EFFECT OF HOUSEHOLD INCOME ON PUBLIC TRANSPORT DEMAND IN SOUTH AFRICA

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DEDICATIONS

This dissertation is dedicated to my dearest parents, my loving father, Mr. David Moss, and my dearest mother, Mrs. Cynthia Moss.

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"I can do all things through God who strengthens me" (Philippians 4:13). To my Father God, who strengthens me, who has been there for me throughout this journey. Thank you Lord for your strength and guidance. It was not easy, but you made it possible. "For I know the plans I have for you" declares the Lord, "plans to prosper you and not to harm you, plans to give you hope and a future" (Jeremiah 29 :11).

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ABSTRACT

High transport expenditure by the low-income households has for a long time been a problem in South Africa. This expenditure consumes a big proportion of their income which limits these households' accessibility to basic services such as health services, employment opportunities and education. Therefore, the study reviewed the effect of household income on public transport demand in South Africa. The aim of the study was to investigate the determinants of public transport demand, through specifically investigating the impact household income has on public transport demand. This study adopted the quantitative approach. The analysis was based on data from the 2017 General Household Survey. Descriptive analysis was conducted to address the objectives of the study. The Probit model was utilised in establishing the relationship between mode choice and household income. The results indicated that household income has a negative effect on public transport demand. The distance to means of transport has a negative relationship on public transport demand, indicating that accessibility plays a significant role in the demand for public transport. The location of a household significantly affects the demand for public transport, more so in peri- urban and rural-farm areas where low-income households reside. Furthermore, variables such as age, social grants and the economically active individuals presented a positive relationship with public transport as a modal choice. Individuals with some form of disability indicated statistical insignificance. The study recommended that, a properly planned coordination of current and new policies for the development of urban planning could be more practical in improving the high transport expenditure through affordability measures by low-income households in South Africa. Furthermore, these spatially targeted developments will enable increases in the accessibility of affordable public transport modes in the peri- urban areas which in turn will manage these high transport expenditures.

Keywords: *Public transport, Demand,household income, modal choice, probit model, South Africa*

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LIST OF ABBREVIATIONS

AME	Average Marginal Effects
CIE	Centre of International Economics
CSG	child support grant
DoT	Department of Transport
EOD	elasticity of demand
MSA	Moving South Africa
NATMAP	National Transport Master Plan
NDP	National Development Plan
NHSTS	National Household Travel Survey
NLTA	National Transport Act
NLTSF	National Land Transport Strategic Framework
NPC	National Planning Commission
NPTR	National Public Transport Regulator
PBS	perceived behavioural control
PRASA	Passenger Rail Agency of South Africa
PTOG	Public Transport Operating Grant
PTISG	Public Transport Infrastructure Systems Grant
PTNOG	Public Transport Network Operating Grant
RIPT	Rapid Integrated Public Transport Systems
SASSA	South African Security System
SOP	state-owned pension
STATSSA	Statistics South Africa

TPB	theory of planned behaviour

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 Background of the study

In both the developed and the developing nations, urban areas have become increasingly dependent on public transport (Pojani & Stead, 2015). Rapid economic development exercises pressure on all infrastructure services, which are important for social and economic sustainability, particularly transport infrastructure. Public transport is very important in every country; it assures access to basic social services such as employment, health and education, by integrating those individuals from the low and middle-income quintiles into the economic mainstream (Kaushik, 2008). Public transport services have over a few decades become the lifeline for getting to work, school and tourism, particularly for those individuals who come from low-income households, individuals with disabilities and the elderly (Liu, 2017). More importantly, public transport has the ability to improve accessibility for those individuals who were and are still affected by the spatial policies that were implemented during the apartheid era (Prim, 2016). Worldwide, the transport systems have become an important element in the economic structures of urban areas (Joly, Masson & Petiot, 2006). Public transport consists of transport infrastructures that enable economic agents to access activities available in the cities and rural areas. Across the world, urban trips are made by privately-owned cars and public transport.

