus Rapid Transport systems (BRT) in major cities by the National Treasury of South Africa (RSA National Treasury, 2016:12), its impact is not evident in the daily lives of South Africans. The ArriveAlive road safety campaign of South Africa avers that the restructuring of the public transportation system is still one of the biggest challenges of the country (ArriveAlive, 2018: online). The ideal, of course, is that spatial

development patterns should be in the long-term public interest, aiding transformation in South Africa (RSA NDP, 2012:275). Therefore, spatial development in South Africa should focus on creating compact, connected, integrated and inclusive cities promoting efficient services, systems and resource-use to create more resilient cities (COGTA, 2016:48).

Spatial inequalities are one of the major themes that ripple through the literature of the current stance of spatial planning in South Africa. South Africa's spatial planning is renowned for its apartheid cities in which spatial planning was used to create segregation between different culture groups (Maylam, 1995:15). Todes and Turok (2018:12) observe that there is some cultural desegregation occurring in South African cities, but the concern is the spatial inequality of the large proportion of the population that live on the edges of the city and have limited access to basic services. Basic services have improved to some degree in the country (Todes & Turok, 2018:12), but several of the municipalities have been placed under administration mostly due to poor financial management. The larger cities have outperformed the smaller cities economically in South Africa over the last two decades (Borel-Saladin & Turok, 2013:33). The spatial planning policies of South Africa are gradually transforming the spatial planning landscape, but related sustainable issues (such as poverty, access to water and energy, economic growth and so more) are influencing the pace of transformation. Thus, the current stance of spatial planning in South Africa should be viewed in a holistic manner since the main goal is improved quality of life for all residents (COGTA, 2016:66).

Inequality of income has increased over the past decades in developing countries and as a result limited the reduction of poverty within these countries (UNDP, 2017:13). The UNDP (2017:13) and UN (2018a:8-9) also report shocking realities (e.g. maternal mortality rates and age of death for children in very poor communities) stemming from inequalities in developing countries, such as South Africa, which pertains to SDGs of elimination of poverty, increased good health and well-being, and economic growth. South Africa's NDP of 2030 identifies the participation of residents from rural communities in economic, social and political aspects of the country as an important goal, one which needs to be supported by good quality education (RSA NDP, 2012:44). The NDP also lists implementing a national spatial framework to build South African communities (RSA NDP, 2012:278). Although the listed inequalities may seem far from the topic of discussion (i.e. spatial planning in South Africa), it relates to the SDG goal of creating sustainable cities and, in particular, sustainable communities (cf. UNDP, 2017:14; UN, 2018a:24-25).

2.5.1 South African spatial planning policies

A change in perception regarding spatial planning can be observed in the literature during the last few decades especially in growing cities (see 2.4.1) (Todes, 2011:116, 120, 128). It is also obvious from the literature that spatial planning in South Africa has undergone many changes since the country's first democratic election in 1994.

The Development Facilitation Act No. 67 of 1995 (DFA) is regarded as the first major planning legislation which was implemented in the hope of facilitating and expediting the transformation of the country in relation to land from its apartheid past (Berrisford, 1997: 57; RSA, 1995:1). The DFA stipulated principles for land development in all nine provinces of the country that had to be encouraged through policies, administrative practices and laws (RSA, 1995:12-14). Many of the principles of the DFA promote aspects contained in the 2030 sustainable development goals, New Urbanism and/or Smart Growth, such as restricting urban sprawl to develop denser cities and towns (cf. Du Plessis & Boonzaaier, 2015), create employment opportunities near residential areas that results in less dependency on the private motor vehicle, encourage sustainable practices and use co-participatory approaches by involving the specific community. The White Paper on Spatial Planning and Land Use Management of 2001 provided a standardised set of principles and norms for land use, land management and spatial planning (cf. RSA Department of Land Affairs, 2001: online). The principles on which spatial planning and land use management should be built in South Africa are sustainability, equality, efficiency, fairness and good governance (cf. RSA Department of Land Affairs, 2001: online). The Spatial and Land Use Management (SPLUMA) Act No. 16 of 2013 replaced the DFA since several parts of the latter act were found to be unconstitutional in 2010 (Fonkam, 2017: online). Table 2.5 provides a summary of SPLUMA.

Among other dominant spatial planning policies used in urban planning in South Africa are the NDP of 2030 (RSA NDP, 2012) and the IUDF (2016). The main objectives of the NDP are to reduce poverty and eliminate inequalities by 2030 (RSA National Planning Commission, 2012:34). One of the critical actions to achieve these two objectives is to create new spatial norms and standards by increasing density in cities, improving transportation and addressing housing market gaps (RSA National Planning Commission, 2012:34). These critical actions are in alignment with New Urbanism and Smart Growth principles which advocate for the integration of mixed housing options (including more affordable housing), use more sustainable transportation methods (such as walking) and increase population densities in cities (CNU, 2009:3-4; Downs, 2005:368; Knaap & Talen, 2005:108). The IUDF (2016:38) also calls for the higher-density urban development but with Transport Oriented Development (TOD) approach which necessitates urban development along mass transit corridors.

Table 2.6 is a comparison of the three main spatial planning policies of South Africa discussed in this section against the dominant spatial planning themes of New Urbanism and Smart Growth discussed in section 2.3.1. Table 2.6 highlights that the current spatial planning policies of South Africa have much in common with the spatial planning themes of New Urbanism and Smart Growth. Increased spatial densities, mixed land use, diverse housing options, walkable neighbourhoods and sustainability emerge as similar themes in the three policies analysed. Although a moderate increase in urban densities and changes in urban form since 1994 is evident (Du Plessis & Boonzaier, 2015:107), Fonkam (2017: online) avers that it will take years and dedication to effectively implement the SPLUMA framework.

Du Plessis (2013:17) identifies seven challenges that hinder the effective implementation of the policy and legislation to transform South Africa, namely: institutional coordination and alignment in regard to urban growth and governance (see 2.4.3); physical and social-economic integration challenges as a result of inequalities of the past (cf. Du Plessis, 2013:88); understanding the space-economy of cities in regard to the need for urban growth and socio-economic redress; infrastructure development and capital investment; spatial planning and sustainability (see 2.4.1); spatial planning and informality (of the poor), and the continuous monitoring of the influence and impact of these plans. The NDP for South Africa also calls for the promotion of equal rights and access to the benefits and opportunities available (i.e. the main purpose of NUA) (National Planning Commission (NPC), 2012: 233). The plan also promotes the lowering of living costs by transforming the transport, telecommunication, food and spatial planning sectors (NPC, 2012:119).

Table 2.5: Spatial Planning and Land Use Management principles (RSA SPLUMA Act No. 16, 2013:14-17)

PRINCIPLE	DESCRIPTION
Spatial justice	• Improved access to land use must be given to everyone with regards to previous development imbalances. • All areas must be included with the spatial development framework including areas classified as regions of poverty and depreciation. • Land use schemes must allow access to disadvantaged communities or persons. • All the areas of municipalities must be included in the land use management system, including all the disadvantaged areas. • The incremental upgrading of informal areas must be part of the land development procedures and produce access to secure tenure. • The value of the land may not influence an application or the outcome for a municipal planning hearing.
Spatial sustainability	• Land development must be in parallel context with the means (financial, institutional and administrative) of the republic. • Prime and unique agricultural land needs to be protected. • Land use measures need to be consistent regarding environmental management instruments. • The functioning of land markets needs to be promoted and inspired for actual and reasonable functioning. • Provisions of all costs of infrastructure and social services in land developments need to be made. • Sustainable locations need to be promoted and urban sprawl needs to be limited. • The end result must be that communities need to be more viable.
Efficiency	• Existing resources and infrastructure must be utilised by land use. • Decision-making procedure must reduce negative financial, economic, or environmental impacts. • The effectiveness and streamlined time frames are linked to the development application procedure.
Spatial resilience	• Environmental and economic shocks are expected in communities when some kind of flexibility occurs within a spatial plan.
Good administration	• An integrated approach to all spheres of government guided by the spatial planning and land use management as embodied by the act. • Proper sector inputs and prescribed requirements during the preparation of spatial planning frameworks must be provided by all government departments. • Land use or land development laws are constantly in functional use. • All parties must provide their input regarding spatial plans, policies and land use schemes on matters affecting them. • The public needs to be informed and empowered regarding policies, legislation and procedures.

Table 2.6: Comparison of South Africa's policies with current dominant spatial planning themes

CRITERIA	**SPLUMA** (RSA Spatial Planning and Land Use Management Act No. 16)	**NDP of 2030** (RSA NDP, 2012)	**IUDF** (RSA Cooperative Government and Traditional Affairs, 2016)
SMART GROWTH (Downs, 2005:368; Knaap & Talen, 2005:108)			
Create a greater diversity of housing, including more affordable housing options	x	x	x
Implement more diverse rules concerning aesthetics, street layouts, and design			
Increase public costs for new developments/new communities via impact fees			
Increase residential densities	x		x
Limit new developments			x
Promote the use of public transit by offering a variety of transportation choices		x	x
Promote public participation	x	x	x
Provide more mixed land uses which include pedestrian facilities (walkable neighbourhoods)		x	x
Reduce obstacles to developer entitlements			
NEW URBANISM (CNU, United States, Department of Housing and Urban Development, 2000: 4-30)			
Pedestrian friendly design that promotes walking, cycling, rollerblading, skateboarding, etc.		x	x
Interconnected street grid networks with a hierarchy of narrow streets, boulevards and alleys that promote walking			x
Mixed land use within neighbourhoods that promotes a diverse population		x	x
Mixed housing of various types, sizes and prices	x	x	x

CRITERIA	**SPLUMA** (RSA Spatial Planning and Land Use Management Act No. 16)	**NDP of 2030** (RSA NDP, 2012)	**IUDF** (RSA Cooperative Government and Traditional Affairs, 2016)
Creating architecture and urban design that contributes to the overall quality of life of its residents		x	x
Public space centre with enough public open spaces with transect planning (population dense city centres with decreasing densities to the edge of the city)			
Increased population densities	x		x
Use of smart transportation (railways between cities, towns and neighbourhoods)		x	x
Sustainable orientated:			
- Consideration of the environmental impact of developments		x	x
- Eco-friendly technologies		x	x
- Use energy efficiently		x	x
- Support local production to promote more sustainable production		x	x
- Reduce driving to promote sustainable orientated transportation		x	x

2.6 CHAPTER SUMMARY

This chapter started with a review of the Ideal City models of Howard, Le Corbusier and Wright (see 2.2). These models were created as solutions to the problems of urban patterns in the years preceding the Second World War which was known for the development of large-scale factories, the implementation of zoning regulations and the Great Depression (cf. LeGates & Stout, 2000:299). It seems as if the Ideal City models influenced the dominant spatial planning themes of the twenty-first century (i.e. New Urbanism and Smart Growth) since many similarities are highlighted in Table 2.3. Sustainable development characteristics are more limited in the Ideal City models since all the models were created to promote an alternative to congested and overcrowded cities and to promote the overall well-being and health of people. On the other hand, the two main spatial planning themes of the last few decades were designed to enforce climate action and create sustainable cities and communities (see 2.3).

The key considerations for spatial planning in this chapter are sustainability, transportation and urban management, as identified from the dominant spatial themes in relation to this study (see 2.4). As section 2.4.1 highlights, sustainability is regarded as a crucial part of future spatial planning. The three key considerations are interrelated in nature. Although transportation may seem disconnected to sustainability, it is one of the target goals of the 11th 2030 sustainable development goal (i.e. sustainable cities and communities) (cf. UNDP, 2017:14; UN, 2018a:24-25). Urban management is the key to achieve the other key considerations (i.e. sustainability and transportation) since policies and regulations guide the future of spatial planning (see 2.4.3).

The chapter ends with a discussion on spatial planning in South Africa to provide a local orientation of current spatial planning practices (see 2.5). In the light of the forecasted growth in South African cities, it is important for South African spatial planners to pay more attention to future spatial development patterns since poor urban planning decisions today impact the social, economic and climate costs for decades to come (RSA IUDF, 2016:36). The current stance of spatial planning in South Africa was further discussed through an analysis of South African spatial planning policies (see 2.5.1) and their alignment to New Urbanism and Smart Growth (see Table. 2.6). Although it is evident that spatial planning policies attempt to promote more sustainable and resilient South African cities, the current stance of spatial development in the country is described as distorted (spatial patterns), underdeveloped (public transportation) with unequal access (to economic and social opportunities) (Du Plessis & Boonzaaier, 2015:88). Countries like South Africa, that do not have prior urban templates to use to affect the transformation depicted in the predominant spatial planning themes mentioned

in this chapter (e.g. compact cities with walkable streets and medium-density mixed neighbourhoods which are connected by public transit nodes), can often face several challenges such as lifestyle preferences of society, socio-economic patterns and inaccurate assumptions of the feasibility of urban densification (Du Plessis, 2012:10). Figure 2.2 attempts to visually summarise the connections mentioned in this summary.

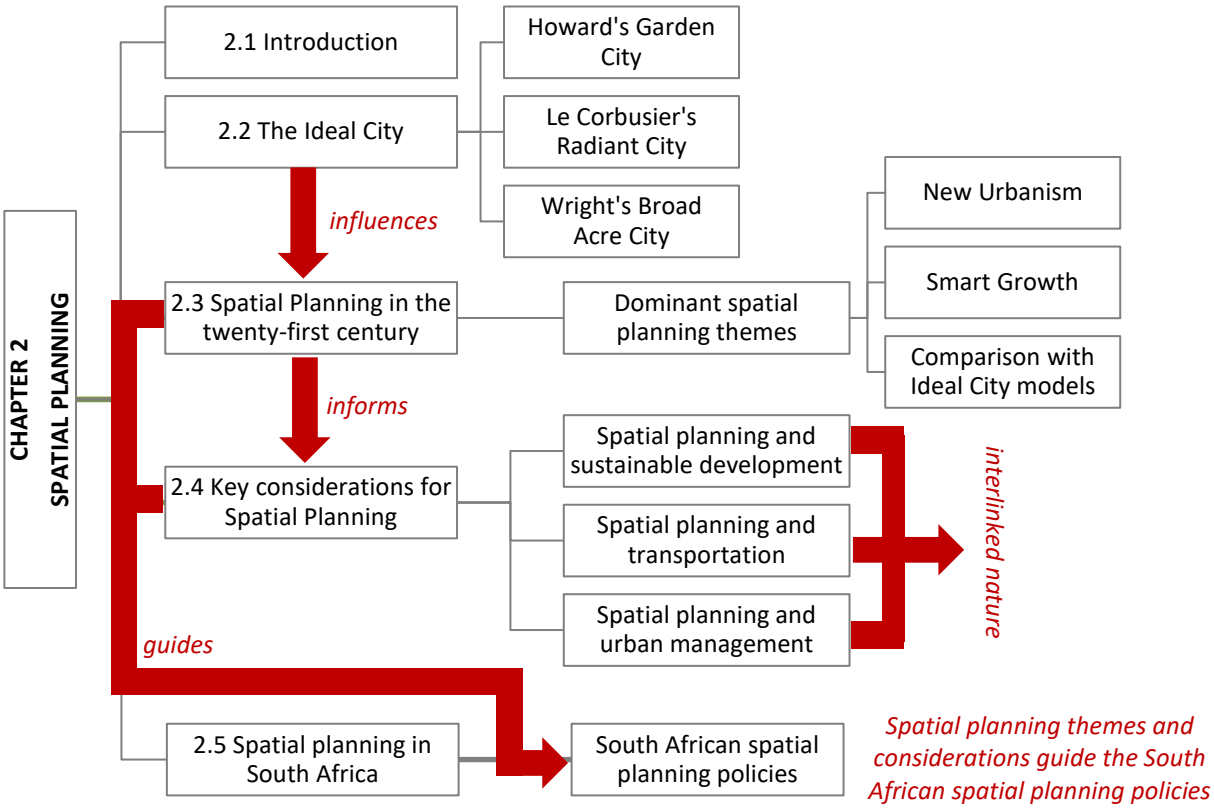


Figure 2.2: Visual summary of the connections between the various sections of this chapter

CHAPTER 3

SUSTAINABLE TRANSPORTATION

3

3.1 INTRODUCTION

Transportation plays an important role within various key considerations such as economic, social, environmental and technological issues (see 3.4) (Filipczyk, 2015:117; Zakowska & Pulawska 2014:68). The number of people in cities is growing including in South Africa (see 2.5). As a result, the number of vehicles on roads is also proliferating to accommodate the increase in people living in cities but this results in a negative impact on the environment and the economic productivity of a country (Cervero, 2006:3; Newman & Kenworthy, 1996:6). More than a decade ago, Cervero (2006:20) already advocated that transportation and spatial planning activities should be closely interlinked within cities. Newman and Kenworthy (1996:6) also provided a summary of the negative aspects of singular vehicle usage (e.g. oil vulnerability, urban sprawl, high infrastructure cost and more). The aim of this chapter is to provide an orientation to the reader of the interlinked nature of transportation, spatial planning (see Chapter 2) and sustainable development (see Chapter 4) with a focus on smaller metropolitan municipalities in South Africa (see 3.5).

The chapter starts with a brief historical overview of transportation (see 3.2). This section is followed with a discussion of the relationship of transportation's role within the dominant spatial planning themes discussed in Chapter 2 (see 3.3) and other key considerations such as economic (see 3.4.1), social (see 3.4.2), environmental (see 3.4.3) and technological (see 3.4.4) considerations. In order to situate this study within the specific context, section 3.5 reviews the status of transportation in South Africa and discusses various modes of transportation and policies. Figure 3.1 presents an outline of this chapter.

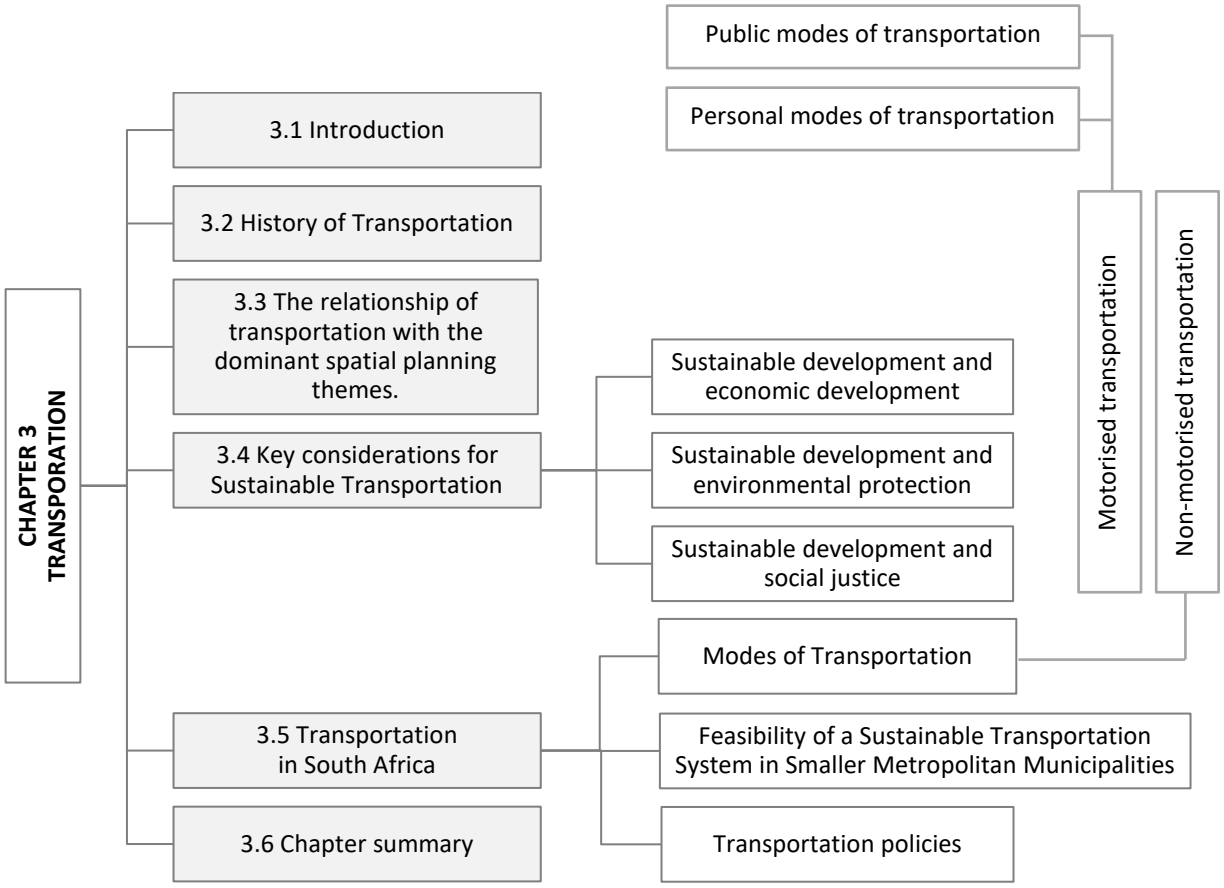


Figure 3.1: Outline of Chapter 3: Transportation

3.2 HISTORY OF TRANSPORTATION

The history of transportation is not brief. Rodrigue and Slack (2017: online) outline the ancient history of transportation in the years preceding the birth of Christ (i.e. BC). The earliest recorded paved road was constructed in 3 000 BC in Mesopotamia and in 100 BC the Roman Empire was the first to construct a major road network system (Rodrigue & Slack, 2017: online). The history of transportation continues from this point to expand over various countries and continents.

Various modes of non-motorised transportation are mentioned before the first industrial revolution such as animal-powered (horses, oxen and donkeys), human-powered (walking, running and swimming), and watercraft (barges and sailboats). In South Africa, the city of Cape Town was used as a service station for the East Indian trade from 1652 to 1806 and as such had a network of roads within the city's parameters. Transportation from Cape Town was mainly horse tracks that led to multiple towns such as Uitenhage, Graaff-Reinet, Tulbagh and Vanrhynsdorp within the Cape province (Mitchell, 2014:36). The first industrial revolution is characterised by the use of steam and water power to promote people's mobility through canals, waterways, roads and railways with new innovations such as the steam engine, combustion engine and automobiles (Encyclopædia Britannica, 2019: online). Henry Ford, the American industrialist, is commonly known for his contribution to the

mass manufacturing of automobiles with his assembly line innovations during this period which was the main contributor to people being able to afford their own motor vehicles. The first industrial revolution earmarked the creation of the combustion engine which took over as the lead mode of transportation in the twentieth century, this resulted in private motor vehicles dominating the roads of South Africa currently (Mitchell, 2014:38).

3.3 THE RELATIONSHIP OF TRANSPORTATION WITH DOMINANT SPATIAL PLANNING THEMES

The relationship of transportation with the main spatial planning themes of the twenty-first century is evident from the discussion in section 2.3. A distinct transition is noted in spatial planning themes from a focus on private transportation (in the Ideal City models) to public transportation (New Urbanism and Smart Growth) in section 2.3.1 (see Table 2.3). Various transportation modes are currently included in the spatial planning themes such as non-motorised (walking and bicycling), and motor-powered (water, rail, air and land transport) modes.

New Urbanism's Center for Transport Oriented Development notes that a new approach to transportation is needed since people's housing preferences are changing, 24-hour neighbourhoods are promoted through mixed land uses, and commuters' preference to use bus and rail transportation modes above personal transportation (New Urbanism, 2019: online). The dominant spatial planning themes encourage spatial and transportation planners to seek solutions for transport orientated problems (Handy, 2005:3), sustainability, inclusiveness (social justice) and liveability in growing cities (Grant, 2009:11; Todes, 2011: 116, 120, 128) (see 2.3.1 and 2.4.1.). Transport orientated development is considered an element of sustainable development (Campbell, 2013:88) and is therefore mentioned in the SDG 11 (see Table 2.4).

The relationship between Smart Growth and transportation is a theme which needs to be discussed (see 2.3.1.2). Smart Growth is concerned with traffic congestion in the ever-increasing development of the community (see 2.3.1.2). The optimisation of transportation facilities can be achieved by introducing smart mobility (Zawieska & Pieriegud, 2018: 41). Smart mobility focusses on automobility and the range of elements that assists with the methods used to travel around the world (Docherty, Marsden & Anable, 2018:114). Smart mobility is the ability to move safer and faster from one point to another. The European Union implemented the concept of smart mobility into their development several years ago which delivered benefits to pipelines, railways, airlines, water and road transportation systems contributing to a more sustainable living environment (Balint, 2017:282; Ferrer, García-Nieto, Alba & Chicano, 2016:1). Smart Growth does not only include smart mobility, but

also includes a smart environment with more sustainable technologies creating a healthier environment, and smart people – educated citizens that are enabled to implement new concepts.

A sub-concept that links with smart mobility is Smart Cities. The ideal smart city occurs when everyone works together to improve the quality of life for all residents through collaboration between the citizens, municipalities, institutions and businesses (Snow, Håkonsson, & Obel, 2017:92). It is difficult to specify the exact parameters of an ideal smart city since different aspects, such as communication, technology and sociology, are involved (Ferrer et al., 2016:1; Orlowski & Romanowska, 2019:119). However, it is important that a smart city's management system should promote optimum use of resources and functions of services (e.g. reduce the consumption of fuel and minimise harmful emissions) (Ferrer et al., 2016:1; Orlowski & Romanowska, 2019:119). For a city to be considered "smart", one needs an efficient transport system for people or goods to be moved from origin to destination (Balint, 2017:284). Smart cities such as Singapore, Barcelona, London, San Francisco, and Oslo are excellent case studies for spatial and transportation planners to promote the integration of smart mobility within current cities.

It is believed that Intelligent Transport Systems (ITS) is a key contributor for a successful smart city, with a direct linkage to smart mobility, smart environment, smart living and smart laws (Balint, 2017:284) as well as cities' Information and Communication Technology (ICT) systems (Kramers, Höjera, Lövehagen, & Wangela, 2014). Some municipalities struggle to implement an ideal smart city due to a lack of competencies that may also suggest that there is a lack of education at local government levels (Alaverdyan, Kučera & Horák 2018:47). A smart city is a concept that has grown rapidly and provides several opportunities in the technology field. Its efficiency has been proven which should promote its inclusion in the curriculums of universities (Alaverdyan et al., 2018:47; Almirall, Wareham, Ratti, Conesa, Bria, Gaviria, & Edmondson, 2017:149). It is important to consider the major challenges of sustainable urban transportation in rapidly growing areas (low to medium income urban areas), due to the lack of attention to sustainable transportation that may lead to serious environmental, economic, health and social problems (Ahmad & De Oliveira, 2016:106).

Smart living can only be achieved if the required infrastructure is provided and people can use the new technologies supported by smart laws which require all legal aspects to be up to date with the development of the new technology (Balint, 2017:284). Technology may not be the most critical factor as other factors such as integrity and connectivity make a city smarter. The way in which some of the required services are provided also assists in the success of a smart city (Pourahmad, Ziari,

Hataminejad & Pashabadi, 2018:23). A city must also have the required vision to implement smart governance, smart economy, smart environment, smart mobility, smart people and smart living (Pourahmad et al., 2018:23). This will ultimately achieve smart living for a city's inhabitants.

The advantages of implementing a smart mobility system include the reduction of travel costs for passengers as well as freight costs for businesses (Balint, 2017:282). Spatial planning is key for the implementation of smart mobility as a dominant theme (see 2.3.1) (Orlowski & Romanowska, 2019:119). Smart mobility is a possible solution to various problems experienced by communities since it may promote the quality of life of commuters through an intelligent environment with an improved flow management system that controls a greater number of vehicles in a metropolitan area (Balint, 2017:284; Ferrer et al., 2016:1).

3.4 KEY CONSIDERATIONS FOR SUSTAINABLE TRANSPORTATION

Transportation plays an important role in the development and shaping of the economy of the world (Filipczyk, 2015:117). Transportation is part of a human's daily life, but it is resource intensive (Filipczyk, 2015:117) and is a major contributor to the ever-increasing CO_2 emissions (Sharifi & Yamagata, 2016:1668) (see 4.3.2). The growing number of vehicles has an alarming impact on urban sprawl, the natural environment and the economic productivity of a country (Cervero, 2006:3). Therefore, it is important to reconsider transportation decisions in terms of sustainable development regarding the economy and social, environmental and technological aspects (Filipczyk, 2015:117).

3.4.1 Economic considerations for sustainable transportation

Economy, nature and society are closely interlinked with each other since the purpose of the economy of a country is derived from the people (i.e. society), whereas the purpose of the people is derived from nature (Ikerd, 2012:16-17). Transportation plays an important role in the development and shaping of the economy of the world (Filipczyk, 2015:117) by creating urban mobility which provides purpose for people through access to employment opportunities (Roy, 2012:150). The main purpose of a transportation system is to move goods and people from origin to destination affordably, fast and safe via land public transport modes such as buses, trains, minibus taxis, trams, trolleys, paratransit, bicycles and motorcycle taxis (Sohail, Maunder & Cavill, 2006:178). A lack of personal mobility or access to transportation hinders the economic and social development of a society (Lee et al., 2017:211).

Many economies focus on large public transportation systems with a high capacity to meet the demand for urban mobility amongst the public (De Almeida Correia, Milakis, Van Arem & Hoogendoorn, 2016:498). However, it is often difficult to provide an inclusive public transportation system for all which has a fair distribution of trip rates and routes (De Almeida Correia et al., 2016:498). The cost of providing urban mobility through various transportation options rests on multiple factors which range from production costs, operating and maintenance, infrastructure costs, labour and environmental protection costs (Filipczyk, 2015:117). The triple bottom-line can be used to depict the comprehensive economic investment that urban mobility can contribute to the social (people), environmental (planet) and financial (profit) goals of a country (Slaper & Hall, 2014:4) (see 2.4.1). Economic growth, social inclusion and environmental protection are the three core elements for sustainable development (see 2.4.1), but environmental protection costs contribute significantly to the economic cost of implementing and maintaining a sustainable transportation system (Filipczyk, 2015:117).

3.4.2 Social considerations for sustainable transportation

Good accessibility has a distinct social meaning for specific societies. Western societies regard proper transportation systems as very important since they attach value to the ability to link people with access to job opportunities and so forth (Nahmias-Biran, Martens & Shifta, 2017:197). Sustainable transportation in regards to social considerations should include a variety of transportation modes as well as equitable distribution of access points.

Active transportation development is the equitable distribution of all transportation benefits and costs between all social groups within the entire service delivery area (Lee et al., 2017:220). Social equity focusses on specific social demographic sub-groups such as the highly disadvantaged population to promote mobility (Lee et al., 2017:212). Creating an autonomous sphere to provide accessibility for every part of a society is essential (Nahmias-Biran et al., 2017:197). However, spatial policies often cause social exclusion of vulnerable groups (i.e. groups of people that have a minimum participation level in places that they do not have access to, although they would like to join or be part of such activities) in a society that is socially and economically disadvantaged (Zakowska & Pulawska 2014:69). Older people may also be included within the vulnerable population group (Adorno, Fields, Cronley, Parekh & Magruder, 2018:300). Spatial equity refers to the equity of access across the entire geographic service area (Lee et al., 2017:220). The conceptualisation and expansion of environmental justice includes the comparative understanding of transit, settlement, opportunities (e.g. jobs) and housing locations that form part of a citizen's right to a city, to avoid social injustice by creating spatial

mismatches (Amar & Teelucksingh 2015:49). Active transportation costs and benefits focus on the distribution of transportation facilities that may not always reach the full potential of the equity effect (Lee et al., 2017:220). Discrimination in terms of social equity, spatial equity and active transportation costs and benefits may result in the restriction of individuals that want to be part of public life and social activities as well as have access to services and goods (Zakowska & Pulawska 2014:69). It also inhibits the participation of marginalised groups in activities that may promote their health and well-being because they do not have access to these services.

The effect poor mobility has on these marginalised groups was shown in an environmental impact assessment that noted that there is a general lack in the improvement of the public's health in Sydney, Australia (Harris, Riley, Sainsbury, Kent & Baum, 2018:115). Public health is influenced by spatial planning and transportation investments which do not promote a healthier lifestyle (Lawrence & Engelke, 2001:203). Non-motorised transportation modes such as walking and bicycling promotes public health (Cervero, 2006:3; Lawrence & Engelke, 2001:203). Both these modes are mentioned in the prevailing spatial planning themes to promote the overall well-being and health of people (see 2.3). The design of walkable neighbourhoods to promote residents' health is a core principle of both New Urbanism (see 2.3.1.1) and Smart Growth (see 2.3.1.2). Good health and well-being are also included in the 2030 sustainable development goals (see Table 2.4) (UNDP, 2017:6).

Urban sprawl does not only have a negative impact on the marginalised groups, but also on the city as a whole as the rapid expansion of cities leads to an increase in the average income of a household, and also to an increase in the use of private vehicles (Ahmad & de Oliveira, 2016:112). Issues relating to the increase in vehicle ownership in combination with a weak public transport system and a non-existing non-motorised transport system are complex (Jones, Tefe & Appiah-Opoku, 2013:23). Without an alternative to private vehicle use such as non-motorised or public transport options, urbanisation forces the city into pollution, congestion, high carbon emissions, and huge social consequences especially regarding the health and well-being of the citizens (Ahmad & de Oliveira, 2016:112).

3.4.3 Environmental considerations for sustainable transportation

The interlinking nature of environmental, social and economic considerations to create sustainable transportation is evident from the literature reviewed in this section. Acceptability, accessibility, availability and affordability are the four cornerstones needed to create sustainable transportation that is equitable and robust (Sharifi & Yamagata, 2016:1672). The importance of propagating sustainable transportation is highlighted in the Global Energy & CO_2 Status Report (2017:3) which

reports an increase of 460 million tonnes of emissions from 2016. The emission increase was mainly due to an additional 170 million vehicles driving on the roads and lower fossil-fuel prices (Global Energy & CO_2 Status Report, 2017:3).

Vehicle emissions dispersing into the atmosphere is a huge environmental problem since the gasses released (i.e. NOX gas which is a mixture of nitric oxide [NO] and nitrogen dioxide [NO_2], CO_2 and Hydrogen Carbon [HC]) results in air pollution and serious health issues (Csikósa, Vargab & Hangosa, 2018:174). The seriousness of the impact of emissions on the environment as well as people's health is evident from the all-time high amount of emissions (32.5 gigatons) reported in the Global Energy & CO_2 Status Report (2017:3). The amount of emissions generated includes several factors such as travel behaviour and travel speed (Wang, Szeto, Han & Friesz, 2018:387). A good example of travel behaviour is the variation in speed between driving on a freeway (as fast as the speed limit allows) and parking area (slower than the speed limit since the driver is looking for a parking space). Therefore, it is important to educate commuters on the impact that their travel behaviour (e.g. mode of transportation, adherence to the speed limit, acceleration and so more) has on the environment (Saleem, Eagle & Low, 2018:82) (see 4.3.2). Behaviour improvements (e.g. eco-driving, vehicle sharing, etc.) and technical energy efficiency improvement (e.g. fuel economy, emissions performance [gCO_2/km]) are two additional ways to protect the environment (Dennehya & Gallachóira, 2018:401; Echenique et al., 2012:136; Filipczyk, 2015:119; Saleem et al., 2018:82) (see 4.3.2).

In light of the importance of mobility for social considerations, alternative transportation modes that are eco-friendlier, such as hybrid and electric vehicles should be considered. Many motor manufacturers such as BMW, Honda, Nissan, Jaguar, Mercedes-Benz and Audi have joined the race to manufacture alternative vehicles. A governmental and industry partners investment in infrastructure for the promotion and development of electric vehicles is a multi-dimensional project but promotes a cleaner and healthier environment (Saleem et al., 2018:82). Energy efficient transportation can also be promoted through improvements in technical energy efficiency (to improve the current fleet of vehicles by improving their fuel economy, emissions or energy performance), improvements in behavioural aspects (eco driving or sharing of vehicles), policies that influence the purchasing of vehicles, modal shift, managing logistics and changing the speed limits (Dennehya & Gallachóira, 2018:401). However, it may not always be as straightforward as one thinks such as in extreme cases of traffic jams and high demands for mobility (Csikósa et al., 2018:175). Alternative low-emission sustainable transportation options are needed to promote mobility since the cumulative impact of emissions on climate change is intensifying (Sharifi & Yamagata, 2016:1672).

3.4.4 Technological considerations for sustainable transportation

Technological advances are evident in our daily lives. Every industrial revolution has brought change in the transportation section from the creation of the combustion engine, the exploration of lightweight materials such as aluminium, the Internet of Things and more recently the use of virtual reality (VR) and artificial intelligence (AI). The third industrial revolution earmarked the creation of the Internet of Things (IoT) (commonly known as the internet) which enabled commuters to plan their daily trips via applications such as Google Maps and Waze that indicate traffic congestion, accidents and optimal routes. The internet also created the opportunity for on-demand ride services such as Uber. New vehicles are also safer than in previous decades with various added safety aspects (i.e. airbags, safety belts, well-being indicators such as fatigue and toxification) and safety assessments (e.g. Euro NCAP ratings). In the past few years, we have seen the emergence of driverless cars (e.g. Google car and Tesla) and inter-vehicle communication devices that promote a green driving strategy (Yanga, Andresb, Sunb, Ganb & Jinb, 2018:298).

Automated traffic systems can minimise the daily constraints of trip distribution which is mostly unpredictable, contributes to pollution, is accident-prone and leads to traffic congestion (Salido, Peinado & Giret, 2011:1426). Such a system may promote a city's transformation into a Smart City since efficient mobility to transport goods or people from origin to destination faster and safer in pristine conditions is important (Balint, 2017:284). However, uncontrolled urbanisation and rapid population growth could hamper the development of the Smart City model (Garau, Masala & Pinna, 2016:35) (see 2.4.1). Fostering a partnership between the transportation and technology sectors is important to utilise products (e.g. software, vehicles, sensors, etc.) that can promote smart mobility to the public (Docherty et al., 2018:115).

3.5 TRANSPORTATION IN SOUTH AFRICA

The role of transportation in respect to economic development, the promotion of social equality and the protection of the environment in a section of a country was discussed in 3.4. The various technological considerations were also touched on in section 3.4.4 to demonstrate how the available technology of this century can be used to promote the economic, social and environmental considerations of transportation.

A city with a high level of vehicle dependency is a big challenge for urban and transport planners in modern times (Ogra & Ndebele, 2015:539). The only way to reverse the effects of vehicle orientated development is to introduce Transport Oriented Development (TOD) which can act as a central role

or model for policy making (Ogra & Ndebele, 2015:539). Urban transportation strategies in South Africa become increasingly important as the planning moves more towards TOD (Bickford & Behrens, 2015: 235). In South Africa, transportation policies focused more on the infrastructure development of light vehicles instead of public transportation as seen in the last half century (Bickford & Behrens, 2015: 235). The TOD in South Africa forced a growing dependency on the use of a personal vehicle, due to the apartheid spatial planning patterns where people were living on the edge of the city in a single unit house (Bickford & Behrens, 2015: 235). In most of the South African cities, the wealthier people use their own personal vehicles and the poorer people use public transportation which indicates that the TOD needs to be adapted (Bickford & Behrens, 2015: 235). This may be a concern, as the main aim of TOD is to reduce vehicular use to reduce the global environmental impacts (Chatman, 2013:17).

Housing developments must be planned with the TOD in such a way that the environmental goals are kept in mind (Chatman, 2013:17). Residential areas with high density, less parking and a number of shops and services could use more public transportation to reduce private vehicle use (Chatman, 2013:17). The lower the density of neighbourhoods, the higher the average distances of walking or cycling is required (De Vos, Van Acker & Witlox, 2014:326: Ogra & Ndebele, 2015:539). Neighbourhoods that are more vehicle orientated with limited public transport services have the tendency of having lower frequencies and an increase in distance to a public transportation stop (De Vos et al., 2014:326). There needs to be a link between land use and the transit systems in order to use the required principles of sustainable development to develop a city (Doulet, Delpirou, Delaunay 2017:1). Introducing the linkage and indicating the different challenges of vehicle dependency and urban sprawl has become one of the key models for sustainable urban planning (Doulet et al., 2017:1).

It is important to have plausible or practical strategies for a TOD plan and it is important to investigate all the aspects of urban policy creation (Xu, Guthrie, Fan & Li, 2017:757). Planners need to study the regional policies, the local conditions and the political priorities of the area also keeping in mind the development (Greenfield/Brownfield), bylaws and zoning regulations (Singh, Lukman, Flacke, Zuidgeest & Van Maarseveen, 2017: 110).

A lack of personal mobility or access to transportation hinders the economic and social development of a society (Lee et al., 2017:211). The economic stance of individual commuters is an important aspect to consider to create sustainable transportation, especially in a country such as South Africa which has more than 15 million people that are unemployed (Stats SA, 2018: online) (see 4.3.1). The Gautrain

public transportation system which was implemented in Gauteng, South Africa in 2010 is an example of a system that does not consider the economic challenges of the majority of the population of the region due to its relatively expensive fares (cf. Gautrain, 2018: online). The Integrated Urban Development Framework (COGTA, 2016:52) of South Africa acknowledges that an integrated transportation system that encourages mobility should promote social development, be more affordable to commuters and provide linkages between the urban and rural areas of a city. Ciommo and Shiftan (2017:144) point out that the perception of mobility within a city is dependent on the accessibility to transportation. This contributes to a high risk of social exclusion if a commuter has limited access to opportunities and key activities (Ciommo & Shiftan 2017:144). Therefore, it is important to offer a variety of transportation modes (see 3.5.1), consider how transportation networks are developed in cities (see 3.7) and review governing policies (see 3.7).

3.5.1 Modes of transportation used in South Africa

According to the National Household Travel Survey (NHTS), travel time is outlined as the most important factor that influences the mode of transport a household selects (Stats SA, 2013a: online; National Household Travel Survey, 2013b:7). The second most important factor is the cost of transportation, followed by flexibility and vehicle safety (National Household Travel Survey, 2013:7). Historically, transportation modes were allocated according to different principles of the region such as political vision, space allocation, societal needs and so on (Gössling, Schröder, Späth & Freytag, 2016:660). However, more recently the aim of creating sustainable transportation has emerged in the light of the 2030 SDGs (see Table 2.4) (Gössling et al., 2016:660). The ideal of the SDGs is to use various traffic and transportation models to accommodate a variety of routing behaviours and vehicle types (Wang et al., 2018:387).

In the past, most public transportation systems focused on the central areas of the cities which hosted the employment densities and high populations that enabled high frequency services, and high usage of planned travel routes. In multi-nodal cities, mixed land use neighbourhoods have emerged which have changed the distribution of residences and employment (Adewumi & Allopi, 2013:1).

The following sections will discuss motorised transportation (see 3.5.1.1) including personal and public modes of transportation as well as non-motorised transportation modes (see 3.5.1.2) such as walking and bicycling.

3.5.1.1 Motorised transportation

Motorised transportation can be categorised into personal motorised modes such as personal motor vehicles and motorcycles, and public motorised transportation which includes conventional/ commuter buses, BRT systems, minibus taxis and Boda-Boda motorcycle taxis.

a) Personal motorised modes of transportation

Have you noticed while driving to work on South African transit corridors the number of vehicles with only one occupant (i.e. the driver)? The dominant mode of vehicle fleet in South Africa in April 2019 was motorcars and station wagons (n = 7 405 978; 65.27%) followed by light load vehicles such as panel vans and light delivery vehicles (n = 2 582 219; 22.76%) (National Traffic Information System, 2019:1). Some South Africans prefer to travel via motorcycle, but this only accounts for 3.05% (n = 346 151) of the total national traffic (National Traffic Information System, 2019:1).

South Africans value their safety, time, money and flexibility when choosing a mode of transportation (Stats SA, 2013:7) which is evident from the dominant mode of transportation currently being personal motorised vehicles in South Africa. However, in the current economic situation of South Africa, the sale of motor vehicles to a single household has declined from 58% in 2006 to 47% in 2015. (Stats SA, 2018:11-12) (see 4.4.1 on the status of economic development in South Africa). The purchasing cost of a motor vehicle remains one of the main factors when a South African decides to buy a new vehicle (Stats SA, 2018:14).

This mode is unsustainable, not only in economic (see 4.3.1), social (see 4.3.3) and environmental (see 4.3.2) terms but also logistically. Parking/storage of personal vehicles is problematic, particularly in high density areas (Freund & Vine, 2010:78). This is evident if you visit a company during office hours since most available parking is used by employees with little space for public use. The same problem occurs if you live in cluster housing such as townhouses or apartments where there is often a rival between residents over parking spaces. South Africa is well-known for its high crime statistics with car hijackings, murders, and common theft being reported daily via social media and broadcast channels such as television and radio. In the twelve-month period preceding March 2018, 50 633 motor vehicles and motorcycles were stolen in South Africa (South African Police Service, 2018:116). This highlights the need for safe parking/storage of personal vehicles in this country.

b) Public motorised transportation

Public transport internationally started with Hansom Cabs (i.e. a two-wheeled horse-drawn cab accommodating two inside, with the driver seated behind) in London which later expanded to the mass public transportation with horse-drawn trams (Crank, 2011: online). With the invention of the motorised engine, public transportation also saw a transformation. In South Africa, trains and trams were commonly used, but public transportation for the masses started when taxi operators were forced to use sedan vehicles with fare meters during the twentieth century. In 1977 a change in legislation allowed the use of minibus taxis which could transport fifteen passengers at a time (Ingle, 2009:72). Public transportation provides mobility to people that do not have access to personal motorised modes of transport due to their economic situation, social characteristics (e.g. age and disability), and personal preference (e.g. reducing emissions by not using a personal vehicle). Other factors also play a role such as urban sprawl, economic growth, living and property cost and a lack of affordable housing (Bhatta, 2010:18).

In South Africa, the most common public transportation modes are conventional, commuter buses, and minibus taxis with limited use of Bus Rapid Transport systems (BRT) only in major metropolitans. Minibus taxis account for 2.94% (n = 333 656) of all vehicles on South African roads, whereas buses, bus-trains and midibuses (larger than a minibus) account for only 0.56% (n = 64 759) (National Traffic Information System, 2019:1). The sub-sections on public transportation explore conventional buses, BRTs and minibus taxis as a mode of transportation in South Africa. Other modes such as rail, air and water are not discussed since these options are very limitedly used within the study area of this research.

c) Conventional/Commuter Buses

South Africans can travel with buses within cities as well as between cities with a variety of bus service providers. The expansion of public transportation systems is important to reduce the use of private vehicles, lower CO_2 emissions, increase accessibility and transit efficiency (Jaiswal et al., 2012:60). An increase in conventional/commuter bus usage is noted in the National Household Travel Survey of 2013 with an approximate 20% of South African households using buses as their main mode of transportation (Stats SA, 2013:103). The majority of commuters (79.4%) reach their closest bus station within a 15-minute walk (Stats SA, 2013:103). This is in alignment with the New Urbanism principle six which promotes public transit by ensuring that building densities and land uses are within walking distance of transit stops (see 2.3.1.1; Table 2.2). Buses are deemed a safer option than minibus taxis, but this mode of transportation has several limitations such as infrequent bus service during off-peak times, limited transportation corridors, longer travel times due to the slow speed of operation and

service delivery issues (Mtizi, 2017:819; Stats SA, 2013:105-106). Commuters also complain about the available facilities at bus stations, the level of crowding on the bus, security at bus stops and their safety when walking to and from the bus stop (Stats SA, 2013:105-106).

d) The Bus Rapid Transit System (BRT)

Bus Rapid Transport systems (BRTs) offer mass transportation for underserviced communities, especially in outlying areas of cities due to the problem of urban sprawl in South Africa (see 2.4.1). Urban sprawl is applicable to almost all cities, even South African city suburbs as reported by Chobokoane and Horn (2015:79).

Buses are the backbone of a public transportation system in urban areas around the world (Babalik-Sutcliffe & Cengiz, 2015:792). A BRT system is an alternative public transportation mode to metro and tram systems. It is bus-based and costs less (Mallqui & Pojani, 2017:254; Venter et al., 2018:149). This system (i.e. BRT system) has become popular as a mass transit system in developing and developed cities (Deng & Nelson, 2012:108; Mallqui & Pojani, 2017:254); however, it is more expensive than conventional bus transport systems but cheaper than light rail systems (Merkert et al., 2017:76). Therefore, the South African government started a Public Transport Network grant to implement BRT in large cities (Van Ryneveld, 2018:2). There are two different types of BRT systems, as explained below.

- Open BRT System: A framework of support from neighbourhoods which is funnelled into the dedicated sections of the system using the same bus from start to finish.
- Closed BRT System: A passenger commutes with the normal (conventional) bus system to the dedicated BRT system and interchanges at stations on the BRT system route (Merkert et al., 2017:76).

More cities are planning to implement a BRT system or to upgrade their current BRT system (Currie & Delbosc, 2011:755; Cervero, 2006:20). BRT systems have several advantages above conventional bus systems such as an increase in commuter comfortability, longer operating hours, increased frequency, improved service delivery and decreased travel time (Currie & Delbosc, 2011:755). Although there are benefits of mitigating to such a system, planners need to consider the energy, security, environmental pollution, urban densities and the catchment/feeder areas and traffic congestion of a city and/or country before making such a decision (Deng & Nelson, 2012:108). Table 3.1 summarises the characteristics of BRT systems:

Table 3.1: Characteristics of the BRT system

Keyword	Description	References
Accessible	Access to the system through multiple routes and transportation corridors.	• Deng and Nelson, 2012:108 • Mallqui and Pojani, 2017:254 • Wan et al., 2016:42
	Access to information about the service	• Merkert et al., 2017:76 • Wan et al., 2016:42
	Access to the bus stations	• Mallqui and Pojani, 2017:254 • Merkert et al., 2017:76 • Van Ryneveld, 2018:2
	Visibility of the system	• Hensher, Li and Mulley, 2014:159
	Ease of use of the ticketing/smart card system	• Adewumi and Allopi, 2013:3 • Mallqui and Pojani, 2017:254 • Wan et al., 2016:42
Affordable	Cost for the commuter	• National Household Travel Survey, 2013:7 • Deng and Nelson, 2012:108 • Wan et al., 2016:42
	Cost of implementation since it can be implemented on an existing infrastructure (cheaper than a light rail system)	• Mallqui and Pojani, 2017:254 • Merkert et al., 2017:76
	Shorter implementation periods than rail	• Deng and Nelson, 2012:108 • Mallqui and Pojani, 2017:254
	Reasonable fare payment for off-vehicle facilities for bicycles, motorcycles and private vehicles	• Adewumi and Allopi, 2013:3 • Merkert et al., 2017:76
Capacity	A high-capacity: A large number of people is transported	• Deng and Nelson, 2012:108 • Merkert et al., 2017:76
	A large number of commuters can enter or exit the bus via wide doors	• Van Ryneveld, 2018:2
Comfortable	Comfortability inside the bus	• Merkert et al., 2017:76 • Wan et al., 2016:42
Connected	Providing a service that is door to door with seamless interchanges, minimum delay and visibility (knowing the movements of the different modes of transport in the area)	• Hensher, Li and Mulley, 2014:159
Flexible	Commuter flexibility of time of usage (also links with accessibility and reliability of the system)	• National Household Travel Survey, 2013:7 • Wan et al., 2016:42
	The flexibility of the system within various urban conditions	• Mallqui and Pojani, 2017:254 • Van Ryneveld, 2018:3
	Flexibility in connecting with other transportation modes such as non-motorised transport (NMT) to assist or benefit with the mobility of the poor	• Deng and Nelson, 2012:108 • Merkert et al., 2017:76 • Venter et al., 2018:149
Frequent	Frequency of trips	• Hensher, Li and Mulley, 2014:159 • Wan et al., 2016:42
Reliable	Reliability that includes the concepts of:	• Babalik-Sutcliffe and Cengiz, 2015:792 • Merkert et al., 2017:76 • Wan et al., 2016:42
	- Punctuality	• Babalik-Sutcliffe and Cengiz, 2015:792

Keyword	Description	References
Safety	Safety in regard to vehicle accidents	• National Household Travel Survey, 2013:7
	Safety in regard to the use of the system including security	• Wan et al., 2016:42
	The behaviour of staff: does not make commuters feel unsafe; professional behaviour	• Wan et al., 2016:42
Speed	Reduced travel time which is promoted by means of:	• Babalik-Sutcliffe and Cengiz, 2015:792 • Merkert et al., 2017:76 • Wan et al., 2016:42
	- Dedicated bus lanes which are not influenced by the congested peak time traffic	• Babalik-Sutcliffe and Cengiz, 2015:792 • Merkert et al., 2017:76
	- An intelligent transportation system that controls the junctions for prioritising traffic	• Merkert et al., 2017:76
Sustainable	Promotes environmental protection by means of reduced vehicular emissions:	
	- Fewer vehicles on the road that improves air quality and traffic flow as a result	• Venter et al., 2018:146
	- New vehicles/buses with lower emission use	• Venter et al., 2018:146

Implementing a BRT system that meets the required level of service needs a strong support system to promote service delivery (Hensher, Li & Mulley, 2014:163; Van Ryneveld, 2018:3). The major challenge is to design and implement a high-quality transport system that offers the required level of service on stringent governmental budgets (Deng & Nelson, 2012:108; Bel & Holst 2018:209). The first financial impact on service delivery is the frequent maintenance of the system including maintenance on buses, bus lanes, bus stops and so on (Adewumi & Allopi, 2013:3). The second financial impact is the large financial (capital) investment required at the start of such a large-scale public transportation system that will meet the needs of the commuters (Bel & Holst 2018:209; Deng & Nelson, 2012:108) as outlined in Table 3.1 (connectedness, comfort, affordability, etc.). Such BRT systems have the potential to extend their positive effects for the urban social, economic and environmental development of a city (Deng & Nelson, 2012:108). However, the quality of service of the BRT system depends on some factors which are often outside the control of the system operators such as congestion on the road which impacts overall commuter satisfaction (Babalik-Sutcliffe & Cengiz, 2015:792). Furthermore, the system caters more for the middle to high income transit corridors, and not the disconnected transit demand areas on the outskirts of a city (Venter et al., 2018:146) which limits the level of service delivery from a social justice context.

e) Minibus Taxis

A major role player in the South African economy and society is the minibus taxi industry (ArriveAlive, 2018: online). Minibus taxis account for between 66% and 68% of all public transport trips in South Africa's metropolitan areas (Stats SA, 2013:41; Van Ryneveld, 2018:6). The majority of South Africa's working class use minibus taxis as their primary mode of transport since they have few other options besides minibus taxis even though they are unsafe, not roadworthy, drive recklessly, and so forth (ArriveAlive, 2018: online; Woolf & Joubert, 2013:284).

Minibus taxis transport eight to fifteen commuters at a time on a semi-fixed route with a flexible timetable (Fowkes, Fanucchi, Raphulu, Simelane, Sejeso & Kgatle, [n.d.]:20). The flexibility of this mode of transport is one of the characteristics that commuters find attractive, but minibus taxis will only depart if all the seats are filled, which may cause an increase in journey time (Fowkes et al., [n.d.]:20). Minibus taxis preferentially operate in high density areas with mixed land use since these areas have a higher number of pick-ups within a given time, which results in more profit for minibus taxi owners (Pan, Qi, Wu, Zhang, & Li, 2013:118). Taxis may also link with other public transportation modes such as conventional buses, BRT systems and rail (Kiggundu & Mukiibi, 2012:8). However, the local news is riddled with featured stories of minibus taxi violence such as violent strikes, lethal shootings, and other crimes (cf. Sibiya, 2017: Online) which makes this mode of transportation unsafe. One of the most noteworthy occurrences regarding minibus taxis was the clash between Uber drivers and metered taxi owners in 2017, during which Uber drivers feared for their lives (Sibiya, 2017: online). Currently, Uber drivers still do not go near the Gautrain stations since they are afraid of attacks from minibus taxi drivers. In recognition of the ongoing violence, The South African National Taxi Council (SANTACO) made an appeal to the South African government to assist them to stop the taxi violence (Smit, 2018: online).

f) Boda-Boda Motorcycle taxis

Although Boda-Boda motorcycle taxis are not a common mode of public transportation in South Africa, it is picking up the preference in other countries such as Uganda, India, the Philippines, Europe and even the United States. This mode of transportation offers hurried commuters in crowded cities an alternative mode of transportation that flies through the traffic (cf. RideApart, 2011: online). In some countries, you can even request a Boda-Boda Uber ride (cf. Ungureanu, 2016: online).

3.5.1.2 Non-motorised transportation

Non-motorised transportation modes such as walking and bicycling can promote public health (Cervero, 2006:3). Walking should be encouraged to reduce automobile trips and save energy since it is a sustainable transportation method (CNU, 2009:3-4; Downs, 2005:368; Knaap & Talen, 2005:108) (see 2.3.1.1; Table 2.2).

South Africa has many pedestrians that commute per foot each day, but this is regarded as an unsafe transportation mode since 38.4% (n = 5,410) of road deaths were pedestrians in 2016 (National Road Agency, 2006: online; RTMC, 2017:52). This is an alarming statistic that speaks to a number of spatial and transportation-related issues such as unfriendly and unsafe pedestrian roads and walkways and limited access to public transport modes (National Road Agency, 2016: online). Although walking and cycling is a way of improving the health of a community, South Africans avoid cycling and walking since it is a high-risk mode of transport (Lee, Abdel-Aty, Xu & Gong, 2019:117). This problem can be solved by significantly increasing the number of pedestrians and cyclists in an area to make motor vehicle drivers more aware of their surroundings (Lee et al., 2019:122; Zhang, Chen & Wei, 2019:263). The rolling gap crossing mode forces vehicles to stop for pedestrians crossing the road at certain points (Zhang et al., 2019:263). In this mode, the position of the crosswalk is very important (Zhang et al., 2019:264) since the behaviour of the driver towards the pedestrian depends how they will react (Xu, Liu, Qu, Ge, Sun & Zhang, 2018:1085).

The Road Traffic Management Corporation (RMTC) has rolled out four pedestrian safety programmes in every province in South Africa since 2016 which are aimed at creating awareness of the importance of safe walking and creating demand for safer, pedestrian-friendly roads within communities (RMTC, 2017:36). Education of safe walking practices and pedestrian-friendly roads in conjunction with the dominant spatial planning themes of this century can promote mobility and the health of the South African community.

3.6 FEASIBILITY AND EMPIRICAL EVIDENCE OF A SUSTAINABLE TRANSPORTATION SYSTEM IN SMALLER METROPOLITAN MUNICIPALITIES IN SOUTH AFRICA

The Local Government: Municipal Structures Act (RSA Act No. 117 of 1998) stipulates three categories of municipalities in South Africa, namely metropolitan municipalities (category A), local municipalities (category B) and district municipalities (category C) (RSA Act No. 117, 1998:19-20). South Africa has 8 metropolitan, 44 district and 226 local municipalities (RSA, 2019: online). Mangaung Metropolitan Municipality (MMM), the study area of this research, is the smallest of all eight metropolitan municipalities (metros) by population size (826 979 people in 2018; the forecasted number of 848 979

people in 2020) (MMM, 2018:44). This metropolitan stretches over one city, namely Bloemfontein and several towns and informal settlements (South African Municipalities, 2019), which results in the need for a sustainable transportation mode.

In April 2019, the MMM announced the launch of its Integrated Public Transport Network (IPTN) which includes a BRT system with the support of the National Treasury's Cities Support Programme (cf. Morapela, 2019: online). Minibus taxis are currently the prominent mode of transportation (32.56%), followed by private motorised transportation (29.3%) and conventional buses (10.55%) in the metro (MMM, 2016:1-2). Therefore, it is clear to see why the launch of the IPTN was met with resistance from various taxi associations. While the BRT system has become quite a popular mode of transportation internationally (Deng & Nelson, 2012:108; Mallqui & Pojani, 2017:254) (see 3.5.1.1.2b), it is more expensive than a conventional bus transport system. The major challenge is to design and implement such a high-quality transport system on stringent governmental budgets (Deng & Nelson, 2012:108; Bel and Holst 2018:209). Venter (2018: online) reports that BRT systems are not financially viable in South Africa due to low population densities using the service. The National Treasury (RSA, 2016:2) confirms this claim and notes that the country's inefficient spatial form results in lower densities and longer trip lengths that result in more financial cost. This is a major challenge in fostering a sustainable transportation system in smaller metropolitan municipalities in South Africa.

People in South Africa spend between 20% to 40% of their salary on transportation (RSA, 2016:2; Stats SA, 2017:36). Sustainable public transportation is needed to provide South Africans with better access, connectivity and mobility which forms part of the key consideration of economic (4.3.1), environmental (4.3.2) and social justice sustainability (see 4.3.3). Access, connectivity and mobility are also characteristics of a BRT system (see Table 3.1 in section 3.5.1.1). However, smaller metropolitan municipalities that operate BRT systems are at a higher financial risk since they require a greater financial income commitment to run such a system and would need alternative funding mechanisms outside of the national grant (RSA, [n.d.]:5; Van Ryneveld, 2018:vi). South Africa had four operational BRT systems in 2016, of which only one was a smaller metropolitan area, namely George. For the city of George to afford its BRT system, it would require 43% of the city's annual property rates. This is unachievable and as a result the city sought alternative funding (RSA, [n.d.]:4). The Public Transportation Network Grant has allocated funding for 13 cities (Van Ryneveld, 2018:10). Other public transportation initiatives in South Africa are the Public Transport Operating Grant, Taxi recapitalisation programme, Passenger Rail Agency of South Africa and the Gautrain (Van Ryneveld, 2018:29).

3.7 SOUTH AFRICAN TRANSPORTATION LEGISLATIVE FRAMEWORK

Policies attempt to promote change within a certain context. Over the years South African transportation policies have encouraged the transformation of the current transportation system towards a more sustainable system (Van Ryneveld, 2018:23-27). Up-to-date and reliable information is key to make informed decisions such as the adequate collection of data and analysis that includes all stakeholders (Vanderschuren, Lane, Korver, 2010:830). Below is a brief summary of the transformation of South African transportation policies:

- White Paper (RSA Ministry of Agriculture, Forestry and Fisheries, 2001) promotes the use of public transport over private car travel and makes public transport more affordable.
- 'Moving South Africa' project (RSA Department of Transport, 1996) attempted to develop a set of guidelines for all stakeholders within the transportation industry.
- Public Transport Strategy and Action Plan (2007) overlapped with the 2010 FIFA World Cup preparations. The first phases of the BRT systems for Johannesburg and Cape Town were implemented before the start of the World Cup.
- National Land Transport Transition Act (Act No. 22 of 2000) provided a set of principles to promote public transportation over private transportation within integrated transport and land use planning.
- National Land Transport Act (Act No. 5 of 2009) created effective bodies at a local level to take responsibility for public transport at metropolitan areas and assigned relevant functions to municipalities.
- Integrated Urban Development Framework (RSA IUDF, 2016) seeks to improve the mobility and connectivity of a transportation system to provide more access to opportunities and services. Table 3.2 summarises the IUDF of South Africa.
  (Van Ryneveld, 2018:23-27)

The National Land Transport Act (Act No. 5 of 2009:45), which is one of the short to medium term strategies of the IUDF (2007), stipulates that land transport planning should be integrated with land development and land use planning processes. Integrated transport and mobility have advantages that support social development, provides economical support and assists with urban and rural linkages that contribute to the infrastructure of South Africa's economy (RSA IUDF, 2016:52). The benefits of integrated transport and mobility are:

- Improvement of mobility and connectivity of a transportation system to promote social justice;
- Higher levels of education, productivity and employment is achieved when travel costs and time is reduced;
- Urban forms are denser which results in more affordable public transportation since there is a direct correlation between energy use and urban density (cf. Vanderschuren et al., 2010:830);
- Reduction in emissions by a change in the mode of transport by using public transport instead of private cars.

  (RSA IUDF, 2016:52)

Some effects that may arise from policy changes in transportation are that the land use patterns may change with new policies and it is important not to create a new problem when solving another problem. In the light of the transformation that South African transportation policies are advocating, the ideal for South Africa is to embrace new technologies in the field of transportation such as Intelligent Transport Systems (ITS) which is successful worldwide (Vanderschuren et al., 2010:830).

Table 3.2: Summary of the Integrated Urban Development Framework of South Africa (2016:52-58)

STATUS QUO
• Transportation costs are high for poor people that have to travel long distances. • Private motor vehicle growth is the highest among all the transportation modes with cities focusing more on private vehicle orientated development. • Each city has a different transportation service that predominately comprises of a bus, minibus taxi and rail systems. (Not all cities have rail systems in place.)
INTERVENTIONS AND INVESTMENTS
• A rapid public transportation system is either planned or being built to upgrade the current public transport system for the bigger municipalities. This is all done through the Public Transportation Network Grant (PTNG). • To improve public transportation services at all levels by focusing more on rail passenger services. • To improve the infrastructure of Non-Motorised Transport (NMT) and to link it to the BRT investments. • To implement programmes to improve road infrastructure.
OPPORTUNITIES
• Many of South Africans' socio-economic challenges can be addressed by public transportation that is affordable and of quality. • Available resources can be used to upgrade the current human settlement, land use and transportation facilities.
CHALLENGES
• Roles and responsibilities need to be outlined. • Subsidy arrangements are a concern. • Disjointed public transport systems.

• Lack of past investments in public transport infrastructure. • Low densities and urban sprawl. • Shortage of transportation systems is a concern.
SHORT TO MEDIUM TERM POLICIES
• Empower cities with the National Land Transport Act. • Strengthen and integrate public transport modes. • Strategic Investment is required. • Effective subsidisation policy is required. • NMT friendly cities are required.
LONG TERM POLICIES
• Reduce emissions and implement standards on private and public emission usage. Each city should manage its own regulation, planning and operation keeping in mind it needs to be affordable and efficient.

3.8 CHAPTER SUMMARY

The purpose of this chapter was to provide an overview of how transportation can be transformed to create a sustainable transportation system in smaller metropolitan areas in South Africa in terms of the economic, social, environmental and technological considerations discussed in this chapter.

The chapter started with a brief overview of the history of transportation and the impact of the first and second industrial revolutions (see 3.2). The next section highlighted the relationship of transportation with the dominant spatial themes of the twenty-first century which was discussed in Chapter 2 (see 3.3). A distinct transition is noted in spatial planning themes from a focus on private transportation (the Ideal City models) to public transportation (New Urbanism and Smart Growth) in section 2.3.1 (see Table 2.3). The IUDF (2016:52) stipulates that land transport planning should be integrated with land development and land use planning processes, therefore this relationship, discussed in section 3.3, is important to this study.

Transportation plays an important role in the economy of the world and is an integral part of a human's daily life (Filipczyk, 2015:117). However, transportation is resource intensive and contributes to the ever-increasing CO_2 emissions (Sharifi & Yamagata, 2016:1668) (see 4.3.2). Therefore, it is important to consider sustainable transportation in terms of economic, social, environmental and technological considerations (see 3.4). Similar considerations are discussed in section 2.4 and section 4.4 which highlights the relationship between the economic development of a country, the protection of the environment and the promotion of social justice through creating a sustainable transportation system.

Much of this chapter is dedicated to the discussion on public transportation in South Africa, relating to the various modes of transportation (see 3.5.1), the feasibility of a sustainable transportation system in smaller metropolitan areas (see 3.5.2) and South African transportation policies (see 3.5.3). The various modes of transport highlight the variety of options that South Africans have, but also point out that travel time, cost of transportation, flexibility and vehicle accidents dictate the mode the commuter will use/prefer (National Household Travel Survey, 2013:7). Motorised transportation includes personal modes of transport (i.e. motor vehicles and motorcycles) (see 3.5.1.1) and public modes of transport (i.e. conventional/commuter buses, BRT systems, minibus taxis, and Boda-Boda motorcycle taxis). Non-motorised transportation includes walking and cycling (see 3.5.1.2).

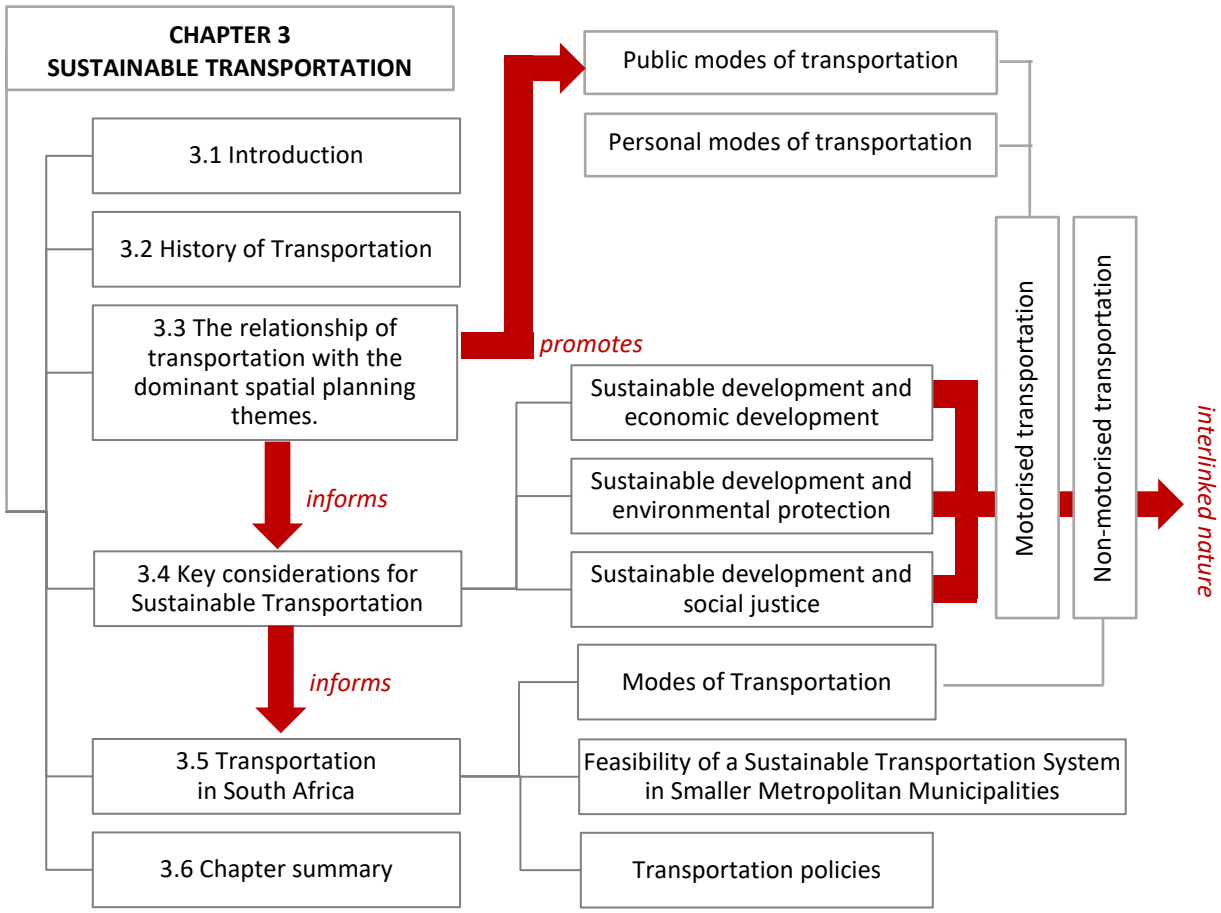


Figure 3.2: Visual summary of the connections between the various sections of this chapter

CHAPTER 4

SUSTAINABLE DEVELOPMENT IN DEVELOPING COUNTRIES

4

4.1 INTRODUCTION

Sustainable development (SD) is a buzzword in most social, economic and environmental circles presently. In interdisciplinary research, such as this study, it is important to incorporate the concept of SD into the lifecycle and urban infrastructure of SD planning in various disciplines (Sahely, Kennedy & Adams, 2005:73). The concept of SD is defined in relation to spatial planning in section 2.4.1 and transportation in section 3.4.1; however, a broad literature overview is discussed in this chapter to fully understand all the key aspects or considerations of this concept with a particular focus on developing countries such as South Africa. This chapter aims to provide a review of the history of SD (see 4.2), to highlight the key considerations of SD (see 4.3), and to provide an overview of SD in South Africa (4.4). Figure 4.1 presents an outline of this chapter.

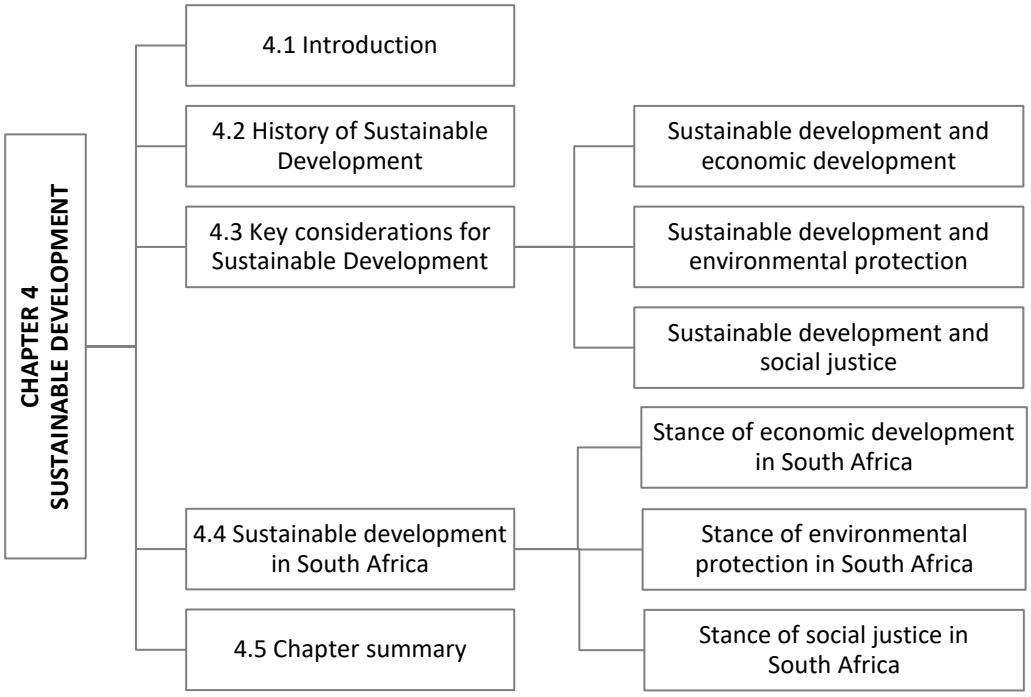


Figure 4.1: Outline of Chapter 4: Sustainable Development

4.2 HISTORY OF SUSTAINABLE DEVELOPMENT

The notion of sustainable development (SD) is not a modern-day fad as the concept has firm roots in ancient times (Du Pisani, 2006:87). However, SD has received more emphasis over the past few decades in the light of the world's ever-increasing population growth, consumption rates and limited available natural resources (Du Pisani, 2006:87). Campbell (2016:390) notes that SD is regarded as a wicked problem in the light of the several contradicting priorities or key considerations of the term and their resulting conflicts (see 4.3). SD is not a constant state of harmony as a result from this compromise but should rather be seen as an ongoing process of change (Campbell, 2016:396; Dierwechter, 2014:692; United Nations World Commission on Environment and Development, 1987:17).

The first report to promote SD among countries was issued by the UN World Commission on Environment and Development, more commonly known as the Brundtland Commission, in 1987 (cf. UN World Commission on Environment and Development, 1987). The term SD was originally coined as a compromise between population growth which in turn increases consumption rates and the conservation of the world's natural resources and environment (Du Pisani, 2006:94). The concept of SD changed during the past twenty years (Campbell, 2016:392-394). SD does not only include the sustainability of the environment, but also the sustainability of economic and social aspects as is evident in the UN World Commission on Environment and Development's 1987 report (Bramley, 2009:31; Sahely et al., 2005:73). This is also referred to as the three E's of sustainability, namely: ecology, economy and equity (Dierwechter, 2014:692). The three R's of sustainability refers to the commonly known three words: recycle, reuse and reduce. A quick search of the World Wide Web identifies various extensions of the three R's to six, nine or even ten which indicates that society is attempting to move from their present destructive processes towards more SD paths as advocated for by the Brundtland Commission (UN World Commission on Environment and Development, 1987:45-46). At the UN Rio+20 summit in Brazil in 2012, governments created a set of 17 Sustainable Development Goals (SDGs) which attempt to create a more sustainable world for future generations (Griggs et al., 2013:305) (see Table 2.4). In summary, SD occurs when all environmental, social and economic aspects/factors are taken into consideration as presented in the interlocking circles model of sustainability.

4.3 KEY CONSIDERATIONS OF SUSTAINABLE DEVELOPMENT

Campbell (2016:389) highlights the three key considerations to achieve SD, namely: economic development (see 4.3.1), environmental protection (see 4.3.2) and social justice (see 4.3.3). He refers to the triangulation of these three key considerations as the planner's triangle. The planner's triangle addresses the three fundamental priorities of property conflicts (i.e. conflicts between the economic development, equity and social justice), development conflicts (i.e. conflicts between equity, social justice and environmental protection) and resource conflicts (i.e. conflicts between environmental protection and economic development) (Campbell, 2016:390). Upon scrutiny of each of the key considerations, it is apparent that they accommodate the UN's 17 SDGs. The following three sections discuss in detail each of the three key considerations for sustainability in relation to the 2030 SDGs.

4.3.1 Sustainable development and economic development

Economic development is listed as one of the goals of both the triple and quadruple bottom-line often referred to in terms of economic growth (Lawler, 2014: online; Slaper & Hall, 2014:4) (see 2.4.1). Economy, nature and society are closely interlinked with each other (Syme & Nancorrow, 2013:451) since the purpose of the economy of a country is derived from the people (i.e. society), and the purpose of the people is derived from nature (Ikerd, 2012:16-17). Therefore, policymakers are including the triple bottom-line in their environmental policy evaluations (Syme & Nancorrow, 2013:451).

The eighth SDG promotes inclusive and sustainable economic growth – employment and decent work for all (see Table 2.4). Societies recognise the need for economic development to grow a country's economy since it has a positive impact on the lives of the citizens. There is a growing movement focussing on economic development to promote well-being and not just economic growth. The Organisation for Economic Co-operation and Development (OECD, 2013:26) notes that the adequacy of the traditional economic model does not consider people's current and future living conditions, thus their health and well-being. The promotion of good health and well-being is the third SDG (see Table 2.4). Employment and decent work for all speaks to the need of society for economic development to have purposeful lives. Unemployment is a reality for a large number of the youth in the world with approximately 71 million unemployed youth worldwide in 2018 (Stats SA, 2018: online). South Africa is no different from the rest of the world with more than one third of all youth being unemployed (Stats SA, 2018: online). Overall, South Africa has an unemployment rate of approximately 26.7% (i.e. more than 15 million people that do not have jobs) (Stats SA, 2018: online). The redesign of the economy in South Africa can be promoted through:

- Local production and service provision;
- Developing business through supported modular scaling and horizontal development;
- Supporting artisanship and customisation to grow a labour-intensive economy;
- Eliminating waste;
- Redesigning the role of business at all levels;
- Placing family and community at the core of the business;
- Changing the perception of nature as a mere provider of resources.
  (Fioramonti, 2017)

Ikerd (2012:16-17) points out that since the three concepts of society, economy and nature are interlinked, it is natural that economies and societies should have an impact on nature. Although society recognises its dependence on natural resources (i.e. oxygen, water, etc.), we often do not acknowledge the link between the economy and nature (Higgins, 2013: online; Fioramonti, 2017). The Intergovernmental Panel on Climate Change (IPCC, 2019:50-52) reports an approximate 1 °C increase in temperature for the previous decade (2006-2015) above pre-industrial levels with an estimated increase of 0.2 °C per decade due to human influence alone. However, Campbell (2016:389) highlights the conflict between societal needs, available natural resources and economic development because of the different characteristics of each.

It is a well-known fact that society's impact on nature is mostly negative (Ikerd, 2012:16-17). This is evident in the natural resource depletion and environmental degradation which was noted by the Brundtland Commission in 1987 (see 4.2) as well as the impact of climate change through the increase in frequency, intensity, spatial extent, duration and timing of extreme weather and climate events (IPCC, 2012:7). Extreme events and disasters are frequently in the news, such as the cyclones Idai and Kenneth that hit the coastline of Mozambique during 2019. However, a slow positive impact on nature can be observed (Du Plessis & Brandon, 2015:53), such as the changing decisions that society makes through various companies' sustainability campaigns, decisions made regarding building materials that are sustainable (e.g. bamboo), as well as the choices individuals in a society make daily (e.g. commuting modes, reusable shopping bags, etc.). Unfortunately, the positive impact on the environment is very slow because nature cannot change/transform as quickly as either the economy or people (Ikerd, 2012:17). One of the prominent initiatives is the zero-emission initiative of the IPCC by mid-century (IPCC, 2019:95).

Although economic growth creates more jobs, resources and a better quality of life for society, we need to take into account that for an economy to grow, it also needs natural resources (e.g. oil, gas, water, etc.) which are finite. A growing economy also contributes to air pollution and climate change (Higgins, 2013: online). The regeneration ability of nature is of particular importance in the context of economic development. Therefore, Ikerd (2012:17) proposes that the traditional three R's (i.e. reuse, recycle and reduce) of sustainability should be balanced against the three R's for ecological regeneration, namely renewal, reproduction and reorganisation. Ecological regeneration is the restoration of the biosphere and social system damage to create a world in which people's social and biophysical environmental needs can be met without the negative impact on nature (Du Plessis & Brandon, 2015:56).

This specific study focuses on transportation and spatial planning as a theme of economic development in order to promote overall sustainability. Lee et al. (2017:211) point out that a lack of personal mobility or access to transportation hinders the economic and social development of a society. A transportation example that relates to economic development is smart mobility (see 3.3). Smart mobility utilises transportation services by accepting challenges that include social, technological, environmental and economic impacts (Zawieska & Pieriegud, 2018:41) (see 3.3 in Chapter 3). Smart Growth and New Urbanism are two adaptive planning approaches which focus on the sustainability of social and economic diverse societies within cities (De Roo, 2012:159-160; Talen, 2006:233) (see 2.3.1). However, as Du Plessis (2012:10) notes, it is often difficult to achieve ecological regeneration through spatial transformation in countries which do not have similar pre-existing models resembling the utopian models of this century (see 3.3).

4.3.2 Sustainable development and environmental protection

The need to promote SD to protect the environment is one of the most prominent aspects we hear, see and learn about in our day-to-day lives. The importance of this key consideration is evident in the shops we visit daily (e.g. the recycle bins available in stores, stores changing visions and missions, etc.), our daily commute routes (e.g. recycle bins available on almost every street for either paper, plastic or glass, informal recyclers sorting garbage, the recent tuk-tuk vehicles on the road, etc.), as well as all communication channels we engage with (e.g. social media, television, radio, etc.).

Environmental protection is incorporated in most curriculum designs, as evident in my own institution, to educate students regarding their role in the protection of the environment presently as well as in the future. The protection of the environment is included in several of the 2030 sustainability goals of

the UN such as the goals aimed at responsible consumption and production, climate action, life below water and life on land (see Table 2.4). The effect of environmental injustice and unsustainable development is evident in many places around the world, such as Durban's South Basin in South Africa (see 4.4) as referred to by Agyeman, Bullard and Evans (2002:79).

CO_2 emissions are identified as one of the major contributing factors to climate change (Sharifi & Yamagata, 2016:1668) which threatens the environment for future generations. CO_2 emissions result from energy supply, transport, buildings, industry, agriculture, forestry and waste management IPCC, (2007:vii) and are associated with the 2030 sustainable development goals of climate action and responsible consumption and production. Global greenhouse gas (GHG) emissions, which includes CO_2 emissions, have grown more than 70% from 1970 to 2004 (IPCC, 2007:3), and have constantly increased over the past decade (2007-2017) (Global Energy & CO_2 Status Report, 2017:3; Sharifi & Yamagata, 2016:1668). CO_2 emissions rose by 1.4% (460 million tonnes or 170 million additional cars) in 2017 alone (Global Energy & CO_2 Status Report, 2017:3), and will increase even more in years to come (Sharifi & Yamagata, 2016:1668). The planet's agricultural productivity decreases by approximately 15% for every degree of warming (Penprase, 2018: 216-217). The IPCC reports that an increase of more than 1.5 °C above the pre-industrial temperature levels will result in human and ecological system risks in coastal, low-lying and island regions due to the rise of sea levels, climate and weather extremes (e.g. droughts, hurricanes, and so more), access to food and water resources, and the overall health the world's population (IPCC, 2019:10-11).

Fossil fuel combustion is the leading cause of ever-increasing CO_2 emissions (Sharifi & Yamagata, 2016:1668). CO_2 emissions are categorised as either direct or indirect emissions in relation to the impact it has on sustainability (Opschoor, 2011:197). Cities often focus on direct emissions to make regions more carbon neutral by means of direct control of the emitter (Opschoor, 2011:197). Such a city (i.e. a low carbon city) should have either zero or negative carbon emissions, but one needs to keep in mind that an eco-city may still just be a theory, which makes policy makers reluctant to implement drastic changes (De Jong, Joss, Schraven, Zhan & Weijnen, 2015:33). The excess use of fossil fuels for mobility requires enhanced tree coverage in the subsequent area to combat the CO_2 emissions (Lebel, Garden, Banaticla, Lasco, Contreras, Mitra et al., 2007:77). Indirect emissions, on the other hand, focus on what products the emitter buys and how these products are transported (Opschoor, 2011:197). This association (i.e. fossil fuel combustion as leading cause in increasing CO_2 emissions) emphasises the relevance of two of the main themes of this study, namely sustainability and transportation (see Chapter 3).

One of the proposals to address the ever-increasing CO_2 emissions is Low Carbon Growth. The use of oversized vehicles, poorly designed offices, homes and retail offices are obvious contributors to high carbon usage (Lebel et al., 2007:77) as well as energy prices that are too low to encourage more energy-efficient homes, industrial processes and transportation (UN World Commission on Environment and Development, 1987:108). Policy-making for Low Carbon Growth can be a difficult process, especially if it influences the agenda for traditional (economic) growth (Ellis, Baker & Lemma, 2009:49). However, the theories behind traditional growth may be less influenced by Low Carbon Growth if the production of goods and services is linked to the actual environmental costs (Ansuategi & Marsiglio 2017:787; Ellis et al., 2009:49). Of course, the ideal would be to shift away from fossil fuels and to use more environmentally friendly energy sources along with lower per capita energy use (Opschoor, 2011:197). This can only be achieved if everyone, from a small city to a large metropolitan region, worldwide can work together and participate in a climate sensitive urban development (Opschoor, 2011:197). Policies that focus on Low Carbon Growth should include the key pillars for low carbon development (e.g. finance for migration, human capital, technology for energy, forestry, trade and regulation) (Ellis et al., 2009:2). Several authors recommend that policy changes should focus on the lifestyles of the poor to combat environmental injustice (Lebel et al., 2007:77; Clark, Millet & Marshall, 2017:097012-1) (see 4.3.3), since there is a fashionable trend of using the principle of sustainable development to create 'green bubbles' for the elite (Campbell, 2013:84). However, to successfully make such policy changes, it needs to be socially inclusive of everyone (cf. Opschoor, 2011:197).

Saleem et al. (2018:82) identified the need to educate commuters on their social responsibility regarding the use of their personal vehicles and the impact of their choices on the environment (e.g. adhering to the speed limit and environmentally friendly alternatives such as walking and/or cycling). Apart from educating commuters, energy efficiency in transportation to promote environmental protection can be further promoted by policy measures (e.g. logistics management, speed limits, etc.), behavioural improvements (e.g. eco-driving, vehicle sharing, etc.) and technical energy efficiency improvement (e.g. fuel economy, emissions performance [gCO_2/km]) (Dennehya & Gallachóira, 2018:401; Echenique et al., 2012:136; Filipczyk, 2015:119; Saleem et al., 2018:82). Yanga et al.'s (2018:298) green driving strategy is a good example of technical energy efficiency improvement since it calculates the optimal speed profile to reduce emissions and fuel consumption between 20% and 30%. New technologies such as bioengineered organisms and new building materials can also assist with the absorption of excess CO_2 emissions in the atmosphere (Penprase, 2018:216-217).

The importance of protecting the environment is evident from the literature reviewed in this section, especially regarding the promotion of responsible consumption and production through our daily choice of transportation methods. This is of importance since the use of fossil fuels is one of the major contributing factors to the ever-increasing greenhouse gas emissions. Chapter 3 explores transportation specific literature that further highlights the role of transportation in sustainability.

4.3.3 Sustainable development and social justice

Sustainable development, social justice and the overall well-being of people are closely linked to each other (Agyeman et al., 2002:77). Poverty is one of the major obstacles for SD and is associated with social justice and the overall well-being of people (UN World Commission on Environment and Development, 1987:16). Most poor communities are vulnerable and are forced to live in locations that have no infrastructure or any services which expose the community to hazardous conditions (Campbell, 2016:392). This often leads to the pollution of water resources, air pollution and environmental destruction, which leads to environmental protection and social justice conflicts (Campbell, 2016:392). The ideal is that a system should promote sustainable development, social justice and the overall well-being of people (Sahely et al., 2005:73). This section discusses various aspects of sustainable development and social justice in relation to the main themes of this study, namely spatial planning and transportation.

Social injustice is promoted through a mismatch of spatial models with the structural elements of a city/town (e.g. housing and underfunded transit systems) (Amar & Teelucksingh, 2015:47). Such a mismatch influences available job opportunities in the poorer sectors of society since it creates spatial disconnections between residential, commercial and industrial areas, that leads to health risks and social inequities (Amar & Teelucksingh, 2015:47). Equity in the social sciences is not seen as a new concept but is a problem that has long been discussed amongst decision makers, however, the contribution of transportation to this problem is often overlooked (Zakowska & Pulawska, 2014:68).

Creating an autonomous sphere to provide accessibility for every part of a society is essential (Nahmias-Biran et al., 2017:197). The conceptualisation and expansion of environmental justice include the comparative understanding of transit, settlement, opportunities and housing locations that form part of a citizen's right to a city to avoid social injustice by creating spatial mismatches (Amar & Teelucksingh 2015:49). This underlines the links between environmental protection (see 4.3.2) and social justice. Campbell (2013:87) notes that the challenge is not to implement sustainable development to make cities more sustainable, but rather defining, measuring, negotiating and implementing sustainable practices. As a result, sustainable development practices are often more

figuratively and descriptively implemented, and these practices vary from city to city (Pearsall & Pierce, 2010:578). The role of spatial planning in relation to the protection of the environment is discussed in detail in section 2.4.2.

Transportation is a daily activity which most people around the world engage with through either public or private transportation modes. Transportation links to the overall well-being of people, social justice and sustainable development and as such is included as part of the third SDG of the UN that speaks to improved health and well-being of all (see Table 2.4). The drastic need to halve the number of traffic accident-related deaths is one of the goals of the SDG (UN, 2018g: online). In 2011, the UN launched the Global Plan for the Decade of Action for Safety in response to the nearly 1.3 million people that die each year in road traffic collisions due to insufficient improvement in road safety strategies and land use planning (UN, 2010:3). The UN (2018:a5) estimates that this number will increase to 1.9 million deaths by 2030 if no action is taken. Half of the reported deaths are vulnerable road users such as pedestrians, cyclists and motorcyclists (UN, 2018a:5). The majority of South Africa's working class (68%) use minibus taxis as their primary mode of transport (Stats SA, 2013:41), which are often an unsafe transportation option (ArriveAlive, 2018: online).

Transportation modes should enable access to and from all the desired locations within a city, town or region to promote transportation equity (El-Geneidy, Buliung, Diab, Van Lierop, Langlois & Legrain, 2016:541). Most studies struggle to find a suitable measuring technique to measure transportation equity to decide exactly what is fair (Pereira, Schwanen & Banister 2017:186). One point of view is that all aspects of the transportation system should enable transportation equity (e.g. road taxes, public transport facilities and fares, bicycle lanes, etc.) (Nahmias-Biran et al., 2017:197). Another stance is that transportation equity should enable horizontal equity (i.e. fairness and equality for all people), vertical equity (i.e. social justice, environmental justice and social inclusion) and consider transportation ability and needs of all commuters, specifically commuters with special constraints (Caggiani, Camporeale & Ottomanelli, 2017:10; Litman, 2006:3; Zakowska & Pulawska, 2014:68).

Horizontal equity relates to the fair treatment of both individuals and groups and it deals with distributional impacts (Caggiani et al., 2017:10; Litman & Burwell, 2006:3; Zakowska & Pulawska, 2014:68). Horizontal equity states that if two people or groups give the same contribution to society then they must receive the same benefits and public policies (Caggiani et al., 2017:10; Zakowska & Pulawska, 2014:68). The use of the horizontal equity models in a utilitarian framework bases preference on the individual which highlights its unsuitability to promote social justice (Ciommo &

Shiftan, 2017:141). Horizontal equity is influenced by land use, external costs, benefits and the design approach of cities in regards to environmental sustainable elements (e.g. pollution, traffic accidents and noise, healthy activities such as food shops and parks, access to secondary services such as public transport, walking and cycling, meetings with community members and social-economical aspects such as crime, housing and unemployment) (Zakowska & Pulawska, 2014:68) (see 4.4.1).

Vertical equity regarding income and social class is also referred to as environmental justice, social justice and social inclusion. It compares two groups with different abilities and needs in accordance with their social class or income (Caggiani et al., 2017:10; Litman & Burwell, 2006:3; Zakowska & Pulawska, 2014:68). The use of a vertical model that disregards social equity can be disastrous since people may not be able to afford transportation, it may not be the preference of the area to use a transportation system or there may not be a need for a transport system (Ciommo & Shiftan, 2017:141). The planner should consider that financially affordable housing should also have access to public transportation at several locations, even if they pay less tax than the higher-class housing (Zakowska & Pulawska 2014:68). Transport policies are justified by favouring the social and economic disadvantaged groups to compensate for any inequities (Caggiani et al., 2017:10; Zakowska & Pulawska, 2014:68). Progressive policies favour these disadvantaged people, whereas regressive policies regard them as a burden. The definitions are used to provide affordable discounts or special services to the disadvantaged groups that cannot bear all the required costs. Vertical equity (regarding mobility need and ability) works with groups or individuals that have different mobility needs or abilities which outlines if the person is able to use the transport system (special needs) or if the person requires the transport system in the first place (Caggiani et al., 2017:10).

The definition of geographic equity states that the supply (i.e. the benefits and cost) are spread across space whereby the definition of social equity states that the supply is spread across the demographic groups (Karner, 2016:47). Based on civil rights and justice perspective, geographic equity is difficult to ignore since there is a continuous pattern of spatial separation and segregation based on demographics (specifically income and race) in the United States (Karner, 2016:47) as well as elsewhere in the world. This is equally true of South Africa. The notion of social equity is considered in every study conducted in transportation equity literature. To understand both these equities (i.e. geographic and social equity), some type of either qualitative or quantitative performance assessment must be made. Performance can be measured in the following ways, namely accessibility, travel time, money invested and air quality. If geographical and social equity performance must be measured, one should look at the performance spatially in units (e.g. residential areas, municipalities and groups of housing) or one should look at the performance of the different demographic groups (e.g. high versus

low income groups). In practice, these two performances are often merged due to the structure of the models used in transportation analysis of the demographics and their comparison to one another (Karner, 2016:47).

The focus is mostly on land use and transport planning when dealing with equity, but something else to consider is territorial equity. Territorial exclusion may arise if there is a lack of equity in any of the following situations, namely: low income areas, low accessibility, limited infrastructure, socio-economic deterioration, deindustrialisation, low education levels, low administration support, high unemployment rates, deteriorating housing conditions, lack of public services and low technical development capacity (Zakowska & Pulawska, 2014:68-69). Disadvantaged groups, both socially and economically, face possible limitations of accessibility due to time frames or specific operating periods of a specific transportation framework. Spatial and temporal mismatches may occur at other periods due to changes in the road network or geography changes over time (El-Geneidy et al., 2016:543). Unfortunately, people that are disadvantaged through the transportation system must somehow depend on other ways of mobility (e.g. a lift from a friend or family member or private transportation). Transit facilities often do not facilitate all age categories and provide social barriers (e.g. barriers in the built environment, social support and transport deficiencies) (Adorno et al., 2018:316). Lee et al. (2017) describe that active transportation equity results from the distribution of transportation costs to benefit all social groups. This definition encompasses three different elements namely social equity, spatial equity and the benefits of active transportation costs. Spatial equity identifies the geographic level compared to the distribution effects. Social equity mostly concerns aspects such as low income, older populations and the minorities according to information gathered through practice and research. The benefits of active transportation costs are to distribute the costs to all active transportation departments to capture the full equity effect (Lee et al., 2017:220).

Transportation planning often needs to compromise between equity, costs, mobility and environmental quality (Litman & Burwell, 2006:6). There is a negative impact of vehicular emissions from the various modes of transportation options for daily commute on the environment and public health (Csikósa et al., 2018:174; Hoehner, Brennan, Brownson, Handy & Killingsworth, 2003:15; Lebel et al., 2007:77). Due to a lack of public transportation systems in most developing countries, such as South Africa, many people make use of their own private vehicles to commute daily which increases vehicular emissions (see 4.4). Transportation impacts various infrastructures (e.g. land use, housing patterns, water and sanitary) that have a direct correlation on the health and well-being of urban populations (Northridge & Sclar, 2003:118-119). Therefore, it is important to consider all related

aspects when making design choices (Dannenberg, Jackson, Frumkin, Schieber, Pratt, Kochtitzky & Tilson, 2003:1500), including the other SDGs that relate to health and well-being, namely to:

- End hunger, achieve food security and improve nutrition, and promote sustainable agriculture (SDG 2);
- Achieve gender equality and empower all women and girls (SDG 5);
- Ensure availability and sustainable management of water and sanitation for all (SDG 6);
- Make cities and human settlements inclusive, safe, resilient and sustainable (SDG 11), and
- Promote peaceful and inclusive societies for SD, provide access to justice for all and build effective, accountable and inclusive institutions at all levels (SDG 16).
  (Buse & Hawkes, 2015:3)

Among the public health issues that result from transportation and land use planning, factors are mental health, asthma and an increase in obesity (Jacobs, Wilson, Dixon, Smith & Evens, 2009:603; Cozens, 2007:233). Policies, such as Low Carbon Growth and New Urbanism, may promote public health benefits through promoting a higher level of physical activity (Cozens, 2007:233; Frank & Engelke, 2001:203; Lebel et al., 2007:77). The promotion of physical activity in a country such as South Africa is essential since our country has a very high ranking of obesity especially amongst the country's women and children (Green, 2017: online). This negative impact on public health and well-being is because of decision makers' poor understanding of the impact of their land use decisions (i.e. spatial planning decisions; see Chapter 2), transportation investments, and the policies related to transportation equity (Lawrence & Engelke, 2001:203; Zakowska & Pulawska, 2014:68). Mobility, traffic congestion and air quality need to be improved by introducing public policies and regulations. If proper investments are made in the transportation sector with adequate decision-making processes for land use, an increase in walking and/or cycling can be made (Frank & Engelke, 2001:203). The link between public health and sustainable cities (Buse & Hawkes, 2015:3) is of specific importance to this study since it highlights the associated link with one of the main themes of this study, namely spatial planning (see Chapter 2).

4.4 SUSTAINABLE DEVELOPMENT IN SOUTH AFRICA

South Africa is no different from any of the world's other developing countries which need to address the mandated SDGs by 2030. However, the UN World Commission on Environment and Development (1987:39) points out that the implementation of SD will differ for each country in accordance with its economic, social and ecological conditions.

South Africa was quite slow with its inclusion of SD in national policies (Swilling, 2011:24). In 2012, the country published the National Development Plan (NDP) which attempts to address the SDGs of the UN (see Table 2.4) (cf. RSA National Planning Commission, 2012). The NDP recognises the importance of sustainable development in maintaining the country's natural resources, promoting economic activity and improving the social welfare of South African citizens (The Department of Environmental Affairs, 2018: online). The South African Department of Planning, Monitoring and Evaluation drafted a five-year Medium-Term Strategic Framework (MTSF) with 14 priorities that the government and its partners wish to address first in the light of reaching the 2030 SDGs (cf. RSA Department of Planning, Monitoring and Evaluation, 2014). Table 4.1 is a comparison of South Africa's policies with the UN's 2030 SDGs.

Table 4.1: Comparison of South Africa's policies with the United Nation's 2030 Sustainable Development Goals (Griggs et al., 2013:305)

CRITERIA	**SPLUMA** (RSA Department of Rural Development and Land Reform)	**NDP of 2030** (RSA NDP, 2012)	**IUDF** (RSA Cooperative Government and Traditional Affairs, 2016)
2030 SUSTAINABLE DEVELOPMENT GOALS			
1. Poverty	x	x	x
2. Zero hunger	x	x	x
3. Good health and well-being		x	x
4. Quality education		x	x
5. Gender equality		x	
6. Clean water and sanitation	x	x	x
7. Affordable and clean energy		x	x
8. Decent work and economic growth	x	x	x
9. Industry innovation and infrastructure		x	
10. Reduced inequalities	x	x	x
11. Sustainable cities and communities	x	x	x
12. Responsible consumption and production		x	x
13. Climate action		x	x
14. Life below water			
15. Life on land	x		
16. Peace, justice and strong institutions	x	x	x
17. Partnerships	x	x	x

4.4.1 The stance of economic development in South Africa

South Africa has made progress since 1994 to manage public finances, but the global and financial crisis of the past decade slowed down the country's economic growth (OECD, 2012:3). It is common knowledge that South Africa's economic development is in a dire state with only one of the three major investment agencies not currently awarding the country junk status. News channels daily report the poor financial status of government owned enterprises (e.g. Eskom, South African Airways, Transnet, etc.).

South Africa needs a (faster) growing economy to address the high unemployment rate since it is impacting on the overall well-being of its citizens (OECD, 2017:12). One of the contributing factors to the slow growth is the prolonged drought that had a negative impact on agriculture, employment, and the overall well-being of the population (OECD, 2017:12). The OECD (2016: online) reports that South Africa had the fourth lowest GDP of the OECD countries (i.e. 13 371.6 US Dollars/capita). The nominal forecasted GDP growth rate for 2020 is 7.3%, but the OECD estimates the real GDP growth as only 1.77% (OECD, 2019: online). Slow economic growth is set to continue in South Africa due to changes in the political environment (e.g. national elections in 2019), high food prices that result in low consumer demand, average wage increases and citizens' non-ability to pay off their debt (OECD, 2017:20-21).

The Gauteng province is regarded as the financial powerhouse of the country generating over a third of South Africa's gross domestic product (GDP) although it is the smallest of all nine provinces (Stats SA, 2019: online). Government is the largest industry in the Free State, the province in which the study area lies, and highlights the importance of government as an economic driver (Stats SA, 2019: online). However, South Africa's government has high levels of corruption in both public and private sectors (RSA NPC, 2012:25, 56). Fighting corruption is difficult in the country due to the high level of corruption amongst senior levels in government and social perceptions of an unjust and unequal economy (RSA NPC, 2012:56).

4.4.2 The stance of environmental protection in South Africa

In 2012, the economy was reported to be unsustainably resource intensive (RSA NPC, 2011:25; South African City Network, 2016:162). The IUDF of South Africa projects that 71.3% of the country's population will live in cities by 2030 (2016:7) (see 2.5). This requires cities to have access to large amounts of water and energy resources, as well as access to transportation modes that place strain on the surrounding environment (RSA NPC, 2012:266-267). The coal used for the generation of

electricity and vehicular emissions contributes respectively 67% and 38% to the total emissions of South Africa (South African City Network, 2016:167) which affects the overall well-being of the population due to air pollution and climate change.

The Department of Environmental Affairs (RSA DEA, 2019: online) reports that population dynamics and economic development (see 4.4.1) are the main drivers of environmental change in South Africa. The way that South Africans make decisions, their value systems and beliefs about how to use/consume resources (e.g. water, energy, food) and their daily activities all influence the natural environment (RSA DEA, 2019: online). The reality is that South Africans are facing the impact of climate change in their everyday lives mainly through the availability and quality of water due to changing rainfall patterns – more severe storms and floods and droughts (RSA Department of Water Affairs, 2017:7). South Africa has been experiencing a serious drought since 2015 which impacts agriculture, water availability and food security (RSA Department of Water Affairs, 2017:7).

More South Africans are becoming aware of their contribution to creating a more sustainable South Africa as can be seen by various formal and informal projects. Informal recyclers are a common sight in South African neighbourhoods picking through garbage bins for paper, plastic, glass and other recyclables (cf. Harrison, Gotz, Todes & Wray, 2014); the Endangered Wildlife Trust's Ecobrick project of various non-profit organisations to build houses and structures by means of compressing non-recyclable plastic materials into two-litre plastic bottles (cf. Vivier, 2018); the expansion of public transportation systems to reduce the use of private vehicles and as a result lower CO_2 emission such as the Gautrain (railway) and Rea Vaya, My CiTi, and A Re Yeng Bus Rapid Transit systems in major capitals (cf. RSA, 2019; South African Citi Networks, 2016:168-169); renewable energy projects such as PV projects, wind power, landfill gas to electricity, wastewater gas to electricity, waste to electricity and micro-hydro (cf. South African Citi Networks, 2016:168). These are only a few of the initiatives that South Africans are embarking on, but it is important to promote more sustainable practices (RSA NPC, 2012:266-267) since environmental sustainability is the foundation for sustainable development concerned with productivity, inclusivity and overall well-being of the country's population (South African City Network, 2016:198). The RSA NDP (2012:197) proposed the following practices to promote a more sustainable South Africa:

- Use natural resources and mineral deposits to fund the transition to a low-carbon future.
- Address developmental challenges in an environmentally sustainable manner and build resilience to climate change.

- Invest in the development of skills, technology and institutional capacity (through education).
- Implement carbon-pricing mechanisms.
- Raise awareness of human decisions, daily activities and value systems and beliefs to promote the protection of the environment.
- Create a zero-waste community with sufficient recycling infrastructure.
- Develop environmentally green products and services.

4.4.3 The stance of social justice in South Africa

Until this date, South Africa remains a very unequal society (Alexander, 2017: online; OECD, 2012:3; RSA NPC, 2012:25) in which unemployment is high (OECD, 2012:3; RSA NPC, 2012:25) and life expectancy is only two-thirds of the OECD average (OECD, 2012:3). South Africa needs a faster growing economy to address the high unemployment statistics of the country (RSA NPC, 2012:27).

The 2030 NDP of South Africa states that the country's main mission is to eliminate poverty and reduce inequality by 2030 (RSA NPC, 2012:24) which is associated with social justice. The report highlights the successes of the republic since its first democratic election in 1994. Some of the most profound successes are that an estimated additional three million people were working in 2012, that the poverty rate declined during this period and that the average income has grown steadily (RSA NPC, 2012:24). However, the census of 2011 reports an increase of almost seven million people from the 2001 census, which casts a shadow on the increase of three million additional people working since 1994 until 2012. Furthermore, Stats SA (2017: online) reports that poverty is currently on the rise in South Africa with approximately 30.4 million South Africans already living below the poverty line in 2015. This casts even more doubt about the successes of the country in reducing the poverty rate.

At the top of this list is the provision of quality basic education for all South Africans which links to the fourth 2030 SDG (Alexander, 2017: online). A brief search of the World Wide Web, newspapers and social media highlights the education crisis that South Africa faces. The demand for free Higher Education by student protests since 2015 may be a tipping point in the economic situation of the country due to limited government resources (OECD, 2017:29). Many students from low and middle-income households cannot afford higher education, and higher education institutions are barely paying their staff from government funding (OECD, 2017:29). The South African National Planning Commission's Diagnostic Report of 2011 identified other social justice challenges in regard to transformation since 1994, namely:

- Infrastructure is poorly located, inadequate and under-maintained.
- Spatial divides hobble inclusive development.
- The public health system cannot meet demand or sustain quality.
- Public services are uneven and often of poor quality.

  (RSA NPC, 2012:25)

4.5 CHAPTER SUMMARY

This chapter complements the previous two literature review chapters of this study by expanding on the concept of SD regarding the three key considerations of SD, namely: economic development, environmental protection and social injustice. These three considerations are interlinked with each other since the one impacts the other (e.g. the economy of a country is derived from society, whereas the society's purpose is derived from nature) (Agyeman et al., 2002:88; Ikerd, 2012:16-17; Syme & Nancorrow, 2013:451).

The chapter starts with a brief history of SD to provide the reader with an oversight of how the concept expanded over the past decades to not only focus on the environment but also on the economic growth of countries and their people (see 4.2). In the light of the expanded definition of SD, the concept is discussed in detail in each context, namely economic development (see 4.3.1), environmental protection (see 4.3.2) and social justice (see 4.3.3). All three key considerations of SD acknowledge the role of spatial planning (see Chapter 2) and transportation (see Chapter 3) to guide the researcher within the context of this study. SD in South Africa is guided by the discussion in section 4.3 and provides the reader with a broad background of the possible challenges the researcher might face within the scope of this study. Although creating sustainable cities is a complex matter with many considerations (i.e. defining, measuring, negotiating and implementing sustainable practices), it is worth pursuing (Campbell, 2013:87). Figure 4.2 attempts to visually summarise the connections mentioned in this summary.

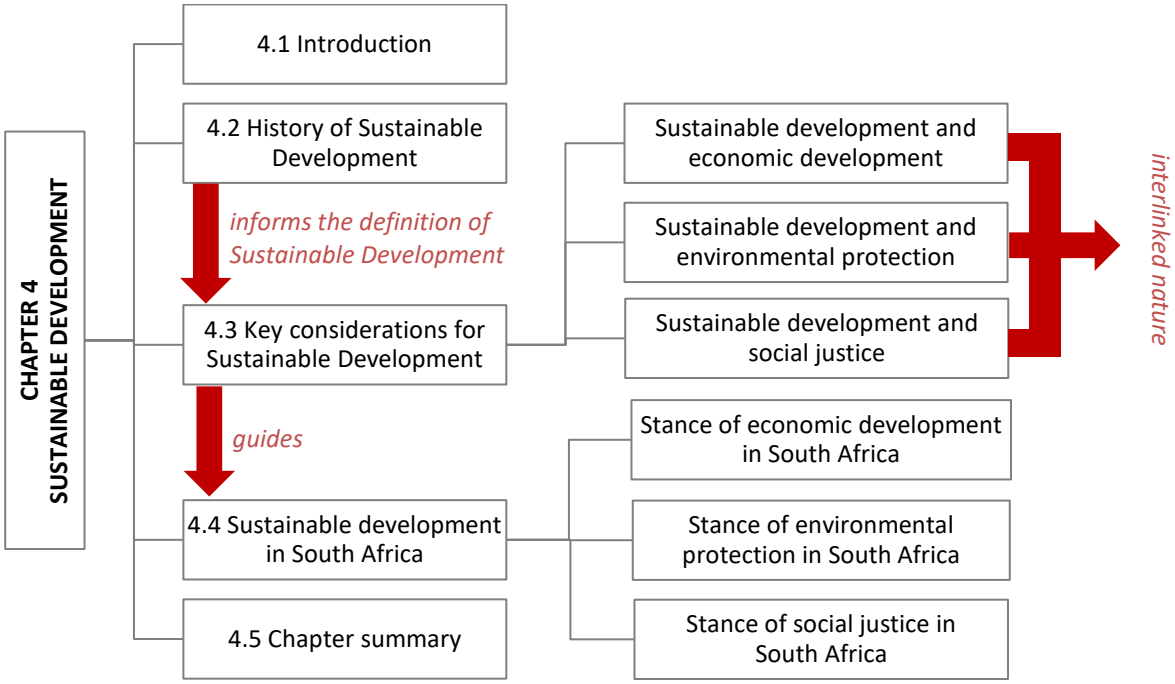


Figure 4.2: Visual summary of the connections between various sections of this chapter

SUMMARY OF LITERATURE CHAPTERS

The first objective of this study calls for the exploration of spatial planning and transportation development guidelines which may influence the sustainable development of public transportation systems. The figure below provides a summary of the alignment of the three literature chapters of this study to the first objective.

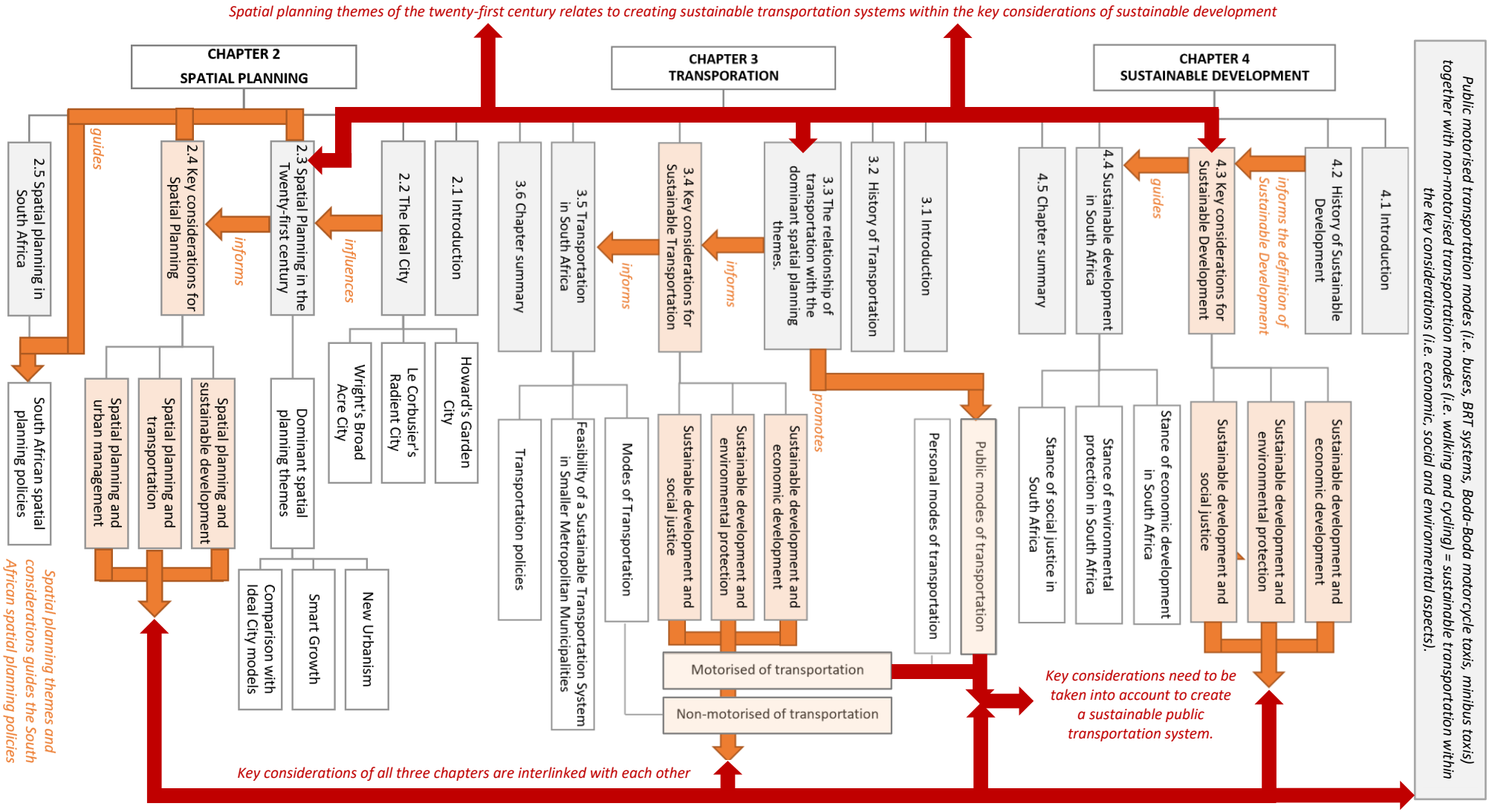


Table 4.2: Summary of Key Considerations from the Literature Review to promote Sustainable Transportation

Key considerations arising from the literature	Sections that explore the key considerations arising from the literature		
	Chapter 2 – Spatial Planning	**Chapter 3 – Transportation**	**Chapter 4 – Sustainable Development**
Economic considerations			
The affordability of transportation mode(s)	2.3.1.1; 2.3.1.2; 2.4.1; 2.5.1	3.3; 3.4.1; 3.4.2; 3.4.3; 3.5.1; 3.5.1.1.1; 3.5.1.1.2; 3.5.3	4.3.3
Environmental considerations			
Environmental friendliness of transportation mode(s)	2.3; 2.3.1.1; 2.4.1; 2.5.1	3.1; 3.3; 3.4; 3.4.1; 3.4.2; 3.4.3; 3.5; 3.5.1.1.1; 3.5.1.1.2; 3.5.1.2	4.1; 4.2; 4.3; 4.3.1; 4.3.2; 4.3.3; 4.4; 4.4.2
Impact of the weather	2.3.1.1		4.3.1; 4.3.2
Spatial considerations			
Commuters' origin and destination land usages	2.3.1.1; 2.3.1.2; 2.3.1.3; 2.4.1; 2.4.3; 2.5.1		
Distance to and from access point to transportation mode(s)	2.3.1.1	3.5.1.1.2; 3.5.1.2; 3.5.2	
Travel distance	2.3.1.1	3.5.5	
Travel time (duration) due to distance and congestion	2.4.2; 2.5; 2.5.1	3.5.1.1.2; 3.5.1; 3.5.3	4.3.3
Pedestrian and cycling friendliness of the spatial form	2.2; 2,3,1,1; 2.5.1	3.3; 3.4.2; 3.5.1; 3.5.1.1.2; 3.5.1.2; 3.5.2	4.3.3; 4.4.2
The number of stops between origin and destination	2.3.1.1; 2.3.1.2	3.4.4; 3.5.1.1.2; 3.5.1.2	
Neighbourhoods are walk- and cycle-friendly	2.3.1.1; 2.3.1.2		
Park-and-ride options for public transportation including motor vehicles, motorcycles and bicycles		3.5.1.1.1; 3.5.1.1.2	

Key considerations arising from the literature	Sections that explores the key considerations arising from the literature		
	Chapter 2 – Spatial Planning	**Chapter 3 – Transportation**	**Chapter 4 – Sustainable Development**
Social considerations			
Social considerations of accessibility			
Access to transportation mode(s)	2.2; 2.3.1; 2.3.1.1; 2.3.1.3; 2.4.1; 2.4.2; 2.4.3; 2.5; 2.5.1	3.4.1; 3.4.2; 3.4.3; 3.5; 3.5.1.1.2; 3.5.3	4.3.1; 4.3.2; 4.3.3; 4.4.2
Access for people with disabilities and special needs			4.3.3
Access to information of transportation mode		3.5.1.1.2; 3.5.3	4.3.3
Access to opportunities with transportation mode	2.2; 2.4.1; 2.5; 2.5.1	3.4.1; 3.4.2; 3.5; 3.5.1; 3.5.3	4.3.3
Social considerations of flexibility			
Flexibility of transportation mode		3.5.1; 3.5.1.1.1; 3.5.1.1.2	
The day and time of travel	2.3.1.1	3.5.2	
Social considerations of mobility			
Number of trips daily (frequency)	2.2; 2.3.1.1; 2.3.1.2; 2.5.1	3.3; 3.4.2; 3.4.4; 3.5.1; 3.5.1.1.2; 3.5.1.2; 3.5.2	4.3.3; 4.4.2
Relocating for public transportation	2.3.1.1	3.5.3	
Preference to use a specific mode of transportation	2.3.1.1; 2.3.1.3; 2.3.1.3; 2.4.2; 2.5; 2.5.1	3.2; 3.3; 3.4.2; 3.5.1.1.1; 3.5.1.1.2; 3.5.3	4.3.2; 4.3.3; 4.4.2
Social considerations of personal needs			
Safety of residential area for non-motorised transportation modes	2.3.1.1; 2.3.1.3; 2.4.1; 2.5	3.3; 3.4.1; 3.4.4; 3.5.1.1.1; 3.5.1.1.2; 3.5.1.2	4.3.3
Road safety	2.5	3.3; 3.4.1; 3.4.4; 3.5.1.1.1; 3.5.1.1.2; 3.5.1.2	4.3.3

Key considerations arising from the literature	Sections that explores the key considerations arising from the literature		
	Chapter 2 – Spatial Planning	**Chapter 3 – Transportation**	**Chapter 4 – Sustainable Development**
Social considerations of transportation needs			
Personal space that the transportation mode(s) offer (comfortability and capacity)		3.3	
Willingness to use public transportation modes if they are available	2.3.1; 2.4.2	3.4.3; 3.5.1; 3.5.1.1.1; 3.5.1.2; 3.5.3	
Importance of reliability of selected transportation mode(s)		3.5.1.1.2	
Road sharing to accommodate motorised and non-motorised transportation	2.2; 2,3,1,1; 2.5.1	3.3; 3.4.2; 3.5.1; 3.5.1.1.2; 3.5.1.2; 3.5.2	4.3.3; 4.4.2
Adherence to the speed limit	2.2; 2.3.1.1	3.4.3; 3.5.3	4.3.2
Acceleration speed	2.2; 2.3.1.1	3.4.3; 3.5.3	4.3.2
The convenience of transportation mode		3.5.1.1; 3.5.1.2	
Social considerations of well-being			
Health benefits of transportation mode	2.3.1.3; 2.4.1; 2.4.2; 2.4.3	3.4.2; 3.4.3; 3.5.1; 3.5.1.1.1;3.5.1.1.2; 3.5.1.2, 3.5.3	4.3.1; 4.3.3
To walk or cycle to gain access to transportation stops.		3.5.1.1.2; 3.5.1.2	

OVERVIEW OF EMPIRICAL RESEARCH

The second, third and fourth objectives of this study form the empirical research of this study. The figure below provides a broad overview of the study and highlights the objectives that correlate with the empirical research.

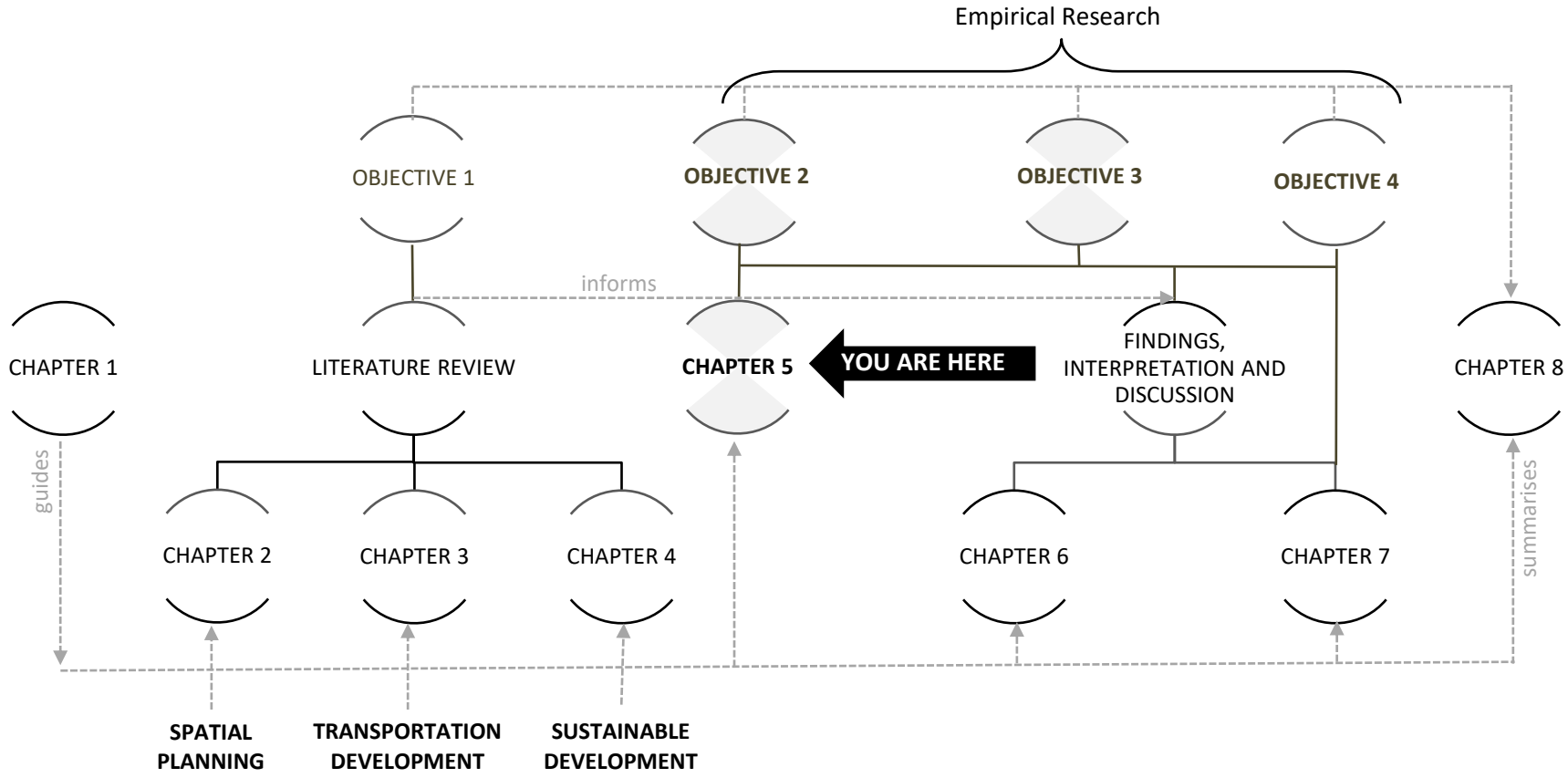


Figure 5.A: Overview of empirical research

CHAPTER 5

RESEARCH DESIGN AND METHODOLOGY

5

5.1 INTRODUCTION

The South African public transportation system is often associated with words such as poor service delivery, unreliable, inaccessible, unsafe, unaffordable, and uncomfortable. MMM currently has a state-subsidised transportation system which residents can use to travel between and within the various towns and cities of the metropolitan (Chobokoane & Horn, 2015:81). Urban sprawl is a common phenomenon in South African cities, with MMM not being an exception, which results in low density areas on the edges of the city that have limited access to basic services such as public transportation (Knaap & Talen, 2005:108). Although the MMM BRT project has many constraints (e.g. limited funding and expectations of high performance and quality) and is far behind on its original operation timeline, the value that this project may bring to the community is not doubted. With this in mind, this research proposes an exploration of the sustainability of a public transportation system for a smaller metropolitan area such as MMM to promote the longevity of such a system. This chapter discusses the research design and methodology followed to explore the problem stated in Chapter 1. Figure 5.1 provides the overall structure of this chapter and its role in the study as the foundation of the empirical research.

5.2 RESEARCH AIM AND OBJECTIVES

The aim of this study is to explore the promotion of a sustainable public transportation system for a smaller metropolitan area in South Africa. Four objectives guided the exploration of this study, namely:

1. To explore spatial planning and transportation development guidelines which may influence the sustainability of public transportation systems (see Chapters 2, 3 and 4).
2. To investigate the transportation needs of the population of the study area (see Chapters 6 and 7).
3. To identify the spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area (see Chapter 7).
4. To propose plausible policy guidelines for the development of a sustainable public transportation system for the study area (see Chapter 7).

Figure 5.2 outlines the alignment of the research design and methodology described in this chapter with the objectives of the study stated above and in Chapter 1.

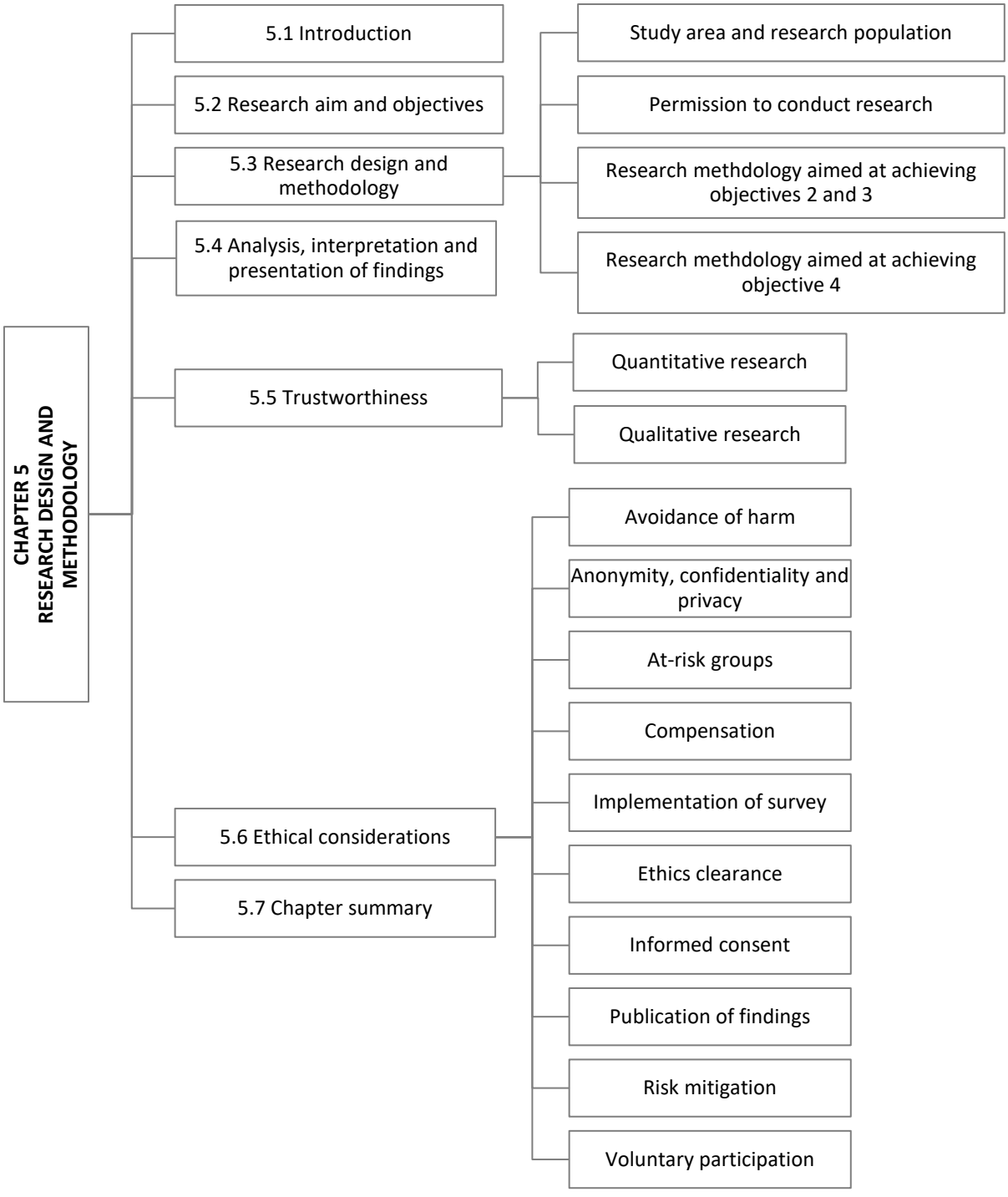


Figure 5.1: Outline of Chapter 5

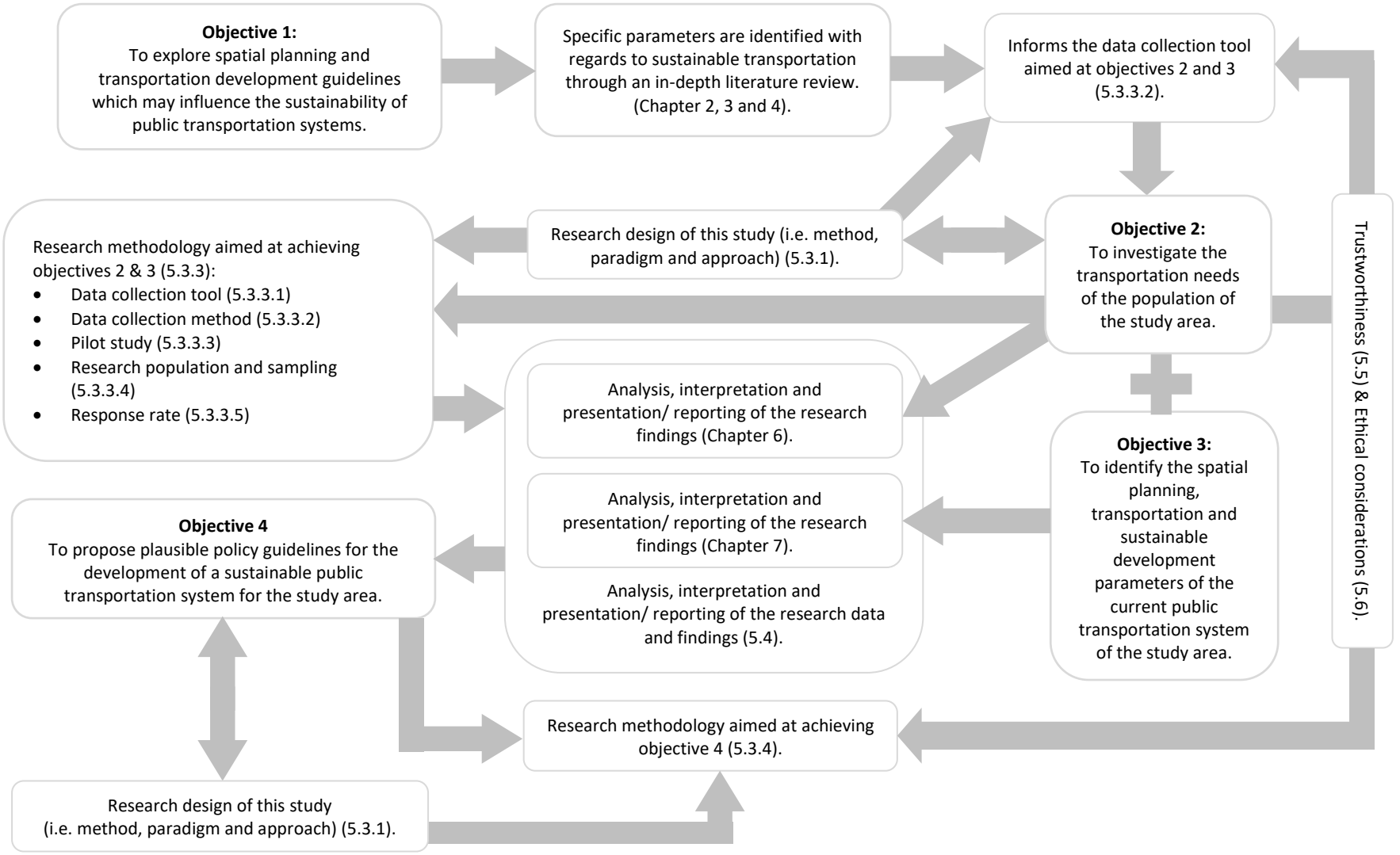


Figure 5.2: Alignment of the research design and methodology

5.3 RESEARCH DESIGN AND METHODOLOGY

The data collection of this study employs a mixed method research design with an explanatory qualitative component. A mixed method research design provides the opportunity for the quantitative and qualitative data to be integrated, related or mixed at certain stages of the research process (Delport & Fouché, 2011:435). Quantitative research follows a deductive approach which tests theories, whereas qualitative research is an inductive approach that generates theories (Gog, 2015:35). A quantitative approach was best suited for the large target population of this research; however qualitative data is also needed to gain an understanding of the individual respondents' need within their social world (Gog, 2015:35). The explanatory mixed method design starts off with the collection and analysis of quantitative data, followed by the collection and analyses of the qualitative data (Delport & Fouché, 2011:441).

This research is viewed through an interpretive lens with the idea to create a hermeneutic interpretation of the perspective of the user (Crouch & Pearce, 2012:61). In this case, it is the individual commuters' transportation needs that are considered, with the aim to sustain a public transportation system. In essence, this paradigm is best suited to understand the subjective world of the human experience in their context and to investigate the integrity of the phenomena (Cohen, Manion & Morrison, 2011:17). The focus of this paradigm is to identify the feelings of the individual in order to generate an in-depth understanding about the phenomena from the point of view of the individual who is directly involved in the phenomena (Cohen et al., 2011:17). The interpretive understanding requires a methodology that assists the researcher to define the social action of the participant and how they provide meaning to the real-life world (Fouchè & Schurink, 2011:309). The extent of the study is seen with a methodological approach that focuses on the systematic, interactive discovery of the real world, and the epistemology is the information that arises from the understanding of meanings and symbols (Fouchè & Schurink, 2011:311).

A single case-study approach was undertaken since the research is interpreted through the lens of the interpretivist paradigm even though it is a mixed method research design. A case study is defined as an in-depth empirical investigation of a specific phenomenon within its real-world context (Yin, 2014:16). Although authors differ in opinion regarding the use of case studies as a research method or strategy/ approach, this research employs it as an approach with the aim to generate theories (Gog 2015:36-37), which in this particular case refers to the generation of plausible guidelines for the development of a sustainable public transportation system for the specific study area (i.e. objective 4). A case-study approach was deemed best suited to investigate the problem at hand since this

research explores a unique case (Cohen et al., 2011:291) and transportation patterns of the sample population (see 1.7 regarding the significance of this study). This study has a physical boundary (i.e. MMM in the Free State, South Africa) (see 5.3.1) which supports the use of a case-study approach.

It furthermore specifies a clear question that needs answering which is broken down into four secondary questions to ensure that the research stays on track. The case study is descriptive in nature since it strives to describe, analyse and interpret the problem stated (Fouchè & Schurink, 2011:320-321). Therefore, this approach is ideal for this study since it provides a holistic and real-world perspective of the problem investigated (Yin, 2014:4,237). The disadvantages of this approach were also considered when exploring a suitable design approach. A single case study, such as this study, has limitations regarding the generalisability and transferability of the findings and the researcher's bias (Yin, 2014:20-21) which impacts the trustworthiness of the research. Appropriate trustworthiness measures were put in place before the data collection started and were upheld throughout the data collection, analysis and interpretation (see 5.3.5).

5.3.1 Study area and research population

The study area is located in the Free State which is one of the nine provinces in South Africa. The Free State, positioned in the middle of South Africa (see Figure 5.3), has a total population of 2 866 700 (Stats SA, 2017:2).

Figure 5.4 is a map of the Free State province with the location of the study area (Mangaung Metropolitan Municipality). The province has one metropolitan and four district municipalities. The main economic sectors for this region are community services (35.30%), finance (26.80%), trade (16.00%), transport (11.80%), and manufacturing (3.50%). Mangaung is also the closest metropolitan municipality to a neighbouring country, namely Lesotho (Municipalities of South Africa, 2019: online).

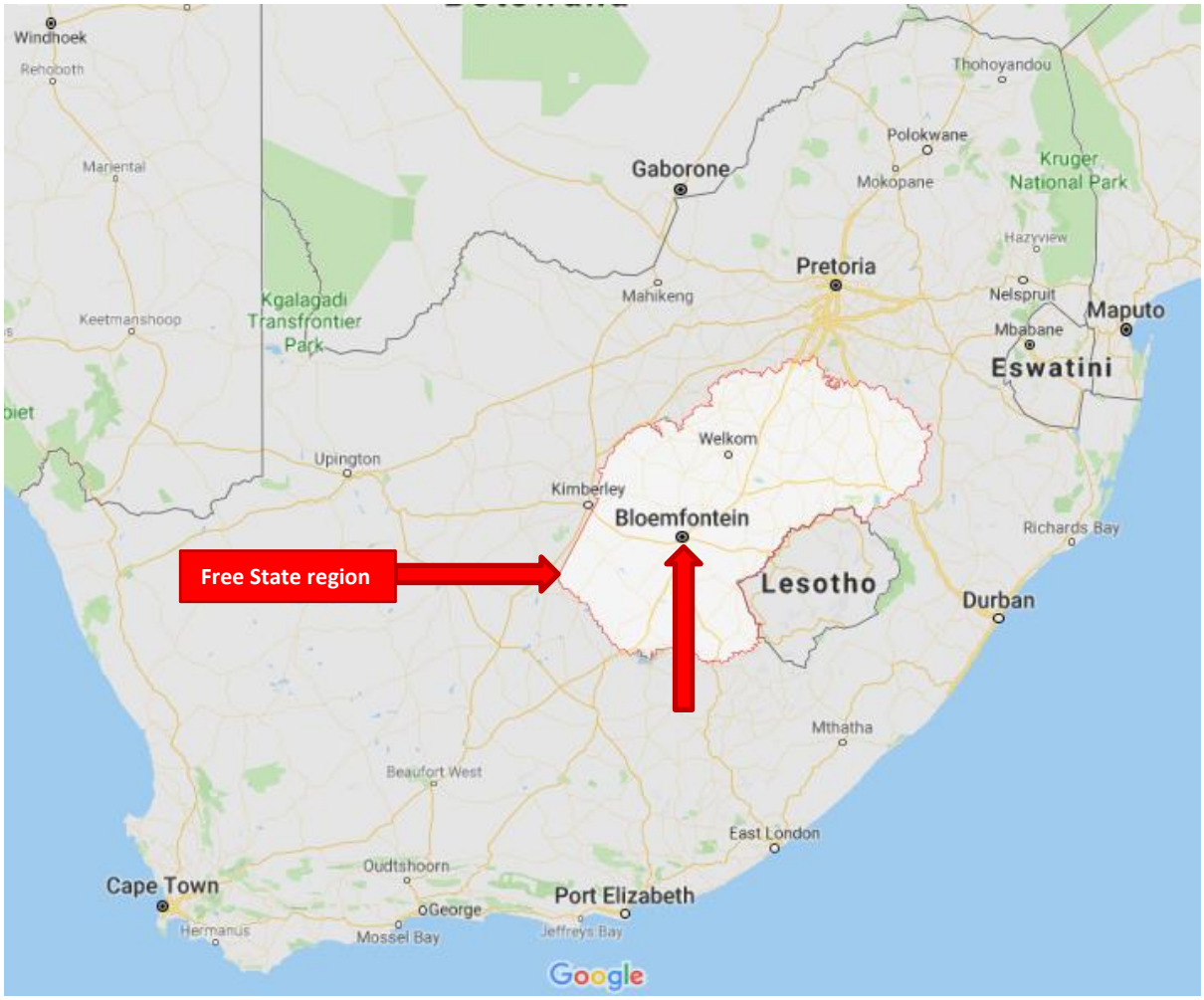


Figure 5.3: Geographical map of South Africa (Google maps)

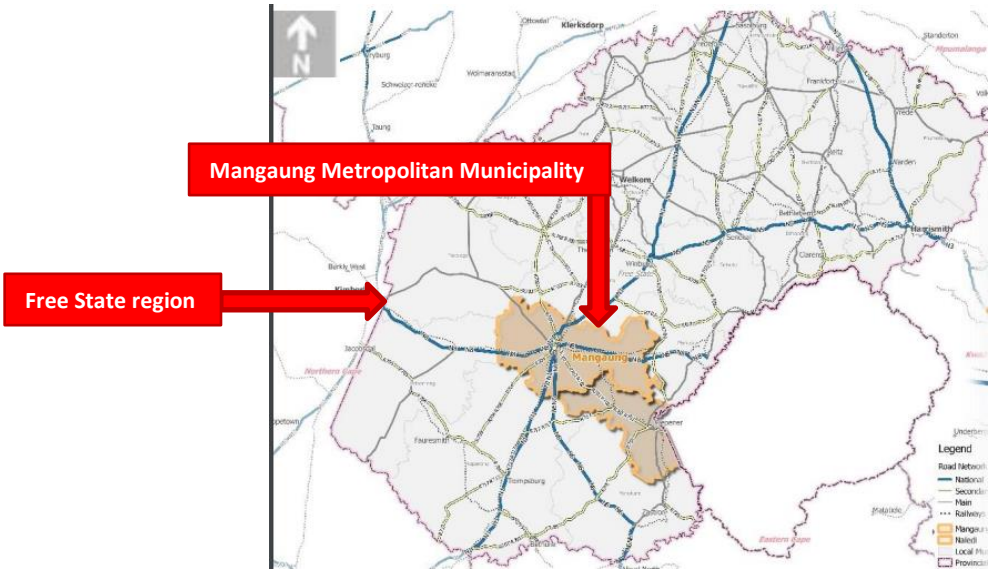


Figure 5.4: Map of the Free State (IPTN, 2017:6)

Figure 5.5 is the map of MMM. The metropolitan has a total area of 9 886 km^2 (Municipalities of South Africa, 2019: online) and a population of 787 803 (Stats SA, 2016: online). Bloemfontein and Mangaung are on the western side of MMM, while Thaba Nchu and Botshabelo are on the eastern side, as indicated on the map in Figure 5.5. The national highway (N1) that connects the capital of the country (Pretoria) with the city of Cape Town passes through the metropolitan area.

Figure 5.5: Map of Mangaung Metropolitan Municipality (Municipalities of South Africa, 2019: online)

For survey purposes, the study area was divided into four different categories, namely Bloemfontein, Mangaung, the far eastern part (Botshabelo and Thaba Nchu), and 'others'. The category 'other' consists of Dewetsdorp, Van Stadensrus, Wepener, and rural farming communities. This provided a clear indication of the movement of respondents in the study area.

5.3.2 Permission to conduct research

An application for ethical clearance was submitted to the Faculty of Natural and Agricultural Sciences at the University of the Free State in April 2017 for approval to conduct the planned research. The application was conditionally approved on the 15 May 2017 by the chairperson of the ethics committee of the faculty (see Appendix A).

5.3.3 Research methodology aimed at achieving objectives 2 and 3

This section describes the methodological process followed to achieve objectives 2 and 3 with the aim to document a logical audit trail with thick (rich) descriptions to promote the trustworthiness of this study.

5.3.3.1 Data collection tool aimed at objectives 2 and 3

The data collection tool was included as part of the ethical application for ethical clearance submitted to the faculty in April 2017. The decision was taken to use a structured questionnaire with the intended sample size in mind. The questionnaire was divided into four sections, namely Section A: Demographic and psychographic information of respondents; Section B: Private transportation users; Section C: Public transportation users, and Section D: Non-motorised transportation users. Respondents should complete all sections relevant to them together with Section A which is compulsory. Section A made use of nominal and ordinal levels of data to describe the demographic and psychographic background of respondents regarding their transportation needs. Sections B, C and D included closed questions with a numerical value on a five-point Likert scale. A five-point Likert scale was used to promote the validity and reliability of the research tool as per the discussion in section 5.3.7. In light of the research design of this study, qualitative questions were also incorporated throughout each section of the questionnaire to fulfil an explanatory role.

The questionnaire addresses the relating ethical considerations stated in section 5.6 by including an informed consent letter (see Appendix B) which highlights the respondents' right to withdraw from the research, issue of beneficence (compensation), non-maleficence (avoidance of harm), confidentiality, and anonymity to only name a few. The researcher and the supervisor's contact information are provided on the front page if there were any uncertainties. The questionnaire was thoroughly planned in regards to decisions about the content, the wording of questions, form of response to questions, and sequence of the questions (Cohen et al., 2011:379). The content of the data collection tool was informed by the literature review (see Chapters 2, 3 and 4) to promote the validity of the research tool. This correlates with the first objective of this study. The wording, response and sequence of the questionnaire was reported on in the pilot study (see 5.3.3.1).

5.3.3.2 Data collection method

The data collection tool was a self-administered and explanatory mixed method questionnaire.

The study started with a purposive sampling method to select the first round of research assistants as a starting point for a snowball sampling technique. Five research assistants, known to the researcher that reside in different residential areas of the metropolitan area, were purposively chosen. These five

research assistants were each given 100 printed questionnaires and informed consent letters to distribute to their network of known and unknown research assistants. The researcher also personally distributed a further 50 questionnaires to known and unknown respondents. The researcher selected a confidence level of 95%, which is not a high confidence level (99%) nor a low confidence level (90%) (Cohen et al., 2018:146). The minimum number of respondents for a 95% confidence level is 384 respondents (Cohen et al., 2018:147). A total of 550 questionnaires were distributed, with 447 respondents completing and returning the questionnaires (81.24% response rate).

5.3.3.3 A pilot study for the questionnaire survey aimed at objectives 2 and 3

A pilot study was conducted with the sample population to ensure that the questionnaire questions prompted responses that align with the correlating objectives as a trustworthiness measure. The respondents were asked to complete a feedback form to indicate whether the questionnaire pitches the questions at the correct level of difficulty, uses the appropriate type of questions, follows a logical order and uses acceptable language which is understandable (see Appendix C). A three-point Likert scale was used with the categories easy, medium and hard. Respondents were also given a space to include an additional opinion or comment regarding the questionnaire. The feedback on the pilot study was positive and respondents felt that the questions were reasonable and on an acceptable level to complete. This resulted in no changes being made to the questionnaire before it was distributed to the sample population described in section 5.3.3.4.

5.3.3.4 Sampling for the questionnaire survey aimed at objectives 2 and 3

The study started with a purposive sampling method to select the first round of research assistants as a starting point for a snowball sampling technique. Five research assistants, known to the researcher that reside in different residential areas of the metropolitan area, were purposively chosen. These five research assistants were each given 100 printed questionnaires and informed consent letters to distribute to their network of known and unknown research assistants. The researcher also personally distributed a further 50 questionnaires to known and unknown participants. The researcher selected a confidence level of 95%, which is not a high confidence level (99%) nor a low confidence level (90%) (Cohen et al., 2018:146). The minimum number of participants for a 95% confidence level is 384 participants (Cohen et al., 2018:147). A total of 550 questionnaires were distributed, with 447 participants completing and returning the questionnaires (81.24% response rate).

5.3.3.5 The response rate for the questionnaire survey aimed at objectives 2 and 3

The response rate of the questionnaires was high, with a total number of 447 replies out of the 550 questionnaires sent out. This is a success rate of 81.24% of all the questionnaires provided. As seen in Appendix B, the questionnaire consists of parts A, B, C, and D. All of the respondents filled in section A, since this section provides the opportunity for all respondents to complete it. Section B consists of all the respondents that use personal vehicles in the study area, thus respondents who do not use their personal vehicles left this part blank. Part C of the questionnaire deals with respondents that use public transportation, so respondents that did not use public transport left this part empty. Part D considered non-motorised transport users, with most of the respondents completing this section. Some of the respondents completed more than one transportation section (B, C, and D).

5.3.4 Research methodology aimed at achieving objective 4

The last objective of this study required proposing plausible policy guidelines for the development of a sustainable public transportation system for the study area. This was done by means of comparing, converging and integrating the research findings obtained through the literature study and the findings obtained by means of the data collection method aimed at objectives 1, 2 and 3.

5.4 ANALYSIS, INTERPRETATION AND PRESENTATION/ REPORTING OF THE RESEARCH DATA AND FINDINGS

As mentioned in section 5.3, a mixed-method design was used for this study. The first step in the study was to do an in-depth literature review to achieve the first objective of the study. The literature review is divided into three different chapters namely: spatial planning, transportation development, and sustainable development. These three chapters provide a thorough background to the study and assisted in the compilation of the questionnaire. Each question used for the questionnaire is linked to credible literature in either one or more of the literature chapters. The questionnaire was constructed to achieve the outcomes of objectives 2 and 3 of the study. This is a mixed-method self-structured questionnaire provided to the respondents of the study area. Firstly, a pilot survey was done in the study area as discussed in section 5.3.3.3 of this chapter. After the pilot study, the questionnaire was distributed evenly over the study area, and the data processed in the following way:

- All the data received (see 5.3.3.3) was entered into a Microsoft Excel spreadsheet to be placed in the correct order and an adequate format.
- Nominal and ordinal variables were established to identify if the sampled data had specific groups or specific ranks.

- If a participant selected an option in the questionnaire, it was marked with a one. A question with a non-response was marked with a zero.
- Quantitative data, which was measured with a Likert scale, was measured in a ranking from 1 to 5 with non-response marked with a 0.
- The standard deviations and bell curve are provided to show the reliability of the study, and the frequencies and means were calculated for each qualitative question.
- The qualitative data (comments provided by the respondents) were copied from the questionnaires and added to an Excel sheet.
- The coding of the qualitative data was done with the information received from the respondents in their comment section.

The data assisted in the identification of the important parameters in the study using both the qualitative and quantitative data. This helped in formulating plausible guidelines and policies to assist with the research outcomes (objective 4).

5.5 TRUSTWORTHINESS

The aspects that dictate the trustworthiness of this study are discussed in this section and refers to the qualitative and quantitative trustworthiness measures separately. Table 5.1 highlights the different trustworthiness measures for qualitative and quantitative research.

Table 5.1: Trustworthiness measures (Schurink et al., 2011:419-421)

Quantitative research	***Qualitative research***
Validity (see 5.5.1.1)	Credibility (see 5.5.2.1)
Reliability (see 5.5.1.2)	Transferability (see 5.5.2.2)
Objectivity (see 5.5.1.3)	Dependability (see 5.5.2.3)
	Confirmability (see 5.5.2.4)

5.5.1 Quantitative research

The trustworthiness for the quantitative research section is discussed in the following sections regarding the validity, reliability and objectivity.

5.5.1.1 Validity

According to Delport and Roestenburg (2015:173), validity is related to the measurement of the research tool versus the required measurement. Validity as a trustworthiness measure refers to the

degree to which a research tool measures what was intended (Delport & Roestenburg, 2015:173). The study is a mixed method study that involves both qualitative and quantitative research to aid the ability to triangulate the data which results in a demonstrative validity method (Cohen et al., 2015:195). The importance of triangulation is to restrict the misrepresentation of the researcher's bias and thus to promote objectivity in the research, without using any specific method (Cohen et al., 2015:195-196). The data collection tool is a self-structured questionnaire that includes both quantitative and qualitative questions in alignment with the research design of this study. The following validity measures were used in this study:

- Content validity:
  - The literature review informs the data collection tool (see Chapters 2, 3 and 4).
  - A pilot study was conducted with the sample population to ensure that the questionnaire questions prompt responses that align with the correlating objective (see 5.3.3.1).
  - My promoter checked for the possibility of bias or misinterpretation in the research tool before the pilot studies were conducted.

- External validity:
  - The majority of the questions in the data collection tool are linked to a five-point Likert scale and the remainder of the questions have either a nominal or ordinal value.
  - A five-point Likert scale was used to promote the validity and reliability of the scale since Lozano et al. (2008:77) recommends a Likert scale between four to seven points. The five-point Likert scale included a neutral option so as not to force a participant to agree or disagree with a statement if they have a neutral opinion.
  - The research design and methodology are described in detail (see 5.3.3 and 5.3.4) and suitable sampling techniques were selected to identify prospective respondents from the target populations who complied with all the inclusion criteria (see 5.3.3.4).

- Internal validity:
  - Pilot studies were employed that included additional feedback questionnaires prior to finalising and administering each questionnaire (see 5.3.3.1). Respondents in the pilot studies were excluded from the population sample for the relevant questionnaire.
  - A five-point Likert scale is used as motivated by Lozano et al. (2008:78).
  - The selection of respondents was spread over the entire study area (see 5.3.3.4).
  - The distribution of the questionnaires started directly after the pilot survey was concluded.

- Non-responding respondents were excluded from the database and a few respondents did not feel comfortable to sign the indemnity form.
- All the data were analysed, interpreted and presented accordingly.

5.5.1.2 Reliability

The definition of reliability is to measure a specific research question more than once and still get a similar result (Delport & Roestenburg, 2015:177). To improve the reliability of the study, the following was done:

- The importance of the study was discussed with the respondents to avoid the increase number of non-responses.
- A five-point Likert scale was used as motivated by Lozano et al. (2008:78).
- Each question was clearly explained to the respondents, and examples were provided if the respondents were unsure.
- If any question was unclear, the pilot study assisted in making the questions clearer to the respondents.

5.5.1.3 Objectivity

The researcher should not be biased or influence the findings of the study in any way. The researcher's objectivity during the analysis of the study was done in the following way:

- Feedback from the pilot survey assisted in asking the question correctly and not guiding the participant to a specific answer.
- The researcher communicated with professionals in the research field and used critical readers to assist in setting up the questionnaire.
- The literature was used to verify the outcomes of the questions obtained from the data analysis.
- Experts from the University of the Free State's Mathematical Statistics and Actuarial Sciences Departments Statistical Consultation Unit were consulted on the data analysis stage of the study.

5.5.2 Qualitative research

The trustworthiness for the qualitative research section is discussed in this following section regarding the credibility, transferability, dependability and confirmability.

5.5.2.1 Credibility

One of the most important trustworthiness subjects in qualitative research is credibility (Schurink et al., 2011:420). This is basically to ensure that the accuracy of the description of the research subject is dealt with appropriately. To ensure that the study has appropriate credibility, the following measures were employed:

- The researcher provided a description of the study area, the research population and sample (see 5.3.1), and the underlying theoretical framework in Chapters 2, 3 and 4 (cf. Cohen et al., 2011:180-181; Schurink et al., 2011:420).
- A mixed method research design is used with an explanatory qualitative component which supports the quantitative data (cf. Schurink et al., 2011:420).
- The data analysis, findings and interpretations are derived from a combination of the qualitative and quantitative data (Chapter 7) which is supported by the literature reviewed in Chapters 2, 3, and 4. Furthermore, the qualitative data is supported by verbatim quotes to enrich the findings.
- Critical reading was done on a continuous basis for all chapters of this study by my promoter and a number of higher education colleagues who were not involved in the study (cf. Schurink et al., 2011:420).

5.5.2.2 Transferability

Transferability indicates that the findings of this study may be transferable to a similar group of respondents in a similar study area. Although findings might be transferable due to the triangulation design and the correspondence of the findings with the theoretical framework of this study (Schurink et al., 2011:420), this was not a purpose of this study. A rich (thick) description of the qualitative data and findings is used to support the findings as recommended by Cohen et al. (2011:180) and Lincoln and Guba (1985:316).

5.5.2.3 Dependability

Dependability is promoted by using a logical, well documented process to promote the ability to repeat the process with a different group of respondents to achieve a similar result (Schurink et al., 2011:420). Dependability is similar to the quantitative trustworthiness measure of reliability (see 5.5.1.2).

5.5.2.4 Confirmability

The confirmability ensures that the researcher does not include bias in any way with the analysis of the data, interpretation of the findings and how it is reported on (Lincoln and Guba, 1985:318-319). Confirmability is similar to the quantitative trustworthiness measure of objectivity (see 5.5.1.3). The data was analysed in such a way that there were limited opportunities to manipulate the outcomes of the study. A triangulation approach and an information-rich audit trail are documented for any future review (cf. Lincoln & Guba, 1985:318-319). Ethical considerations and critical readers further supported the confirmability of the findings. Although all the quantitative and qualitative trustworthiness measures were taken, the researcher is aware of his own subjectivity in the research process. Constant reflection and scrutinising of the data analysis, interpretation and reporting/ representation of the findings is done to promote the confirmability of this research. These measures contribute to the trustworthiness of study, as outlined by McMillan and Schumacher (2006:327) and Merriam (2009:229).

5.6 ETHICAL CONSIDERATIONS

Several ethical considerations were respected. This is especially required when researching human respondents (cf. Strydom, 2011:113). The following, listed as important by Strydom (2011:113-129) were taken into account:

- avoidance of harm (see 5.6.1);
- anonymity (see 5.6.2);
- confidentiality and privacy (see 5.6.3);
- at-risk groups (see 5.6.4);
- compensation (see 5.6.5);
- possible deception of respondents (see 5.6.6);
- ethics clearance (see 5.6.7);
- informed consent (see 5.6.8);
- publication of the findings (see 5.6.9);
- risk mitigation (see 5.6.10);
- voluntary participation (see 5.6.11).

5.6.1 Avoidance of harm

The questionnaire provided to the respondents did not influence the respondents in any harmful way. The respondents felt safe in completing the questionnaire, were not emotionally influenced in any way, or physically injured in any way. None of the respondents were forced to complete any part of the questionnaire. This is evident in the response rate seen in Chapters 6 and 7 for each question.

5.6.2 Anonymity, confidentiality and privacy

Each participant has the right to privacy, and the responses to the questionnaire are confidential. Each questionnaire is kept at a safe location with the written consent assuring the participant of their anonymity. The questionnaires will be kept in a safe space for five years, as specified in the informed consent. No personal details (name, surname or address of respondents) were asked of the respondents.

5.6.3 At-risk groups

Respondents that were younger than 18 and older than 65 were excluded from the respondents as they were regarded as potentially vulnerable respondents. Any respondents that resided outside the study area (Mangaung Metropolitan district) were also excluded from the survey.

5.6.4 Compensation

No compensation was given to any respondents in the survey. This was a voluntary survey for the respondents to complete, and they were informed of this at the beginning of the questionnaire.

5.6.5 Implementation of the survey

All the respondents were handled in the same way with no deception or irregularities in the completion of the survey. The respondents were free to opt-out at any stage of the questionnaire and were free to ask any question at any time. The indemnity clearly stated the required information, and all respondents signed the document accordingly.

5.6.6 Ethics clearance

Ethical clearance was obtained at the Department of Natural Sciences at the University of the Free State in April 2017 (see Appendix A).

5.6.7 Informed consent

The required information about the study was provided in the informed consent part of the questionnaire. This important information is provided to the participant which includes an explanation

that they do understand the language and that the study is voluntary (Strydom, 2011:117-118). Some of the important information mentioned is:

- Information on the research topic (e.g., this survey aims to establish your need as a resident of the Mangaung Metropolitan Municipality for a sustainable public transportation system).
- The contact information of the student and the supervisor if the participant was uncertain about the survey.
- The location of the study area and if the respondents live inside the study area.
- The right to opt-out of the questionnaire and the rights of the respondents in completing the questionnaire.
- To confirm their anonymity and to indicate what will happen to the questionnaire afterwards.

5.6.8 Publication of findings

The ideal is to publish the findings of the study in accredited journals, as specified in the informed consent of the questionnaire. It will also be important that the findings of the study contribute to further research in the future.

5.6.9 Risk mitigation

No personal information was captured to ensure the privacy, confidentiality, and anonymity of the respondents during the different stages of the collection and interpretation of the data. All the data was placed in evidence tamper-proof bags after it was captured and locked up in a safe to ensure that there is no unauthorised access to the data. This is to be kept in a safe for the next five years.

5.6.10 Voluntary participation

The participation in this study was voluntary, as specified in the informed consent letters of the questionnaire. Respondents were required to read through the informed consent letter and sign it to acknowledge that they were comfortable in completing the questionnaire. The respondents were more than welcome to stop at any stage of the questionnaire or not to complete any part of the study.

5.7 CHAPTER SUMMARY

The methodology and research design provide a logical and well-documented process of this study through the different stages of the study (Lincoln & Guba, 1985:318-319) to promote the generalisability and transferability of the findings of this research as well as to enable other researchers to duplicate this study. The profile of the respondents and the data analysis of the qualitative and quantitative data is reported on in Chapters 6 and 7 respectively, with Chapter 8 serving as a concluding chapter that discusses the research questions, limitations, and recommendations of this study.

OVERVIEW OF FINDINGS, INTERPRETATION, AND DISCUSSION CHAPTERS

The second and third objectives of this study call for the investigation of the transportation needs of the population of the study area, and to identify spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area respectively. The figure below provides a broad overview of the study and highlights the two objectives the findings, interpretation, and discussion chapters aim to address.

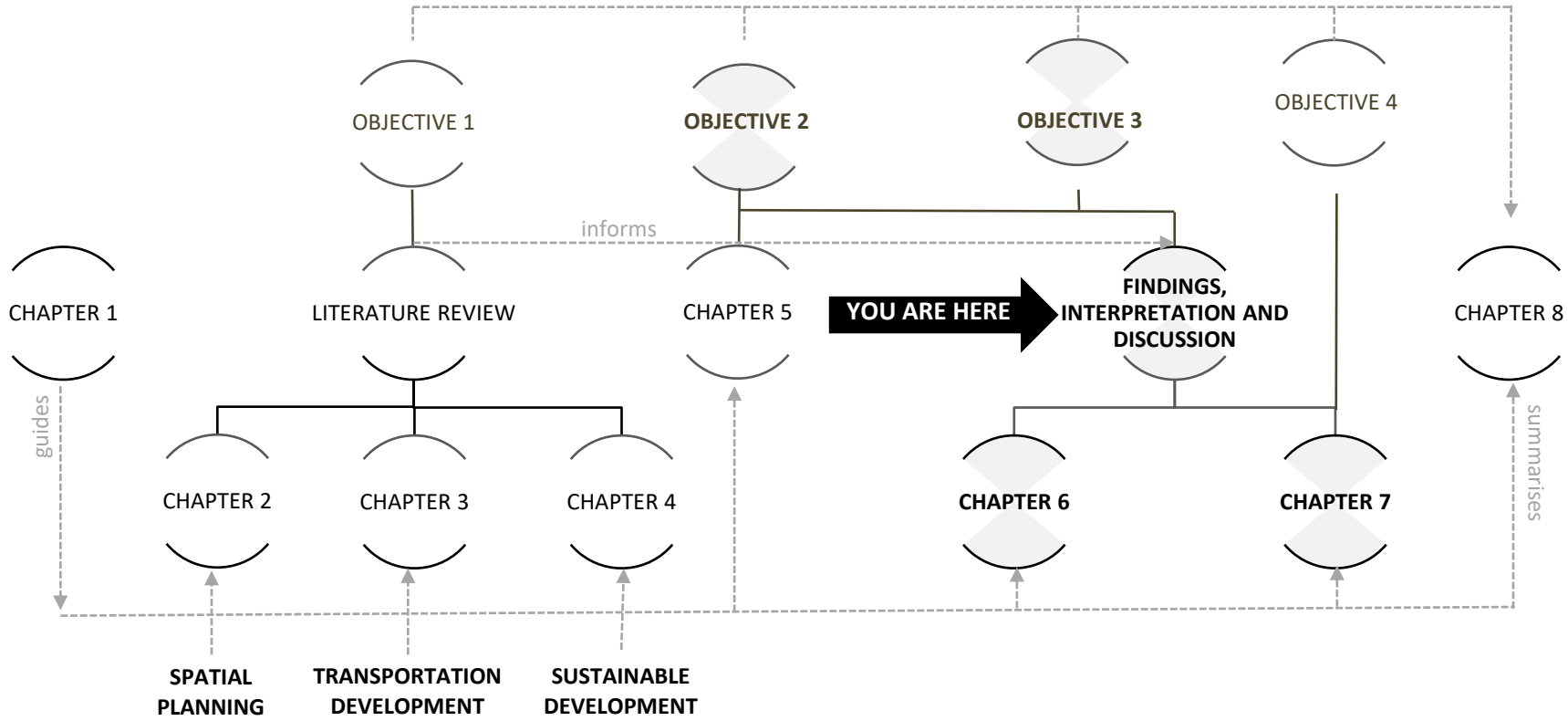


Figure 6.A: Overview of findings, interpretation, and discussion chapters

CHAPTER 6

FINDINGS, INTERPRETATIONS, AND DISCUSSIONS OF THE DEMOGRAPHIC AND PSYCHOGRAPHIC PROFILE OF RESPONDENTS

6

6.1 INTRODUCTION

This chapter provides a foundation for the findings, data interpretation, and discussion of this study and focuses on the demographic and psychographic profile of the respondents. The succeeding chapter explores the statistical analysis of the dataset more in-depth. Figure 6.1 provides an outline for this chapter.

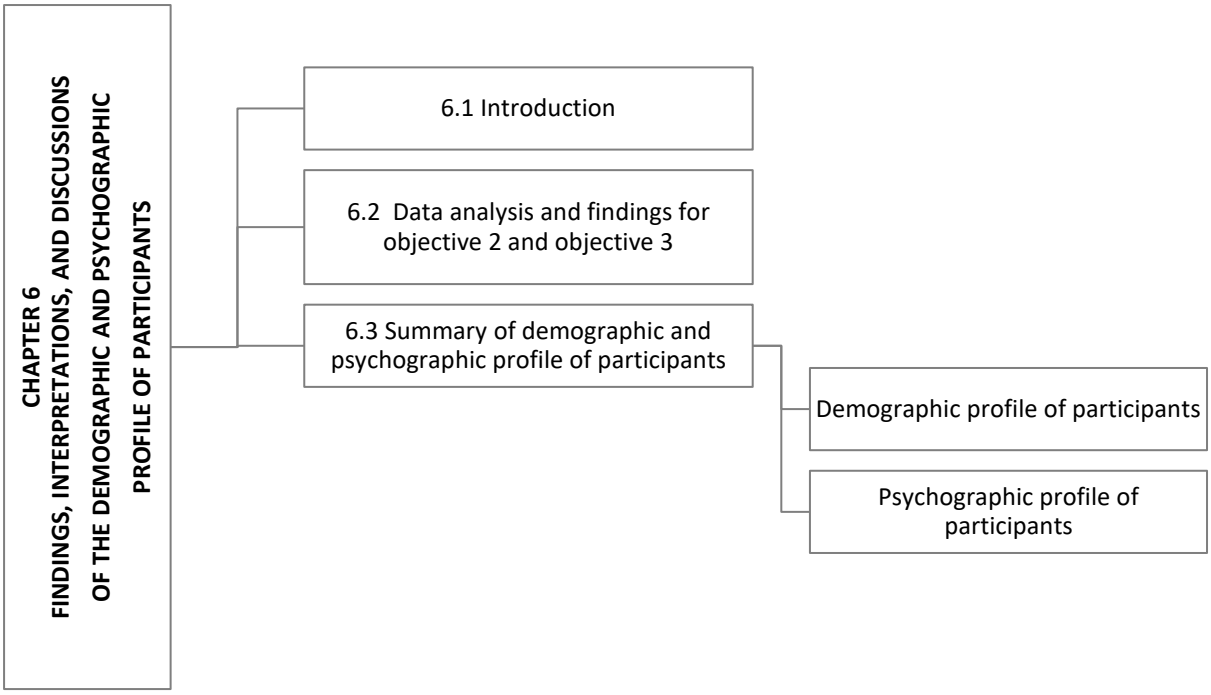


Figure 6.1: Outline of Chapter 6: Findings, interpretations, and discussions of the demographic and psychographic profile of respondents

6.2 DATA ANALYSIS AND FINDINGS FOR OBJECTIVE 2 AND OBJECTIVE 3

The purpose of this section is to outline the participant profile of the study population by discussing their demographic (see 6.2.1) and psychographic (see 6.2.2) profile. The participant profile is discussed in an attempt to meet the second (i.e. to investigate the transportation needs of the population of the study area) and third (i.e. to identify spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area) objectives of this study.

6.2.1 Demographic profile of respondents

The demographic profile of respondents includes age (see 6.2.1.1), gender (see 6.2.1.2), employment status (see 6.2.1.3) and special needs/disability (6.2.1.4).

6.2.1.1 Age of respondents

The inclusion criteria of this study excluded respondents aged younger than 18 or older than 65 years since these age groups are considered at-risk groups (as explained in Chapter 5). Five respondents did not answer this question and were excluded from the age data analysis. Figure 6.2 provides an overview of the age classification of respondents. The majority of respondents were 26 to 35 years old (34,84%; n = 154), followed by 96 respondents (21.72%) aged 36 to 45. Overall, the age distribution of respondents provides a variety that contributes to a representative sample of the population.

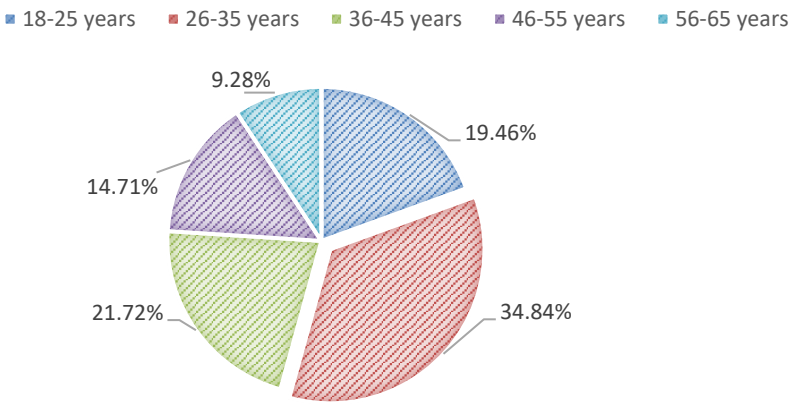


Figure 6.2: Age profile of respondents (n = 442 respondents)

6.2.1.2 Gender profile

The gender profile of respondents was included to ensure that the population sample has a maximum variation to promote the trustworthiness of the data. Ten respondents did not indicate their gender and were as a result excluded from the data analysis (2.2%; n = 10). The gender profile is presented in Figure 6.2. The figure indicates that there were slightly more male respondents (52.86%; n = 231) than female respondents (46.45%; n = 203). Three respondents indicated another gender than male or female (0.69%; n = 3).

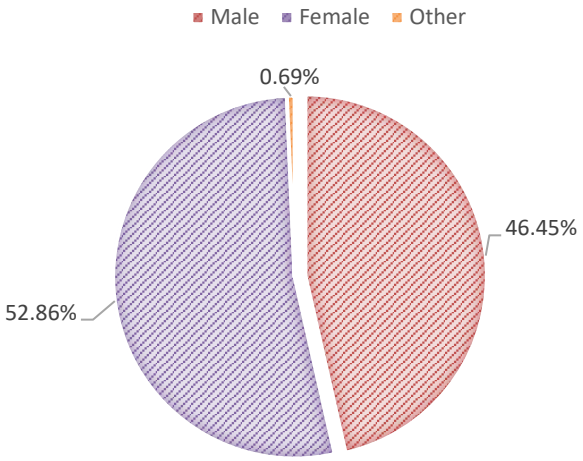


Figure 6.3: Gender profile of respondents (n = 437 respondents)

6.2.1.3 Employment status of the respondents

The employment status of respondents may influence their travel frequency and mode of transportation. The statistical analysis of this question was done according to the three categories provided to the respondents, namely full-time employment, part-time/casual employment, and unemployment. The response rate of this question was 423 respondents since 24 respondents did not answer this question. The majority of respondents (60.28%; n = 253) are employed full-time (see Figure 6.4). There is an almost equal division between part-time/casually employed (20.57%, n = 88) and unemployed respondents (19.15%, n = 79).

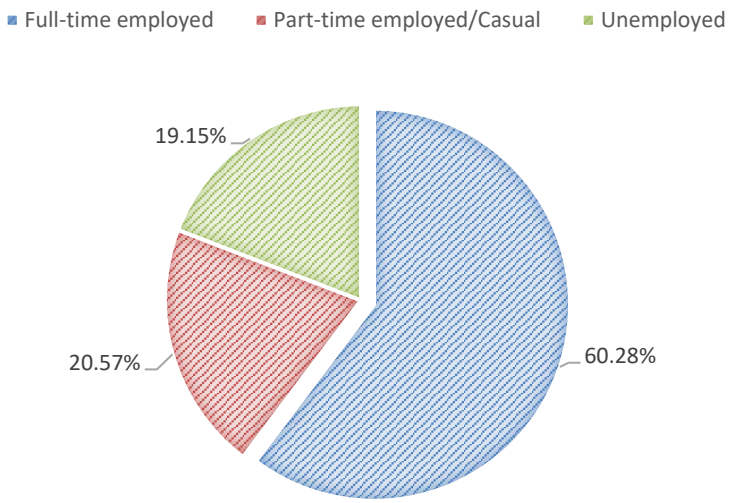


Figure 6.4: Employment status of respondents (n = 423 respondents)

6.2.1.4 Special assistance required for transportation

Special assistance is required for travellers that have special needs when commuting, including physical and/or mental disability or needs assistance when commuting (i.e. minors, elderly and new parents). Of the respondents, 33 did not complete this question (n = 33). Only 15 respondents indicated that they have special assistance needs when travelling (n = 15; 3.62%) (see Figure 6.5). Of the before-mentioned respondents, only two respondents provided details of their special needs which included the use of a wheelchair, and vision impairment.

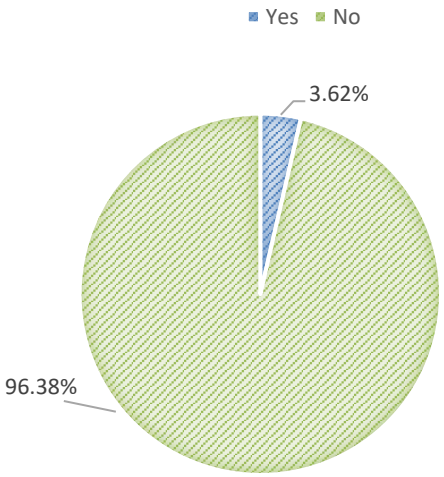


Figure 6.5: Special assistance needs of respondents (n = 414 respondents)

6.2.1.5 Summary of the demographic profile of respondents

This summary paragraph aims to identify the demographic profile of respondents in relation to age and employment status. Commuters' perception of mobility is dependent on their status of accessibility to transportation (discussed in section 7.2.1), residential and/or work area (discussed in section 7.2.1), and employment (Ciommo & Shiftan, 2017:144) (see 3.5). The employment stance of commuters is an important aspect to consider to create sustainable transportation, especially in a country such as South Africa which has more than 15 million people that are unemployed (Stats SA, 2018: online) (see 3.4.1 and 4.3.1). Gender and special assistance are not taken into account in this summary since these two parameters do not have a significant impact on the demographic profile of the population sample. Figure 6.6 and Table 6.1 provide an oversight of the demographic profile of the respondents of this study.

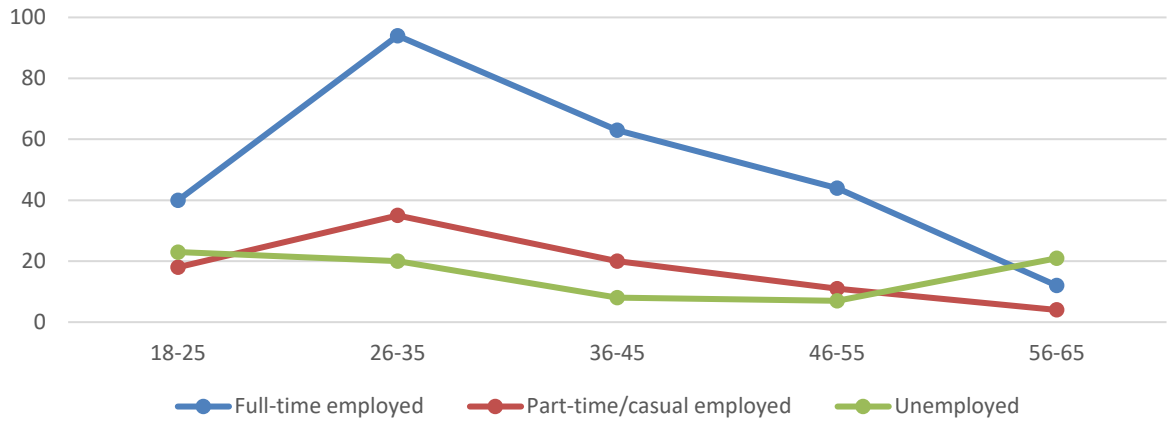


Figure 6.6: Distribution of participant age vs employment status

Table 6.1: Summary of participant age vs employment status

Age category	18-25	26-35	36-45	46-55	56-65	Total
Number of respondents	86	154	96	65	41	**442**
% of total age group of respondents	*19.46%*	*34.84%*	*21.72%*	*14.71%*	*9.28%*	
Number of full-time employed respondents	40	94	63	44	12	**253**
% of total employed respondents (n = 423)	*9.46%*	*22.22%*	*14.89%*	*10.40%*	*2.84%*	
Number of part-time/casually employed respondents	18	35	20	11	4	**88**
% of total employed respondents (n = 423)	*4.25%*	*8.27%*	*4.73%*	*2.60%*	*0.95%*	
Number of unemployed respondents	23	20	8	7	21	**79**
% of total employed respondents (n = 423)	*5.44%*	*4.73%*	*1.89%*	*1.65%*	*4.96%*	

Figure 6.6 clearly shows that the majority of the respondents were full-time employed. It is of interest to note that most of these respondents were 26 to 35 years of age (see green highlight in Table 6.1). Furthermore, the majority of people aged 46 to 65 were unemployed (4.96%) in comparison with the other age categories where more of the respondents were full-time employed.

6.2.2 Psychographic profile of respondents

The psychographic profile of respondents focusses on the travel behaviour and preferences of respondents including travel origin and destination of respondents (see 6.2.2.1), the number of daily trips/commutes and the mode of transport (see 6.2.2.2).

6.2.2.1 Travel origin and travel destination of respondents

This section discusses the findings on participants' (respondents) travel origin and destination of the respondents of this study as well as providing a comparison table to highlight the travel patterns of the respondents.

Figure 6.6 shows the residential area which was interpreted as the travel origin of the respondents. Several respondents did not provide their residential location/travel origin (n = 44; 9.84%) and were therefore excluded from the statistical pie chart in the figure below (see Figure 6.7). Therefore, the total number of respondents for this question is 405. The data was divided into four main categories according to the three distinct geographic areas of the metropolitan region, namely Bloemfontein, Botshabelo and Thaba Nchu, and Mangaung. An '*other*' response was recorded for respondents that did not provide a geographic residential location or who might work within the study area but does not reside in the study area. Botshabelo (n = 39) and Thaba Nchu (n = 22) were grouped together for the purpose of this study and includes respondents residing in Section B (n = 1), Section F (n = 1), Section H (n = 1), Section K (n = 1), and Section S (n = 2). Figure 6.7 demonstrates that the majority of respondents reside in Mangaung (51.35%; n = 208), followed by Bloemfontein (25.18%; n = 102) of which 3.36% (n = 13) of the respondents reside in the CBD of Bloemfontein. The Botshabelo and Thaba Nchu category had a total of 68 respondents (16.79%). The statistical pie chart provides evidence of a variety of respondents across the study area which promotes the trustworthiness of this study.

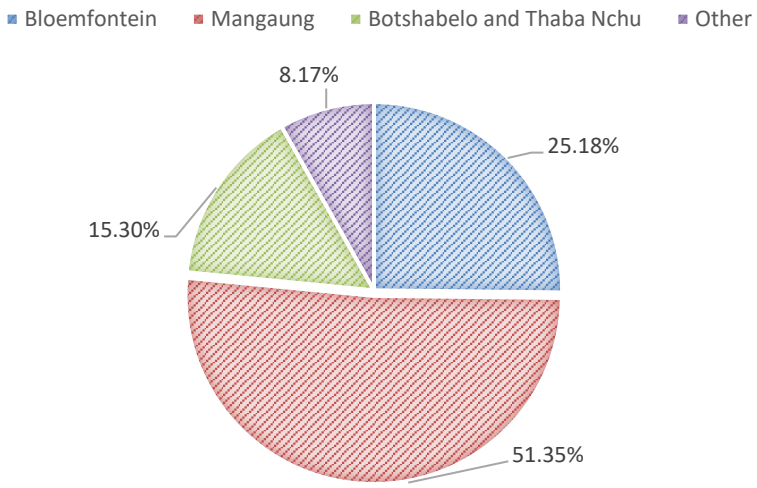


Figure 6.7: Travel origin of respondents (n = 405 respondents)

This section discusses the destination to which respondents travel from their origin location. The travel destination dataset was divided into the same categories as the residential location dataset to

promote the comparison of the datasets (see Figure 6.8). Of the respondents, 65 (n = 65) did not complete this section and were excluded from the analysis of this question. The majority of respondents (n = 174; 59.59%) travel to Bloemfontein with 12.04% (n = 46) of these respondents travelling to the CBD of Bloemfontein. Mangaung is the second-highest travel destination of respondents (n = 152; 39.79%;). It is of interest to note that very few respondents travel to the Botshabelo and Thaba Nchu category as a destination (n = 8; 2.09%).

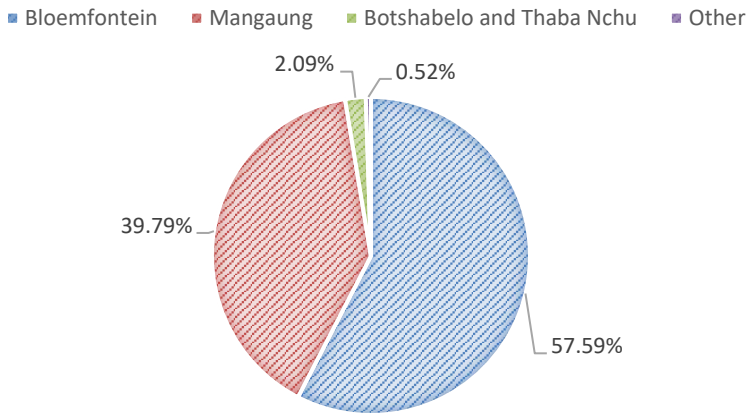


Figure 6.8: Travel destination of respondents (n =382 respondents)

Table 6.2 provides a summary of the travel origin and destination of respondents. The majority of respondents who live in Bloemfontein (thus their travel origin) travels within the city (n = 58 trips; 50.43%). Commuters travelling from Mangaung travel mostly within Mangaung (n = 109 tips; 49.32%) and thereafter to the city of Bloemfontein (n = 89 trips; 40.27%). Respondents who live in Botshabelo and Thaba Nchu also travel mostly to Bloemfontein (n = 24 trips; 55.81%). Figure 6.9 visually displays the data of Table 6.2. From Figure 6.8 it is clear that a large number of respondents commute to the city of Bloemfontein daily from various areas within the study area (see the red segment in Figure 6.8). It is only the respondents that live in the Mangaung area that have a slightly higher percentage of travel within the Mangaung area itself. The ideal Garden City model of Howard speaks to this travel pattern seeing that cities offer higher wages and more employment opportunities than the country-side (see 2.2). The DFA of South Africa, which was later replaced by SPLUMA, promotes the restriction of urban sprawl to develop denser cities and towns (cf. Du Plessis & Boonzaaier, 2015; SPLUMA, 2013:14-17) and to create employment opportunities near residential areas (see 2.5.1). However, the travel origin and destination data of the sample population indicate that employment opportunities are often in the city and this requires commuters to travel from outlying areas with various modes of transportation.

Table 6.2: Travel Origin and Destination summary

Travel Origin	Travel Destination	Trips	% of trips
Bloemfontein	Bloemfontein	58	50,43%
	Mangaung	30	26,09%
	Botshabelo & Thaba Nchu	3	2,61%
	Other	23	20,00%
	Not specified	1	0,87%
	Total trips	**115**	
Mangaung	Bloemfontein	89	40,27%
	Mangaung	109	49,32%
	Botshabelo & Thaba Nchu	1	0,45%
	Other	21	9,50%
	Not specified	1	0,45%
	Total trips	**221**	
Botshabelo & Thaba Nchu	Bloemfontein	24	55,81%
	Mangaung	14	32,56%
	Botshabelo & Thaba Nchu	4	9,30%
	Other	1	2,33%
	Not specified	0	0,00%
	Total trips	**43**	
Other	Bloemfontein	3	100%
	Mangaung	0	0%
	Botshabelo & Thaba Nchu	0	0%
	Other	0	0%
	Not specified	0	0%
	Total trips	**3**	

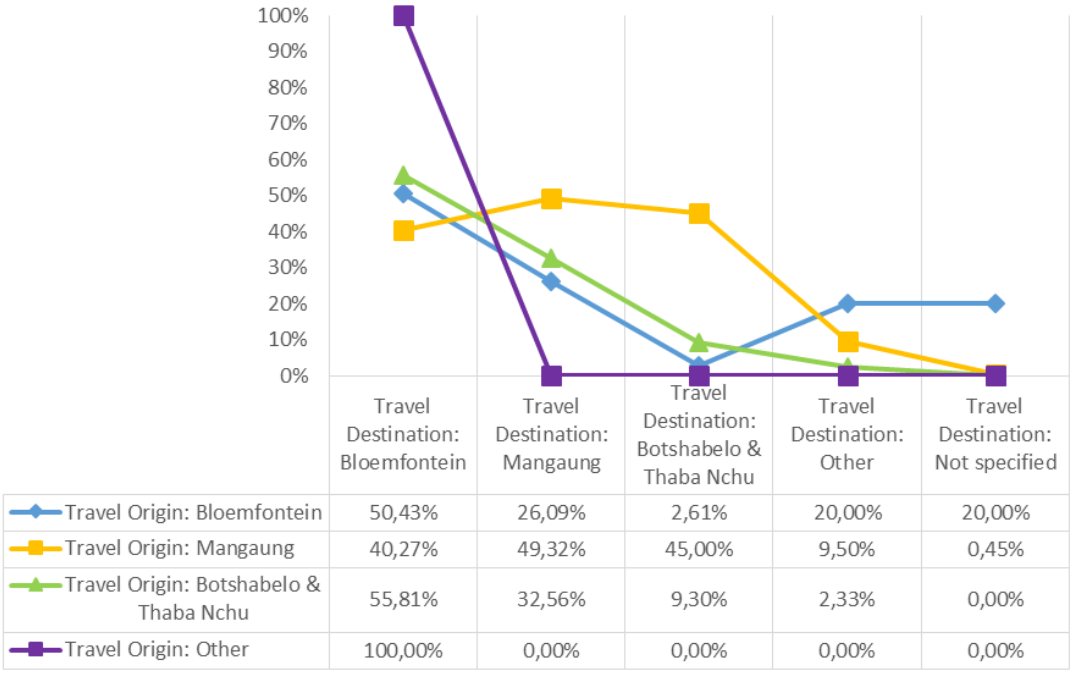


Figure 6.9: Visual representation of the travel origin and destination dataset of respondents

6.2.2.2 Mode of transportation of respondents

This section explains the variables of each mode of transportation used by respondents to inform the psychographic profile of the respondents of this study. Respondents were allowed to complete all relevant questions pertaining to their mode(s) of transportation.

The spatial planning of a city, or in the case of this study, a metropolitan, impacts the mode of transportation and mobility of its residents (see 2.4.2). Figure 6.10 supports the literature that access to a mode of transportation is a very important consideration for commuters. The majority of respondents indicated that it is either an important (n = 206; 50.12%) or very important (n = 140; 34.06%) consideration. Most respondents indicated the need for more accessible transportation routes for public transportation (see 7.2.3 in Chapter 7). Access to specific modes of transportation is discussed in section 6.2.2.2.

Public transportation like minibus taxis and buses must have accessible routes available through the city so that they be used easy and be affordable (Participant 423).

Health, good environment and easy accessible for users (Participant 377).

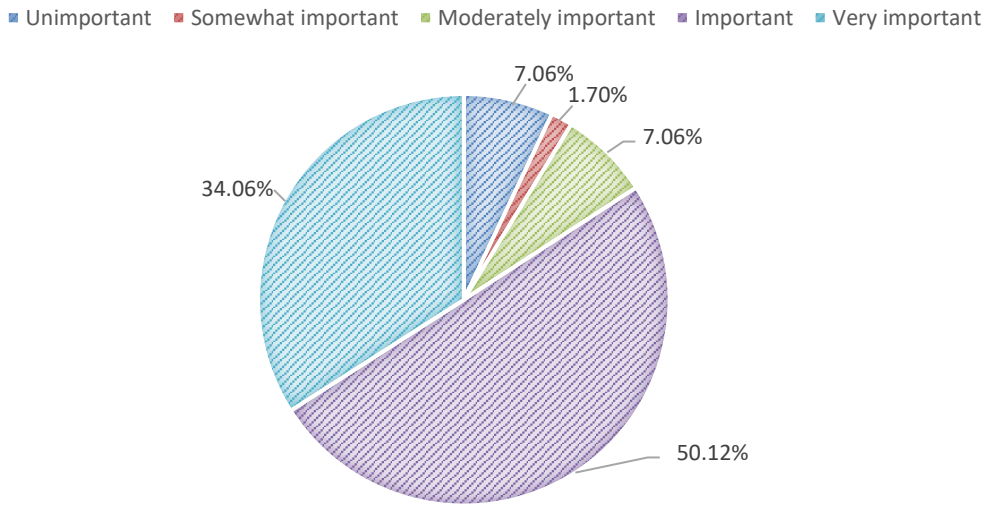


Figure 6.10: Importance of access to transportation mode (n = 411 respondents)

Respondents had to indicate, on average, how many trips or commutes they complete daily and the mode of transportation they use to complete these trips or commutes. Respondents were allowed to select more than one category on the questionnaire which resulted in a higher number of trips than respondents (n = 447 respondents). In total, an average of 1 828 daily trips or commutes are made by the respondents of this study (see Figure 6.11). The majority of respondents use minibus taxis (n =

564; 30.85%), followed by personal vehicles (n = 353; 19.31%) and cycling (n = 322; 17.61%). Figure 6.11 provides evidence once again that the selection of respondents was done with maximum variation in mind to promote the trustworthiness of this study. The following paragraphs discuss the number of trips per mode of transportation.

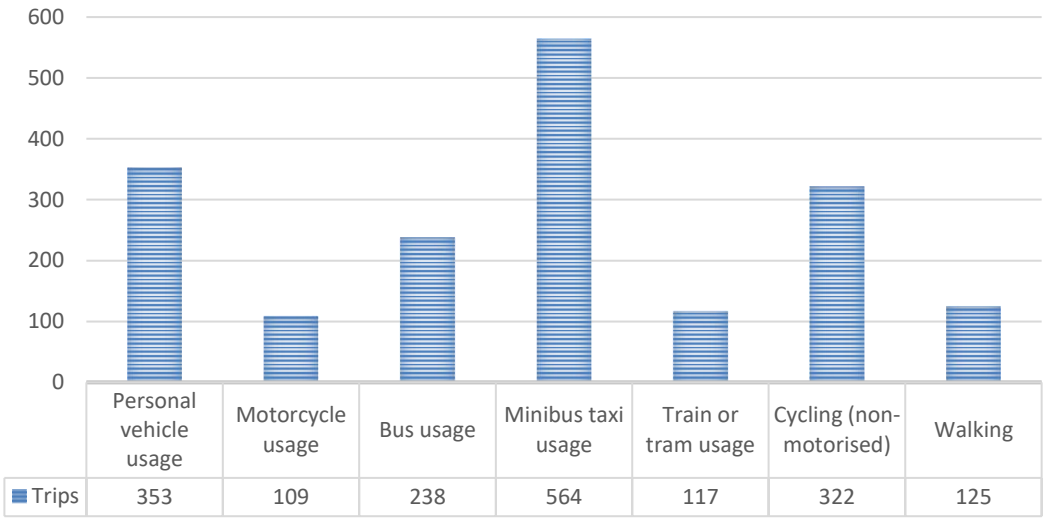


Figure 6.11: Trips per transportation mode per day (n = 1 828 trips)

6.2.2.2.1 Private Motorised Transportation

The National Traffic Information System (2019:1) reports that private motorised transportation such as motor vehicles and station wagons are the dominant mode of transportation in South Africa (see 3.5.1.1.a). For the purpose of this study, private motorised transportation includes SUVs/4x4s, private minibuses (not minibus taxis), passenger vehicles, pick-ups (LDVs), and motorcycles. Respondents who make use of their private vehicles, mostly use this transportation mode (n = 92; 72.44%) (see Figure 6.12). The majority of these respondents (n = 64; 40.00%) make use of passenger vehicles which uses petrol (n = 92; 65.25%) (see Figure 6.13).

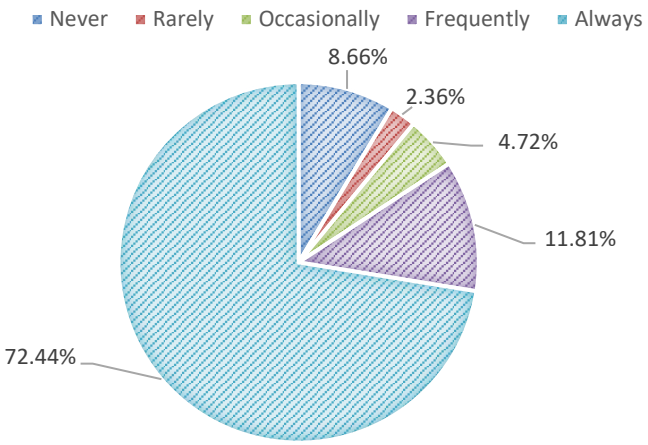


Figure 6.12: Frequency of usage of private motorised transportation (n = 127 respondents)

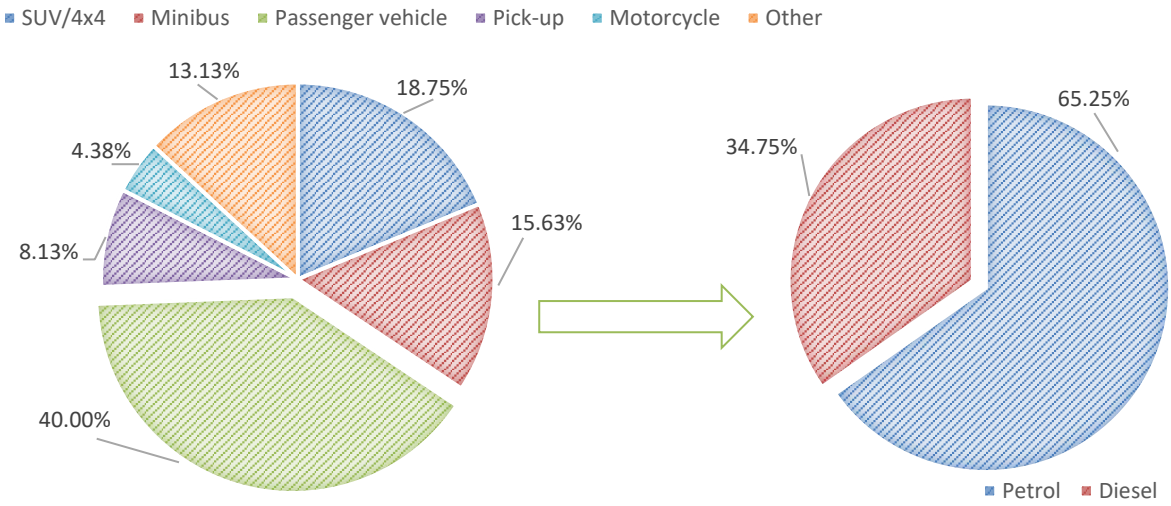


Figure 6.13: Type of personal vehicles (n = 160) and fuel type (n = 141) *(multiple options allowed)*

a) Trips/commutes made by private motorised transportation modes

The questionnaire differentiated only between private vehicles and motorcycles and not the different types of private vehicles used. Therefore, the section to follow describes the trips/commutes made by private vehicles and motorcycles.

Trips or commutes made with personal vehicles are classified as when a participant uses their own personal vehicle to complete their daily trips (mostly as a single passenger) for the purpose of this study. Personal vehicles were the second leading mode of transportation to complete respondents' daily trips (n = 353; 19.31%). Figure 6.14 indicates the different types of daily trips/commutes that respondents complete with their personal vehicles. Trips or commutes to respondents' home (n = 70; 19.83%) and their work (n = 87; 24.65%) are the two highest categories and correlates with the majority of respondents being full-time employed (see 6.2.1.3). It is curious that the *other* category

(n = 61; 17.29%) has such a high number of trips since it excludes shops, schools and leisure which was assumed to be the predominant daily activities of people.

Figure 6.14: Type of daily trips/commutes completed with personal vehicles (n = 353 trips)

Motorcycles were the lowest mode of transportation used to complete daily trips (n = 109; 5.96%) (see 6.2.2.2). Motorcycles mostly carry one participant per trip, at the most two respondents. The type of daily trips/commutes completed with motorcycles was divided into the same categories as personal vehicle usage (see Figure 6.15). The majority of motorcycle trips in the study area are made for *other* reasons (n = 49; 44.95%) apart from home, work, shops, leisure or schools. This is of interest since these commutes were assumed to be the predominant daily trips/commutes made by people.

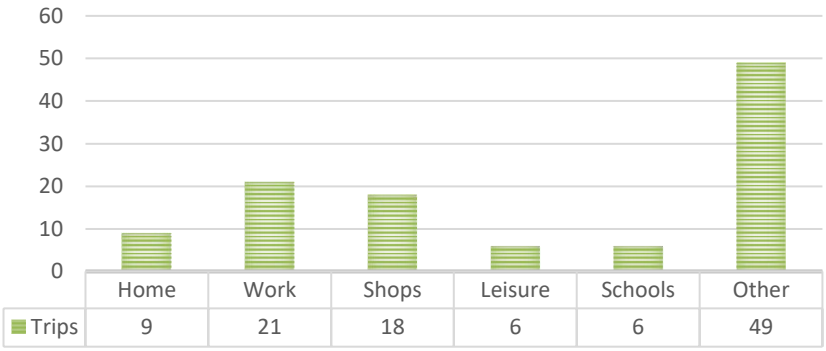


Figure 6.15: Type of daily trips/commutes completed with motorcycles (n = 109 trips)

b) Number of daily trips/commutes and number of stops

An important consideration for respondents using personal motorised transportation is travel time, travel distance (see 6.2.2.3), the number of trips they need to make daily and the ability to stop (see comment above). The freedom that private motorised transportation offers respondents may result in respondents not wanting to use public transportation from my own experience. The quotation below supports this statement.

I enjoy using my transport as it is more faster and I can stop wherever whenever I want to (Participant 201).

I don't do public transportation (Participant 19).

A stop is defined, for the purpose of this study, as a period of no movement or parking of the vehicle at any public or private place between the commuters' travel origin and destination. For example, a commuter travels daily from their residential area to their work but needs to stop at the shops to pick up milk and bread. This example accounts for one stop. Whereas, a trip is defined, for the purpose of this study, as the number of commutes made daily from travel origin to various travel destinations. For example, a commuter travels daily from their residential area to their children's school and back to their origin destination (i.e. residential home). This commuter later that day also travels from their residential area to the shops to buy clothes for the children for an upcoming party and back to their origin destination (i.e. residential home). That evening, this commuter needs to attend a parent evening at their children's school and travels once again from their travel origin to the school and back. This example accounts for three trips. Respondents (n = 150 for stops; n = 154 for trips) had to select the number of stops and trips they make daily (see Figure 6.16).

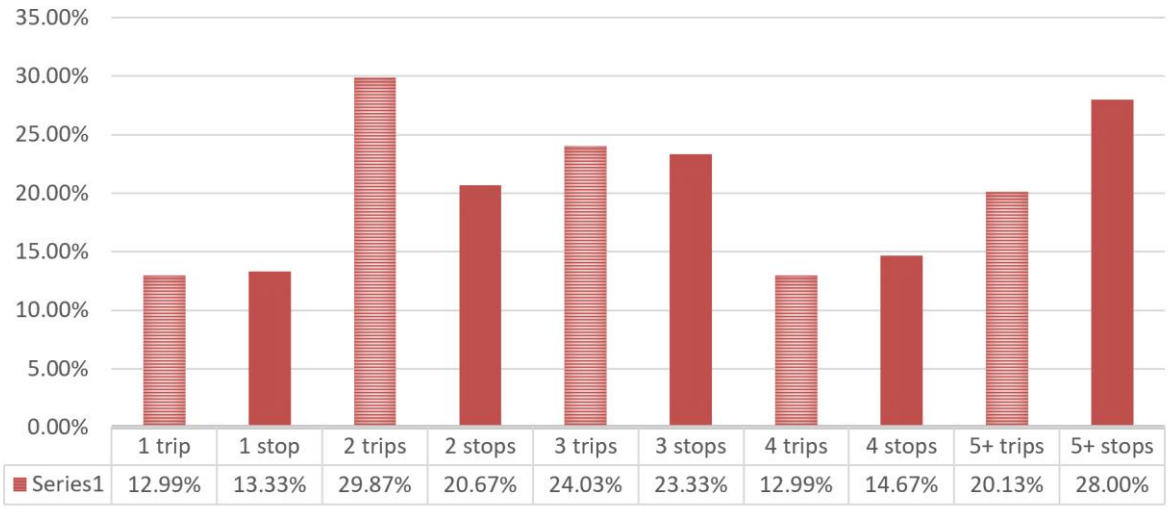


Figure 6.16: Number of stops per trip (n = 150) and daily trips made by private vehicles (n = 154)

Respondents indicated that they mostly stop either two (n = 31; 20.67%), three (n = 35; 23.33%) or more than five times (n = 42; 28.00%) within their daily commute. The number of trips respondents make daily is similar to the number of the stops, namely two (n = 46; 29.87%), three (n = 37; 24.03%) or five or more trips (n = 31; 20.13%). There does not seem to be any significant difference amongst the number of stops or trips that respondents make daily.

6.2.2.2.2 Public motorised transportation

Public transportation provides mobility to people that do not have access to personal motorised modes of transport due to various variables described in section 3.5.1.1.b. Only respondents that use public transport completed this section in the questionnaire. Similar to private motorised transportation, respondents that use public transportation mostly selected that they 'always' use this mode to commute/travel daily (n = 186; 61.59%) (see Figure 6.17). Figure 6.18 highlights which type of transportation these respondents use, but do not distinguish between fuel types as in section 6.2.2.2.1.

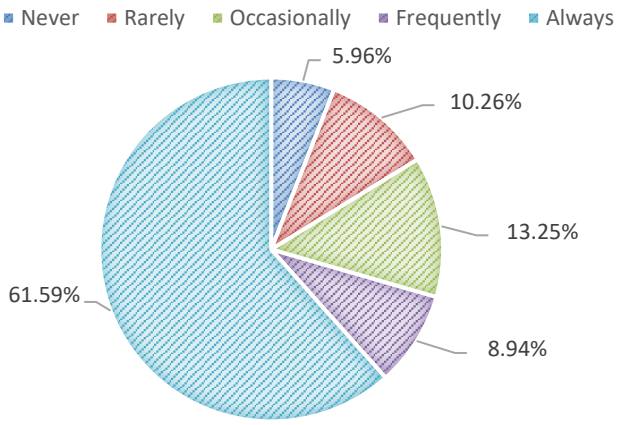


Figure 6.17: Frequency of usage of public motorised transportation (n = 302 respondents)

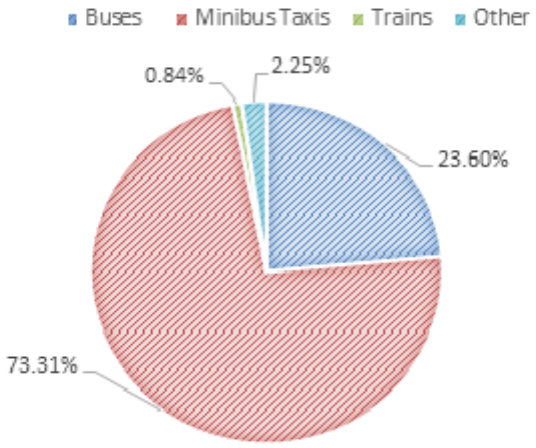


Figure 6.18: Type of public transportation used (n = 356) *(multiple options allowed)*

As seen in Figure 6.18, minibus taxis are the most popular option for public transportation with a total of 73.31% (n = 261) of the respondents using it for daily commuting/travelling. Buses are in second place with a total of 23.60% (n = 84) of public transport respondents using it. No responses were recorded for trams and therefore it was not included in the pie chart.

a) Trips/commutes made by public motorised transportation modes

Buses: Bus usage is classified as public transportation with less flexibility in their usage. This is a transport mode with fixed pick-up and drop-off points. Bus usage may be more affordable for the respondents and serves its purpose to connect people on routes all over the study area. Buses are the transportation mode that handles the most passengers at one time and serves as a mass transportation system. The majority of the respondents of this study do not use bus services to complete their daily trips/commutes (n = 238; 13.02%) (see Figure 6.19). Respondents that do use this service, once again, use this mode mostly for *other* trips/commutes (n = 72; 30.25%), followed by work (n = 62; 26.05%) and home (n = 51; 21.43%). Leisure (n = 6; 2.52%) and schools (n = 9; 3.78%) were the two lowest categories.

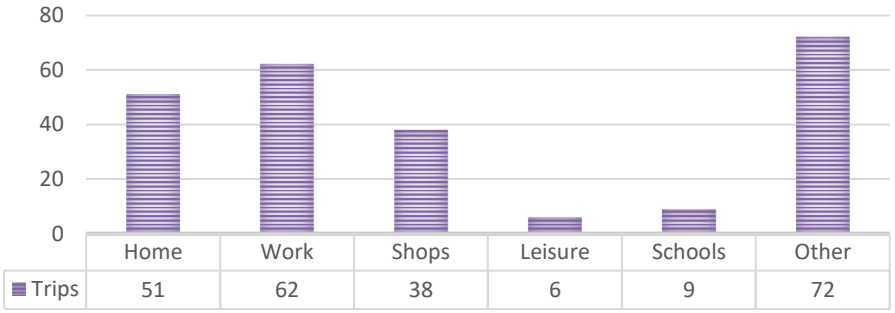


Figure 6.19: Type of daily trips/commutes completed with buses (n = 238 trips)

Minibus taxis: Minibus taxis are seen as a more flexible mode of transport than the conventional bus system with more stops on a transport route. This mode of transportation takes fewer persons than the buses and more persons than a normal sedan vehicle. Minibus taxis were the main mode of transport used for the daily trips/commutes of the respondents (n = 564; 30.85%) (see 6.2.2.2 and Figure 6.20). The three highest number of trips/commutes made by respondents were to their work (n = 153; 27.13%), shops (n = 125; 22.16%) and their homes (n = 121; 21.45%). This mode of transportation's trips/commutes are similar to the trips/commutes completed with personal vehicles (see 6.2.2.2.1) being work, home and shops as the major categories, followed by the *other* category.

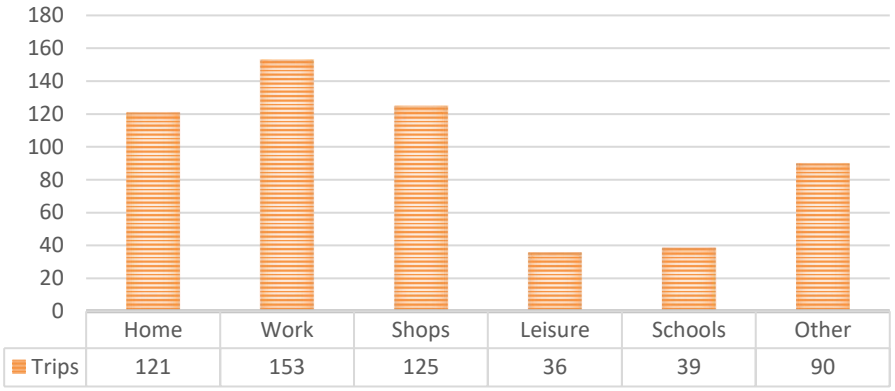


Figure 6.20: Type of daily trips/commutes completed with minibus taxis (n = 564 trips)

Trains and trams: These are modes of transport that are not popular (nor really available) within the metropolitan area. There are not many trains or trams available in the study area which therefore resulted in the low number of trips (n = 117) (see Figure 6.21). As with the other less used modes of transportation such as motorcycles and buses, the *other* category received the highest number of trips/commutes by respondents in the study area (n = 53; 45.31%). Shops are the second highest category (n = 22; 18.81%) but is significantly less than the *other* category.

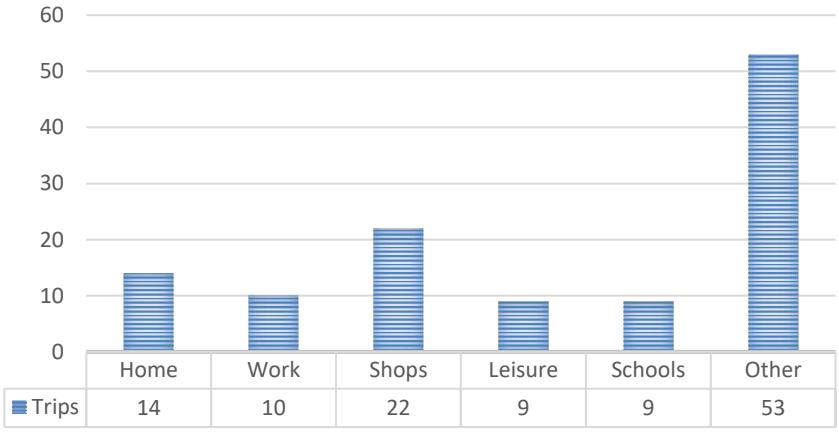


Figure 6.21: Type of daily trips/commutes completed with train and tram usage (n = 117 trips)

b) Number of daily trips/commutes and number of stops

Respondents were asked to indicate on which days of the week and the time of day they travel and the number of stops and trips they make daily in order to establish a public transportation travel pattern. The respondents that make use of private motorised transportation did not have to indicate the days of the week and the time of day since their mode of transportation allows them the flexibility to travel whenever they want to. The travel pattern behaviour is important to this study since it supports the second and third objectives of this study. Figure 6.22 illustrates the days of the week and

time of day that respondents travel within the study area. There is no significant variance between the days of the week that respondents travel; however, there is a slight decrease on Tuesdays (n = 236 responses; 16.79%), Thursdays (n = 222 responses; 15.79%) and over weekends (n = 203 responses; 14.44%). A significant difference can be observed between respondents travelling in the morning, especially during 06:30 to 08:30 (n = 149; 29.86%) and the remainder of the day. It seems that most respondents travel in the morning to the destination and return to their travel origin throughout the day. There is quite a large difference between the morning peak and the time period directly after it (i.e. 09:00 - 15:00) (n = 56; 11.22%). The red circles in Figure 6.22 indicate this difference.

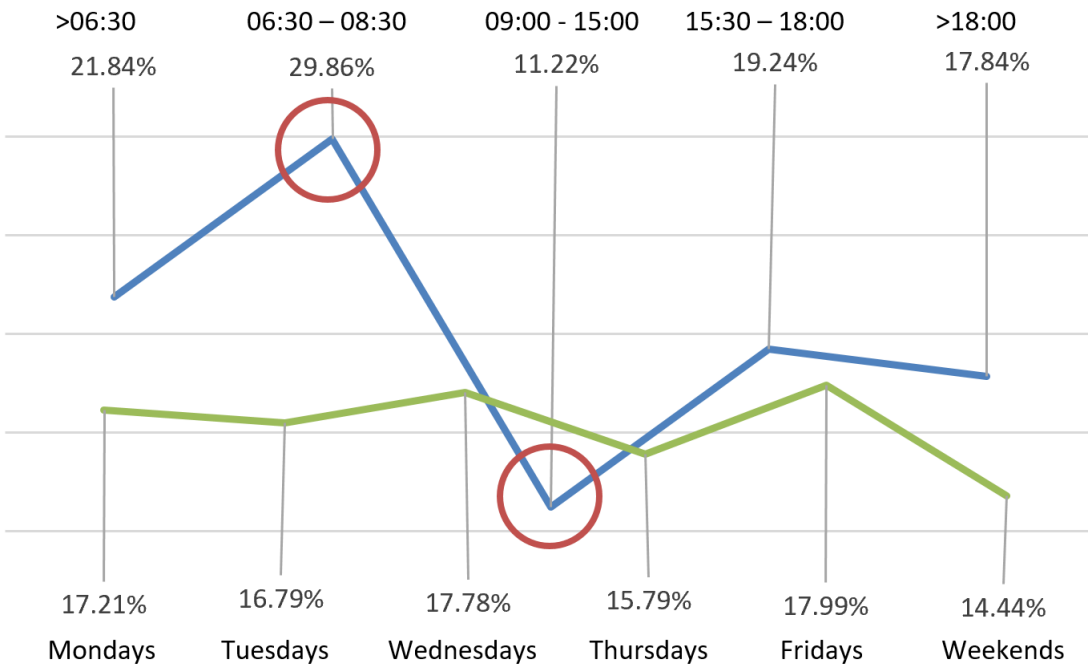


Figure 6.22: Days of the week (n = 1 406 responses) and time of day (n = 499 responses) that respondents travel within the study area

Daily trips and number of stops during a trip are defined similarly to the definition provided in section 6.2.2.2. Figure 6.23 provides a comparison of the number of trips and stops of respondents using public transportation. Most of the respondents (n = 122; 37.31%) make two trips daily, followed by four trips per day (n = 88; 26.91%). There is a significant variation in the number of stops that people using public transportation make. Almost half of the respondents make five or more stops per trip (n = 157; 48.31%). A possible reason for this variation can be attributed to respondents taking into account the occurrences when they need to connect to another public transportation route. For example, buses travel from west residential areas to the CBD, where commuters then need to connect to another bus that travels from the CBD to eastern residential areas.

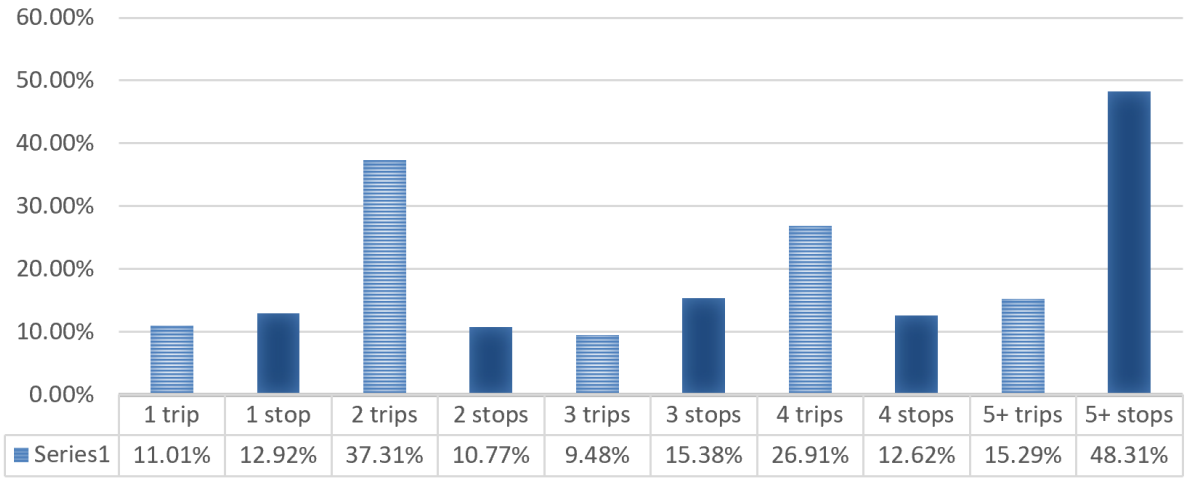


Figure 6.23: Number of stops per trip (n = 325) and daily trips made by respondents using public transportation (n = 372)

6.2.2.2.3 Non-motorised transportation

Non-motorised transportation includes walking and cycling (see 3.5.1.2). Non-motorised transportation offers the South African population with an accessible and cheap means of transportation, but it is often regarded as unsafe (see 3.5.1.2). Figure 6.24 highlights the frequency in which respondents use this mode of transportation, and Figure 6.25 shows the type of non-motorised transportation.

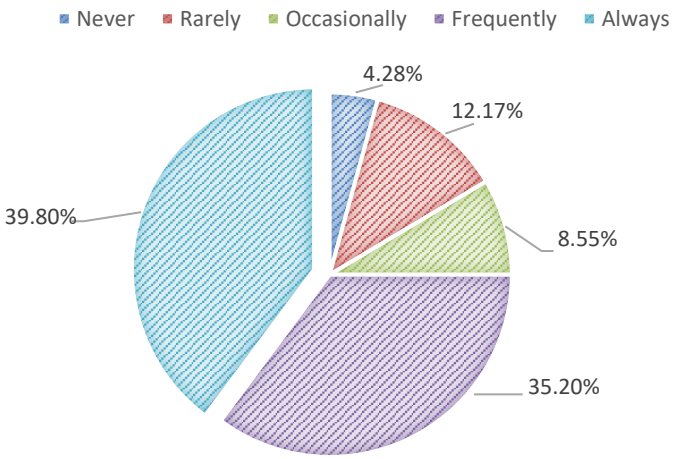


Figure 6.24: Frequency of usage of public motorised transportation (n = 304 respondents)

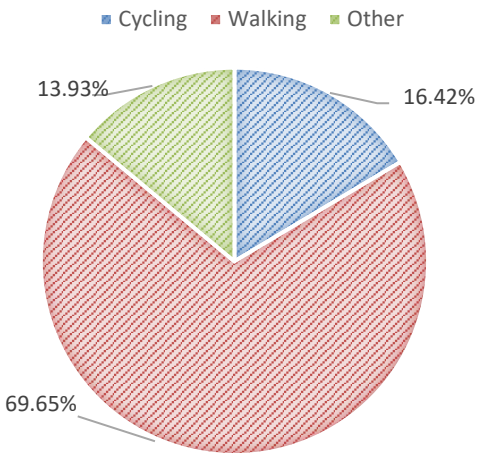


Figure 6.25: Type of non-motorised transportation used (n = 402 responses) *(multiple options allowed)*

The majority of respondents frequently (n = 107; 35.20%) or always (n = 121; 39.80%) use this mode of transportation (see Figure 6.24). More than two-thirds of the respondents (n = 280; 69.65%) walk to their travel destination (see Figure 6.25). A number of 56 respondents (n = 13.93%) indicated *other*, which is slightly lower than the cycling category (n = 66; 16.42%). Other non-motorised means of transportation can include rowing, skateboarding, rollerblading and so forth.

a) Trips/commutes made by non-motorised transportation modes

Cycle usage is a non-motorised transport mode. A single person uses a bicycle to travel to their desired location. Figure 6.26 illustrates the different trip locations for respondents using cycles. Cycles predominantly carry only one participant, and in extreme (and often unsafe) situations, two respondents. Cycles are the second highest non-motorised mode of transportation recorded in this study (n = 322 trips; 17.61%). Shops are the most popular location for people with cycles to travel to with a total of 101 trips (31.37%), followed by work trips/commutes (n = 80; 24.84%). Only a small percentage of cycle trips/commutes are made for leisure (n = 8; 2.48%).

Figure 6.26: Type of daily trips/commutes completed with cycles (n = 322 trips)

Walking is a healthy non-motorised transportation mode for respondents which is promoted in the dominant spatial planning themes of this century (see 2.3.1). Walking is not a popular mode of transportation (n = 125 trips; 6.84%) and is in the low category of modes used to complete daily trips/commutes together with trains and trams (n = 117; 6.40%), and motorcycles (n = 109; 5.96%). More than half of the total number of trips/commutes made by walking are to *other* destinations (n = 73; 58.40%) than work, home, shops, leisure or schools, similar to the motorcycle (see 6.2.2.2.1) and train and tram (see 6.2.2.2.2) categories (see Figure 6.27).

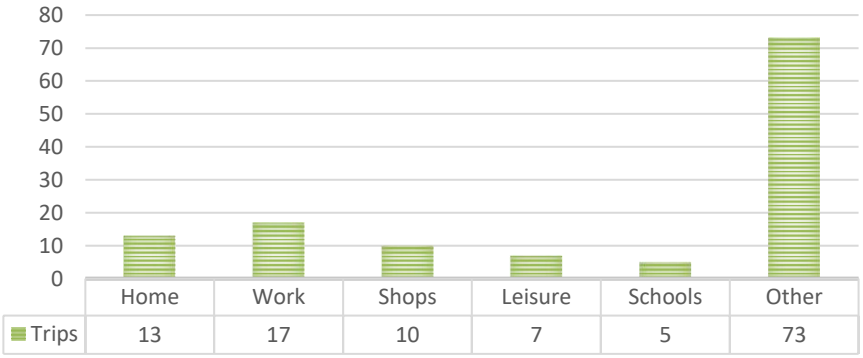


Figure 6.27: Type of daily trips/commutes completed by walking (n = 125 trips)

b) Number of daily trips/commutes and number of stops

Daily trips and number of stops during a trip are defined similarly to the definition provided in section 6.2.2.2.1. Figure 6.28 provides a comparison of the number of trips and stops of respondents using non-motorised transportation. Figure 6.16 clearly shows that the majority (n = 143; 43,47%;) of respondents do two trips per day with the second most (n = 66; 20.06%) completing five or more trips daily. Similar to public transportation, most respondents that use non-motorised means of transportation make five or more stops per trip (n = 113; 34.35%).

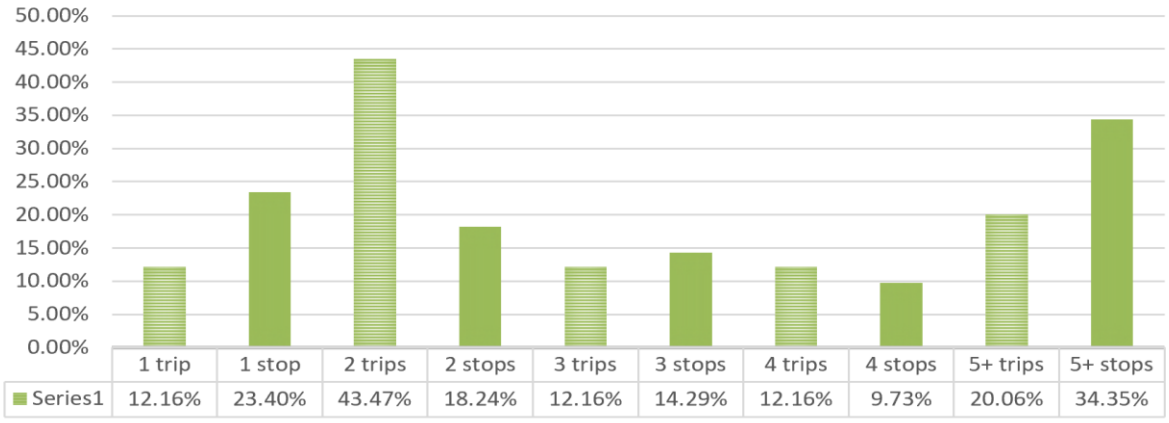


Figure 6.28: Number of stops per trip (n = 329) and daily trips made by respondents using non-motorised transport (n = 329)

6.2.2.2.4 Summary of the mode of transportation of respondents

a) Trips/commutes comparison summary of all the modes of transportation

The number and mode of daily trips/commutes of respondents have been discussed in detail in the previous sections. The aim of this section is to provide an overview of how the different modes of transportation compared with each other. Figure 6.29 and Table 6.3 provide a comparison of the number and mode of daily trips/commutes of the respondents of this study for the 447 respondents of this question (n = 1 828 trips).

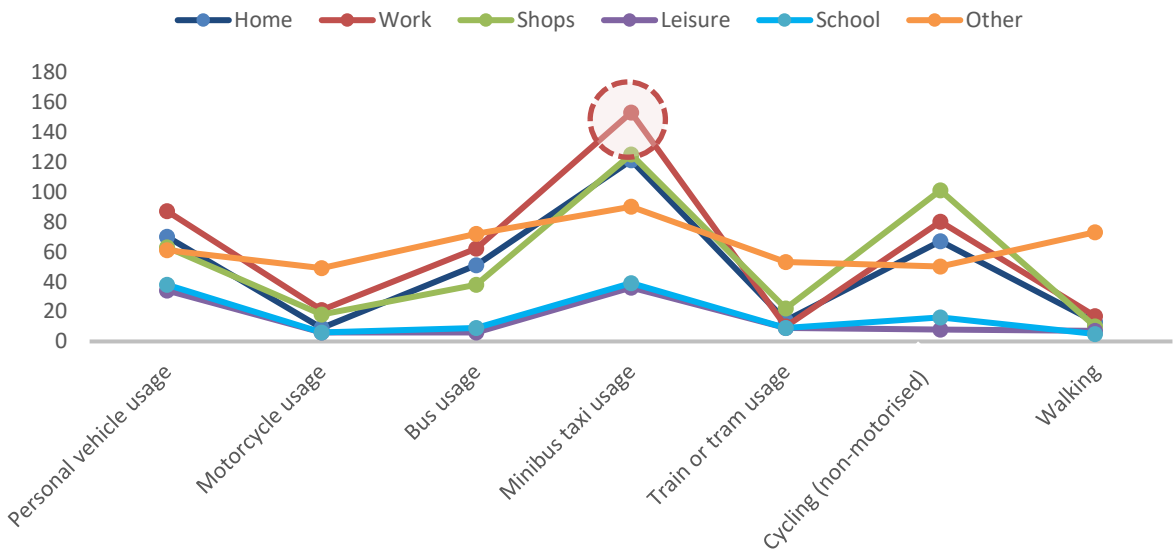


Figure 6.29: Trip comparison between the different modes (n = 1 828 trips)

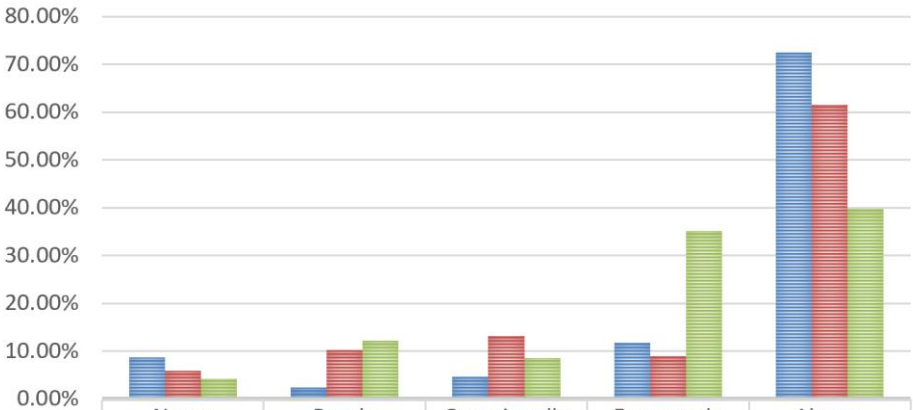
Table 6.3: Comparison table of number and mode of daily trips/commutes of respondents

Destination	Home	Work	Shops	Leisure	School	Other	TOTAL
Number of trips/commutes with personal vehicles	70	87	63	34	38	61	**353**
%	19,83%	24,65%	17,85%	9,63%	10,76%	17,28%	19,31%
Number of trips/commutes with motorcycles	9	21	18	6	6	49	**109**
%	8,26%	19,27%	16,51%	5,50%	5,50%	44,95%	5,96%
Number of trips/commutes with buses	51	62	38	6	9	72	**238**
%	21,43%	26,05%	15,97%	2,52%	3,78%	30,25%	13,02%
Number of trips/commutes with minibus taxis	121	153	125	36	39	90	**564**
%	21,45%	27,13%	22,16%	6,38%	6,91%	15,96%	30,85%
Number of trips/commutes with trains and/or trams	14	10	22	9	9	53	**117**
%	11,97%	8,55%	18,80%	7,69%	7,69%	45,30%	6,40%
Number of trips/commutes with cycles (non-motorised)	67	80	101	8	16	50	**322**
%	20,81%	24,84%	31,37%	2,48%	4,97%	15,53%	17,61%
Number of trips/commutes made by walking	13	17	10	7	5	73	**125**
%	10,40%	13,60%	8,00%	5,60%	4,00%	58,40%	6,84%
TOTAL	**345**	**430**	**377**	**106**	**122**	**448**	**1828**
% of total trips/commutes to destination	**18.87%**	**23.52%**	**20.62%**	**5.79%**	**6.68%**	**24.52%**	**100%**

When the data is interpreted, it is evident that almost a third of all trips/commutes (n = 1 828 total trips) are made by minibus taxis (n = 564; 30.85%) of which the majority is to the respondents' work destination (n = 153) (see red highlight in Table 6.3). During the data analysis of the different transportation modes in section 6.2.2.2.1 to 6.2.2.2.3, it became evident that the *other* destination category received many responses. From Table 6.3 it is evident that almost a quarter of all trips/commutes of respondents are made to *other* destinations apart from their home, work, shops, schools or for leisure activities (n = 448; 24.52%) (see red highlight in Table 6.3). This is interesting to note since the listed destinations were thought to be the dominant places that people visit daily, and the *other* category was included to combine less-dominant destinations such as visiting a medical practitioner, religious gathering or a fuel station. One possible reason for this finding can be that the categories were interpreted differently by various respondents which could have been avoided by including clearer descriptions of each category. The other notable finding is that there is a high number of respondents using bicycles as their primary mode of transportation (n = 322; 17.61%) which is only slightly lower than respondents using personal vehicles or buses.

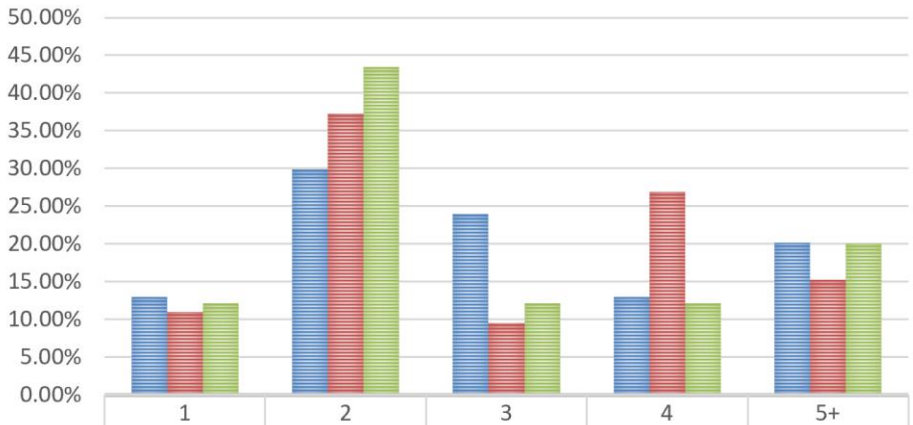
b) Summary of the mode of transportation that respondents use

The main psychographic profile discussed in this section was the frequency of usage of a specific mode of transportation, the type of transportation used within this mode, the number of trips made daily using a specific mode of transportation, and the number of stops made per trip. Figures 6.30 to 6.32 provide a visual comparison between the frequency (see Figure 6.30), daily trips (see Figure 6.31) and the number of stops (see Figure 6.32) of each mode of transportation.



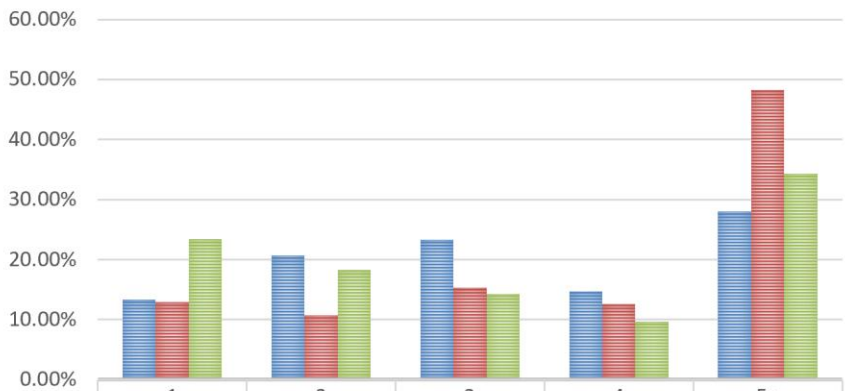
	Never	Rarely	Occasionally	Frequently	Always
Private Motorised Transportation	8.66%	2.36%	4.72%	11.81%	72.44%
Public Motorised Transportation	5.96%	10.26%	13.25%	8.94%	61.59%
Non-Motorised Transporation	4.28%	12.17%	8.55%	35.20%	39.80%

Figure 6.30: Comparison of the frequency of usage of the various modes of transportation



	1	2	3	4	5+
Private Motorised Transportation	12.99%	29.87%	24.03%	12.99%	20.13%
Public Motorised Transportation	11.01%	37.31%	9.48%	26.91%	15.29%
Non-Motorised Transporation	12.16%	43.47%	12.16%	12.16%	20.06%

Figure 6.31: Comparison of the number of daily trips made by respondents using the various modes of transportation



	1	2	3	4	5+
Private Motorised Transportation	13.33%	20.67%	23.33%	14.67%	28.00%
Public Motorised Transportation	12.92%	10.77%	15.38%	12.62%	48.31%
Non-Motorised Transporation	23.40%	18.24%	14.29%	9.73%	34.35%

Figure 6.32: Comparison of the number of stops per trip made by respondents using the various modes of transportation

Commuters who use private and public motorised transportation, almost always use this mode of transportation when travelling (72.44% and 61.59% respectively). Whereas, commuters using non-motorised transportation identified that they frequently (35.20%) or always (39.80%) use this mode of transportation. Figure 6.30 shows that most respondents make two daily trips, no matter what mode of transportation they use. Significant variations are observed in the transportation modes used to make three and four trips daily. Private motorised transportation makes significantly more use of three daily trips (24.03% compared with 9.48% for public transportation and 12.16% for non-motorised transportation); whereas public motorised transportation makes significantly more use of four daily trips than the other modes of transportation discussed in this section (26.91% compared to 12.99% for private motorised transportation and 12.16% for non-motorised transportation). The majority of all modes of transportation make five or more stops per trip (see Figure 6.32). Respondents using public transportation have a significantly higher percentage of five or more stops (48.31% compared with 28% for private motorised transportation and 34.35% for non-motorised transportation).

6.2.2.3 Distance and time considerations of respondents

Apart from access, the distance and time that respondents travel daily have a particular influence on their selection of mode of transportation (see sections 2.4.2; 2.5.1; 3.5.1; 4.3.3). Figure 6.33 confirms that distance is regarded by the sample population group as either an important (n = 172; 41.65%) or very important (n = 175; 43.37%) consideration when selecting a mode of transportation in the study area. Limited access to a mode of transportation often results in respondents having to use other, more time consuming transportation modes such as walking (see comment below).

Yes! Sometimes I walk a long distance and it gets tiring because there are no taxis moving around to help those who are walking (Participant 133).

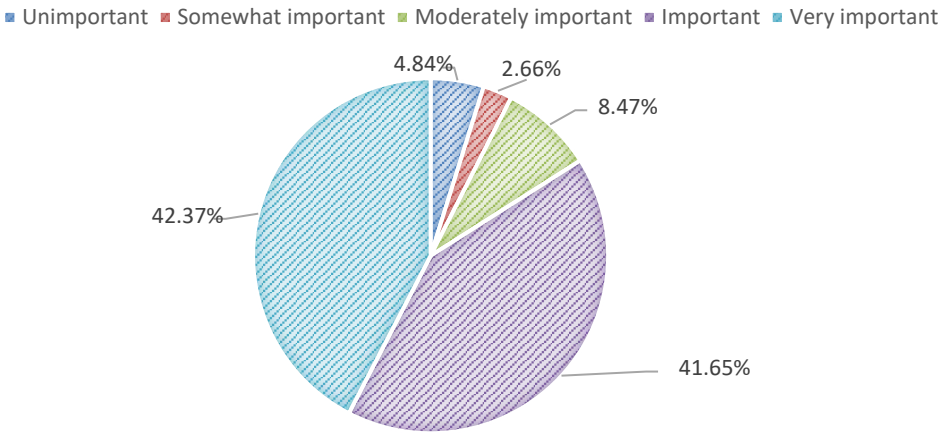


Figure 6.33: Importance of travel distance (n = 413 respondents)

Figure 6.34 visually represents the average distance travelled by respondents daily from their origin destination (residential area) to their work, shops, schools, industrial/manufacturers/wholesalers, etc. Only 8.66% (n = 38) of the respondents travel more than 50 km per day. Taking the study area into consideration, these are most likely the commuters travelling from Botshabelo and Thaba Nchu to areas within Bloemfontein. Only 7.29% (n = 32) of the respondents travel between 41 km to 50 km per day, which indicates that 15.95% (n = 70) of respondents travel more than 40 km per day. The majority of the respondents travel less than 30 km per day (n = 350; 79.73%). There is a wide distribution of average daily travel distances amongst the distance categories, which supports a sample with maximum variation.

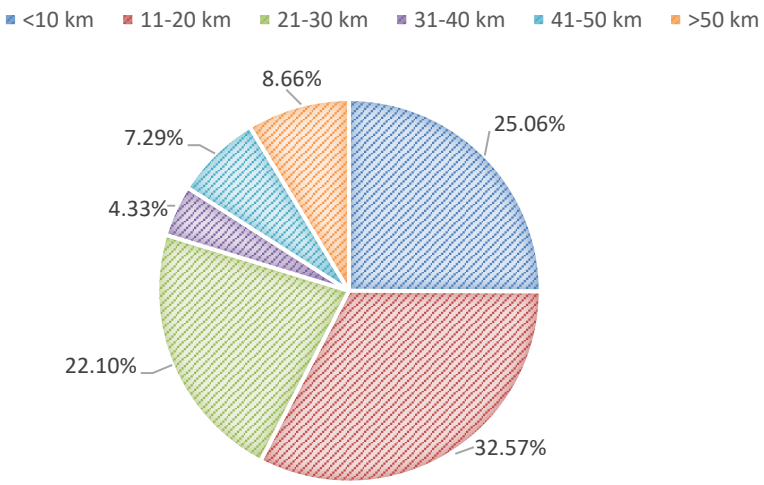


Figure 6.34: Average distance travelled by respondents daily (n = 439 respondents)

South African households spend approximately 30% (or even more) of their income, energy and time on transportation (RSA NDP, 2012:233). According to the National Household Travel Survey (NHTS), travel time is outlined as the most important factor that influences the mode of transport a household selects (Stats SA, 2013a: online; Stats SA, 2013b:7). These findings are supported by the respondents of this study that indicated that travel time is either an important (n = 227; 55.10%) or very important (n = 125; 30.34%) consideration when selecting their mode of transportation (see Figure 6.35). Some qualitative responses also highlighted this need (see comments below).

Our minibus driver need to respect our time (Participant 330).

Public transportation should always be on time on the travel routes so that users of public transportation don't become late on their jobs and home (Participant 381).

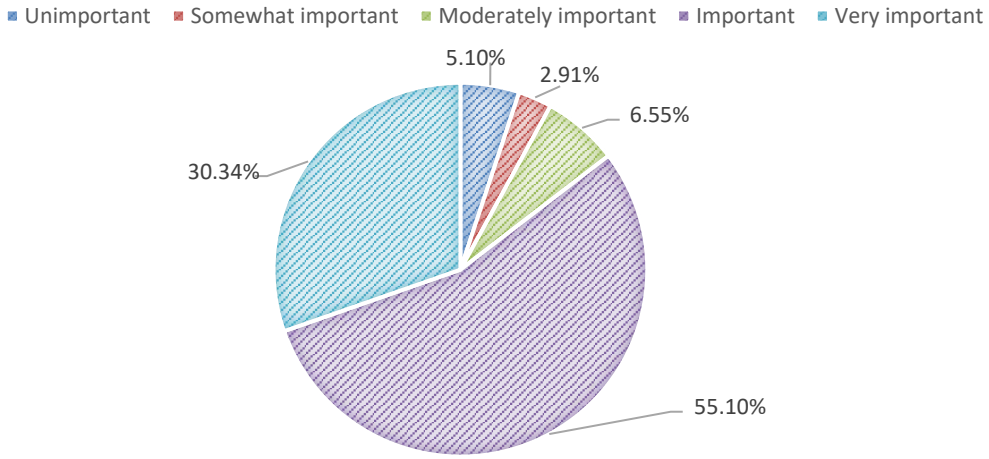


Figure 6.35: Importance of travel time of respondents (n = 412 respondents)

As seen in the Figure 6.36, the majority of respondents travel between 11 to 30 minutes daily (n = 169; 39.12%), followed by another group of respondents that travel between 31 to 45 minutes (n = 104; 24.07%) which accounts for 63.19% of the sample population. This finding highlights why travel time is such an important factor for the respondents when selecting a mode of transportation.

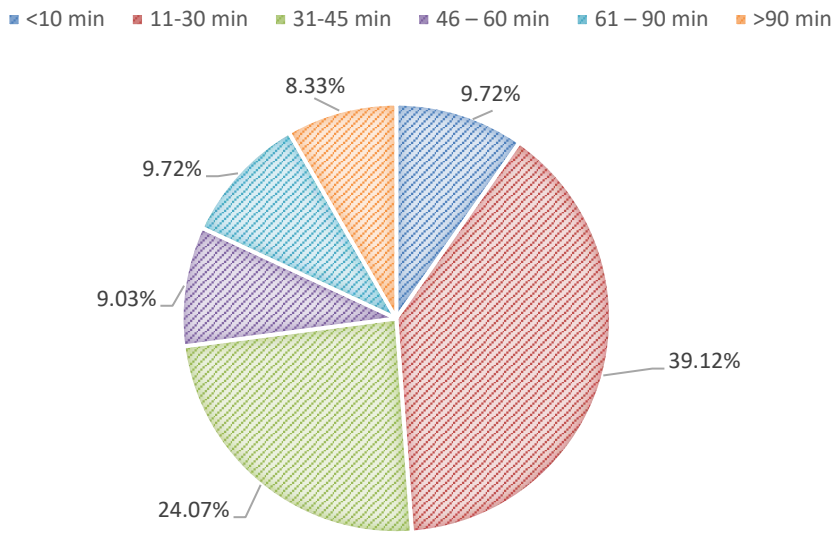


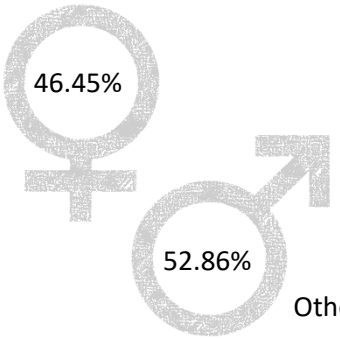
Figure 6.36: Average time spent travelling daily (n = 432 respondents)

6.3 SUMMARY OF DEMOGRAPHIC AND PSYCHOGRAPHIC PROFILE OF RESPONDENTS

A summary of the demographic and psychographic profile of respondents are visually represented in the figure below (see Figure 6.37). This chapter identified the transportation needs of the population of the study area (objective 2) and identified transportation-specific parameters of the current public transportation system of the study area (objective 3).

Demographic profile of respondents

Age and Employment Profile	18-25	26-35	36-45	46-55	56-65
% of total age group of respondents	*19.46%*	*34.84%*	*21.72%*	*14.71%*	*9.28%*
% of total employed respondents	*9.46%*	*22.22%*	*14.89%*	*10.40%*	*2.84%*
% of total employed respondents	*4.25%*	*8.27%*	*4.73%*	*2.60%*	*0.95%*
% of total employed respondents	*5.44%*	*4.73%*	*1.89%*	*1.65%*	*4.96%*



Other = 0.69%

Psychographic profile of respondents

% of daily trips/commutes made with various modes of transportation

Modes of transportation	Personal vehicles	Motor-cycles	Buses	Minibus taxis	Trains/ trams	Cycles	Walking
% of daily trips/commutes	19.31%	5.96%	13.03%	30.85%	6.41%	17.61%	6.83%

Travel Origin

Mangaung = 51.35%
Bloemfontein = 25.18%
Botshabelo and Thaba Nchu = 15.30%
Other = 8.17%

Travel Destination

Bloemfontein = 57.59%
Mangaung = 39.79%
Botshabelo and Thaba Nchu = 2.09%
Other = 0.52%

Average time spent travelling daily

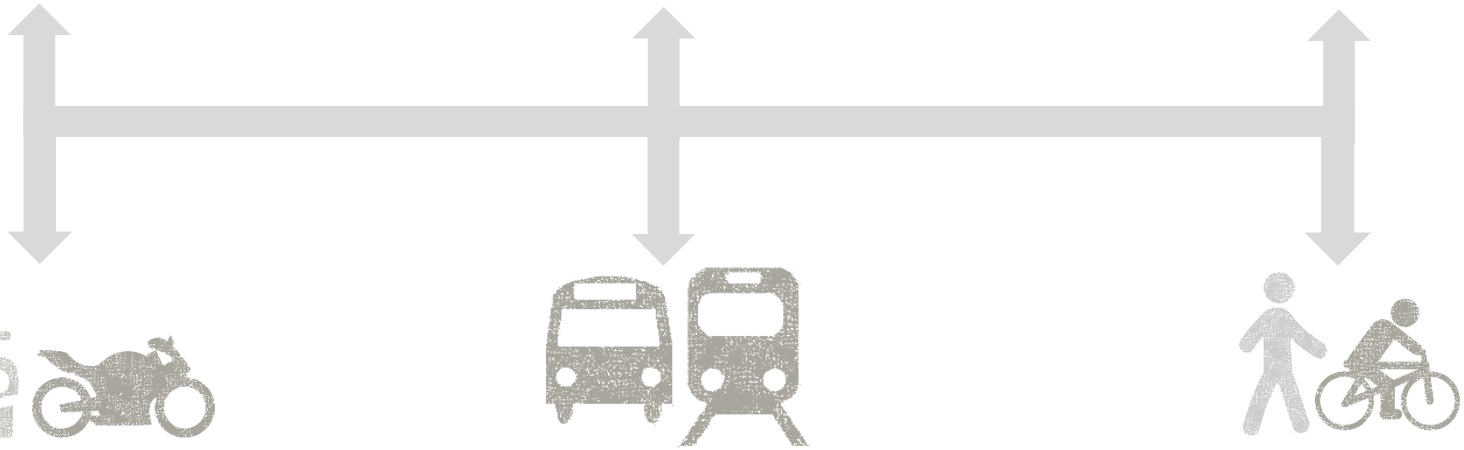
<10 min	11-30 min	31-45 min	46-60 min	61-90 min	>90 min
9.72%	39.12%	24.07%	9.03%	9.72%	8.33%

Average distance travelled by participants daily

<10 km	11-20 km	21-30 km	31-40 km	41-50 km	>50 km
25.06%	32.57%	22.10%	4.33%	7.29%	8.66%

Destination to which participants travel daily

Destination	Home	Work	Shops	Leisure	School	Other
% of total trips/commutes	18.87%	23.52%	20.62%	5.79%	6.68%	24.52%



	Private Motorised Transportation Private motor vehicles and motorcycles	**Public Motorised Transportation** Buses, minibus taxis, trains and trams	**Non-Motorised Transportation** Walking, cycling, and other
	COMMUTES: Private vehicle = 353 Motorcycle = 109	**COMMUTES:** Buses = 238 Minibus taxis = 564 Trains and Trams = 117	**COMMUTES:** Cycling = 322 Walking = 125
	USAGE: 72.44% of participants who use this mode always use it.	**USAGE:** 61.59% of participants who use this mode always use it.	**USAGE:** 39.80% of participants who use this mode always use it, and 35.20% use this mode frequently.
	TRIPS: More than half of the participants (53.90%) make between 2 to 3 trips daily.	**TRIPS:** Majority of the participants (37.31%) make 2 trips daily or 4 trips (26.91%).	**TRIPS:** Majority of the participants (43.47%) make 2 trips daily.
	STOPS: Most participants make five or more stops per trip (28.00%).	**STOPS:** Most participants make five or more stops per trip (48.31%).	**STOPS:** Most participants make five or more stops per trip (34.35%).

Figure 6.37: Visual summary of the demographic and psychographic profile of the respondents of this study

CHAPTER 7

SUSTAINABLE TRANSPORTATION NEEDS OF RESPONDENTS

7

7.1 INTRODUCTION

This chapter explores the statistical analysis of the dataset more in-depth, identifies the public transportation needs and provides guidelines for a sustainable transportation system. This chapter contributes to the findings of the conclusions drawn in Chapter 8. Figure 7.1 provides an outline of this chapter.

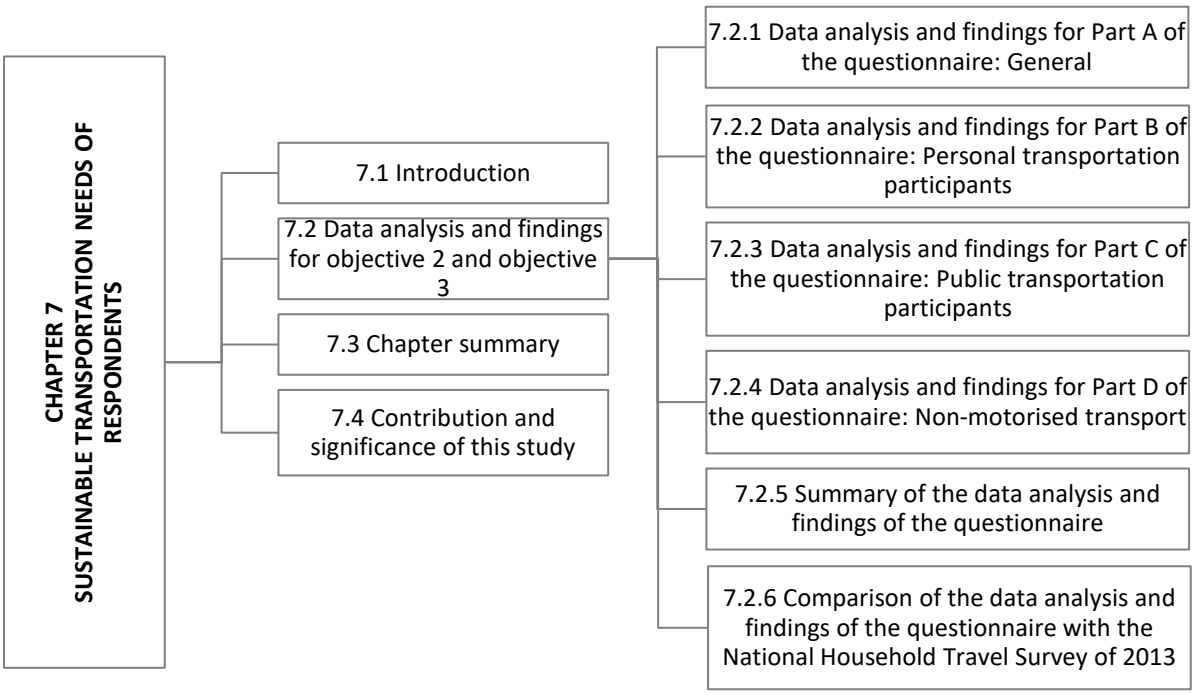


Figure 7.1: Outline of Chapter 7: Sustainable transportation needs of respondents

7.2 DATA ANALYSIS AND FINDINGS FOR OBJECTIVE 2 AND OBJECTIVE 3

This is a continuation from Chapter 6 and addresses objectives 2 and 3 of this study. Statistical analysis was undertaken to investigate the transportation needs of the population of the study area (i.e. objective 2) and to identify spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area (i.e. objective 3).

The total response rate of this study was 447 respondents. The data collection tool was divided into four parts, namely Part A which was filled in by all the respondents (n = 447) (reported on in section 7.2.1); Part B relates to personal vehicle usage (n = 154) (reported on in section 7.2.2); Part C relates to public transportation users (n = 330) (reported on in section 7.2.3), and Part D non-motorised transportation users (n = 331) (reported on in section 7.2.4). Respondents could complete all relevant parts of the questionnaire.

The analysis of each of these sections relates to the information provided in Table 7.1. This table is an extension of the table drafted in Chapter 4 (see 4.5) which summarises the economic, environmental, spatial and social considerations of this study, the correlated questions in the data collection tool, and the literature chapters from which these considerations were derived. The sections to follow in this chapter interpret and discuss each part of the data collection tool's quantitative and qualitative data. In some instances, the qualitative codes were assigned a positive (+) or negative (-) value to aid in the interpretation.

Table 7.1: Key economic, environmental, spatial and social considerations of this study

Key considerations arising from the literature	Questions	Chapter 2 Spatial Planning	Chapter 3 Transportation	Chapter 4 Sustainable Development
Economic considerations				
The affordability of transportation mode(s)	12.15; 13.2; 26.5	x	x	x
Environmental considerations				
Environmental friendliness of transportation mode(s)	12.16; 15.7; 23.4; 26.4	x	x	x
Impact of the weather	12.5	x		x
Spatial considerations				
Commuters' origin and destination land usages	6.1 - 6.4; 8.1 - 8.4	x		
Distance to and from access point to transportation mode(s)	6.5; 8.5	x	x	
Travel distance	10; 12.1; 23.7	x	x	
Travel time (duration) due to distance and congestion	11; 12.2; 12.3; 13.5	x	x	x
Pedestrian and cycling friendliness of the spatial form	6.2; 8.2; 15.9	x	x	x
The number of stops between origin and destination	12.4; 15.4; 23.3; 26.3	x	x	
Neighbourhoods are walk- and cycle-friendly	6.2; 8.2; 26.9	x		
Park-and-ride options for public transportation including motor vehicles, motorcycles, and bicycles	23.6		x	
Social considerations				
Social considerations of accessibility				
Access to transportation mode(s)	9; 12.6	x	x	x
Access for people with disabilities and special needs	12.9			x
Access to information about transportation mode	12.7; 13.4		x	x
Access to opportunities with transportation mode	12.17	x	x	x

Key considerations arising from the literature	Questions	Chapter 2 Spatial Planning	Chapter 3 Transportation	Chapter 4 Sustainable Development
Social considerations of flexibility				
The flexibility of transportation mode	12:10		x	
The day and time of travel	12.3; 21; 22	x	x	
Social considerations of mobility				
Number of daily trips (frequency)	15.3; 23.2; 26.2	x	x	x
Relocating for public transportation	13.6	x	x	
Preference to use a specific mode of transportation	12.6	x	x	x
Social considerations of personal needs				
Safety of residential area for non-motorised transportation modes	26.9	x	x	x
Road safety	12.13	x	x	x
Social considerations of transportation needs				
Importance of reliability of selected transportation mode(s)	12.14		x	
Road sharing to accommodate motorised and non-motorised transportation	15.9	x	x	x
Adherence to the speed limit	15.5	x	x	x
Convenience of transportation mode	12:10		x	
Social considerations of well-being				
Health benefits of transportation mode	12:18; 15,11; 23.5	x	x	x
To walk or cycle to gain access to transportation stop	26.7		x	

Table 7.1 is a critical reference for this chapter and is used as a guideline to assist in analysing these chapters (Chapter 2, 3, 4) along with Figure 7.2 that shows how the process of the analysis takes place.

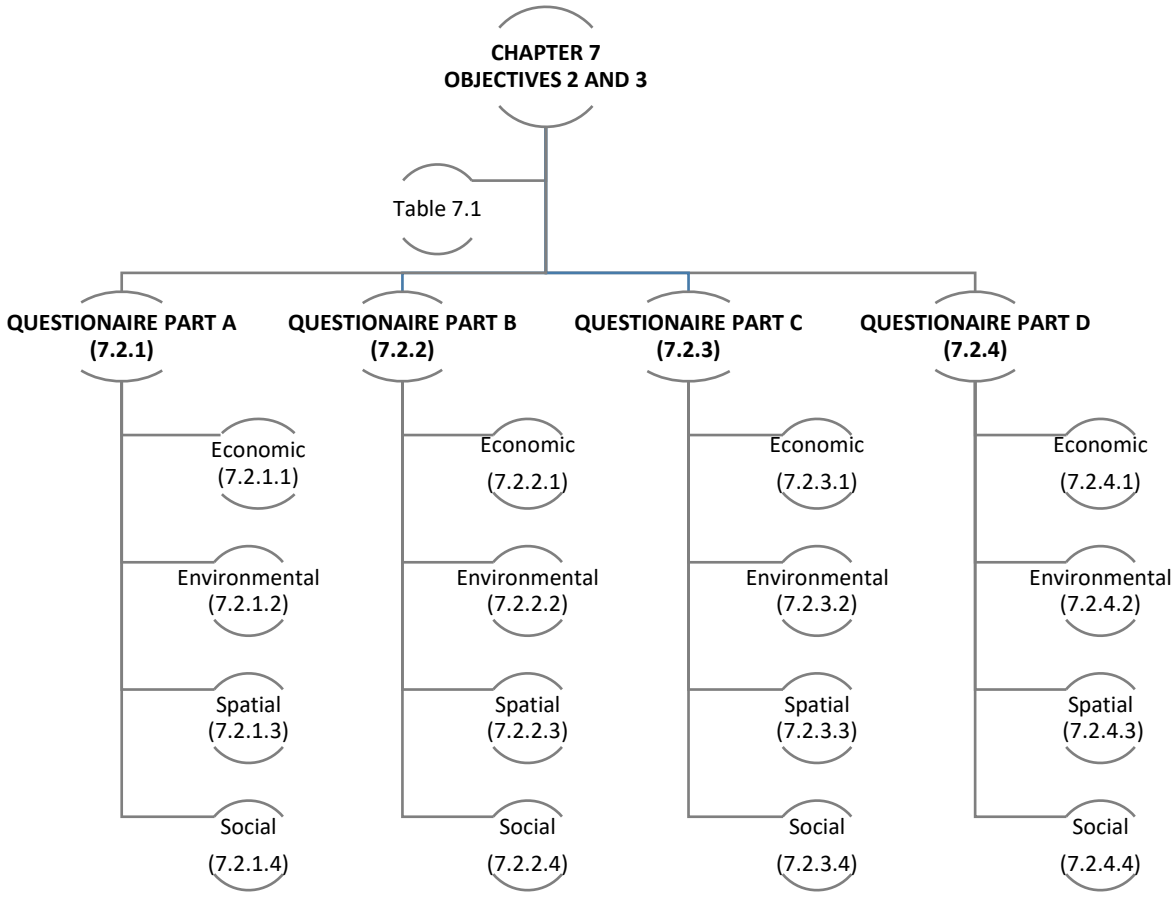


Figure 7.2: The data analysis interpretation and discussion sequence of this chapter

7.2.1 Data analysis and findings for Part A of the questionnaire: General

This section focuses on the first part of the questionnaire, namely the general perspective of all the respondents. There are several questions related to the social and economic background of the respondents which were already described in Chapter 6 with the remainder of the topics discussed in this section.

Table 7.2 depicts the quantitative data analysis of the questions to this section of the data collection tool. From Table 7.2 it is evident that the participation from the respondents is high, with most of the questions obtaining a high response rate. The considerations which are requested as important to the most respondents are road safety (mean = 4.36), general safety (mean = 4.34), reliability (mean = 4.16), travel distance (mean = 4.14), travel time (mean = 4.10), trip duration (mean = 4.03), accessibility and reliability (4.02). The majority of the remaining considerations of this part were.

Table 7.2: Quantitative data analysis of the questions in Part A of the data collection tool

Questions	*Question Number*	*Strongly Disagree*		*Disagree*		*Neutral*		*Agree*		*Strongly Agree*		*Mean*
My residential area has houses, shops, schools and industrial/ manufacturers/wholesalers (n = 418)	6.1	13	*3.11%*	32	*7.66%*	46	*11.00%*	224	*53.59%*	103	*24.64%*	3.89
My residential area is pedestrian and cycling-friendly (n = 417)	6.2	41	*9.83%*	62	*14.87%*	73	*17.51%*	169	*40.53%*	72	*17.27%*	3.41
My residential area is safe (n = 416)	6.3	65	*15.63%*	82	*19.71%*	109	*26.20%*	100	*24.04%*	60	*14.42%*	3.02
My residential area offers easy access to public transportation (n = 419)	6.4	7	*1.67%*	40	*9.55%*	55	*13.13%*	180	*42.96%*	137	*32.70%*	3.95
My residential area's public transportation stops are walking distance from my house, shops, schools and industrial/ manufacturers/wholesalers which I want to visit (n = 422)	6.5	25	*5.92%*	59	*13.98%*	52	*12.32%*	196	*46.45%*	90	*21.33%*	3.63
This neighbourhood has houses, shops, schools and industrial/ manufacturers/wholesalers (n = 428)	8.1	4	*0.93%*	39	*9.11%*	77	*17.99%*	207	*48.36%*	101	*23.60%*	3.85
This neighbourhood is pedestrian and cycling-friendly (n = 423)	8.2	28	*6.62%*	57	*13.48%*	87	*20.57%*	181	*42.79%*	70	*16.55%*	3.49
This neighbourhood is safe (n = 427)	8.3	35	*8.20%*	88	*20.61%*	121	*28.34%*	140	*32.79%*	43	*10.07%*	3.16
This neighbourhood offers easy access to public transportation stops (n = 424)	8.4	4	*0.94%*	34	*8.02%*	81	*19.10%*	196	*46.23%*	109	*25.71%*	3.88
This neighbourhood's public transportation stops are walking distance from my work, shops, schools and industrial/ manufacturers/wholesalers which I want to visit (n = 432)	8.5	9	*2.08%*	45	*10.42%*	62	*14.35%*	235	*54.40%*	81	*18.75%*	3.77
The distance I need to travel (n = 413)	12.1	20	*4.84%*	11	*2.66%*	35	*8.47%*	172	*41.65%*	175	*42.37%*	4.14
The duration of my trip (travel time) (n = 412)	12.2	21	*5.10%*	12	*2.91%*	27	*6.55%*	227	*55.10%*	125	*30.34%*	4.03
The day and time I need to travel (n = 410)	12.3	14	*3.41%*	10	*2.44%*	43	*10.49%*	198	*48.29%*	145	*35.37%*	4.10
The number of stops I need to make (n = 413)	12.4	54	*13.08%*	11	*2.66%*	63	*15.25%*	203	*49.15%*	82	*19.85%*	3.60
The weather (sunny, rainy, windy, etc.) (n = 412)	12.5	105	*25.49%*	24	*5.83%*	43	*10.44%*	129	*31.31%*	111	*26.94%*	3.28
Access to use my transportation mode (n = 409)	12.6	29	*7.06%*	7	*1.70%*	29	*7.06%*	206	*50.12%*	140	*34.06%*	4.02
Access to information about my transportation mode (n = 409)	12.7	69	*16.87%*	19	*4.65%*	35	*8.56%*	154	*37.65%*	132	*32.27%*	3.64
Wheelchair accessibility of my transportation mode (n = 330)	12.8	132	*40.00%*	12	*3.64%*	21	*6.36%*	113	*34.24%*	52	*15.76%*	2.82

Questions	*Question Number*	*Strongly Disagree*		*Disagree*		*Neutral*		*Agree*		*Strongly Agree*		*Mean*
The meet-and-assist option of my transportation mode (n = 334)	12.9	112	*33.53%*	15	*4.49%*	29	*8.68%*	119	*35.63%*	59	*17.66%*	2.99
The flexibility/convenience my transportation mode offers me (n = 414)	12.10	51	*12.32%*	8	*1.93%*	48	*11.59%*	205	*49.52%*	102	*24.64%*	3.72
The personal space my transportation mode offers me (n = 414)	12.11	54	*13.04%*	13	*3.14%*	46	*11.11%*	180	*43.48%*	121	*29.23%*	3.73
The general safety of my transportation mode (n = 412)	12.12	8	*1.94%*	5	*1.21%*	22	*5.34%*	180	*43.69%*	197	*47.82%*	4.34
The road safety of my transportation mode (n = 413)	12.13	10	*2.42%*	4	*0.97%*	20	*4.84%*	174	*42.13%*	205	*49.64%*	4.36
The reliability of my transportation mode (n = 414)	12.14	17	*4.11%*	7	*1.69%*	33	*7.97%*	192	*46.38%*	165	*39.86%*	4.16
The cost/affordability of my transportation (n = 413)	12.15	37	*8.96%*	15	*3.63%*	32	*7.75%*	146	*35.35%*	183	*44.31%*	4.02
The environmental friendliness of my transportation mode (n = 412)	12.16	23	*5.58%*	16	*3.88%*	56	*13.59%*	193	*46.84%*	124	*30.10%*	3.92
Access to opportunities (such as work) that my transportation mode offers me (n = 410)	12.17	65	*15.85%*	33	*8.05%*	36	*8.78%*	149	*36.34%*	127	*30.98%*	3.59
The benefits my transportation mode has for my health (such as physical activity) (n = 411)	12.18	36	*8.76%*	28	*6.81%*	55	*13.38%*	148	*36.01%*	144	*35.04%*	3.82
I would use public transportation if there were more bus routes available (n = 356)	13.1	45	*12.64%*	48	*13.48%*	53	*14.89%*	148	*41.57%*	62	*17.42%*	3.38
I would use public transportation if fares were cheaper (n = 352)	13.2	40	*11.36%*	34	*9.66%*	47	*13.35%*	146	*41.48%*	85	*24.15%*	3.57
I would use public transportation if the service was more reliable (n = 348)	13.3	42	*12.07%*	19	*5.46%*	45	*12.93%*	175	*50.29%*	67	*19.25%*	3.59
I would use public transportation if information regarding the service was more transparent (n = 349)	13.4	39	*11.17%*	18	*5.16%*	71	*20.34%*	160	*45.85%*	61	*17.48%*	3.53
I would use public transportation if the service times/ operation hours were more flexible (n = 350)	13.5	43	*12.29%*	21	*6.00%*	45	*12.86%*	178	*50.86%*	63	*18.00%*	3.56
I would consider relocating to another residential area which offers access to public transportation (n = 352)	13.6	63	*17.90%*	68	*19.32%*	56	*15.91%*	114	*32.39%*	51	*14.49%*	3.06
Sum		**1360**		**996**		**1753**		**5837**		**3644**		
Mean		**40**		**29.29**		**51.56**		**171.68**		**107.18**		
% Selected		**10.01%**		**7.33%**		**12.90%**		**42.95%**		**26.81%**		
SD												**0.38**

neutral. Therefore, since they are not regarded as important (thus a mean of 4.00 or less) they are tentatively excluded from the policy guidelines for the development of sustainable public transportation in the study area (i.e. objective 4). The standard deviation of this section is 0.38, which indicates that respondents had a small variation in opinions regarding which considerations are important. Figure 7.3 supports this explanation.

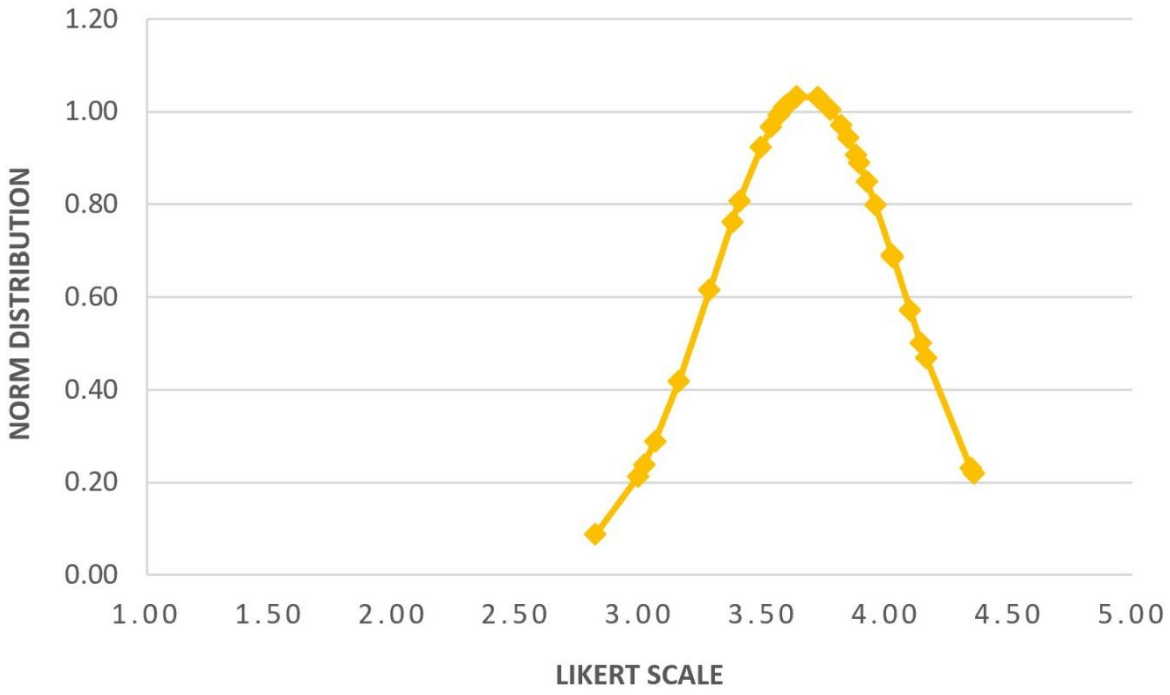


Figure 7.3: Bell curve of mean distribution of Part A of the questionnaire according to the five-point Likert scale employed (σ = 0.38)

The qualitative data pertained to the comments of the respondents in Part A of the data collection tool and serves as an explanatory role in this study (see Table 7.3). Singular codes emerged for economic, environmental and spatial considerations. However, several codes emerged for social considerations that support the findings from the perspective of the person. The qualitative data was very limited in this part of the questionnaire; however, it supports the quantitative data analysis of several of the considerations which achieved a mean 4.00 or more (see Table 7.3). One new consideration emerged from the qualitative data, namely reliability. Overlapping codes amongst the emerging themes are highlighted with colour codes in Table 7.3.

Table 7.3: Emerging qualitative codes of Part A of the questionnaire

KEY CONSIDERATIONS	EMERGING QUALITATIVE CODES	QUANTITATIVE MEAN
ECONOMIC CONSIDERATIONS	Affordable	Affordability (mean = 4.02)
ENVIRONMENTAL CONSIDERATIONS	Condition of roads (potholes)	Road Safety (mean = 4.36)
SPATIAL CONSIDERATIONS	Mixed land use	n/a
	Access (to a variety of land use modes within walking distance)	n/a
	Accessible	Access to transportation mode (mean = 4.02)
	Travel distance influence mode	Travel distance (mean = 4.14)
SOCIAL CONSIDERATIONS	Access (to a variety of land use modes within walking distance)	n/a
	Accessible	Access to transportation mode (mean = 4.02)
	Affordable	Affordability (mean = 4.02)
	Comfortable	n/a
	Flexible	n/a
	Reliability	Reliability (mean = 3.59)
	Safety	General safety (mean = 4.34)
OTHER	Age considerations	n/a

7.2.1.1 Economic considerations for Part A

This section relates to the economic considerations for Part A of the questionnaire, as shown in Table 7.2. The affordability and cost (questions 12.15) of transportation is an important factor in everybody's lives (see Chapters 2, 3 and 4) and contributes to each person's living expenses (see 2.3.1.1; 2.3.1.2; 2.4.1; 2.5.1; 3.3; 3.4.1; 3.4.2; 3.4.3; 3.5.1; 4.3.3). The information received from the survey clearly indicates that most (n = 329; 79.66%) of the respondents either selected agree (n = 146; 35.35%) or strongly agree (n = 183; 44.31%) regarding the importance of affordability. The results provide a high mean (4.02) in the question and indicate that affordability is an important factor for the respondents. The result of the above four issues indicates that they are important and that the respondents are reluctant to pay more for transportation.

> *Public transportation should be affordable, cheaper and operation hours be flexible to the works of the public transportation* (Participant 370).
>
> *Public transportation should be cheaper, affordable, not overloaded with passengers, and also comfortable for the users of the transportation* (Participant 400).
>
> *Passengers or public transportation users must be comfortable and feel happy to use them as the transport is flexible, cheaper and affordable* (Participant 415).

The real question is if the respondents are willing to change to public transportation if the services are reasonably priced (question 13.2). Out of all the respondents (n = 352), only 41.48% (n = 146) of the respondents agreed and 24.15% (n = 85) of respondents strongly agreed. This indicates that 65.63% (n = 231) of respondents agree and strongly agree with this question. Although it looks as if the respondents' mindset is more to agree or strongly agree, the mean for the question is 3.57. This question is classified as neutral since it has a mean between three and four, and as a result is tentatively excluded from the policy guidelines.

7.2.1.2 Environmental considerations for Part A

This section relates to the environmental considerations for Part A of the questionnaire, as shown in Table 7.2. The first question (12.15) (n = 412) relates to the concern of weather conditions for a participant and may be due to multiple factors in relation to the weather conditions. This question relates to a few sections (2.3.1.1; 4.3.1) in Chapters 2 and 4. A percentage of 25.49% (n = 105) of the respondents fully disagreed that weather conditions influenced them in any way when using their daily transportation mode; 31.31% (n = 129) of the respondents agreed that weather is a concern with 26.94% (n = 111) strongly agreeing. This indicates that more than half (n = 240; 58.25%) of the respondents agree or strongly agree that the weather influences their daily trips. The mean of the section is 3.28 which indicates that the number of respondents that selected strongly disagree influenced the mean to be less than four although more than half (58.25%; n = 240) selected agree or strongly agree. This question has a neutral response rate and is seen as less important. This may be due to the drought the study area encountered the past few years (Dean, 2019: online) or that respondents can use their mode of transport without rain affecting them at all.

The environmental friendliness of their current mode of transportation is outlined in the next section (question 12.16). This is brought forward to the questionnaire due to the popularity in Chapter 2, 3 and 4[1]. From all the respondents (n = 412) it is shown that 46.84% (n = 193) agreed with the environmental friendliness of their mode of transportation and 30.10% (n = 124) strongly agreed. This indicates that 76.94% (n = 317) of the respondents agree or strongly agree with the statement. The mean of this section is 3.92, which is neutral, but also close to four. This may be a more popular question of all neutral means.

[1] See sections 2.3; 2.3.1.1; 2.4.1; 2.5.1; 3.1; 3.3; 3.4; 3.4.1; 3.4.2; 3.4.3; 3.5; 3.5.1.1; 3.5.1.2; 4.1; 4.2; 4.3; 4.3.1; 4.3.2; 4.3.3; 4.4; 4.4.2

7.2.1.3 Spatial considerations for Part A

The following section relates to the land uses the respondents encounter every day. Question 6.1 and 8.1 relate to the land use of the respondents' residential area, the location they travel to daily and their travel patterns. This is discussed in Chapter 2 and is mentioned several times (2.3.1.1; 2.3.1.2; 2.3.1.3; 2.4.1; 2.4.3; 2.5.1). Firstly, the results (n = 418) of question 6.1 focus on the respondents' residential land use type. As seen from the results, there is 53.59% (n = 103) that agrees to the fact that their residential area has multiple functions and 24.64% (n = 103) of respondents strongly agree. So, a total of 78.23% (n = 327) of respondents agree or strongly agree with this with a mean of 3.89 for this question. This provides uniformity to the type of residential area the respondents' lives in.

I do not stay far away from where I am working, so I like walking to my work place and since we have a mall I usually buy at those shops rather than going to town (Participant 182).

Question 8.1 focuses on the destination land use of the respondents. The outcomes of this question are similar to the outcomes of the previous question (6.1). The results are that 48.36% (n = 207) of the respondents agree with the type of land use, and 23.60% (n = 101) of respondents strongly agree. Thus 71.96% (n = 308) of respondents agree or strongly agree with the statement. This is almost similar to question 6.1, with a difference of 6.27%. The question has a mean of 3.85, which is close to four and also similar to the mean (3.89) of question 6.1. Although the mean is classified as neutral, it still indicates that the majority of residential areas and the areas that respondents travel to are mixed land use.

Question 6.2 and 8.2 relate to the pedestrian and cycle-friendliness of the residential area they live in and the areas they are travelling to. Both these questions are obtained from Chapter 2, 3 and 4[2]. Firstly, question 6.2 deals with the respondents' residential area. From the results obtained (n = 417), it is shown that most of the respondents agree that their residential areas have some type of facility that accommodates pedestrians and cyclists with 17.72% of the respondents strongly agreeing. The mean for this section is 3.41 which is closer to three and also neutral. Even though there is a combined total of 57.80% of respondents selecting agree or strongly agree, it is not a clear indication that everyone's residential areas have the infrastructure to handle pedestrians or cyclists. Question 8.2 looks at the area where the respondents travel to. From of the number of respondents, 42.79% (n = 181) agree with this section and 16.55% (n = 70) of respondents strongly agree. Again, as in question 6.2, the combined total selection for agree and strongly agree is similar (n = 251; 59.34%). It is also evident that not all the areas are pedestrian or cycling-friendly with a neutral mean of 3.49.

[2] See sections 2.2; 2.3.1.1; 2.5.1; 3.3; 3.4.2; 3.5.1; 3.5.1.2; 4.3.3; 4.4.2; 4.4.3

The following two questions (6.3 and 8.3) focus on the safety of the residents' area and the place to which they are travelling. Both these questions are from all the literature chapters (2, 3 and 4) and is obtained from several sections in these chapters (see 2.3.1.1; 2.3.1.3; 2.4.1; 2.5; 3.3; 3.4.1; 3.4.4; 3.5.1.1a; 3.5.1.1.b; 3.5.1.2; 4.3.3). Firstly, the focus is on the safety of the respondents' current residential area. The results (n = 416) obtained from the survey shows that 26.20% (n = 109) are neutral on this with the remainder of the options not providing a significant stand-out result. On the other side of the spectrum, 24.04% (n = 100) of the respondents agree and 14.42% (n = 60) strongly agree. With a mean of 3.02 (neutral), not all the respondents agreed with this question. This may be due to the residents living in different areas or that most of the areas may be unsafe. The safety of the area that respondents are travelling to is outlined in question 8.3. From the results (n = 427) it seems that 32.79% (n = 140) of the respondents selected agree and 28.34% (n = 121) of respondents were neutral about the safety. The remainder of the selections is evenly spread out with 20.61% (n = 88) of respondents selecting disagree, 8.20% (n = 35) selecting strongly disagree and 10.07% (n = 43) of respondents selecting strongly agree. The mean is 3.16, which is close to three and also close to the mean of question 6.3 of 3.02. Thus, the different residential areas may vary on safety aspects, but there is an indication that some residential areas may be unsafe.

The following section focuses on questions 6.4 and 8.4, which focus mostly on access to transportation in the respective areas. Access to transportation is brought forward a number of times in the literature review with the references of question 6.4 and 8.4 being similar[3]. Question 6.4 focuses on the access to transport of the respondents from their residential area. The repose is overwhelming to either agree at 42.96% (n = 180) or strongly agree at 32.70% (n = 137) which indicates that most respondents have access to transportation with 75.66% (n = 317) agreeing or strongly agreeing. The mean is also high at 3.95 in the neutral category. This indicates that there is some need for access to transportation. In question 8.4, access to transportation at the respondents' destination is discussed. From the results (n = 424), it is seen that 46.23% (n = 196) of the respondents agree with their accessibility to transportation and 25.71% of them strongly agree. This indicates that 71.94% (n = 305) of the respondents agree or strongly agree. The mean for this question is 3.88 (neutral), which is close to four and indicates that the access to transport is of an acceptable standard.

Questions 6.5 and 8.5 focus on the walking distance of the respondents to and from their public transportation stops. These two questions relate to spatial planning and sustainable transport (see 2.3.1.1; 3.5.1.1; 3.5.1.2). Question 6.5 is focused on the walking distance in the respondents' own

[3] See sections 2.2; 2.3.1; 2.3.1.1; 2.3.1.3; 2.4.1; 2.4.2; 2.4.3; 2.5; 2.5.1; 3.4.1; 3.4.2; 3.4.3; 3.5; 3.5.1.1.2; 3.5.3; 4.3.1; 4.3.2; 4.3.3; 4.4.2

residential area to their required destination. The respondents (n = 422) for this section mostly selected agree with a total of 46.45% (n = 196). Strongly agree obtained a result of 21.33% (n = 90) of the respondents' selections. The mean for this section is 3.63, which is the neutral mean between three and four. Question 8.5 focuses on the walking distance at the destination of the public transportation stop. From the total number of respondents, more than half of the respondents selected agree with a total of 54.40% (n = 235) and strongly agree obtained a percentage of 18.75% (n = 81). The mean of this section is 3.77 (neutral), which is a bit higher than question 6.5.

The following section is related to the distance required to travel daily to accomplish daily activities. This section (question 12.1; n = 413) relates to the information obtained in Chapter 2 and 3 regarding travel distance (2.3.1.1; 3.5.1). This section is dominated by either agree at 41.65% (n = 172) or strongly agree at 42.37% (n = 175). This is a combined total of 84.02% (n = 347) of respondents selecting this option, which indicates a high number of respondents selecting this option. The total mean for this section is 4.14, which indicates it is an important question for this study. Thus, respondents feel that travel distance is important for their daily travel.

This section relates to the time one requires to travel daily. The question (12.2) is based on how long respondents have to travel per day and is related to Chapters 2, 3 and 4 from the literature section (see 2.4.2; 2.5; 2.5.1; 3.5.1; 4.3.3). From the results (n = 412) obtained in this section, it is seen that 55.10% (n = 227) of the respondents agree that this is important and 30.34% (n = 125) strongly agree. The combined agree and strongly agree is 85.44% (n= 352) with the mean of the total resonance at 4.03. It indicates that time is an important factor for the respondents.

The following section has to do with the time of day a participant needs to travel (question 12.3; n = 410). It is important for respondents not to arrive late at home or work and is related to the literature in Chapter 2 (see 2.3.1.1). The response of the respondents shows that they do value their time with a total of 48.29% (n = 198) of respondents agreeing with this question and 35.37% (n = 145) strongly agreeing. The mean of the question is 4.10, with a combined total of 83.66% (n = 343) of respondents either selecting agree or strongly agree. With a mean that is classified as important, the respondents are required to travel at certain times and days to accomplish their transport needs.

> *...minibuses should save time for travels. Cause the traveller don't want to be late where their travel to or from* (Participant 384).

Public transportation should always be on time on the travel routes so that users of public transportation don't become late on their jobs and home (Participant 381).

...the minibus taxis must go straight to the home. From home and not wasting times of the passenger by looking for more passengers along the way (Participant 400).

The flexibility of the scheduled times and the flexibility of the operation times of the public transportation system for the respondents is based on information obtained in Chapter 3 (see 3.5.1.1.b). The outcomes (question 13.5; n = 350) from the survey shows that 50.86% (n = 178) of the respondents agree and 18.00% (n = 63) strongly agree with this statement. The mean of this section is 3.56. This is a neutral mean with a value between three and four with some of the options in the lower spectrum. The response is that respondents are not too ambitious for flexible times.

The importance of the number of stops a participant needs to make to complete their daily activities (see 2.3.1) is mentioned in the following section (question 12.4). As seen in Table 7.2, 49.15% (n = 203) of respondents agree with this statement and 19.85% (n = 82) strongly agree. The mean is at 3.60, which is neutral and indicates that a number of respondents are not totally concerned about the number of stops required for their daily travel schedule.

7.2.1.4 Social considerations for Part A

Specific transportation mode(s) (e.g. personal vehicle, public transport or non-motorised) is important to all road users. This is a topic discussed several times in the literature review[4] and outlined as an important parameter in the specific sections. From the survey, the majority of the respondents agree (n = 206; 50.12%) or strongly agree (n = 140; 34.06%) to the question with a combined total of 84.18% (n = 346). This question outlines how important it is for respondents to have their own mode of transport which generated a mean of 4.02. They are less reluctant to use public transportation.

The meet-and-assist option is based on question 12.9 (n = 334) which looks at someone assisting a person at a mode of transport to travel from origin to destination (see 4.3.3). From the results, it is seen that 35.63% (n = 119) of the respondents agreed with this question, but a total of 33.53% (n = 112) of respondents strongly disagreed with this question. Strongly agree obtained a 17.66% (n = 59) with the remainder obtaining 8.68% (n = 29) and 4.49% (n = 15) for neutral and disagree respectively. The mean is 2.99, which indicates it is less important than the other parameters. Respondents feel this is not important or required of their current transportation system.

[4] See sections 2.2; 2.3.1; 2.3.1.1; 2.3.1.3; 2.4.1; 2.4.2; 2.4.3; 2.5; 2.5.1; 3.4.1; 3.4.2; 3.4.3; 3.5; 3.5.1.1.b; 4.3.1; 4.3.2; 4.3.3; 4.4.3

This section deals with access to information with regard to their mode of transportation (question 12.7). This is important with regard to availability, scheduling or cancellation of routes (3.5.1.1.b-e; 4.3.3). The respondents (n = 409) for this question selected agree (n = 154; 37.65%) or strongly agree (n = 132; 32.27%) as more important than the rest of the options. Although it shows that agree and strongly agree are selected most often, the total score between them (69.92%) is less than 70% of the respondents' responses. The mean of this section is 3.64 with the information to a mode of transportation being neutral. The result obtained for this question may indicate that the respondents are so used to the scheduling that they do not need to be reminded again of any scheduling information. This can also relate to the respondents using private transport or taxis that are not based on formal scheduling.

Question 13.4 (n = 349) has to do with the transparency of information with regard to public transportation. It is evident from the literature that this has an important influence on people for the use of public transportation (see 3.5.1.1.b). From the data received from the survey (n = 349), it shows that 45.85% (n = 160) of respondents selected agree and 20.34% (n = 71) selected neutral and 17.48% (n = 61) selected strongly agree. The response for disagree and strongly disagree are lower with the mean for this question at 3.53. This response to this question is classified as neutral with the mean being between three and four.

Question 12.17 (n = 410) relates to how a mode of transportation can offer access to opportunities for a participant. There is a link between access to transportation and opportunities for employment (see 2.2; 2.4.1; 2.5; 2.5.1; 3.4.1; 3.4.2; 3.5; 3.5.1; 4.3.3). From the feedback obtained, it shows that 36.34% (n = 149) of respondents agree with this, and 30.98% (n = 127) strongly agree. This may relate to the mode of transport one uses or to the respondents having less ambition to find an opportunity. The mean for this question is 3.59.

The flexibility and convenience of a person's mode of transport are seen as important by the literature review (see 3.5.1; 3.5.1.1). Question 12.10 addresses the flexibility or convenience of the mode of transport. The respondents (n = 414) selected mostly agree (n = 205; 49.52%) or strongly agree (n = 102; 24.64%) for this question. This indicates that more respondents feel it is important that their selected mode of transportation should offer flexibility and convenience. This question obtained a mean of 3.72 which is classified as neutral.

Public transportation service time/operation hours should be more flexible and efficient to the passenger (Participant 398).

Question 13.6 (n = 352) focuses on the participant's willingness to move if there were more access to public transportation in a different residential area. As shown in the literature, people may be reluctant to change their home address for better transportation opportunities (2.3.1.1; 3.5.1). The response per option is balanced with agree obtaining 32.39% (n = 114) and the remainder of the options being similar. The mean (3.06) is low as well, which indicates this question is less important than the other questions.

...*some towns or at Rural areas it is more difficult for them to get access to public transport* (Participant 201).

There's no public transport on Tweespruit. That's why I used my vehicle (Participant 203).

Public transportation is only accessible in Fauna during the week, on weekends no public transport, one has to walk a long distance to get transport. If this can be taken into consideration, we would be very much happy (Participant 303).

The routes of the minibuses should be closer to the home of the workers as they are the one who are using the public transportation to the work and back home everyday (Participant 408).

Yes! Sometimes I walk a long distance and it gets tiring because there are no taxis moving around to help those who are walking (Participant 133).

The road safety of respondents is part of question 12.13 which gives an insight into how respondents (n = 413) rate road safety. It is evident in the literature chapters (2, 3 and 4) that road safety is of some concern to road users (2.5; 3.5.1.1; 4.3.3). As seen in Table 7.2, strongly agree obtained a 49.64% (n = 205), which is the highest thus far for this category. A percentage of 42.13% (n = 174) of the respondents selected agree; combined with strongly agree, 91.77% (n = 379) of the respondents that partook in this question feel that road safety is very important. The mean of this question is at 4.36, which is of high importance for this survey.

Public transportation should or must go to maintenance on every 6 months, to avoid stuck on public transportation on the road with road users (Participant 382).

Public transport is an affordable transportation. But sometimes it's difficult for me to use public transport because some of the transports aren't stable or allowed to be on the road (Participant 199).

Drivers are reckless and don't always follow rules of the road (Participant 295).

Public transportation supposed to be in good and safety condition for the users who use them to avoid accident of the public transportation on the road (Participant 375).

Public transportation should pick up transport users from home and take them to work on daily buses, to avoid dangerous situation to the transport users on to the communication thugs (Participant 382).

Personal space is important for a road user and is asked in question 12.11 (n = 414). This is also outlined in section 3.3 of the literature review. From the respondents' feedback, it is seen that 43.48% (n = 180) agree that they need their personal space with 29.23% (n = 121) strongly agreeing. The response may differ between the type of respondents that completed this section with regards to their current mode of transport. The mean for this question is at 3.73, which is classified as neutral.

Treatment of public transportation taxi is bad, they do not treat us like people (Participant 30).

Passengers of public transportation users must be comfortable and feel happy to use them as the transport is flexible, cheaper and affordable (Participant 415).

The following section relates to the importance of reliability on the mode of transport, which is important if the participant needs to rely on it every day (question 12.14; n = 414). This is also evident in the literature review in section 3.5.1.1. As seen from the result in Table 7.2, 46.38% (n = 192) of respondents agree that their mode of transport needs to be reliable and 39.86% (n = 165) strongly agree. The mean of this question is 4.16, which is higher than four. Thus, it is an important parameter and is supported by the qualitative data analysis.

Question 12.18 (n = 4.11) looks at if the respondents are aware of the health benefits of their mode of transportation, which relates to the physical activity part (see sections 2.3.1.3; 2.4.1; 2.4.3; 3.4.2; 3.4.3; 3.5.1.1.b; 3.5.1.2; 4.3.1; 4.3.3). From the data received, it is seen that 36.01% (n = 148) of respondents agree and 35.04% (n = 144) of the respondents strongly agree. This totals up to 71.05% (n = 292) of the respondents. This indicates that the respondents are aware that their mode of transport is either good or bad for them. The mean is at 3.82 which is neutral and is closer to four.

From this section above, it is seen that several questions provided positive feedback. This distinguishes the more important questions from the less important questions. Figure 7.4 indicates the question number and the mean of each question as discussed in the section above (see 7.2.1.1 to 7.2.1.3). The order of the questions starts on the left-hand side and continues on the right-hand side, starting with the highest mean working down to the lowest mean. The horizontal line in the figure indicates a mean of four. This assists in indicating which means are above or below four.

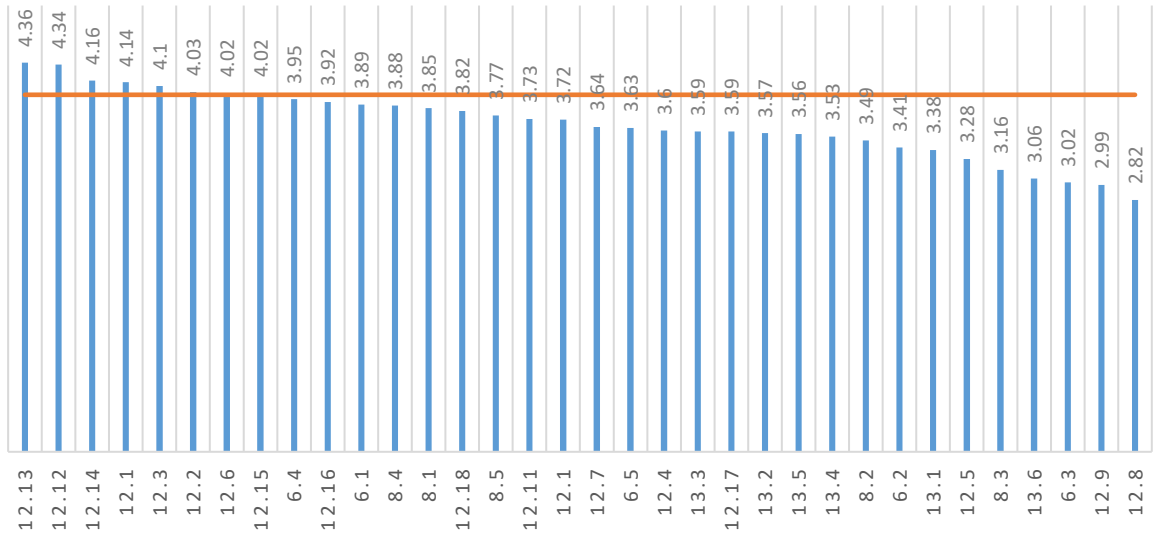


Figure 7.4: Mean of questions in Part A

The average mean of this section is 3.68, which is part of the questionnaire (Part A). A mean of below three is seen as less important, an average between three and four is seen as neutral and an average of above four is seen as important. The intention is to identify the questions or aspects that are more important as the foundation of the findings. As seen in Figure 7.4, from the 34 questions in this section, 24 of the questions have a mean of between three and four. From the remainder of the questions, there are eight questions that scored above four and two questions that scored below three, as seen in Table 7.4. The two questions that stood out were the road safety of the transport mode (question 12.13) (mean of 4.36) and the general safety surrounding the use of the mode (question 12.12) (mean of 4.34). The reliability aspect of transport (question 12.14) is the third most important question with a mean of 4.16 and in fourth place is the distance one needs to travel (question 12.1) with a mean of 4.14. In the fifth place, it is the day and time someone needs to travel (question 12.3) with a mean of 4.10 and sixth place is the duration of the trip (question 12.2) with a mean of 4.03. In the seventh (question 12.6) and eighth place (question 12.15) is the access to a respondents' transportation mode (mean of 4.02) and the cost/affordability of the respondents' transportation (mean of 4.02). These are

the eight parameters that stood out in this section with a mean that is classified as important by the respondents.

Although the means provide an informative idea of the important parameters, the next section looks at the percentage of agree and strongly agree. Figure 7.5 indicates the question number and the percentage agree and strongly agree with each question as discussed in the section above (see 7.2.1.1 to 7.2.1.2). The order of the questions starts on the left-hand side and continues on the right-hand side, starting with the highest mean working down to the lowest mean. The orange horizontal line in the figure indicates a percentage of 80%. This assists in indicating which percentage is more or less than 80%.

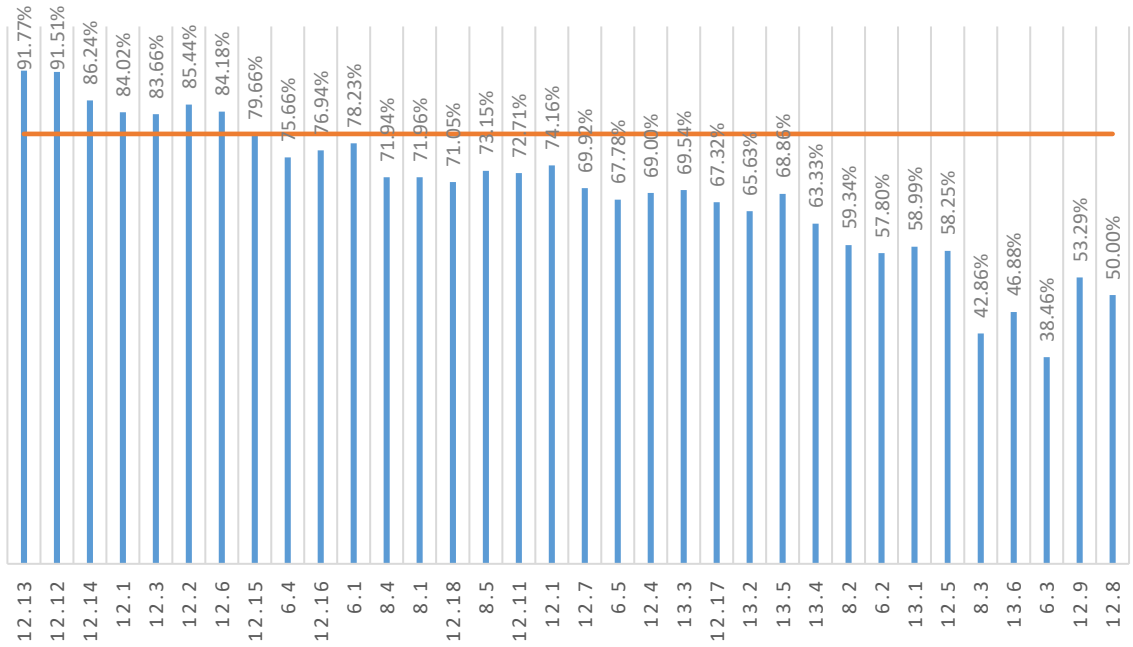


Figure 7.5: Agree and strongly agree percentages for Part A

As shown in Figure 7.5 a combined selection of agree and strongly agree is specified. The order of the results for this section is exactly the same for the highest-scoring question as for the means of the questions in Figure 7.3. Questions 12.13 and 12.12 did exceptionally well with a percentage of 91.77% and 91.51%. The remainder of the top eight questions all had an average of above 80% except for question 12.15 (79.66%). The remainder of the questions obtained a percentage of less than 80%, with some of the questions obtaining less than 50% (questions 8.3, 13.6, and 6.3).

7.2.1.5 Comparison of responses between respondents that use private vs public transportation

The aim of this section is to compare the responses of respondents in Part A of the questionnaire to identify any bias in responses. This section firstly starts by exploring the responses of respondents that own or use private vehicles daily (7.2.1.5.a), followed by an analysis of the responses of respondents using public transportation (7.2.1.5.b) and concludes with a comparative summary (7.2.1.5.c).

a) Analysis of the responses of respondents that use private transportation daily

This section focuses on the responses of Part A on the questionnaire, which is only answered by the people that own or use private vehicles daily. This is filtered by only selecting respondents that completed Part B of the questionnaire. Thus, this excludes respondents that use public transportation. This is to compare the responses of vehicular respondents to the reaction of all the respondents. This excludes any bias sections based on the different modes of transport. Figure 7.6 provides an outline of the various questions with regard to personal vehicle use among the respondents.

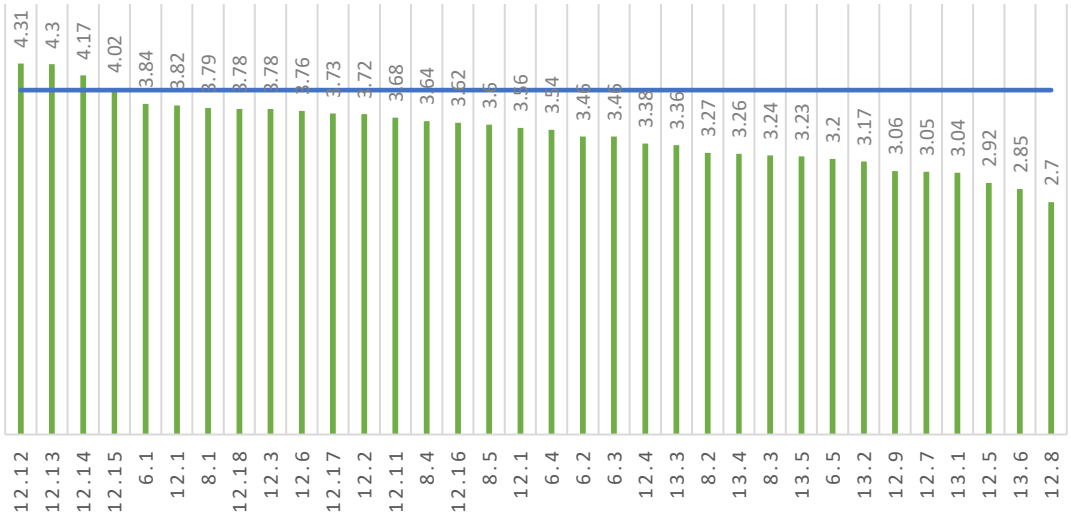


Figure 7.6: Mean of the responses of respondents that use personal transportation in Part A

As seen in Figure 7.6, the majority (27) of the questions have an average mean of between three and four. This indicates that the remainder (seven) of the questions are either below three or above four. The elements with a mean below three which seemed less important are the weather conditions (12.5) with a mean of 2.92, access for disabled persons (12.8) with a mean of 2.70 and to move from residence to another area for better public transportation (13.6) with a mean of 2.85. As seen in Table 7.4, there are only four questions that have a mean of above four, which is less than the means of all respondents together. General safety (12.12) with a mean of 4.31, road safety (12.13) with a mean of 4.30, the reliability of their transport mode (12.14) with a mean of 4.17 and the cost of transportation (12.15) with a mean of 4.02 are seen as important. A personal vehicle will provide more freedom

regarding aspects like weather, accommodating disabled people, and relocation is less of a factor in a personal vehicle. Important aspects are safety (all forms), reliability, and cost.

In Figure 7.7 a comparison is made between the percentages obtained for agree plus strongly agree. This is to see if there is any relevance between the mean of the question and the percentages obtained. The horizontal line through the graph is an indication of where 80% is and will prove a guideline between the parameters.

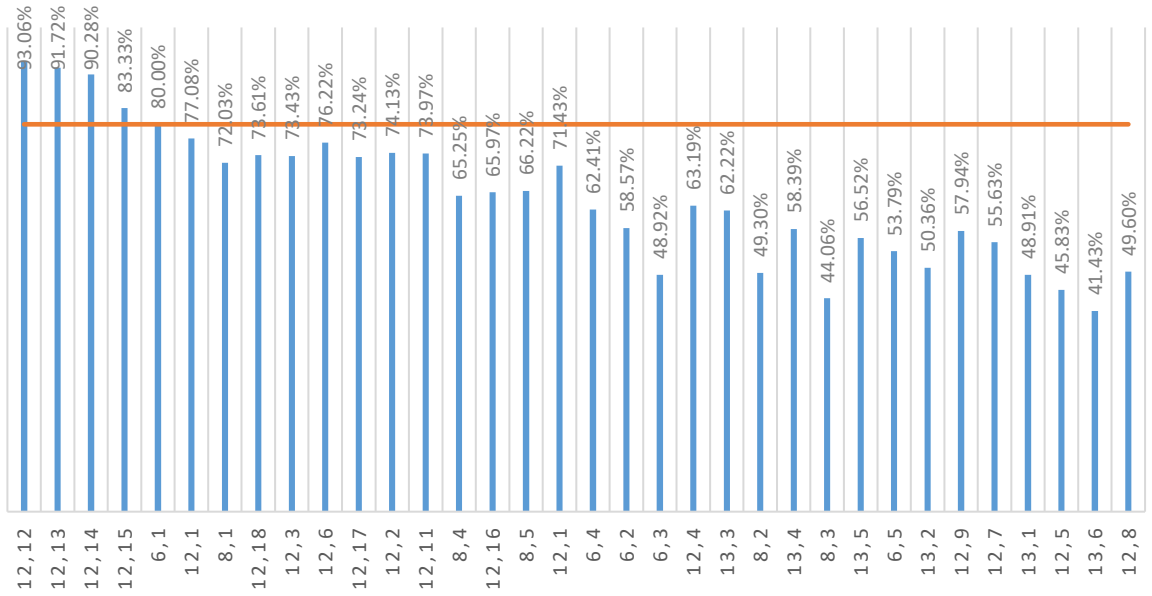


Figure 7.7: Agree and strongly agree response percentages of respondents that use personal transportation in Part A

As seen from the percentages in Figure 7.7, there is a direct correlation between the order in this figure (7.5) and the order in Figure 7.6. The same four parameters that had a mean of above four, have a percentage of greater than 80%. The only difference is that question 6.1 has an average of above 80%, but a mean of less than four (3.84). This clarifies the four major parameters for this section.

b) Analysis of the responses of respondents that use public transportation daily

The following section focuses on the respondents that chiefly completed the section of public transportation. This will exclude any respondents that mainly use private transportation and thus have no connection with public transportation.

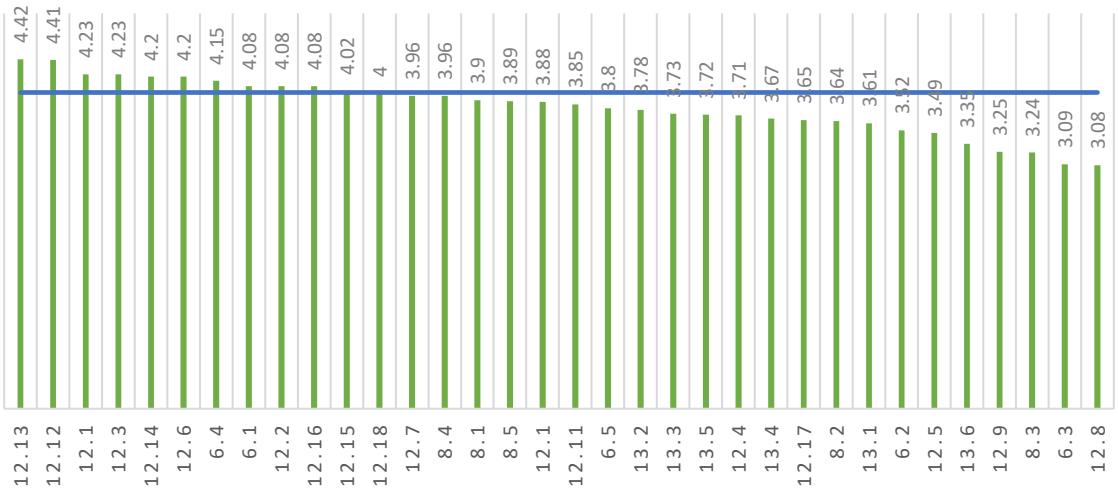


Figure 7.8: Mean of the responses of respondents that use public transportation in Part A

Figure 7.8 presents all the means from the respondents that use public transportation. This is quite different from the previous figures as there are twelve questions that have a mean of above four. The question with the highest mean is 4.42, which relates to the road safety of the respondents. This indicates that respondents are aware of the dangers on the road and that they are under threat in their mode of transport. The second highest mean is very close at 4.41, which has to do with the general safety of their mode of transportation. Respondents need to feel safe with their mode of transportation and feel it is an important parameter. In third place, the distance one needs to travel every day is important. This may relate to the time spent on the road with an overall mean of 4.23. In the fourth position is the question with regard to the day and time one needs to use their mode of transport with the question obtaining an overall mean of 4.23. This is due to the flexibility respondents require to use their mode of transport. In the fifth position is the question with regard to the reliability of the mode of transportation. The reliability is important regarding getting to work or scheduled appointments on time. This question had an overall mean of 4.20. The sixth question is related to access to the mode of transportation. If access is restricted, it may restrict people moving in an urban environment, and it obtained a mean of 4.20. In the seventh place is the ease of access to public transportation with this question obtaining a mean of 4.15. In eighth place is the land use of the original departure point (respondents' residential areas). This question has an overall mean of 4.08. In ninth place is the duration of the trip itself with a mean of 4.08. This relates to the time the respondents spend commuting per day. The environmental friendliness of the mode of transportation is seen as the tenth most important with a mean of 4.08. The eleventh most important question looks at the general cost and affordability of the mode of transport. The question has an overall mean of 4.02. The last of the more important parameters is the health benefits of their mode of transport. This question overall has a mean of 4.00, which has the lowest mean of all the important parameters. The remainder of the parameters are below four with none of the questions obtaining less than three.

Figure 7.9 deals with the percentages of agree plus strongly agree. This is to compare if there is any significance between the means and the percentages obtained in the different questions. Again, the horizontal line through the graph is an indication of where 80% is and will prove as a guideline between the parameters.

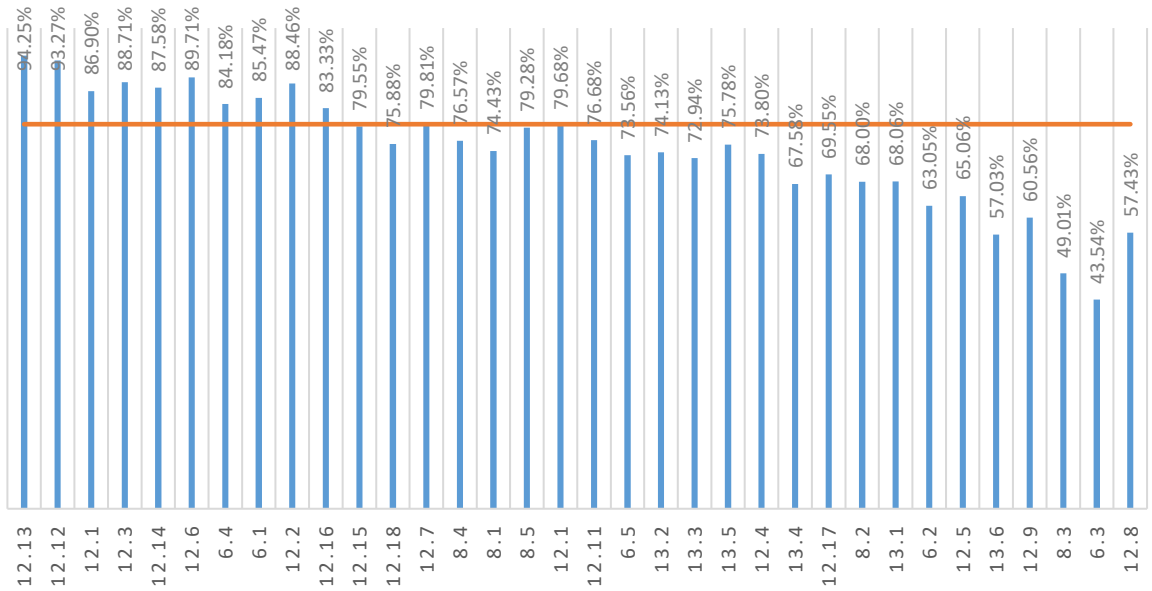


Figure 7.9: Agree and strongly agree response percentages of respondents that use public transportation in Part A

As seen in Figure 7.9, the mean and percentages of some elements are different compared to Figure 7.7. The order of the percentages is different, with question 12.13 and question 12.12 remaining the more important parameters. Question 12.15 and 12.18 obtained less than 80% although they have a mean of more than four. From the remainder of the questions that had a mean of more than four, all have a percentage of more than 80%.

c) *Comparative summary of responses of respondents that use private vs public transportation in Part A of the questionnaire*

This section provides a summary of Part A with the relevant findings. Table 7.4 provides an outline of the different questions and compares all the results under section 7.2.1. Thus, all the respondents, vehicle respondents, and public transport respondents are compared with one another.

Table 7.4: Comparative summary of responses of respondents that use private vs public transportation in Part A of the questionnaire

QUESTIONS: PART A	TRANSPORTATION MODE		
	ALL	PERSONAL	PUBLIC
The distance I need to travel	4.14	3.82	4.23
The duration of my trip (travel time)	4.03	3.72	4.08
The day and time I need to travel	4.1	3.78	4.23
Access to use my transportation mode	4.02	3.76	4.2
Wheelchair accessibility of my transportation mode	2.82	2.70	3.08
Meet-and-assist option of my transportation mode	2.99	3.06	3.25
The general safety of my transportation mode	4.34	4.31	4.41
The road safety of my transportation mode	4.36	4.30	4.42
The reliability of my transportation mode	4.16	4.17	4.2
The cost/affordability of my transportation	4.02	4.02	4.02
The weather (sunny, rainy, windy, etc.)	3.28	2.92	3.49
I would consider relocating to another residential area which offers access to public transportation	3.06	2.85	3.35
My residential area has houses, shops, schools and industrial/manufacturers/wholesalers	3.89	3.20	4.08
My residential area offers easy access to public transportation	3.95	3.54	4.15
The environmental friendliness of my transportation mode	3.92	3.62	4.08
Standard deviation	**0.38**	**0.40**	**0.35**

As seen from Table 7.4, from the public transportation section, more questions are highlighted as a concern (above four) with a total number of 11 questions. Respondents with private transportation have fewer concerns (lower than four) than respondents that use public modes of transportation (above four). Overall, from all the respondents there are eight concerns. Public transportation has no means under three, while vehicle users have three questions under three. The sections highlighted in red in Table 7.4 is an indication of the questions that had a mean of less than three. Starting with the wheelchair section, the mean is under three for all respondents and vehicular respondents yet public transportation respondents rated this more than three. These results thus show that vehicular respondents cause the mean to be below three for all respondents. Meet-and-assist scored just under three, although the mean is above three for vehicular users and public transport users. The reason for the mean to be below three is that respondents that only use non-motorised transport cannot be categorised under the vehicular or public transport section. Therefore, the non-motorised respondents feel meet-and-assist may not be required.

The top four questions (the distance I need to travel; the duration of my trip; the day and time I need to travel and access to use my transportation mode) in Table 7.4, is dominated by the public transportation users and this assisted in the mean exceeding the required four. The same happened with the last three questions (My residential area has houses, shops, schools, and industrial/manufacturers/wholesalers; My residential area offers easy access to public transportation and the environmental friendliness of my transportation mode) with public transportation respondents shifting the mean to above four.

Consequently, the four main concerns are the general safety of the transportation mode, the road safety of the transportation mode, the reliability of the transportation mode and the affordability of the transportation mode. These are the only questions that averaged above four for all categorised respondents.

7.2.2 Data analysis and findings for Part B of the questionnaire: Personal transportation respondents (max n = 154)

This section discusses the data analysis and findings of respondents that own a vehicle or use a company vehicle to conduct their day to day activities. Table 7.5 outlines the means for each question in Part B of the questionnaire. From Table 7.5 it is evident that respondents mostly (n= 92; 72.44%) use their personal vehicles to commute daily (mean = 4.37). Other considerations that also achieved a mean of over four are road sharing with other transportation modes (mean = 4.26), social responsibility (mean = 4.23), and adherence to the speed limit (mean = 4.07). The considerations of this part had an equal split between neutral and important. The four neutral considerations are at this stage tentatively excluded from the policy guidelines for the development of sustainable public transportation in the study area (i.e. objective 4). The standard deviation of this section is 0.52, which indicates that respondents had a small variety in opinion regarding which considerations were important or neutral. Figure 7.10 supports this explanation.

Table 7.5: Quantitative data analysis of the questions in Part B of the data collection tool

Questions	*Question Number*	*Never*		*Rarely*		*Occasionally*		*Frequently*		*Always*		*Mean*
I use my personal vehicle to travel (n = 127)	15.1	11	8.66%	3	2.36%	6	4.72%	15	11.81%	92	72.44%	4.37
I adhere to the speed limit (n = 152)	15.5	17	11.18%	2	1.32%	16	10.53%	36	23.68%	81	53.29%	4.07
I consider my social responsibility towards the environment when I use my personal vehicle (n = 147)	15.7	4	2.72%	11	7.48%	15	10.20%	34	23.13%	83	56.46%	4.23
I use my personal vehicle to carpool or ride together when travelling to my work, shops, schools, etc. (n = 151)	15.8	34	22.52%	25	16.56%	9	5.96%	24	15.89%	59	39.07%	3.32
I share the road with a cyclist or stop for a pedestrian (n = 153)	15.9	6	3.92%	4	2.61%	21	13.73%	35	22.88%	87	56.86%	4.26
Questions	***Question Number***	***Very slow***		***Slow***		***Medium***		***Fast***		***Very Fast***		***Mean***
I categorise my average acceleration speed as… (n = 153)	15.6	1	0.65%	5	3.27%	101	66.01%	32	20.92%	14	9.15%	3.35
Questions	***Question Number***	***Strongly Disagree***		***Disagree***		***Neutral***		***Agree***		***Strongly Agree***		***Mean***
I would consider changing my mode of daily transportation to public transportation if it is a viable and an available option for me (n = 153)	15.10	26	16.99%	22	14.38%	30	19.61%	42	27.45%	33	21.57%	3.22
I would consider changing my mode of daily transportation to walking and/or cycling to improve my health if it is a viable and available option for me (n = 1540)	15.11	24	15.58%	23	14.94%	25	16.23%	60	38.96%	22	14.29%	3.21
Sum		**123**		**95**		**223**		**278**		**471**		
Mean		**15.38**		**11.88**		**27.88**		**34.75**		**58.88**		
% selected		**10.34%**		**7.98%**		**18.74%**		**23.36%**		**39.58%**		
SD								**0.52**				

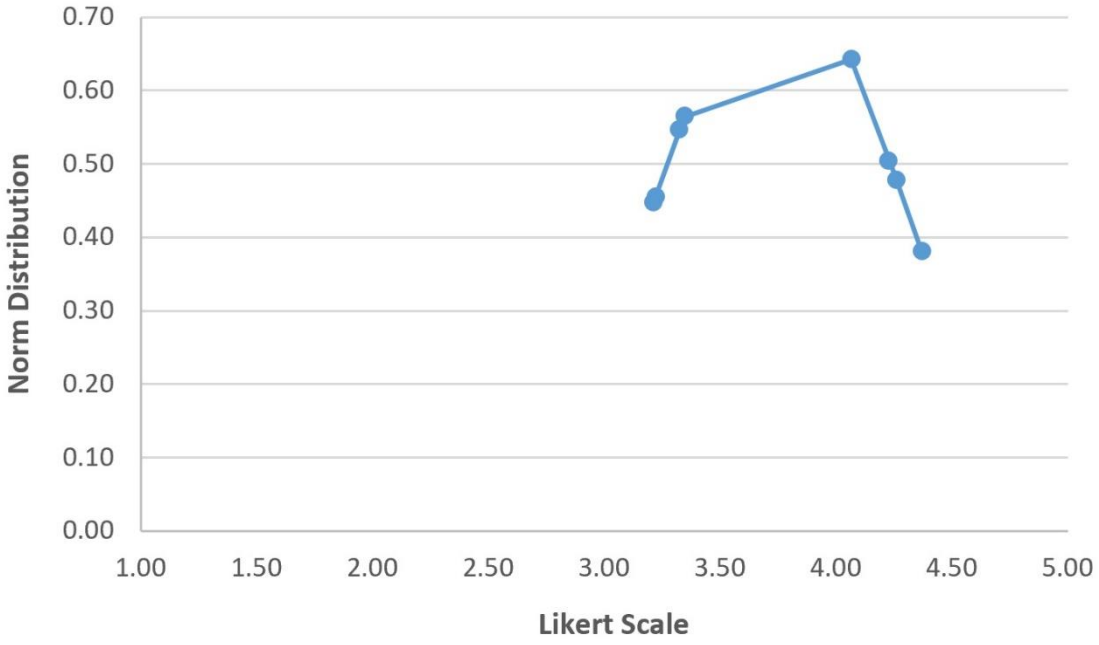


Figure 7.10: Bell curve of mean distribution of Part B of the questionnaire according to the five-point Likert scale employed (σ = 0.52)

As seen in Table 7.4, the majority (mean of 4.37) of the people that completed this section used their vehicle daily. Thus, they show no interest in public transportation or other modes of transport. They do adhere to the speed limits with a total mean of 4.07. Thus, most of the vehicles, according to this survey, drive safely and abide by the speeding laws of the road. Environmental considerations are made when using their vehicles (mean of 4.23) even though it is more environmentally friendly to not use a vehicle at all. Different modes of non-motorised transport are considered (e.g. cyclist and pedestrians) (mean of 4.26). The above sections all have a mean of more than four and can be considered as more important than the other categories. The following scored between three and four in a more moderate category: The classification of their acceleration speed (mean of 3.35), to use their vehicle for carpooling (mean of 3.32), to change their mode of transport to public transportation or to non-motorised transportation if it was a viable option (mean of 3.22) and to change their habits for the improvement of their health (mean of 3.21). As seen in this section, it may be challenging to convince the respondents to change their mode of transport. They are not willing to change their mode for environmental reasons or health reasons even if carpooling is an option. Even though it is mentioned as not willing, it still scored with a mean of between three and four.

The qualitative data pertained to the comments of the respondents in Part B of the data collection tool and serves as an explanatory role in this study (see Table 7.6). Only the quantitative considerations of carpooling, sharing of the road with other road users, and preference to use this

mode emerged in the qualitative analysis. Overlapping codes are coloured coded in Table 7.6 to show that some codes relate to economic, environmental, spatial and/or social considerations.

Table 7.6: Emerging qualitative codes of Part B of the questionnaire

KEY CONSIDERATIONS	EMERGING QUALITATIVE CODES	QUANTITATIVE MEAN
ECONOMIC CONSIDERATIONS	High fuel prices (-)	
	Carpooling (+)	
ENVIRONMENTAL CONSIDERATIONS	Carpooling (+)	Carpooling or ride-along (mean = 3.32)
SPATIAL CONSIDERATIONS	n/a	n/a
SOCIAL CONSIDERATIONS	Time (shorter trip duration) (+)	
	Flexibility (ability to make flexible stops) (+)	
	Sharing road with pedestrians and cyclist (+)	Sharing of road with pedestrians and cyclist (mean = 4.26)
	Preference to use mode (+)	Using this mode of transportation (mean = 4.37)
	Enjoyment (using mode) (+)	
OTHER	Age consideration	
	Gender (reason for a new car)	

7.2.2.1 Economic considerations for Part B

For this section, no economical consideration questions have been included in the quantitative components of this part; however, the negative impact of high fuel prices on this mode of transportation emerged from the qualitative data (see Table 7.6). Carpooling is interpreted as a positive economic consideration in this instance and also promotes the reduction of the number of vehicles on the road, which in turn leads to reduced emission gasses. This promotes environmental protection considerations, therefore, the overlapping codes amongst the themes (see green highlight in Table 7.6).

> *Petrol price is too high* (Participant 95).

7.2.2.2 Environmental consideration for Part B

Question 15.7 (n = 147) is linked to the social responsibility in respect of the environment when a personal vehicle is used. A percentage of 56.46% (n = 83) of respondents say they are always aware of the environmental impact of their mode of transportation. This is a high percentage, which is more than half of the respondents; 23.13% (n = 34) of the respondents selected the option frequently. Thus 79.59% (n = 117) of respondents think about the environmental impact frequently or always, as asked

in this question (15.7). This correlates with the literature findings in Chapter 4, section 4.3.2. This section has a mean of 4.23 and is seen as important. Personal vehicle users do feel responsible for the environment.

7.2.2.3 Spatial considerations for Part B

Awareness towards cyclists or pedestrians is seen as important in multiple sections of the literature review (2.2; 2.3.1.1; 2.5.1; 3.3; 3.4.2; 3.5.1; 3.5.1.1.b; 3.5.1.2; 4.3.3; 4.4.2), and the willingness to stop for them at required times. As seen in Table 7.4, there are 56.86% (n = 87) of the respondents that feel they are always aware of cyclists and pedestrians when they drive, with 22.88% (n = 35) being frequently aware. According to the data, 79.74% (n = 122) of respondents are frequently and always aware of the questions stated in Table 7.4. The mean of this question is 4.26, which is high. This indicates that respondents do consider pedestrians and cyclists while driving their vehicles.

I like sharing the road with pedestrians and cyclist because we all need road (Participant 201).

7.2.2.4 Social consideration for Part B

Question 15.11 (n = 154) is about changing the mode of transport to improve one's health by walking or cycling more. From the data provided, it is seen that 38.96% (n = 60) of the respondents agree with the question with 14.29% (n = 22) of the respondents strongly agreeing; 16.23% (n = 25) of respondents are neutral, 14.94% (n = 23) disagree and 15.58% (n = 24) strongly disagree. This question has a mean of 3.21 which is much lower than the average mean (3.75) of this section. This question is less important than the other questions where respondents feel less reluctant to change their mode of transport.

I enjoy using my [private] transport as it is more faster and I can stop wherever whenever I want to (Participant 201).

Driving behaviour relates to the next question with regard to adherence to the speed limit (question 15.5; n = 152). Speed refers to the running speed of a vehicle of a streak of road and is mentioned in Chapters 2, 3 and 4 (see 2.2; 2.3.1.1; 3.4.3; 4.3.2). The respondents indicated that most of them (53.29%; n = 81) adhere to the speed limit with some of them (23.68%; n = 36) adhering to the speed limit frequently. This indicates that 76.97% of the respondents frequently or always adhere to the speed limit. The mean of the question is above four (4.07) which indicates that most of the respondents do adhere to the speed limit and that it is an important parameter for this section.

Yes, I would suggest that taxi drivers limit their speed more especially in Dr Bachior road every morning rush hour and in the afternoon (Participant 110).

Question 15.6 (n = 153) is a continuation of question 15.5 which looks at the acceleration of their vehicle. From the data in Table 7.4, it is seen that the respondents mostly (n = 101; 66.01%) have an acceleration that is categorised as medium. Few respondents selected very slow and slow, with a combined total of 3.92% (n = 6); 20.92% (n = 32) of the respondents accelerate fast, and 9.15% (n = 14) of the respondents accelerate very fast. The mean of this question is 3.35. Most of the drivers have a moderate acceleration speed.

The qualitative analysis highlighted the importance of respondents' time, the flexibility private vehicles offer, and their willingness to share the road with other road users. Respondents that use this mode of transportation also prefer this mode above others and enjoy using it.

I enjoy using my transport as it is more faster and I can stop wherever whenever I want to. I like sharing the road with pedestrians and cyclist because we all need road (Participant 201).

7.2.3 Data analysis and findings for Part C of the questionnaire: Public transportation respondents (max n = 330)

The following section focuses on respondents that use public transportation. Table 7.7 outlines the means for each question in Part C of the questionnaire. Similar to the prior section, the standard deviation of this section is also low (σ = 0.39), which indicates that respondents had a small variety in opinion regarding which considerations were important or neutral. Figure 7.11 supports this finding. The average mean of this section is 4.09, with the most popular answer in this section being strongly agree (39.58%) and the lowest option being disagree (7.98%). This section contained only six questions, of which five scored a mean of greater than 4.00. The importance for a participant to have a park-and-ride option available at their nearest public transportation stop was the only question in this section that obtained a mean of less than four (see question 23.6 in Table 7.7).

The only question with a mean less than 4.00 was, "*it is important for me to have a park-and-ride option available at my nearest public transportation stop"* (see question 23.6 in Table 7.7).
As seen in Table 7.7. it is clear that question 23.5 has the most significant mean with a mean of 4.56 and a combined total (frequently and always) of 92.07%. This indicates that the respondents do

consider their health when using public transportation and feel it is very important. In the second place is question 23.4. with a mean of 4.27 with a combined total (frequently and always) of 85.89%. This indicates that the respondents have a sense of the impact on the environment when using public transportation with a high number of respondents selecting this option. In the third place is question 23.8. with several respondents selecting agree and strongly agree with a total of 83.44%. The respondents feel that public transport is affordable with a mean of 4.13. In fourth place is the distance they need to travel to a public transport stop (question 23.1) with a mean of 4.13 and an accumulative percentage of 88.04% between agree and strongly agree. In the fifth place is the question with regard to the use of public transport. This section obtained a mean of 4.10 with a combined percentage of 70.53%. which is lower than the other questions. The last question (23.6) has the lowest mean of 3.38 with a combined percentage of agree and strongly agree at 60.61%. This indicates that these respondents are not interested in a park-and-ride option near their public transportation stop.

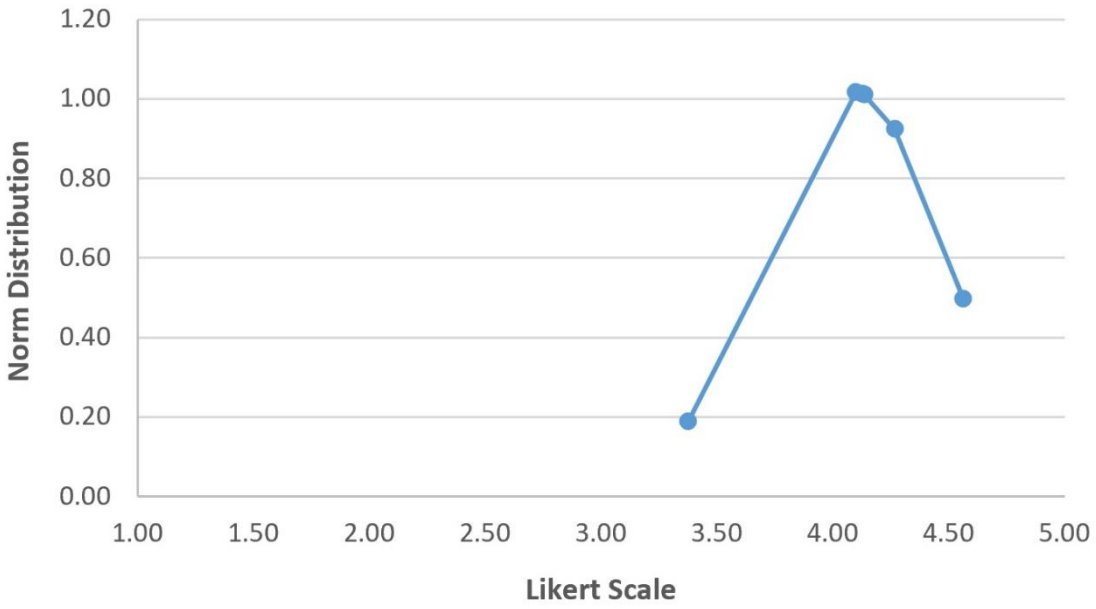


Figure 7.11: Bell curve of mean distribution of Part C of the questionnaire according to the five-point Likert scale employed (σ = 0.39)

Table 7.7: Quantitative data analysis of the questions in Part C of the data collection tool

Questions	*Question Number*	*Never*		*Rarely*		*Occasionally*		*Frequently*		*Always*		*Mean*
I use public transportation to travel (n = 302)	23.1	18	5.96%	31	10.26%	40	13.25%	27	8.94%	186	61.59%	4.10
I consider my social responsibility towards the environment when I use public transportation (n = 326)	23.4	19	5.83%	5	1.53%	22	6.75%	104	31.90%	176	53.99%	4.27
I consider my health when I use public transportation (n = 328)	23.5	12	3.66%	5	1.52%	9	2.74%	62	18.90%	240	73.17%	4.56
Questions	***Question Number***	***Strongly Disagree***		***Disagree***		***Neutral***		***Agree***		***Strongly Agree***		***Mean***
It is important for me to have a park-and-ride option available at my nearest public transportation stop (n = 330)	23.6	61	18.48%	43	13.03%	26	7.88%	111	33.64%	89	26.97%	3.38
It is important for me that the distance from my public transportation stop is not too far from where I need to go (n = 326)	23.7	13	3.99%	9	2.76%	17	5.21%	171	52.45%	116	35.58%	4.13
I feel public transportation is an affordable transportation mode for me (n = 326)	23.8	12	3.68%	23	7.06%	19	5.83%	127	38.96%	145	44.48%	4.13
Sum		**135**		**116**		**133**		**602**		**952**		
Mean		**22.50**		**19.33**		**22.17**		**100.33**		**158.67**		
% Selected		**6.97%**		**5.99%**		**6.86%**		**31.06%**		**49.12%**		
SD												**0.39**

The qualitative data pertained to the comments of the respondents in Part C of the data collection tool and served as an explanatory role in this study. The qualitative data analysis of this part of the questionnaire contained rich information from which 46 codes emerged which mostly relate to the theme of social considerations of this study (see Table 7.8). Overlapping codes are coloured coded in Table 7.8 to show that some codes relate to economic, environmental, spatial and/or social considerations.

Table 7.8: Emerging qualitative codes of Part C of the questionnaire

KEY CONSIDERATIONS	EMERGING QUALITATIVE CODES	QUANTITATIVE MEAN
ECONOMIC CONSIDERATIONS	Affordable (-) and (+)	I feel public transportation is an affordable transportation mode for me (mean = 4.13)
	Fares (-)	
	Fares (economic considerations) (-)	
	Fares: Problems with tickets (-)	
	Fares: Wasting time of commuters to wait for full fares (-)	
ENVIRONMENTAL CONSIDERATIONS	Condition of roads (-)	
	Road safety (general) (-)	
	Road safety (from origin to destination) (-)	
	Road Safety (good and safe conditions) (-)	
	Safety (Road – Reckless driving) (-)	
	Environment (clean) (-)	
	Environment (good) (-)	
	Health (environment) (-)	
	Maintenance (-)	
	Speed Limit (-)	
	Weather (cold in warm weather) (-)	
	Weather (heat in cold weather) (-)	
SPATIAL CONSIDERATIONS	Time (reduced trip duration) (-)	
	Access (general) (-)	
	Access (limited access in some towns and rural areas) (-)	
	Access (mode of transport) (-)	
	Access (no access – use private mode) (-)	
	Routes (-)	
	Routes (limit of routes in a specific residential area) (-)	
	Routes (to promote mobility/flexibility) (-)	
	Road safety (from origin to destination) (-)	
	Distance (from the access point) (-)	Importance of distance from the stop (mean = 4.13)
	Distance (travel) (-)	
SOCIAL CONSIDERATIONS	Time (on time) (-)	
	Time (respect) (-)	

KEY CONSIDERATIONS	EMERGING QUALITATIVE CODES	QUANTITATIVE MEAN
	Access (information; i.e. newsfeed) (-)	
	Access (limited access in some towns and rural areas) (-)	
	Access (mode of transport) (-)	
	Access (no access – use private mode) (-)	
	Affordable (-) and (+)	I feel public transportation is an affordable transportation mode for me (mean = 4.13)
	Comfortable (-)	
	Flexible (-)	
	Reliable (-)	
	Road safety (general) (-)	
	Road safety (from origin to destination) (-)	
	Road Safety (good and safe conditions) (-)	
	Safety (general) (-)	
	Safety (Road – Reckless driving) (-)	
	Condition of transport (clean) (-)	
	Condition of transport (good) (-)	
	Health (passengers) (-)	I consider my health when using this mode of transportation (mean = 4.56)
	Limit number of passengers (-)	
	Operational Hours (extended) (-)	
	Operational Hours (flexible) (-)	
	Speed Limit (-)	
	Respect for commuters (-)	
	Efficient (-)	
	Personal preference not to use this mode (-)	Using this mode of transportation (mean = 4.10)
	Satisfied users (-)	
	Usage (-)	
OTHER	Disability needs (+)	

7.2.3.1 Economic considerations for Part C

The importance of affordability for public transportation is asked in question 23.8 (n = 326). This is previously discussed in Chapter 3 of the literature review (3.4.1; 3.5.1.1.b) and included in the questionnaire. It is interesting to note that most respondents (n = 145; 44.48%; mean = 4.56) indicated that public transportation is an affordable mode of transportation to use in the study area according to the quantitative data analysis. However, from the qualitative data analysis it emerged that because most respondents agreed that public transportation is affordable, affordability for all is a consideration that needs to be considered in the policy guidelines. Affordability (-) and (+) of public transportation is an overlapping code in both economic and social considerations. In some instances,

respondents that indicated that public transportation is affordable mentioned that due to other reasons such as flexibility, reliability or safety they do not use it (see the verbatim quote of Participant 199 for an example).

Affordable (-)

> *I walk to work, because taxis prices is too much for me. I earn little money* (Participant 218).
>
> *Is that am a hawker. and most of time I buy a ticket of seven days and it expires before trips ended* (Participant 210).

Affordable (+)

> *Public transport is an affordable transportation. But sometimes it's difficult for me to use public transport because some of the transports aren't stable or allowed to be on the road* (Participant 199).

Other qualitative codes pertaining to affordability also emerged from the data analysis, such as issues with fares, problems with ticketing, and wasting of commuters' time while waiting for the taxi to fill up ('full fares'). The remainder of the options obtained a low selection frequency with neutral at 5.83% (n = 19), disagree at 7.06% (n = 23) and strongly disagree at 3.68% (n = 12).

> *Public transportation should be a sun and good environment for the road users or passenger, the minibus taxis must go straight to the home. From home and not wasting times of the passenger by looking for more passengers along the ways* (Participant 400).

7.2.3.2 Environmental consideration for Part C

Question 23.4 (n = 326) focused on the respondents' responsibility to the environment when they use public transport. Public transport is a more environmentally friendly option compared to using a personal mode of transportation (see 4.3.2). More than half of the respondents (53.99%; n = 176) indicated that they always consider their social responsibility towards the environment when they use public transportation. This question achieved a mean of 4.27, and as a result, will be included in the proposed policy guidelines of this study. Qualitative codes that relate to environmental considerations are all negative views of the:

- current conditions of the roads on which respondents need to travel (see verbatim quotations of respondents 199 and 375);

- the stance of road safety in general, during respondents' commute from their origin to destination, and the poor conditions in which respondents often need to travel (see the verbatim quotation of participant 407);
- reckless driving by public transportation drivers which often includes not adhering to the speed limit (see the verbatim quotation of participant 295);
- an environment that is not clean which impacts respondents' health (see verbatim quotations of respondents 370 and 425);
- on proper maintenance of public transportations (see the verbatim quotation of participant 376); and
- the suitability of the temperature inside public transportation (see the verbatim quotation of participant 428).

Public transport is an affordable transportation. But sometimes it's difficult for me to use public transport because some of the transports aren't stable or allowed to be on the road (Participant 199).

Drivers are reckless and don't always follow rules of the road (Participant 295).

Health environment is one of the most important aspect that must be placed on the reviews of the public transportation (Participant 370).

Public transportation supposed to be in good and safety condition for the users who use them to avoid accident of the public transportation on the road (Participant 375).

Public transport should be maintenance on regularly buses, and also flexible, comfortable to the transportation users (Participant 376).

Public transportation should be health, clean environment and travel trips faster so that transport users cannot be late to work (Participant 378).

Public transportation should or must always be clean and in good condition for the benefits of the travellers or transportation users (Participant 389).

Public transportation should or must take users of transportation to the work safe and should take workers back to home (Participant 407).

Health environment is one of the most important aspect that must be placed on when the review or improvement want to be done regarding transport system to improve travelling for users of the public transportation (Participant 425).

Public transportation should have heat that can warm the passenger during the winter and fan must be installed to be operated during summer and also for news feed (Participant 428).

7.2.3.3 Spatial considerations for Part C

The distance one needs to travel (see 2.3.1.1; 3.5.1.1.b; 3.5.1.2) to a public transportation stop is mentioned in question 23.7 (n = 326). In this section. 52.45% (n = 171) of the respondents agree that it is important for a public transportation stop to be close to them with 35.58% (n = 116) that strongly agree. This contributes to 88.03% (n = 287) of the respondents who agree and strongly agree. The mean for this question is 4.13 which indicates the topic is important to the respondents. They do not want to walk great distances to their transportation and prefer it to be close to their home or place of work as seen from the emerging qualitative codes of *Distance (from the access point) (-)* and *Distance (travel) (-).*

Yes! Sometimes I walk a long distance and it gets tiring because there are no taxis moving around to help those who are walking (Participant 133).

Public transportation is only accessible in Fauna during the week, on weekends no public transport, one has to walk a long distance to get transport. If this can be taken into consideration, we would be very much happy (Participant 303).

Other qualitative codes relate to time, access, routes and road safety. Respondents pointed out that access to public transportation is often limited in certain areas (see verbatim quotes of respondents 303, 348, and 420) or that there is no access to one mode which forces commuters to use other modes of transportation. As a result, access refers to the need for more flexible routes to accommodate the needs of commuters. All the codes associated with access overlap with the social considerations theme of this study, since it impacts on the social justice parameters of accessibility as pointed out in the literature (see the table of summary of key considerations at the end of Chapter 4).

Our public transport need to meet us half way at least get into our location (Participant 348).

The routes of the minibuses should be closer to the home of the workers as they are the one who is using the public transportation to the work and back home everyday (Participant 408).

Minibus taxis should have the special routes that will be easy accessible, flexible and also comfortable (Participant 420).

Question 23.6 (n = 330; i.e. It is important for me to have a park-and-ride option available at my nearest public transportation stop) is the only question that received a mean less than four. However, the majority of the respondents either agree (n = 111; 33.64%) or strongly agree (n = 89; 26.97%) with the need for park-and-ride options. However, in line with the minimum mean of the importance of each consideration, park-and-ride options are tentatively excluded from the policy guidelines.

7.2.3.4 Social consideration for Part C

Health considerations are important concerns when considering options, as seen in multiple sections of the literature review (see 2.3.1.3; 2.4.1; 2.4.3; 3.4.2; 3.4.3; 3.5.1.1.b; 3.5.1.2; 4.3.1; 4.3.3). Question 23.5 (n = 328) is linked to a respondents' perception of health when using public transportation. This includes being more active by walking or cycling when accessing public transportation at the required stops. As seen in Table 7.7, many respondents (73.17%; n = 240) are always aware of their health conditions when they use public transportation. The qualitative data analysis highlighted another health consideration, namely the impact that the environment of public transportation has on their health, as already pointed out in section 7.2.3.2 (see verbatim quotes of respondents 370 and 378).

Time is another social consideration that emerged from the qualitative data. Respondents pointed out that there is a need for public transportation that ensures that they are on time for their work, thus transportation that is on time.

Public transportation should be more available routes network so that public transportation users cannot be late to the destination (Participant 369).

Public transportation should be health, clean environment and travel trips faster so that transport users cannot be late to work (Participant 378).

Public transportation should always be on time on the travel routes so that users of public transportation don't become late on their jobs and home (Participant 381).

Other qualitative codes that did not emerge in this section (economic, environmental or spatial considerations for Part C), are:

- access to information whilst using public transportation (see the verbatim quote of participant 428);
- the comfort of passengers whilst using this mode of transportation (see verbatim quotes of participant 397, 428, and 414);
- the need for more flexible, reliable and efficient services (see the verbatim quote of participant 414);
- improved safety of the commuters/passengers (see the verbatim quote of participant 397);
- the poor condition of the vehicles (e.g. buses, minibus taxis) (see verbatim quotes of participant 199 and 397);
- the need to limit the number of passengers carried during commutes (see the verbatim quote of participant 428);
- flexible or extended operational hours to accommodate the needs of respondents (see the verbatim quote of participant 426); and
- respect for passengers (see the verbatim quote of participant 330).

Public transport is an affordable transportation. But sometimes it's difficult for me to use public transport because some of the transports aren't stable or allowed to be on the road (Participant 199).

Our minibus driver need to respect our time (Participant 330).

Public transportation should be not ramfull inside and safety for passengers and also flexible and comfortable (Participant 397).

Public transportation should be cheaper, affordable and not overloaded with passenger, and also comfortable for the users of the public transportation (Participant 400).

Public transportation should be cheaper, affordable, flexible and comfortable to the users of the transportation on daily basis from work to home and home to work (Participant 414).

Some workers who use public transportation work easily in the morning like 06:00 AM until later 18:00 PM, so public transportation should or must accommodate people who's using it on daily basis (Participant 426).

Public transportation should have heat that can warm the passenger during the winter and fan must be installed to be operated during summer and also for news feed (Participant 428).

7.2.4 Data analysis and findings for Part D of the questionnaire: Non-motorised transport (max n = 331)

This section focuses on all the respondents that use non-motorised transport in some part of their daily transport. This is either by walking or cycling to a bus stop or walking or cycling as a primary mode of transportation. Table 7.9 provides a summary of the means of the different questions answered by the respondents. The standard deviation of this section is the lowest of all the sections of this study ($\sigma = 0.33$). Figure 7.12 showcases the distribution of the mean and highlights the low variety in opinion regarding which considerations were important or neutral.

As seen in Table 7.9, the question (26.4) that stood out is with regard to the respondents' responsibility to the environment when using non-motorised transportation. This is the only question that obtained a mean of more than four (4.35) and has a combined (frequently and always) percentage of 87.65%. This indicates the importance of this question. The second most important question is related to the use of non-motorised transport because it is convenient. The mean (3.96) for this question is just below four but has a combined (agree and strongly agree) percentage of 76.06% which is below 80%. This indicates that respondents do feel comfortable when using non-motorised transportation. The question in the third position is when respondents use non-motorised transport to access to public transportation. The mean (3.95) for this question is also just below four and has a combined (agree and strongly agree) percentage of 80.06% which is the last of the questions in this section that scored more than 80%. This indicates that respondents use multiple modes of transportation to commute

from one area to another. In the fourth place is the question related to the respondents using public transportation. This question has a mean of 3.94 and a combined (frequently and always) percentage of 75%. In the fifth place is the question related to the safe storage space for a bicycle when using public transportation. The mean for this question is 3.91 with an overall (agree and strongly agree) percentage of 76.66% for this question. This may be a viable option for the future with the mean that is close to four and the percentage being just below 80%. In the sixth position is the question related to a neighbourhood being pedestrian and cycle-friendly. The mean for this question is 3.64 which is significantly lower than the mean of the previous question with a combined (agree and strongly agree) percentage of 62.69%. This indicates that this is a less important question than the previous ones. In the seventh position is the question related to the respondents that use non-motorised transport to save on transportation costs. This question is less popular with a mean of 3.56 and a combined (agree and strongly agree) percentage of 64.63%. The last question relates to the use of non-motorised transport because the participant has no other option. This question received the worst feedback for this section with a mean of 3.25 and a combined percentage of 56.57% (agree and strongly agree).

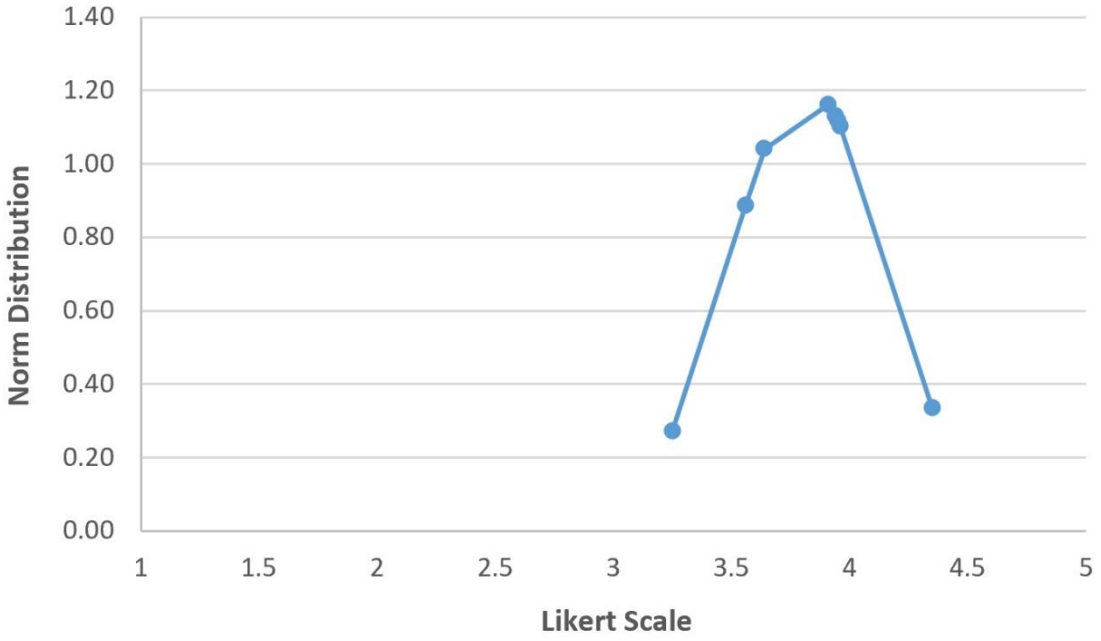


Figure 7.12: Bell curve of mean distribution of Part D of the questionnaire according to the five-point Likert scale employed (σ = 0.33)

The qualitative data pertained to the comments of the respondents in Part D of the data collection tool and serves an explanatory role in this study (see Table 7.10). Four of the eight quantitative considerations emerged in the qualitative analysis as can be seen in Table 7.10. The colour-coded highlights in the table below highlight the data which overlaps in the key considerations.

Table 7.9: Quantitative data analysis of the questions in Part D of the data collection tool

Questions	*Question Number*	*Never*		*Rarely*		*Occasionally*		*Frequently*		*Always*		*Mean*
I use non-motorised transportation to travel (n = 304)	26.1	13	4.28%	37	12.17%	26	8.55%	107	35.20%	121	39.80%	3.94
I consider my social responsibility towards the environment when I walk or cycle (n = 324)	26.4	8	2.47%	5	1.54%	27	8.33%	108	33.33%	176	54.32%	4.35
Questions	***Question Number***	***Strongly Disagree***		***Disagree***		***Neutral***		***Agree***		***Strongly Agree***		***Mean***
I walk or cycle to reduce my transportation cost (n = 328)	26.5	45	13.72%	36	10.98%	35	10.67%	113	34.45%	99	30.18%	3.56
I walk or cycle because I do not have another means of transport (n = 327)	26.6	69	21.10%	51	15.60%	22	6.73%	98	29.97%	87	26.61%	3.25
I walk or cycle to my nearest public transportation stop (n = 331)	26.7	21	6.34%	18	5.44%	27	8.16%	157	47.43%	108	32.63%	3.95
I walk or cycle because it is the most convenient mode of transportation for me (n = 326)	26.8	19	5.83%	16	4.91%	41	12.58%	134	41.10%	116	35.58%	3.96
My neighbourhood is walk- and cycle-friendly (n = 327)	26.9	13	3.98%	51	15.60%	58	17.74%	125	38.23%	80	24.46%	3.64
When I use my bicycle to travel to work/shop/bus stop there are safe storage spaces for my bicycle (n = 317)	26.10	34	10.73%	19	5.99%	21	6.62%	110	34.70%	133	41.96%	3.91
Sum		222		233		257		952		920		
Mean		24.67		25.89		28.56		105.78		102.22		
% Selected		8.59%		9.02%		9.95%		36.84%		35.60%		
SD												0.33

Table 7.10: Emerging qualitative codes of Part D of the questionnaire

KEY CONSIDERATIONS	EMERGING QUALITATIVE CODES	QUANTITATIVE MEAN
ECONOMIC CONSIDERATIONS	Walk because of economic stance = too high minibus taxi prices (-)	I walk or cycle to reduce my transportation cost (mean = 3.56)
	Economic consideration (saves money) (+)	
	Preference to use bicycle due to part-time employment	
ENVIRONMENTAL CONSIDERATIONS	N/A	
SPATIAL CONSIDERATIONS	Routes (limited) (-)	
	Sidewalks (sufficient) (-)	My neighbourhood is walk- and cycle-friendly (mean = 3.64)
	Storage space for bicycle (-)	When I use my bicycle to travel to work/shop/bus stop there is safe storage space for my bicycle (mean = 3.87)
SOCIAL CONSIDERATIONS	Access (limited access to public transportation) (-)	
	Safety (theft) (-)	My neighbourhood is walk- and cycle-friendly (mean = 3.64)
	Health (personal) (+)	
	Preference to use bicycle due to part-time employment	I walk or cycle because it is the most convenient mode of transportation for me (mean = 3.96)
	Usage (multi modes of transportation)	
OTHER	N/A	

7.2.4.1 Economic considerations for Part D

Question 26.5 (n = 328) is about the reduction of transportation costs by either walking or cycling. This may be due to a lack of funds forcing a participant to walk or cycle. Although this question has a mean of only 3.82, emerging qualitative codes (i.e. W*alk because of economic stance = too high minibus taxi prices (-)*; *Economic consideration (saves money) (+),* and *Preference to use bicycle due to part-time employment*) supports the need to acknowledge the economic considerations of respondents since it impacts their choice of mode of transportation.

> *Sometimes I use my bicycle to travel to shops because it saves me money and it also improves my health* (Participant 199).
>
> *Walk because of economic stance; too high minibus taxi prices* (Participant 218).

7.2.4.2 Environmental consideration for Part D

Question 26.4 (n = 324) relates to the respondents' feeling of responsibility to the environment when they use non-motorised transportation. In total, 87.65% (n = 284) of respondents either agree (33.33%; n = 108) or strongly agree (54.32%; n = 176) that non-motorised transportation protects the environment. No qualitative codes emerged for environmental considerations in this part of the questionnaire.

7.2.4.3 Spatial considerations for Part D

Question 26.9 (n = 327) reports on the friendliness of the respondents' neighbourhoods regarding walking and cycling (i.e. *My neighbourhood is walk- and cycle-friendly*). The mean of this question is 3.64 which indicates that respondents are not in agreement with this statement which is supported by the emerging qualitative codes of insufficient sidewalks, limited storage space for bicycles and limited routes available (see Table 7.10). Sufficient sidewalks, in particular, link to the dominant spatial themes of this century (see 2.3).

There should be sufficient sidewalks and safe storage for bicycle (Participant 334).

More storage space for bicycle need to be implemented in the shops, school, work, etc. (Participant 346).

7.2.4.4 Social consideration for Part D

Question 26.7 (n = 331) addresses if respondents walk or cycle to their nearest public transportation stop. From the data obtained it is seen that 47.43% (n = 157) of respondents agree with this question and 32.63% (n = 108) of respondents strongly agree. This indicates that 80.06% (n = 265) of respondents agree or strongly agree with this question. The mean of the question is at 3.96 which is very close to the inclusion limit for the proposed policy guidelines. No directly related qualitative codes emerged (see Table 7.10). However, respondents did indicate that they often use multiple transportation modes due to limited access to their preferred mode.

Yes! Sometimes I walk a long distance and it gets tiring because there are no taxis moving around to help those who are walking (Participant 133).

Other considerations that emerged from the qualitative data include safety (see verbatim quotes of respondents 346 and 348), improving personal health (see verbatim quotes of respondents 59 and 199), and preference to use this mode of transportation (see a verbatim quote of respondents 115).

Sometime I like to walk is good for my body (Participant 59).

I always prefer using my bicycle every time I go to work since I am working only for part-time (Participant 115).

Sometimes I use my bicycle to travel to shops because it saves me money and it also improves my health (Participant 199).

Safety for our bicycle need to be considered (Participant 346).

Lack of safety for bicycle in the area (Participant 348).

7.2.5 Summary of the data analysis and findings of the questionnaire

This section discusses the summary of the quantitative and qualitative data analysis and interpretation of sections 7.2.1 to 7.2.4 of this chapter with the aim to identify proposed policy guidelines to meet objective 4 of this study.

On the whole, the quantitative data analysis of this study indicated a limited difference in respondents' opinions for the questions and statements included in the data collection tool. The standard deviation of all parts of the questionnaire is 0.41 which indicates that data are all clustered closely around the mean of this questionnaire (mean = 3.75; see Figure 7.13). Table 7.11 summarises all the considerations which obtained a mean of 4.00 or more according to the mean of the question. A total of 18 (n = 18) considerations emerged from the quantitative analysis with the consideration with the highest mean being *I consider my health when I use public transportation* (mean = 4.56), and the considerations with the lowest mean being *the cost/affordability of my transportation* (mean = 4.02) and *access to use my transportation mode* (mean = 4.02). The questions with a mean below four were tentatively excluded from the proposed policy guidelines although some may be included again in the light of the qualitative data analysis. Figure 7.14 provides a summary of the emerging codes and themes of the qualitative data analysis of this study. The different sections from which the codes emerged in the questionnaire are indicated by the following abbreviations: PT – Private Transportation (Part B); PUB – Public Transportation (Part C), and NM – Non-motorised Transportation (Part D). Codes with no abbreviation emerged from Part A of the questionnaire.

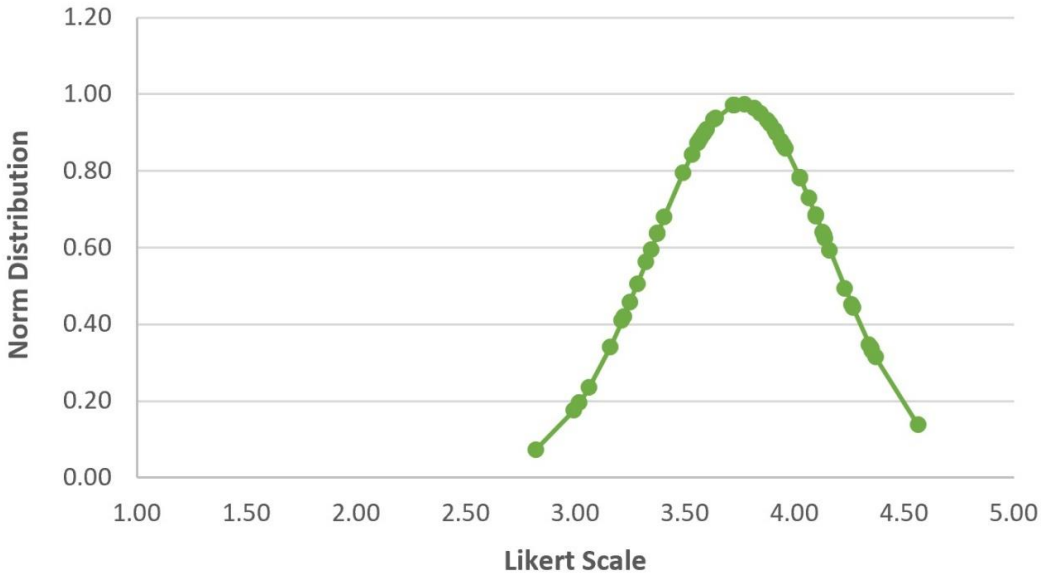


Figure 7.13: Bell curve of mean distribution of Part A, B, C and D of the questionnaire according to the five-point Likert scale employed (σ = 0.41)

Table 7.11: Summary of the guidelines derived from the quantitative data analysis of the questions in Part A, B, C and D of the data collection tool

Questions	***Mean***	***Part***
I consider my health when I use public transportation (n = 328)	4.56	C
I use my personal vehicle to travel (n = 127)	4.37	B
The road safety of my transportation mode (n = 413)	4.36	A
I consider my social responsibility towards the environment when I walk or cycle (n = 324)	4.35	D
The general safety of my transportation mode (n = 412)	4.34	A
I consider my social responsibility towards the environment when I use public transportation (n = 326)	4.27	C
I share the road with a cyclist or stop for a pedestrian… (n = 153)	4.26	B
I consider my social responsibility towards the environment when I use my personal vehicle (n = 147)	4.23	B
The reliability of my transportation mode (n = 414)	4.16	A
The distance I need to travel (n = 413)	4.14	A
It is important for me that the distance from my public transportation stop is not too far from where I need to go (n = 326)	4.13	C
I feel public transportation is an affordable transportation mode for me (n = 326)	4.13	C
The day and time I need to travel (n = 410)	4.10	A
I use public transportation to travel (n = 302)	4.10	C
I adhere to the speed limit (n = 152)	4.07	B
The duration of my trip (travel time) (n = 412)	4.03	A
The cost/ affordability of my transportation (n = 413)	4.02	A
Access to use my transportation mode (n = 409)	4.02	A

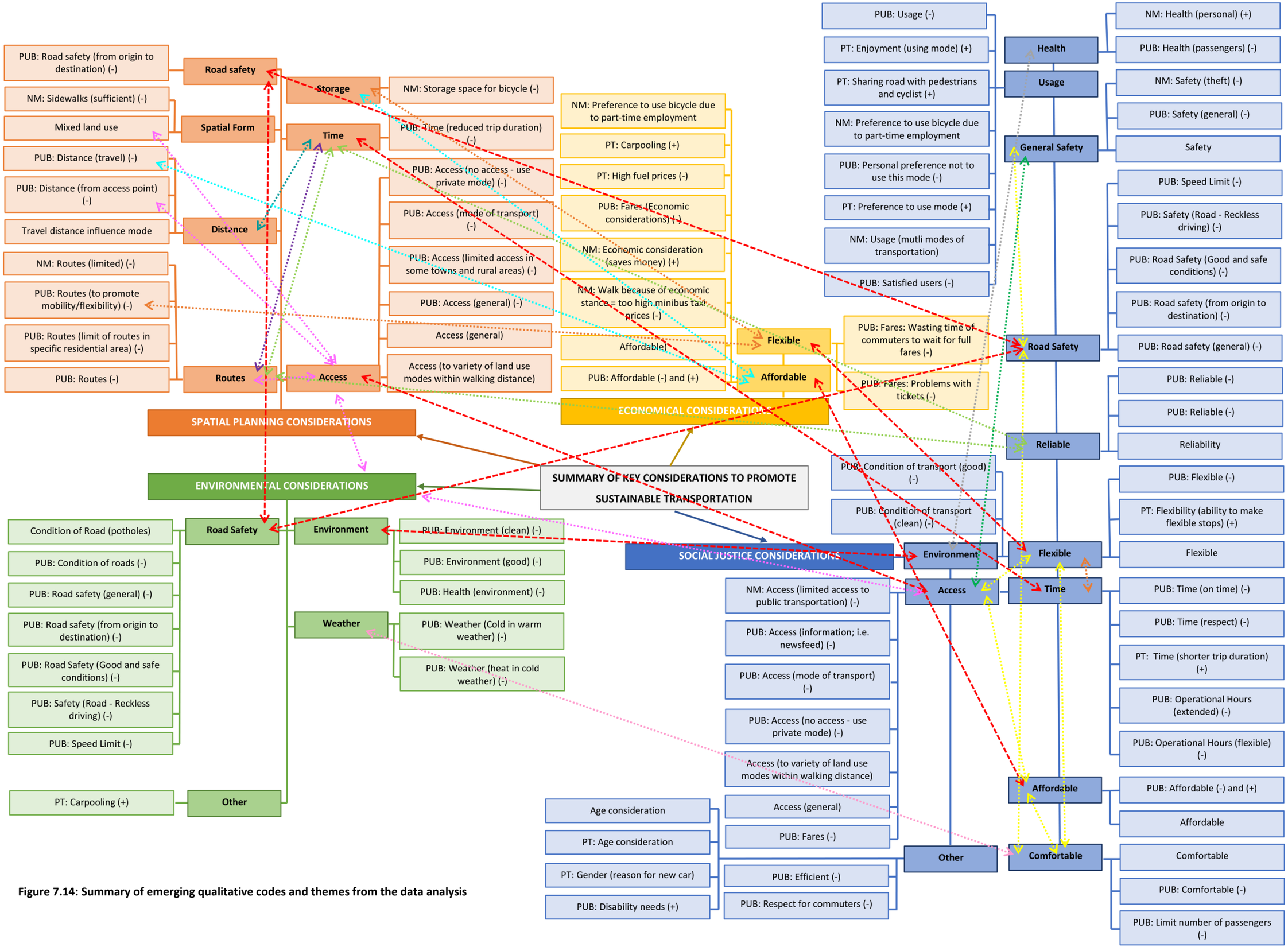


Figure 7.14: Summary of emerging qualitative codes and themes from the data analysis

The coding of the qualitative dataset was done to identify patterns of similarity, in order to identify which guidelines need to be added to the proposed policy guidelines of objective 4. Four dominant themes emerged from the qualitative data analysis in accordance with the literature, namely spatial (n = 18 primary codes), economic (n = 11 primary codes), environmental (n = 14 primary codes) and social (n = 48 primary codes) considerations. The social justice considerations emerged as the dominant theme in the qualitative data analysis of this study, which supports the viewpoint and needs of the population sample. Figure 7.14 points out, with red stippled arrows, the overlapping secondary codes amongst the themes. It is interesting to note these codes always link to one of the secondary codes in the social considerations theme, which supports once again the viewpoint and needs of the population sample. The emerging themes and codes from the qualitative data analysis are discussed at the hand of Table 3.1 which outlines the characteristics of BRT systems. Different coloured stippled arrows are used to show connections between the characteristics discussed below.

7.2.5.1 Accessible

Accessibility was often cited in the qualitative responses of the respondents with the need to have access to a variety of land uses, mode(s) of transportation, and information. The employment of mixed land use in spatial planning is one of the criteria that emerged from the literature. In the questionnaire, respondents had to indicate whether their residential area has houses, shops, schools and industrial/manufacturers/wholesalers (mean = 3.89) and if the area to which they commute daily has houses, shops, schools and industrial/manufacturers/wholesalers (mean = 3.85). However, the importance for respondents to have access to a variety of land uses within their immediate environment is considered important since it allows respondents to use non-motorised transportation modes which may have an impact on the environment. This is indicated in Figure 7.14 with a purple stippled arrow (⋯▸).

I do not stay far away from where I am working, so I like walking to my workplace and since we have a mall I usually buy those shops rather than going to town (Participant 182).

Most respondents indicated that access to their transportation mode is important when they decide which transportation mode to use when commuting (mean = 4.02). One participant indicated access to information, in particular, newsfeed, is important for them. The importance of respondents' need to have access to information of their transportation mode is supported in the literature (see Merkert et al., 2017:76; Wan et al., 2016:42) and achieved a mean of only 3.64; however, with the mention of it in the qualitative data and the support of the literature, this consideration will be included in the proposed policy guidelines.

Problems with public transportation fares were categorised under the theme of economic considerations, but in the light of literature (see Table 3.1) it was listed under the secondary code of accessibility under social considerations, since respondents should be able to use a ticketing/smart card system with ease (Adewumi & Allopi, 2013:3; Mallqui & Pojani, 2017:25; Wan et al., 2016:42).

Is that am a hawker, and most of time I buy a ticket of seven days and it expires before trips ended (Participant 210).

Other access considerations mentioned in the literature are (1) access to the system through multiple routes and transportation corridors (Deng & Nelson, 2012:108; Mallqui & Pojani, 2017:254; Wan et al., 2016:42), (2) access to the transportation access points (Mallqui & Pojani, 2017:254; Merkert et al., 2017:76; Van Ryneveld, 2018:2), and (3) the visibility of the system (Hensher et al., 2014:159). Firstly, the secondary code of routes emerged in the spatial considerations theme with respondents pointing out that limited routes are available which impacts their mobility (see Figure 7.14). The majority of respondents (n = 210; 58.99%) indicated in the questionnaire that they would use public transportation if more bus routes were available. The mean of this question was 3.38; however, the need to expand on the current public transportation routes is highlighted by the qualitative data analysis in Figure 7.14 to promote the mobility of the sample population (see the purple stippled arrow ⋯▸). Secondly, the spatial consideration of distance from the transportation access point was also coded from the qualitative responses of the qualitative section of the questionnaire. Distance from the transportation access point is an important consideration for respondents since it dictates their mode of transportation. In the quantitative section of the questionnaire, respondents indicated a mean of 3.88 in response to the question if their neighbourhood offers easy access to public transportation stops. Similar to the previous consideration, the qualitative data promotes the inclusion of this code in the proposed policy guidelines for objective 4. This link has also been indicated with a purple stippled arrow in Figure 7.14 (⋯▸). Thirdly, the visibility of the system did not emerge as a code from the qualitative data analysis, nor is it considered important from the quantitative analysis.

Yes! Sometimes I walk a long distance and it gets tiring because there are no taxis moving around to help those who are walking (Participant 113).

7.2.5.2 Affordable

The cost/affordability of respondents' transportation mode is regarded as important for respondents. The quantitative data analysis supports this statement (mean = 4.02) as well as the qualitative data analysis (see Figure 7.14). The Integrated Urban Development Framework of South Africa (2016:52-58) notes that due to the sprawling nature of South African cities, travel distances are often far which impacts the affordability of commuting. The cost of public transportation is an important consideration which impacts the sustainability of any public transportation system (National Household Travel Survey 2013:7; Deng & Nelson, 2012:108; Wan et al., 2016:42), such as the planned BRT system in MMM (link indicated with a light blue stippled arrow⋯▸in Figure 7.14). Another aspect pointed out in the literature is the need for affordable park-and-ride options for bicycles, motorcycles and private vehicles (Adewumi & Allopi, 2013:3; Merkert et al., 2017:76). Although this question achieved a mean of 3.38 in the quantitative data analysis, it was mentioned by respondents' qualitative responses, under the secondary code of storage in the spatial considerations theme (see the light blue stippled arrow⋯▸in Figure 7.14 to note this connection).

7.2.5.3 Comfortable

Merkert et al. (2017:76) and Wan et al. (2016:42) note that comfortability inside public transportation is an important consideration for commuters. Comfortability in public transportation did emerge as a code in the qualitative data analysis with respondents referring to the need for comfortable public transportation which is not overloaded (max number of passengers). The comfort of a transportation mode also impacts respondents' mode of transportation (see the verbatim quote of participant 272). The qualitative analysis accentuated the relationship that exists between comfortability, accessibility, flexibility, and affordability; since respondents mostly referred to public transportation that is accessible, flexible, affordable, and comfortable (see the bright yellow stippled arrow⋯▸ in Figure 7.14 under the social considerations theme to note this connection). Another connection that stood out from the qualitative analysis is the association with comfort and road safety. The UN launched the Global Plan for the Decade of Action for Safety in response to the nearly 1.3 million people that die each year in road traffic collisions due to insufficient improvement in road safety strategies and land use planning (UN, 2011:3) (see 4.3.3). Section 3.5.1.1.1 discusses the situation of the minibus taxi industry in South Africa and points out not only road safety issues but also the lack of general safety of commuters whilst using this transportation mode (see the bright yellow stippled arrow⋯▸ in Figure 7.14 under the social considerations theme to note this connection). Road safety is a secondary code associated with spatial, environmental and social considerations.

Yes, I would suggest that taxi drivers limit their speed more especially in Dr Bachior road every morning rush hour and in the afternoon (Participant 110).

I travel by means of a pool car from Bfn to Thaba Nchu. Used to travel by means of minibus in the past. Minibus was very uncomfortable (Participant 272).

Public transportation should pick up transport users from home and take them to work on daily buses, to avoid dangerous situation to the transport users on to the communication thugs (Participant 282).

Public transportation should be cheaper, easy to access and comfortable to the transportation user on daily basis (Participant 390).

Public transportation should be cheaper, affordable, not overloaded with passenger, and also comfortable for the users of the transportation (Participant 400).

Passengers or public transportation users must be comfortable and feel happy to use them as the transport is flexible, cheaper and affordable (Participant 410).

7.2.5.4 Connected

The literature states that BRT systems should provide a door to door service with seamless interchanges, minimum delays and visibility (knowing the movements of the different modes of transport in the area) (Hensher et al., 2014:159). No quantitative question links to this characteristic, but the secondary code of routes speaks to connectedness in public transportation with a link to time. The time association pertains mostly to travel time, but also to respect for commuters to be on time for their employment or appointments. See the dark purple stippled arrow (⋯▸) in Figure 7.14 under the spatial and social considerations theme to note this connection.

Our minibus driver need to respect our time (Participant 330).

Public transportation should always be on time on the travel routes so that users of public transportation don't become late on their jobs and home (Participant 381).

Public transportation must be available at all connection of the road, and have many routes as possible to safe travel time (Participant 404).

7.2.5.5 Flexible

Respondents pointed out the need for a transportation mode that is flexible in regards to operational hours, fares and stops which links to the themes of economic and social considerations. The need for flexibility of time of usage is supported in the literature (National Household Travel Survey 2013:7; Wan et al., 2016:42), although it only received a mean score of 3.56. Most respondents, however, did

indicate in the quantitative section of the questionnaire that they would use public transportation more often if the operational hours were more flexible (see Table 7.2; see the orange stippled arrow ⋯▸ in Figure 7.14). Another flexibility consideration is the need to connect with other modes of transportation such as walking and bicycling to promote the mobility of the poor (Deng & Nelson, 2012:108; Merkert et al., 2017:76; Venter et al., 2018:149). Affordable park-and-ride options may support such a flexible connection between the modes (see the orange stippled arrow ⋯▸ in Figure 7.14 noting the link between storage as a spatial consideration and flexibility as an economic consideration). Mallqui and Pojani, (2017:254) and Van Ryneveld (2018:3) also note that the transportation system itself needs to be flexible to accommodate various urban conditions. The majority of the respondents indicated that the flexibility/convenience that their transportation mode offers them is important (see Table 7.2); however, the mean was only 3.72. The qualitative data analysis supports that respondents consider the flexibility of stops and fares as important (see Figure 7.14).

Public transportation should be affordable, cheaper and operation hours be flexible to the works of the public transportation (Participant 370).

Public transportation must be available all time and also be cheap, flexible and reliable to people (Participant 424).

7.2.5.6 Frequent

Frequency of trips (see Table 7.1) per se was not indicated in either the quantitative nor qualitative data analysis; however, the qualitative codes of routes, time and reliability point to the need for frequency. Respondents noted the need for reliable public transportation that is on time so that it does not influence their employment, appointments or connections with a wider variety of routes to increase the mobility of respondents (see Figure 7.14). See the light green stippled arrow ⋯▸ in Figure 7.14 to note this link.

7.2.5.7 Reliable

In the previous section, the connection between frequency, time and reliability has already been made, but Babalik-Sutcliffe and Cengiz (2015:792) specifically note the punctuality of such a transportation system. The majority of respondents did indicate that they would make use of public transportation more often if the service was more reliable (see Table 7.2). However, this question received a mean of 3.59 in the quantitative data analysis, but respondents did indicate that it is important that their mode of transportation was reliable (mean = 4.34). The qualitative analysis sheds

light on the need for a punctual transportation mode (see verbatim quotes below). Therefore, the punctuality of the service is included in the proposed policy guidelines.

Public transportation should always be on time on the travel routes so that users of public transportation don't become late on their jobs and home (Participant 381).

Public transportation should always travel faster and be on time to be used by people who use public transportation on daily basis to works (Participant 409).

7.2.5.8 Safety (general and road safety)

The characteristic of safety includes safety in regard to vehicle accidents (National Household Travel Survey 2013:7), safety in regard to the use of the system, including security (Wan et al., 2016:42), and behaviour of staff (Wan et al., 2016:42). Safety was divided into general safety and road safety in the data collection tool. Respondents indicated that their general safety (mean = 4.34) and the road safety of the transportation mode (mean = 4.36) are both important when they select their transportation mode. Respondents indicated a neutral response regarding the safety of their residential area (mean = 3.02) and the areas in which they work, visit, shop and so forth (mean = 3.16) which impacts the importance of general safety of the commuter (see the verbatim quotation of respondents 282 and 383 in support of this finding). Therefore, general safety has a link to the social and spatial consideration of access (see the forest green stippled arrow⋯▸ in Figure 7.14), which links with the prior link between access and distance within the spatial considerations theme in Figure 7.14.

Public transportation should pick up transport users from home and take them to work on daily buses, to avoid dangerous situation to the transport users on to the communication thugs (Participant 282).

Public transportation routes should be more closer to the home of the transport users for safety purpose (Participant 383).

7.2.5.9 Speed (Reduced travel time)

The characteristic of speed relates to reduced travel time (see Table 7.1). The duration of respondents' trip (travel time) is an important factor when they select their transportation mode (mean = 4.03). The qualitative data support this finding as it emerged both in the spatial and social considerations themes in Figure 7.14. Another new link emerged between the impact of travel time and distance (see the teal stippled arrow⋯▸ in Figure 7.14).

Public transportation should be health, clean environment and travel trips faster so that transport users cannot be late to work (Participant 378).

Public transportation should always travel faster and be on time to be used by people who use public transportation on daily basis to works (Participant 409).

7.2.5.10 Sustainable (Environmental Protection)

The sustainable characteristics refer specifically to environmental protection. The environmental friendliness of respondents' mode of transportation was considered as a neutral response since it obtained a mean of 3.92. An entire theme emerged from the qualitative data analysis which notes the impact of the environment on road safety, the impact of the weather, and health of the respondents (see Figure 7.14).

In general, it seems that respondents do not make conscious decisions to protect the environment but that their decisions lead to environmental protection. One participant indicated he/she carpools daily, but not as an environmental decision, but rather a comfort decision (see the verbatim quotation of participant 272). Another participant opts to walk sometimes rather than use motorised transportation since it is good for his/her health, also not an environmental decision (see verbatim quotation of participant 59). Both these responses result in fewer vehicles on the road that improves the air quality and traffic flow (Venter et al., 2018:146), but not as a deliberate attempt to protect the environment. Similarly, one participant indicated she has a relatively new vehicle because of her gender (may be a safety concern) and not to reduce her emissions (see the verbatim quotation of participant 284) (Venter, et al., 2018:146).

Sometime I like to walk is good for my body (Participant 59).

I travel by means of a pool car from Bfn to Thaba Nchu. Used to travel by means of minibus in the past. Minibus was very uncomfortable (Participant 272).

My car is relatively new, I'm a girl. I don't know anything (Participant 284).

The secondary code of road safety refers to the impact the environment has on road safety. Emerging codes make reference to the current condition of the roads, in particular, the negative impacts of potholes on road safety, reckless driving, non-adherence to the speed limit and road safety. Road safety is noted in section 7.2.5.8 as a spatial, environmental and social consideration. Non-adherence to speed limits speaks to driver behaviour including acceleration speed and adhering to the speed limit since it impacts the number of emissions generated (see 3.4.3). Respondents that used private

transportation indicated that they do adhere to the speed limit (mean = 4.07) and that most of them have a medium acceleration speed (n = 101; 66.01%). However, respondents that use public transportation noted reckless driving and non-adherence to the speed limit (see verbatim quotations of respondents 110 and 295). The poor conditions of the roads impact road safety, since if drivers speed and drive recklessly on poor road conditions, it may increase the potential for road accidents. Furthermore, this may also relate to the point of overloading as pointed out in section 7.2.5.3 that notes the overloading of public transportation modes which was already indicated by the bright yellow stippled arrow ⋯▸ in Figure 7.14.

Fix the potholes in the roads! (Participant 26).

Yes, I would suggest that taxi drivers limit their speed more especially in Dr Bachior road every morning rush hour and in the afternoon (Participant 110).

Drivers are reckless and don't always follow rules of the road (Participant 295).

Please repair roads, the pothole is bad (Participant 317).

Although the weather is an environmental consideration, respondents indicated a neutral response when asked if the weather influences their mode of transportation (mean = 3.28). In the qualitative data, weather did emerge as a code but relates more to the comfort of the passenger. As a result, a connection is indicated between the weather and comfortability in Figure 7.14 by means of a light pink (⋯▸) stippled arrow.

The last environmental consideration pertains to the environment itself which has an impact on the health of the passengers. Respondents did indicate that they consider their health when they use public transportation (mean = 4.56). However, the quantitative results of this question can be interpreted in two ways: passenger health due to the environment of the transportation mode or promotion of their personal health since they need to be more mobile – walking some distance due to a lack of access. Therefore, the qualitative data was employed to shed light on this interpretation. Respondents noted in their qualitative responses that the environment of public transportation is often dirty which influences their health. The environment is listed as both an environmental and social consideration in Figure 7.14 with a link between the environment and the health of respondents (see the light grey ⋯▸ stippled arrow in the figure). Other respondents indicate that they sometimes like to walk to promote their health (see verbatim quotation above of participant 59) which renders both interpretations of the quantitative data valid.

Public transportation should be health, clean environment and travel trips faster so that transport users cannot be late to work (Participant 378).

Public transportation environment supposed to be clean at all time for their health of the transportation users, become users of transportation mustn't get sick from unclean environment of the transportation (Participant 411).

7.2.6 Comparison of the data analysis and findings of the questionnaire with the National Household Travel Survey of 2013

This section compares the findings of the empirical investigation of this study with the results obtained from the National Household Travel Survey (NHTS) of South Africa conducted in 2013 (Stats SA, 2014). The 2013 NHTS details the concerns of the public transportation users of South Africa. Although the NHTS data is several years old, there is no newer data available for comparison at this stage. The comparison focuses on minibus taxis and buses within the Free State region, since trams are very limitedly used within the Free State. Table 7.12 summarises the results obtained from the 2013 NHTS regarding the dissatisfaction of minibus taxis and bus services within the Free State Province (Stats SA, 2014:101, 107). The percentages indicated in Table 7.12 are the percentage of total respondents agreeing with this reason of dissatisfaction, with the top five reasons for dissatisfaction per mode of public transportation highlighted in red bold text. Table 7.12 shows that there is a high correlation between the 2013 NHTS and the summary of the data analysis and findings of this study as seen by the notation in table of correlating sections in the summary.

The most prominent reason for dissatisfaction with minibus taxis and buses are the facilities at the taxi ranks and bus stops such as toilets and offices (Stats SA, 2014:101, 107). Respondents of this study did mention the facilities per se but spoke about the impact the environment surrounding the taxi ranks and bus stops has on their health (see 7.2.5.10). Most respondents indicated that they consider their health when they use public transportation (mean = 4.56). Respondents noted in their qualitative responses that the environment of public transportation is often dirty, which may link to limited access to facilities such as sanitation services.

Safety is another prominent reason which surfaced in the 2013 NHTS and includes safety in regard to vehicle accidents (Stats SA 2014:7), poor conditions of the road (Stats SA, 2014:92), safety in regard to the use of the system, security and behaviour of staff (Wan et al., 2016:42). Respondents of this study supported the NHTS data by indicating that their general safety (mean = 4.34) and the road safety of the transportation mode (mean = 4.36) are both important when they select their transportation mode.

A sustainable public transportation system needs to conform with the three key considerations of sustainable development, namely economic development, environmental protection, and social justice considerations. The aim of such a system is to promote the mobility of people, however, it seems that access is still one of the most important transport-related problems that households experience in the Free State (Stats SA, 2014:92). A few years have passed since the 2013 NHTS was conducted, but it is evident from this study that accesses related aspects are still prominent considerations for respondents when they use public transportation (see 7.2.5.1). The secondary code of routes emerged in the spatial considerations theme with respondents' pointing out that limited routes are available which impacts their mobility (see Figure 7.14). The majority of respondents (n = 210; 58.99%) also indicated that they would use public transportation if more bus routes were available. This is a new insight that points towards the need to design a sustainable public transportation system that is accessible by giving attention to the considerations which impact access such as spatial planning considerations (e.g. routes, distance from access point, mixed land use), environmental considerations (e.g. weather), social justice considerations (e.g. flexibility, affordability, comfortability, and safety [general and road]), and economic considerations (e.g. affordability) (see Figure 7.14).

In summary, the comparison of the data analysis and findings of the questionnaire with the 2013 NHTS validates the findings of this study to a certain extent by highlighting that over the last few years there has not been significant change in the needs of the population, apart from the individual commuter's willingness to use public transportation if all the considerations are taken into account.

Table 7.12. Reasons for dissatisfaction with minibus taxi and bus services of those who use public transportation in the Free State province (Stats SA, 2014:101, 107)

Dissatisfaction reason: Minibus taxi service	(%)	Correlating section	Dissatisfaction reason: Bus service	(%)	Correlating section
The distance between the taxi rank/route and your home	29	7.2.5.1	The distance between the bus stop and your home	22,8	7.2.5.1
The travel time by taxi	20.5	7.2.5.9	The travel time by bus	18,4	7.2.5.9
Security on the walk to/from the taxi rank	**37.7**	7.2.5.8	Security on the walk to/from the bus stop	**36.3**	7.2.5.8
Security at the taxi ranks	**42.8**	7.2.5.8	Security at the bus stops	**39.4**	7.2.5.8
Security on the taxis	35	7.2.5.8	Security on the buses	27,8	7.2.5.8
The level of crowding in the taxis	26,6	7.2.5.3	The level of crowding in the bus	**39.6**	7.2.5.3
Safety from accidents	**38.6**	7.2.5.8	Safety from accidents	24,1	7.2.5.8
The frequency of taxis during peak period	29,1	7.2.5.6	The frequency of buses during peak period	25,7	7.2.5.6
The frequency of taxis during off-peak period	32,3	7.2.5.6	The frequency of buses during off-peak period	**28.6**	7.2.5.6
The waiting time for taxis	36	7.2.5.9	The punctuality of buses	18,7	7.2.5.7
The facilities at the taxi ranks, e.g. toilets, offices	**54.8**	7.2.5.10	The facilities at the bus stop, e.g. toilets, offices	**51.1**	7.2.5.10
Roadworthiness of taxis	**40.6**	7.2.5.8	The bus fares	23	7.2.5.2
Behaviour of the taxi drivers towards passengers	34,9	7.2.5.4 (respect)	Behaviour of the bus drivers towards passengers	20,9	7.2.5.4 (respect)
The taxi service overall	31,2	-	The bus service overall	19,8	-

7.3 CHAPTER SUMMARY

The aim of this section is to summarise the quantitative and qualitative data analysis and interpret sections 7.2.1 to 7.2.4 of this chapter with the aim to propose plausible policy guidelines for the development of a sustainable public transportation system in the study area (i.e. objective 4). The literature review provided a broad overview of the stance of South Africa's spatial planning system (see 2.5.1), the transportation system (see 3.7) and sustainable development (see 4.4). The South African public transportation system is often associated with words such as poor service delivery, unreliable, inaccessible, unsafe, unaffordable, and uncomfortable. The Republic of South Africa's Department of Transportation (2019: online) indicates that MMM should have completed their public transport network development planning and service contract designs during 2013/14 and started with the network development in 2014/15. In a meeting held in 2017 on the progress, challenges, and risks faced by cities to roll out the BRT systems, MMM reported that their go-live date is during the financial year of 2019/20 for Phase 1 which includes the areas of Bloemfontein CBD, Freedom Square, Rocklands, and Waaihoek (MMM, 2017:8). The project steering committee cites very limited funding, and expectations of high performance and quality as the main challenges which this project faces (MMM, 2017:41).

Important spatial, transportation and sustainable development considerations were identified through a literature review (see Chapters 2, 3 and 4) which informed the data collection tool (i.e. a mixed-method questionnaire). The questionnaire was distributed to 447 respondents within the MMM (see Chapter 6 for the demographic and psychographic compilation of the respondents). The chapter started with an in-depth discussion on the quantitative and qualitative data analysis according to the four parts of the questionnaire, namely Part A – general questions related to all respondents; Part B – questions related to respondents that use private transportation; Part C – questions related to respondents that use public transportation, and Part D – questions related to respondents that use non-motorised transportation such as walking and bicycling. Respondents could answer the sections that pertained to them since some respondents use multiple modes to commute daily.

Each section was discussed according to the four themes of this study, namely economic, environmental, spatial and social considerations. Quantitative data were represented for each part of the questionnaire in Tables 7.2, 7.5, 7.7 and 7.9. These tables indicated, with a green highlight, the questions that had a mean rating of 4.00 or more which was interpreted as important to all respondents. These questions were summarised in Table 7.11 in section 7.2.5 as a starting point to derive the possible policy guidelines in line with objective 4 of this study. The qualitative data was used as an explanatory component for the quantitative data, and in several instances highlighted the importance of a consideration which achieved a mean below four by means of a comparative table between the emerging qualitative codes and relating quantitative questions (see Tables 7.3, 7.6, 7.8

and 7.10). The re-inclusion of a consideration based on the emerging qualitative codes from the data analysis was supported by verbatim quotations where necessary. Several verbatim quotations were used more than once since respondents often provided statements or answers which had more than one code assigned. Lastly, sections 7.2.5.1 to 7.2.5.10 aligned the quantitative and qualitative data with the proposed characteristics of BRT systems outlined in the literature. Plausible policy guidelines are proposed to promote a sustainable public transportation system for the MMM according to this research study in the diagram below (see Table 7.13).

Table 7.13: Proposed plausible policy guidelines to promote a sustainable public transportation system for the MMM

1. Promote commuters' **health** by means of:
   - 1.1 encouraging commuters to use **non-motorised transportation modes to reach access points** within short distances of their origin or travel destinations.
   - 1.2 ensuring that the bus **environments are clean** (free from rubbish, germs and so more) so that commuters do not become ill.
   - 1.3 promoting an active and healthy lifestyle by creating a **safe environment.**

2. Change commuters' transportation mode of **preference** by:
   - 2.1 offering a **connected** public transportation system that connects with other modes of transportation they may use.
   - 2.2 educating commuters about their **social responsibility to protect the environment**.
   - 2.3 offers a **variety of land uses** within their immediate environment.
   - 2.4 using **multiple routes and transportation corridors** for different travel distances so as not to increase the **travel time** of the commuters.
   - 2.5 offering more **frequent trips** (time and number of fares).
   - 2.6 providing a service that is **flexible** regarding:
     - 2.6.1 operational hours of the service.
     - 2.6.2 pricing of the fares and tickets that can be purchased.
     - 2.6.3 stops that can be made.
   - 2.7 **reducing the travel time** of commuters by implementing:
     - 2.7.1 dedicated bus and taxi lanes that are not influenced by congested peak time traffic.
     - 2.7.2 an intelligent transportation system that controls the junctions for prioritising traffic.
   - 2.8 offering a service that is **comfortable** including:
     - 2.8.1 heating and cooling systems on the bus according to the **weather**.
   - 2.9 providing a **reliable** service that is punctual and on time.
   - 2.10 implementing **spatial considerations** to promote non-motorised transportation such as:
     - 2.10.1 dedicated bicycle lanes.
     - 2.10.2 even, wide-paved sidewalks.

3. Promote the **safety** of commuters by means of:
   - 3.1 regular **maintenance** of the buses.
   - 3.2 improving **road conditions** such as potholes.
   - 3.3 employing traffic calming techniques to counter **speeding** and **reckless driving.**
   - 3.4 increasing the general **safety** of access points in origin and travel destinations.
   - 3.5 **decreasing the distance** that respondents need to travel to their **nearest access point**.
   - 3.6 adhering to the **maximum number of passengers** per vehicle which promotes the road safety and **comfort** of the trip for the passengers.

4. Ensure that this mode of transportation is **accessible** to everyone by means of:
   - 4.1 sufficient **access points** on the travel routes of the population that is within walking distance.
   - 4.2 providing **information** about the **transportation mode** which commuters can access such as pricing, times, routes and so more.
   - 4.3 ease of use of the **ticketing system**.
   - 4.4 the flexibility of **purchasing tickets and fares**.
   - 4.5 **multiple routes and transportation corridors** according to the travel routes of the population (see Chapter 6)**.**

5. Implement **affordable** fares which include:
   - 5.1 affordable **park-and-ride options** which include safe storage for other modes of transport such as private transportation and non-motorised transportation (e.g. bicycles).
   - 5.2 affordable fares which are in line with the **socio-economic stance** of the commuters of the area.

6. **Educate** commuters to:
   - 6.1 **share the road** with other users such as cyclists and pedestrians.
   - 6.2 change their travel (e.g. reduce the number of trips daily) and driving **behaviours** (e.g. acceleration and speeding).
   - 6.3 purchase private transportation that is more **environmentally friendly** with lower emissions.
   - 6.4 use transportation modes that are more environmentally friendly such as **carpooling or ride-along opportunities**.

7. Transportation planners and spatial planners should **work together** in the future to:
   - 7.1 avoid/counter urban sprawl in future developments.
   - 7.2 evaluate current land use policies in regard to the proposed policy guidelines.
   - 7.3 introduce spatial developments that promote the movement of non-motorised transportation.
   - 7.4 provide appropriate facilities that accommodate public transportation.

7.4 CONTRIBUTION AND SIGNIFICANCE OF THIS STUDY

This study aimed to explore the promotion of a sustainable public transportation system for a smaller metropolitan area in South Africa. Four objectives guided the exploration of this study, namely:

1. To explore spatial planning and transportation development guidelines which may influence the sustainability of public transportation systems (see Chapters 2, 3 and 4).
2. To investigate the transportation needs of the population of the study area (see Chapters 6 and 7).
3. To identify the spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area (see Chapter 7).
4. To propose plausible policy guidelines for the development of a sustainable public transportation system for the study area (see Chapter 7).

As noted in the problem statement of this study, RSA's Department of Transportation's (2019: online) expansion of the BRT programmes have been severely delayed due to a number of challenges as reported to the Parliamentary Monitoring Group in 2017. The original aim of the BRT programmes was to ensure that all city residents are not more than 500 m away from a BRT system by 2020. It will be difficult to achieve this, with only a few days left on the calendar before the start of the 2020 year. The MMM reported that they envision to go-live with the first phase of the BRT system in the financial year of 2019/20; however, little progress has been made. The current position of the rollout of the programme accentuates the importance of this research because when it is eventually implemented, it should be sustainable even within the financial limitations of the municipality. This study attempted to address the gap in knowledge between the three knowledge areas of spatial, transportation and sustainable development to propose plausible policy guidelines for the development of a sustainable public transportation system in the study area that acknowledges the need to protect the environment, contributes to the economic development of the country and provides social justice to the residents of the area which includes increased mobility. Although the policy guidelines might be generalisable to other public transportation systems of the other metropolitan areas such as George, Buffalo City, Ekurhuleni, Msunduzi and Polokwane, it is recommended to investigate the specific transportation needs (see Chapter 6).

CONCLUDING OVERVIEW OF THE RESEARCH JOURNEY

The four objectives of this study provided the framework of this research's journey through the eight chapters. The figure below provides a concluding overview of the study and highlights how the objectives contributed to the research journey.

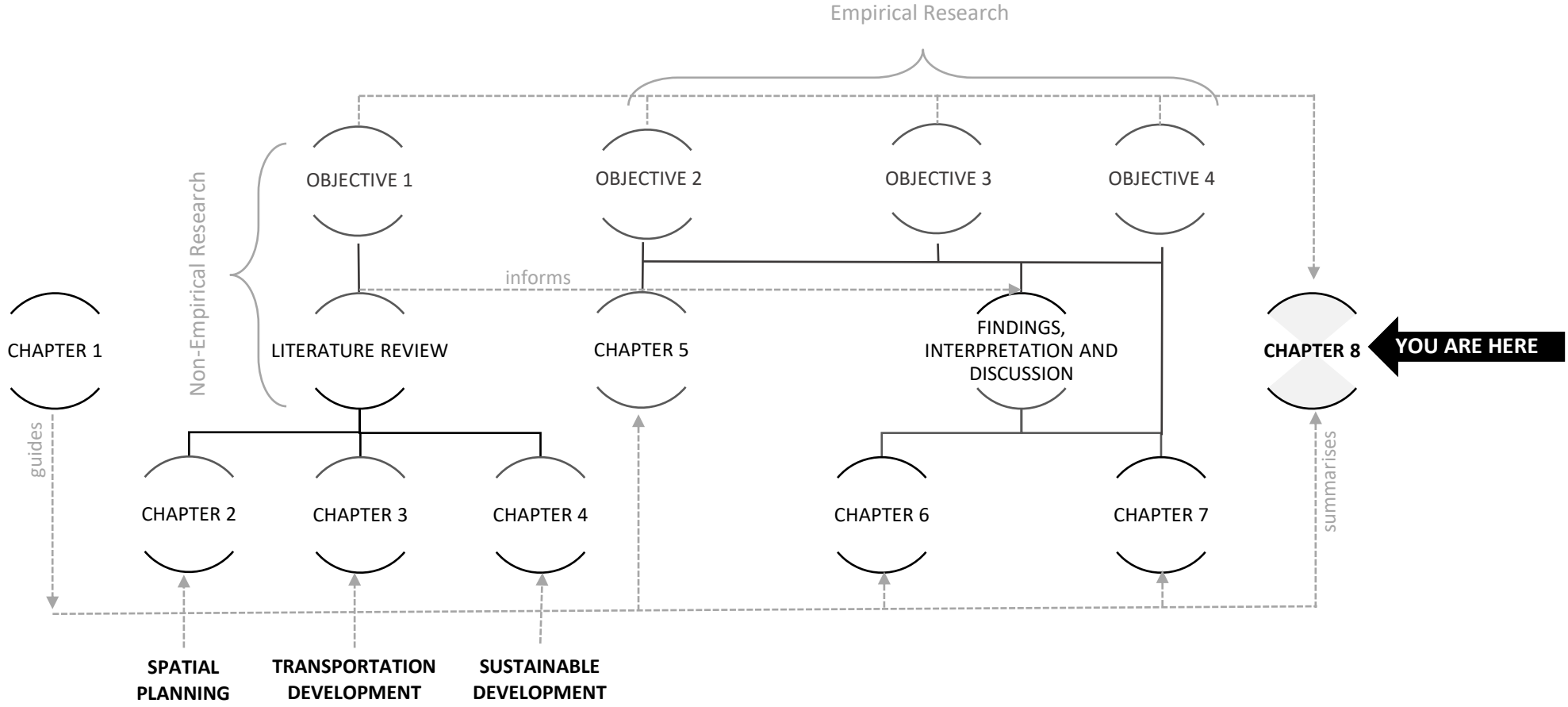


Figure 8.A: Overview of the conclusion and research journey

CHAPTER 8

CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

8

8.1 INTRODUCTION

The South African public transportation system is often associated with words such as 'poor service delivery', 'unreliable', 'inaccessible', 'unsafe', 'unaffordable', and 'uncomfortable'. MMM currently has a state-subsidised transportation system which residents can use to travel between and within the various towns and cities of the metropolitan region (Chobokoane & Horn, 2015:81). Urban sprawl is a common phenomenon in South African cities, with MMM not being an exception, which results in low density areas on the edges of the city that have limited access to basic services such as public transportation (Knaap & Talen, 2005:108). Although the MMM BRT project has many constraints (e.g. limited funding and expectations of high performance and quality) and is far behind on its original operation timeline, the value that this project may bring to the community is not doubted. In light of these expectations, this research proposes an exploration of the sustainability of a public transportation system for a smaller metropolitan area such as MMM. The primary research question of this study was how to promote the development of a sustainable public transportation system for a smaller metropolitan area in South Africa. Four secondary research questions were derived to answer the primary research question which is answered in this chapter, namely:

1 What are the spatial planning and transportation development guidelines which may influence the sustainability of public transportation systems? (see 8.2)
2 What are the transportation needs of the population of the study area? (see 8.3)
3 What are the spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area? (see 8.4)
4 What policy guidelines can be proposed to develop a sustainable public transportation system for the study area? (see 8.5)

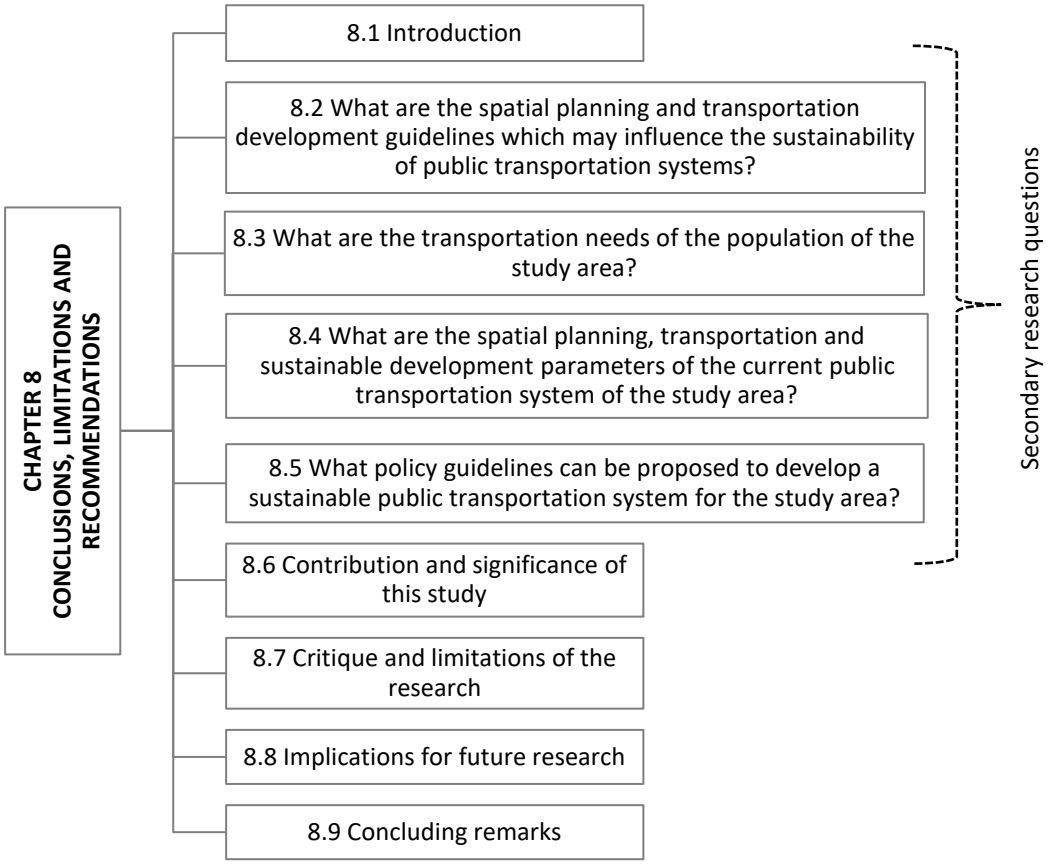


Figure 8.1: Outline of Chapter 8: Conclusions, limitations and recommendations

8.2 WHAT ARE THE SPATIAL PLANNING AND TRANSPORTATION DEVELOPMENT GUIDELINES WHICH MAY INFLUENCE THE SUSTAINABILITY OF PUBLIC TRANSPORTATION SYSTEMS?

The first of the secondary research questions required the exploration of the literature to identify spatial planning and development guidelines which could influence the sustainability of public transportation systems. A literature review was undertaken, as the non-empirical research component of this study, into the themes of spatial planning (see Chapter 2), transportation (see Chapter 3), and sustainable development (see Chapter 4) to identify these guidelines. The guidelines derived from the literature review were used to inform the data collection tool of this study.

The literature review of spatial planning guidelines started with an exploration of the guidelines related to the ideal city (see 2.2). In the years preceding the Second World War, several factors influenced the ways of thinking about urban patterns in the light of the urban reform crisis with several planners, or visionaries as Hall (2014:2) refers to them, stepping in and introducing ideas for the ideal city. This knowledge laid the first foundation, after which the review shifted to twenty-first century spatial planning themes (i.e. Smart Growth and New Urbanism) (see 2.3). In the twenty-first century,

spatial planning leans more towards alternative approaches and the concept of the Ideal City, than those of previous eras, due to the increase of globalisation, the creation of mega cities and more diverse populations. The review of the spatial planning themes of the last few decades informed the key considerations of spatial planning which were explored, namely sustainability, transportation and urban management (see 2.4). The chapter drew to an end with a review of the current stance of spatial planning in South Africa which noted the projection that 71.3% of the country's population will live in cities by 2030 (RSA IUDF, 2016:7) (see 2.5). This is a higher level of urbanisation than the projected statistics reported in section 2.4.1, which estimates that by 2050 approximately two-thirds of the world's population will live in cities (UNDP, 2017:14). This growth pattern is in alignment with Watson's (2009:2263) study that forecasts that a large proportion of the population growth in cities will take place in cities of the Global South. Therefore, South African spatial planners may benefit from taking note of the key guidelines derived from this chapter, as well as those that emanate from this study. The key spatial planning guidelines are summarised in Table 8.1.

Transportation plays an important role in the development and shaping of the economy of the world. Transportation is part of humans' daily life, but it is resource intensive (Filipczyk, 2015:117) and is a major contributor to the ever-increasing CO_2 emissions (Sharifi & Yamagata, 2016:1668) (see 4.3.2). The growing number of vehicles has an alarming impact on urban sprawl, the natural environment and the economic productivity of a country (Cervero, 2006:3). The review of literature on transportation explored the transformation of transportation systems from traditional systems (such as those that originated in the Roman Empire) into more sustainable systems (such as those in Smart Cities). The first industrial revolution had a major influence on transportation, with motor vehicles overtaking non-motorised transportation in most parts of the world (see 3.2). The review also explored the relationship of transportation with the main spatial planning themes of the twenty-first century (see 2.3 and 3.3). A distinct transition is noted in spatial planning themes from a focus on private transportation (in the Ideal City models) to public transportation (New Urbanism and Smart Growth) (see 2.3.1). Another aspect worth highlighting is the relationship between land transport planning and its integration with land development and land use planning (see 3.3). Key considerations explored for sustainable transportation included economic (see 3.4.1), social (see 3.4.2), environmental (see 3.4.3) and technological (see 3.4.4) considerations. The last part of the chapter explored sustainable transportation in South Africa (see 3.5) by reviewing the current modes of transportation used in the country (see 3.5.1), the feasibility of a sustainable transportation system in smaller metropolitan municipalities in South Africa (see 3.6), and South African transportation guidelines (see 3.7). Key sustainable transportation guidelines are summarised in Table 8.1.

Sustainable development was the last literature chapter of the non-empirical research of this study. SD has received growing emphasis over the past few decades in the light of the world's ever-increasing population growth, consumption rates and limited available natural resources (Du Pisani, 2006:87). SD is regarded as an ever-changing wicked problem since it is never in a constant state of harmony (Campbell, 2016:396; Dierwechter, 2014:692; United Nations World Commission on Environment and Development, 1987:17). The three key considerations that influence the state of harmony of SD is economic development (see 4.3.1), environmental protection (see 4.3.2) and social (in)justice (see 4.3.1). All three considerations were discussed in Chapters 2 and 3 with specific attention on spatial planning and transportation to focus the literature review to the problem investigated through this research. The literature review ends with a reflection on South Africa's progress to achieve their set SD goals by 2030 as outlined in their National Development Plan (NDP) (cf. RSA National Planning Commission, 2012). Key sustainable development guidelines regarding spatial planning and sustainable transportation are summarised in Table 8.1.

Table 8.1: Summary of the key spatial planning and sustainable transportation guidelines for public transportation systems (*see summary table at the end of the non-empirical research*)

1) ECONOMIC CONSIDERATIONS	
• The affordability of transportation mode(s)	
2) ENVIRONMENTAL CONSIDERATIONS	
• Environmental friendliness of transportation mode(s) • Impact of the weather	
3) SPATIAL CONSIDERATIONS	
• Commuters' origin and destination land usages • Distance to and from the access point to transportation mode(s) • Travel time (duration) due to distance and congestion • Park-and-ride options for public transportation including motor vehicles, motorcycles and bicycles	• Pedestrian and cycling friendliness of the spatial form • The number of stops between origin and destination • Neighbourhoods are walk- and cycle-friendly • Travel distance
4) SOCIAL CONSIDERATIONS	
4.1) Social considerations of accessibility	***4.2) Social considerations of flexibility***
• Access to transportation mode(s) • Access for people with disabilities and special needs • Access to information of transportation mode • Access to opportunities with transportation mode	• Flexibility of transportation mode • The day and time of travel

4.3) Social considerations of mobility	*4.4) Social considerations of personal needs*
• Number of trips daily (frequency) • Relocating for public transportation • Preference to use a specific mode of transportation	• Safety of residential area for non-motorised transportation modes • Road safety
4.5) Social considerations of transportation needs	***4.6) Social considerations of well-being***
• Personal space that the transportation mode(s) offer (comfortability and capacity) • Willingness to use public transportation modes if they are available • Importance of reliability of selected transportation mode(s) • Road sharing to accommodate motorised and non-motorised transportation • Adherence to the speed limit • Acceleration speed • Convenience of transportation mode	• Health benefits of transportation mode • To walk or cycle to gain access to transportation stop

8.3 WHAT ARE THE TRANSPORTATION NEEDS OF THE POPULATION OF THE STUDY AREA?

The second of the secondary research questions asked for the investigation into the transportation needs of the population of this study area which is needed to inform the parameters of the public transportation systems. Empirical research was undertaken to answer this question as per the methodology described in section 5.3.2. A research design was proposed through the interpretivist lens since the focus of this research question was around the person rather than the data (see 5.3). The data collection tool employed an explanatory mixed method design in light of the large intended target population but still with a focus of gaining an understanding of the individual participant's transportation needs (see 5.3). The empirical research identified that the majority of respondents were aged between 26 to 35 (34.84%) and full-time employed (22.22%). More than half of the sample population travel from Mangaung (51.35%) to Bloemfontein (57.59%) which highlights the need for transportation routes along this corridor. The majority of respondents travel between 11-30 minutes (39.12%) or 31-45 minutes (24.07%) daily. The travel time sounds reasonable but compared to the travel distance of the majority of respondents (11-20 km; 32.57%) it highlights the unequal society of South Africa (see Table 7.11 and Figure 7.14). The majority of the respondents make use of minibus taxis (30.85%) although it is not their preferred mode of transportation due to a lack of alternative public transportation systems which are accessible (see 7.2.5.1), affordable (see 7.2.5.2), comfortable (see 7.2.5.3), connected (see 7.2.5.4), flexible (see 7.2.5.5), frequent (see 7.2.5.6), reliable (see 7.2.5.7), safe (see 7.2.5.8), reduce their travel time (see 7.2.5.9) and sustainable (see 7.2.5.10).

8.4 WHAT ARE THE SPATIAL PLANNING, TRANSPORTATION AND SUSTAINABLE DEVELOPMENT PARAMETERS OF THE CURRENT PUBLIC TRANSPORTATION SYSTEM OF THE STUDY AREA?

The third secondary research question required investigation into the spatial planning, transportation and sustainable development parameters of the current public transportation system of MMM. Empirical research was undertaken to answer this question as per the research design and methodology in Chapter 5 using the same data collection tool employed to answer the previous secondary research question (see 8.2). The quantitative data analysis of this study indicated overall a limited difference in respondents' opinions for the questions and statements included in the data collection tool. The standard deviation of all parts of the questionnaire is 0.41 which indicates that data are all clustered closely around the mean of this questionnaire (mean = 3.75; see Figure 7.12). Table 7.11 summaries all the considerations which obtained a mean of four or more according to the mean of the question, and Figure 7.14 provides a summary of the emerging codes and themes of the qualitative data analysis of this study. The social justice considerations emerged as the dominant theme in the qualitative data analysis of this study, which supports the use of the interpretivist paradigm and population need determined in section 8.3. The data of the second and third secondary research questions were integrated to derive a holistic summary of the findings derived from the empirical research (see 7.2.5). The integration of the quantitative and qualitative data identified the need for a sustainable public transportation that is accessible (see 7.2.5.1), affordable (see 7.2.5.2), comfortable (see 7.2.5.3), connected (see 7.2.5.4), flexible (see 7.2.5.5), frequent (see 7.2.5.6), reliable (see 7.2.5.7), safe (see 7.2.5.8), reduce their travel time (see 7.2.5.9), and sustainable (see 7.2.5.10) in order to meet the transportation needs of the population (see 8.3).

8.5 WHAT POLICY GUIDELINES CAN BE PROPOSED TO DEVELOP A SUSTAINABLE PUBLIC TRANSPORTATION SYSTEM FOR THE STUDY AREA?

The fourth and last secondary research question pulls together the empirical and non-empirical research of this study to derive policy guidelines for the development of a sustainable public transportation system for MMM. Important spatial, transportation and sustainable development considerations were identified through a literature review (see Chapters 2, 3 and 4) which informed the data collection tool (i.e. a mixed-method questionnaire). The questionnaire was distributed to 447 respondents within the MMM (see Chapter 6 for the demographic and psychographic compilation of the respondents). The quantitative questions were summarised in Table 7.11 in section 7.2.5 as a starting point to derive the possible policy guidelines. The qualitative data was used as an explanatory component for the quantitative data, and in several instances highlighted the importance of a consideration which achieved a mean below four by means of a comparative table between the

emerging qualitative codes and relating quantitative questions (see Tables 7.3, 7.6, 7.8 and 7.10). Some of the excluded considerations from the quantitative data analysis were re-included based on a strong emergence in the qualitative data analysis. Plausible policy guidelines were proposed to promote a sustainable public transportation system for the MMM according to this research study in section 7.3, which includes (1) promoting commuters' health, (2) changing commuters' transportation mode of preference, (3) promoting the safety of commuters, (4) ensuring access to the specific public transportation mode, (5) implementing affordable fares, (6) educating commuters regarding certain transportation-related matters, and (7) a commitment to greater collaboration between transportation and spatial planners to work together in the future.

8.6 CONTRIBUTION AND SIGNIFICANCE OF THIS STUDY

This study aimed to explore the promotion of a sustainable public transportation system for a smaller metropolitan area in South Africa. Four objectives guided the exploration of this study, namely:

1. To explore spatial planning and transportation development guidelines which may influence the sustainability of public transportation systems (see Chapters 2, 3 and 4).
2. To investigate the transportation needs of the population of the study area (see Chapters 6 and 7).
3. To identify the spatial planning, transportation and sustainable development parameters of the current public transportation system of the study area (see Chapter 7).
4. To propose plausible policy guidelines for the development of a sustainable public transportation system for the study area (see Chapter 7).

As noted in the problem statement of this study, RSA's Department of Transportation's (2019: online) expansion of the BRT programme has been severely delayed due to a number of challenges as reported to the Parliamentary Monitoring Group in 2017. The original aim of the BRT programmes was to ensure that all city residents are not more than 500 m away from a BRT system by 2020. The achievement of this aim is outside the reach of the Republic's Department of Transportation with only a few days left on the calendar before the start of the 2020 year. The MMM did report that they envision to go-live with the first phase of the BRT system in the financial year of 2019/20; however, little progress has been made. The dismal state of the rollout of the programme accentuates the importance of this research because when it is eventually implemented, it should be sustainable even within the financial limitations noted by the metropolitan municipality.

The contribution and significance of this study are the generation of new knowledge regarding sustainable public transportation systems for smaller cities and metropolitan areas in South Africa on which there is limited published research. Furthermore, this study sought to address the gap in knowledge between the areas of spatial, transportation and sustainable development practices in South Africa to design more sustainable transportation systems through the convergence, synthesis and integration of the empirical and non-empirical facets of this study. This brought about a new insight of the interdependency of the various economic, environmental, spatial and social justice considerations that emerged from the data analysis and highlighted the need for greater future collaborations between all stakeholders to create transportation systems that meet the needs of all South African people, even those living in smaller metropolitan areas. The comparison of the data analysis and findings of this study with the 2013 NHTS validates the findings of this study to a certain extent, but highlights that over the last few years there has not been significant change in the needs of the population, apart from the individual commuter's willingness to use public transportation if all the considerations are taken into account. The convergence, synthesis and integration of the empirical and non-empirical facets of this study were finally compiled into the proposed plausible policy guidelines to promote a sustainable public transportation system for MMM. Although the policy guidelines might be generalisable to other public transportation systems of other metropolitan areas such as George, Buffalo City, Ekurhuleni, Msunduzi and Polokwane, it is recommended to investigate the specific transportation needs of the population of those specific areas (see Chapter 6). The following is outlined as significant to the study:

- The findings obtained in Table 7.13 outlined the proposed plausible policy guidelines to promote a sustainable public transportation system for the MMM.
- The comparison between the findings of the study and the findings of the data analysis and findings of the questionnaire with the National Household Travel Survey of 2013 (see 7.2.6).
- Section 7.4 outlines the significance obtained from the conclusion chapter.

8.7 CRITIQUE AND LIMITATIONS OF THE RESEARCH

The intent of the study was not to generalise the findings of this research or to draw definite conclusions from the findings of the research design and methodology. Some assumptions and limitations were made, namely:

- The respondents that completed the questionnaire were familiar with their surroundings and the basic knowledge of their mode of public transportation.

- Non-responsiveness from respondents in the questionnaire was due to a lack of transport experience, not to a lack of understanding of the questions and respondents that are part of the vulnerable population (see 5.6.3).
- The researcher aimed to distribute the questionnaire to all parts of the study area. The researcher assumed that all areas of the study area were reached with the questionnaire.
- The study area of MMM was selected on the basis of its size and the researcher was restricted to this metropolitan only within his time and financial constraints.
- The data analysis was restricted on the basis of the objectives of the study. Further analysis beyond the objectives of this study was also restricted due to time constraints.
- Limited generalisability of the findings is due to the research design and methodology of this study.

8.8 IMPLICATIONS FOR FUTURE RESEARCH

Future research pertaining to the policy guidelines for the design of a sustainable public transportation system in smaller metropolitans can be conducted through in-depth interviews with spatial and transportation planners to expand on the proposed guidelines derived from this study. If the proposed policy guidelines discussed in section 8.5 is implemented, it may open the way for the exploration of the feasibility and effectiveness of the application of these guidelines into the national policies of South Africa. Lastly, to investigate the linkage between spatial frameworks for BRT systems that relates to the economic impact and to focus more on public involvement with the development of sustainable transportation.

8.9 CONCLUDING REMARKS

The research journey documented in the eight chapters of this thesis showcases my learning experiences and growth not only as a researcher but also in my personal capacity as a transportation planner. During this journey, I came to the realisation that research is often a chaotic and messy journey which I had to make peace with despite my preference for order and structure. Viewing my research from a wider perspective, I realised that the journey validated my commitment towards the implementation of the knowledge I have gained from this journey within my own practice. I also came to the realisation that I need to share my new knowledge with my fellow colleagues in both urban planning and civil engineering, as well as my industry colleagues in both these sectors. Last, but not least, this journey ignited a renewed passion in me for the value of new knowledge generation in my discipline and its contribution to the social welfare of the people of my country.

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10.1 APPENDIX A:

ETHICAL CLEARANCE DOCUMENT

10

Faculty of Natural and Agricultural Sciences

15-May-2017

Dear **Mr Everardt Burger**

Ethics Clearance: **An exploration into spatial planning for increased sustainability of a city through improved public transport: A case study of Bloemfontein.**

Principal Investigator: **Mr Everardt Burger**

CONDITIONALLY APPROVED

This letter confirms that a research proposal with tracking number: **UFS-HSD2017/0281** and title: **An exploration into spatial planning for increased sustainability of a city through improved public transport: A case study of Bloemfontein.** was given ethics clearance by the Ethical Committee pending clarification of the following:

Chair:

Date need to be adjusted - this should not delay approval. It appears that this application has been completed on the Humanities e-form and submitted to the Humanities ethics committee. I have looked at this and I do not see any ethical issues.

Conditional Approval

CONDITIONAL APPROVAL

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether or not the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of.

Note:

1. This clearance is valid from the date on this letter to the time of completion of data collection.
2. Progress reports should be submitted annually unless otherwise specified.

Yours Sincerely

Prof. RR (Robert) Bragg
Chairperson: Ethics Committee
Faculty of Natural and Agricultural Sciences

Natural and Agricultural Sciences Research Ethics Committee
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10.2 APPENDIX B:

INFORMED CONSENT LETTER AND QUESTIONNAIRE

10

Dear prospective participant,

You are invited to participate in a survey conducted by Mr Everardt Andre Burger under the supervision of Prof Verna Nel, a Professor of Urban and Regional Planning, in the faculty of Natural and Agricultural Sciences working towards a PhD in Urban and Regional Planning at the University of the Free State. **The aim of this survey is to establish your need as a resident of the Mangaung Metropolitan Municipality for a sustainable public transportation system.**

The survey you have received has been designed to study the project description in non-scientific language. You were selected to participate in this survey because you are a resident within the Mangaung Metropolitan Municipality. The study would exclude any participant which is under the age of 18 and/or who do not reside in either Brolong Bga Moroka, Bloemfontein, Botshobelo, Mangaung, Morago, Opoms, Peter Swart, Rodenbeck, Sonskyn, Thaba Nchu or any rural area within the municipality. By completing this survey, you agree that the information you provide may be used for research purposes, including dissemination through peer-reviewed publications and conference proceedings.

It is anticipated that the information we gain from this survey will help us to state anticipated outcomes of the project. You are, however, under no obligation to complete the survey and you can withdraw from the study prior to submitting the survey. The survey is developed to be anonymous, meaning that we will have no way of connecting the information that you provide to you personally. Consequently, you will not be able to withdraw from the study once you have submitted your survey based on the anonymous nature of the survey. If you choose to participate in this survey it will take up no more than twenty minutes. You will not benefit from your participation as an individual, however, it is envisioned that the findings of this study will indicate anticipated benefits of the study. We do not foresee that you will experience any negative consequences by completing the survey. The researcher undertake to keep any information provided herein confidential, not to let it out of our possession and to report on the findings from the perspective of the participating group and not from the perspective of an individual.

The records will be kept for a minimum of five years for audit purposes. The research was reviewed and approved by the Ethics Review Committee of the University of the Free State.

The primary researcher, Mr Everardt Andre Burger, can be contacted at everardtbur@gmail.com The study leader, Prof Verna Nell, can be contacted at NelVJ@ufs.ac.za.

I hereby voluntarily agree to participate in the above-mentioned research project and declare that I am 18 years or older and that I have read and understand all the information and conditions pertaining to this interview.

_____ _____

Signature of participant Date

SECTION A - DEMOGRAPHIC & PSYCHOGRAPHIC INFORMATION OF THE PARTICIPANT

1. What is your age?

☐ 18-25 years ☐ 26-35 years ☐ 36-45 years

☐ 46-55 years ☐ 56-65 years ☐ >65+ years

2. What is your gender?

☐ Male ☐ Female ☐ Other

3. What is your current employment status?

☐ Full-time employed ☐ Part-time employed/Casual ☐ Unemployed

4. Do you require any special assistance when travelling or have a disability?

☐ Yes ☐ No *Please specify* _____

5. What is the residential area and town/city in which you live in the Mangaung Metropolitan Area (MMA)?

Residential area _____ *Town/City* _____

6. Rate your level of agreement with the following statements regarding the neighbourhood in which you live, which you indicated in the previous question, by marking the most suitable option with an 'x'?

6.1	My residential area has houses, shops, schools and industrial/manufacturers/wholesalers	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
6.2	My residential area is pedestrian and cycling friendly	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
6.3	My residential area is safe	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
6.4	My residential area offers easy access to public transportation	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
6.5	My residential area's public transportation stops are walking distance from my house, shops, schools and industrial/manufacturers/wholesalers which I want to visit	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*

7. What is the area and town/city to which you travel every day or most frequently for work, shopping and/or leisure?

Residential/Commercial or Industrial area _____ *Town/City* _____

8. Rate your level of agreement with the following statements regarding the neighbourhood, which you indicated in the previous question, that you travel most frequently to by marking the most suitable option with an 'x'?

8.1	This neighborhood has houses, shops, schools and industrial/manufacturers/wholesalers	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
8.2	This neighborhood is pedestrian and cycling friendly	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
8.3	This neighborhood is safe	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
8.4	This neighborhood offers easy access to public transportation stops	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
8.5	This neighborhood's public transportation stops are walking distance from my work, shops, schools and industrial/manufacturers/wholesalers which I want to visit	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*

9 Mark the most suitable option with an 'x' regarding the mode of transportation you use for the various activities?

9.1	I use my personal vehicle to travel to…	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*
9.2	I use my personal motorcycle to travel to…	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*
9.3	I use the bus to travel to…	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*
9.4	I use a minibus taxi to travel to..	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*
9.5	I use a train or tram to travel to…	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*
9.6	I cycle to…	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*
9.7	I walk to…	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*
9.8	I use another means to travel to…	*Home*	*Work*	*Shops*	*Leisure*	*Schools*	*Other*

10 What is the average distance you travel daily between your residential area, work, shops, schools, industrial/manufacturers/ wholesalers and etc.?

☐ <10 km ☐ 11-20 km ☐ 21-30 km

☐ 31-40 km ☐ 41-50 km ☐ >50 km

11 What is the average time you spent travelling daily?

☐ <10 min ☐ 11-30 min ☐ 31-45 min

☐ 46 – 60 min ☐ 61 – 90 min ☐ >90 min

12 Rate the level of importance for you when you need to decide on the mode of transportation you want to use (personal vehicle, bus, minibus taxi, walking, cycling, etc.) by marking the most suitable option with an 'x'?

12.1	The distance I need to travel	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.2	The duration of my trip (travel time)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.3	The day and time I need to travel	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.4	The number of stops I need to make	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.5	The weather (sunny, rainy, windy, etc.)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.6	Access to use my transportation mode	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.7	Access to information of my transportation mode (bus schedules, routes, etc.)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.8	Wheelchair accessibility of my transportation mode (if you have a disability)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.9	Meet-and-assist option of my transportation mode (if you need special assistance such as mothers with babies, people with disabilities, the elderly, etc.)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.10	The flexibility/convenience my transportation mode offers me	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.11	The personal space my transportation mode offers me	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.12	The general safety of my transportation mode (e.g. theft, mugging, etc.)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.13	The road safety of my transportation mode (e.g. traffic accidents, etc.)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.14	The reliability of my transportation mode	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.15	The cost/affordability of my transportation (vehicle repayments, petrol/diesel cost, fair cost, etc.)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.16	The environmental friendliness of my transportation mode	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.17	Access to opportunities (such as work) that my transportation mode offers me	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*
12.18	The benefits my transportation mode has for my health (such as physical activity)	*Unimportant*	*Somewhat important*	*Moderately important*	*Important*	*Very important*

13 Mark the most suitable option with an 'x' regarding the following statements?

13.1	I would use public transportation if there were more bus routes available.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
13.2	I would use public transportation if fares were cheaper.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
13.3	I would use public transportation if the service was more reliable.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
13.4	I would use public transportation if information regarding the service was more transparent.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
13.5	I would use public transportation if the service times/operation hours were more flexible.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
13.6	I would consider relocating to another residential area which offers access to public transportation?	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*

14 Do you have any comments that you would like to share in addition to your answers in this section?

_____

_____

_____

_____

VERY IMPORTANT

INSTRUCTIONS: COMPLETE ONLY THE APPLICABLE SECTIONS IN REGARD TO YOUR MODE/S OF TRANSPORTATION THAT YOU USE. YOU MAY COMPLETE SECTION B, C AND/OR D DEPENDING ON YOUR TRANSPORTATION USAGE.

Complete Section B only if you use your personal vehicle or motorcycle as your transportation means.
Complete Section C only if you use public transportation (busses, minibus taxis, trains or trams) as your transportation means.
Complete Section D only if you walk or cycle as your transportation means.

SECTION B – I USE MY PERSONAL VEHICLE OR MOTORCYCLE AS TRANSPORTATION MEANS

15 Mark the most suitable option with an 'x' regarding the following statements?

15.1	I use my personal vehicle to travel	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
15.2	I transport on average the following number of persons	*1*	*2*	*3*	*4*	*5+*
15.3	I make on average the following number of trips daily	*1*	*2*	*3*	*4*	*5+*
15.4	My trips on average involve the following number of stops	*1*	*2*	*3*	*4*	*5+*
15.5	I adhere to the speed limit	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
15.6	I categorise my average acceleration speed as…	*Very slow*	*Slow*	*Medium*	*Fast*	*Very Fast*
15.7	I consider my social responsibility towards the environment when I use my personal vehicle	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
15.8	I use my personal vehicle to car pool or ride together when travelling to my work, shops, schools, etc.	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
15.9	I share the road with a cyclist or stop for a pedestrian…	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
15.10	I would consider changing my mode of daily transportation to public transportation if it is a viable and available option for me?	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
15.11	I would consider changing my mode of daily transportation to walking and/or cycling to improve my health if it is a viable and available option for me?	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*

16 What type of personal vehicle do you use?

☐ SUV/4x4 ☐ Minibus ☐ Passenger vehicle

☐ Pick-up ☐ Motorcycle ☐ Other

17 What is the fuel type and engine capacity of your personal vehicle?

☐ Petrol ☐ Diesel *Please specific the capacity in CC terms*

18 What is your average fuel efficiency?

Please specific the fuel efficiency in km/l terms

19 Do you have any comments that you would like to share regarding your usage of your personal vehicle which you have indicated in this section?

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SECTION C – I USE PUBLIC TRANSPORTATION AS MY TRANSPORTATION MEANS

20 What type of public transportation do you use most often?

☐ Busses ☐ Minibus Taxis ☐ Trains

☐ Trams ☐ Other (please specify) _____

21 What day/s of the week do you use public transportation (select all the applicable options)?

☐ Monday ☐ Tuesday ☐ Wednesday

☐ Thursday ☐ Friday ☐ Saturday and Sunday (Weekends)

22 What time/s of the day do you use public transportation (select all the applicable options)?

☐ >06:30 ☐ 06:30 – 08:30 ☐ 09:00 – 15:00

☐ 15:30 – 18:00 ☐ >18:00

23 Mark the most suitable option with an 'x' regarding the following statements?

23.1	I use public transportation to travel	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
23.2	I make on average the following number of trips daily with public transportation	*1*	*2*	*3*	*4*	*5+*
23.3	My public transportation trips on average involve the following number of stops	*1*	*2*	*3*	*4*	*5+*
23.4	I consider my social responsibility towards the environment when I use public transportation	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
23.5	I consider my health when I use public transportation	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
23.6	It is important for me to have a park-and-ride option available at my nearest public transportation stop.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
23.7	It is important for me that the distance from my public transportation stop is not to far from where I need to go.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
23.8	I feel public transportation is an affordable transportation mode for me.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*

24 Do you have any comments that you would like to share regarding your usage of public transportation which you have indicated in this section?

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SECTION D – I USE NON-MOTORISED TRANSPORTATION AS MY TRANSPORTATION MEANS

25 What type of non-motorised transportation do you use most often?

☐ Cycling ☐ Walking ☐ Other

26 Mark the most suitable option with an 'x' regarding the following statements?

26.1	I use non-motorised transportation to travel	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
26.2	I make on average the following number of trips daily either walking or cycling	*1*	*2*	*3*	*4*	*5+*
26.3	My non-motorised transportation trips on average involve the following number of stops	*1*	*2*	*3*	*4*	*5+*
26.4	I consider my social responsibility towards the environment when I walk or cycle	*Never*	*Rarely*	*Occasionally*	*Frequently*	*Always*
26.5	I walk or cycle to reduce my transportation cost.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
26.6	I walk or cycle because I do not have another means of transport.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
26.7	I walk or cycle to my nearest public transportation stop.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
26.8	I walk or cycle because it is the most convenient mode of transportation for me.	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
26.9	My neighbourhood is walk- and cycle-friendly (e.g. cycle lanes, sufficient sidewalks)	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
26.10	When I use my bicycle to travel to work/shop/bus stop there are safe storage space for my bicycle	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*

27 Do you have any comments that you would like to share regarding your usage of non-motorised transportation which you have indicated in this section?

_____

_____

_____

_____

END OF THE SURVEY

THANK YOU FOR YOUR PARTICIPATION

10.3 APPENDIX C:

FEEDBACK QUESTIONNAIRE FOR THE PILOT STUDY

10

Dear prospective participant,

Welcome to the feedback questionnaire for the specified pilot survey that you completed recently as part of a pilot study for my PhD in Urban and Regional Planning at the University of the Free State. This questionnaire aimto provide feedback regarding difficulty of completion, logical order, type of questions and language.

I truly appreciate your willingness to share your experience. The questionnaire will take approximately 10 minutes of your time. Your participation in this study is voluntary and your anonymity will be protected.

I hereby voluntarily agree to participate in the above-mentioned feedback survey and declare that I am 18 years or older and that I have read and understand all the information and conditions pertaining to this survey.

_____ _____

Signature of participant Date

1. How did you find the completion of the questionnaire of this pilot study?

☐ Easy ☐ Medium ☐ DHard

Please provide a reason for your choice with suitable examples:

_____

_____

2. How did you experience the logical order of the questionnaire?

☐ Easy ☐ Medium ☐ DHard

Please provide a reason for your choice with suitable examples:

_____

_____

3. How did you experience the type of questions asked?

☐ Easy ☐ Medium ☐ DHard

Please provide a reason for your choice with suitable examples:

_____

_____

4. How did you experience the language used in the questionnaire?

☐ Easy ☐ Medium ☐ DHard

Please provide a reason for your choice with suitable examples:

_____

_____

5. Is there anything else you want to mention?

_____

_____

_____

_____

END OF THE SURVEY
THANK YOU FOR YOUR PARTICIPATION

10.4 APPENDIX D:

LETTER FROM THE EDITOR

10

Carine Joubert

Language Services | Taaldienste

076 592 7168
carine.joubert9@gmail.com

Letter from the editor

17 October 2019

To whom it may concern,

I, Carine Joubert, assisted in the editing and proofreading of the Doctoral Thesis, AN EXPLORATION INTO SPATIAL PLANNING FOR INCREASED SUSTAINABILITY OF A CITY THROUGH IMPROVED PUBLIC TRANSPORT: A CASE STUDY OF BLOEMFONTEIN, researched and written by Mr. Everardt Burger.

The editing included fixing grammatical errors and here and there a sentence was restructured to make it more readable. A final proofreading was done to ensure that there are minimal mistakes. The tables and figures were only edited if there were misspelled words, and the numbering of tables and figures were checked to ensure that they follow chronologically on each other. The editing and final proofreading also included checking the numbering and format of the headings and table of contents. The appendixes were read through but no changes were made. I edited the reference list according to the Harvard style, as requested by the researcher.

None of the research, data or ideas portrayed by the author was changed during the editing and proofreading phase and it only focused on the language use for easy readability

Qualification: BA Honours in Applied Linguistics, University of Pretoria, 2016

Qualified in: Editing, proofreading, transcriptions, translations, script editing, copywriting, academic writing, general language services.

Kind regards

Carine Joubert