Private car use provides comfort and freedom but cannot be used by everyone, only by the fortunate groups, classified as those with high incomes that own cars in their households (Joly, Masson & Petiot, 2006). Furthermore, the low-income households are solely dependent on public transport because of income constraints. Additionally, mode choice is made up of trade-offs, which comprise the costs of transport mode, accessibility and availability of the mode choice. Nevertheless, these transport systems differ from one country to another. Therefore, the way in which these transport systems are put in place depend on factors relating to the transport policies of that particular country.

In South Africa, the 1996 White Paper on National Transport Policy remains the backbone of transport policy. Some of the features of the transport policy include ensuring that passenger

transport is consumer friendly; addresses user needs, and accommodates individuals from different locations and income quintiles to be provided transport efficiently (Department of Transport, 1996).

Thomas (2016) explained that providing a safe, easily accessible and most affordable public transport infrastructure is a prerequisite for socio-economic advancement of the South African population. A number of surveys have been conducted in South Africa, which indicated that high transport costs have a negative impact on low-income households. According to The Income and Expenditure survey (2015) conducted by the Department of Statistics every five years, which seeks to establish what South Africans spend their money on, the 1996 White Paper policy is not living up to its purpose. Essentially, transport is the second largest expenditure group and is estimated at 17.1% of total household consumption expenditure. The average South African household spent R16 319 on transport between September 2010 and August 2011 (Income and Expenditure Survey, 2015). Roughly, one out of every six rand spent goes towards transport expenditure. The statistics are staggering, and do not live up to the transport policy of providing affordable and accessible public transportation for all income quintiles, more particularly the low-income households. Households are spending excessively on transport, this high expenditure is particularly problematic for the low-income households. Moreover, transport expenditure tends to be more regressive on the income of the poor relative to the high-income households (Venter, 2011). These households end up using more than 20% of their income on transport expenses. According to the Statistics South Africa (2015) report on Measuring Household Expenditure on Public Transport, it was found that minibus taxis are the most commonly used mode of public transport in South Africa with just more than half (51.0%) of the households that use public transport (76.7%) relying on them, followed by buses (18.1%) and trains (7.6%). The minibus taxi services are a more convenient mode of transport in terms of accessibility and availability. However, minibus taxi services are excessively expensive compared to other modes of transport but because of time constraints and accessibility, individuals normally opt for the minibus taxi services.

Furthermore, in most developing countries like South Africa, the affordability of public transport has been attracting more attention, as policy debates have shifted focus on the transport investment perspective to determine how the overall transportation costs can be reduced in ways which public transport can benefit the low-income households (Venter, 2011). A technical report released by Statistics South Africa in 2015 indicated that households from

the lowest income quintiles spend more of their income on public transport compared to households from the highest income quintiles. Low-income households are usually situated further away from cities, resulting in these individuals need to make frequent trips to the cities to access basic services.

Furthermore, in South Africa, the further away one is from the urban areas the more trips one has to take to reach a single destination – resulting in higher expenditures in transport.

This study addressed the transport deficiency through exploring the variations of public transport demand factors at a household level in South Africa, focusing on the analysis of household income and the demand for public transport as well as the overall nature of public transport in South Africa. The research study employed secondary data from the 2017 General Household Survey and the focus was on a household level.

1.2 Statement of the Problem

South Africa suffers from a defective spatial form, particularly the households that were previously disadvantaged and are still disadvantaged by the apartheid era policies (Prim, 2016). Moreover, due the spatial inconsistencies, these low-income households incur higher transport costs relative to the high-income households. Exploring the income data from Statistics South Africa, for instance, the 2011 Census data shows that the annual household income for low-income groups – defined by Statistics South Africa as those earning R1–R19 200 per annum – comprises 29% of the population. Furthermore, the middle-income group is defined as those with an annual income of R19 201–R307 200 and consists of 48.3% of the total population. Cumulatively, the low and middle-income households encompass a massive population of 77.3%. The primary issue on the demand side of public transport is affordability, which is largely determined by household income. The biggest proportion of households in South Africa spend their household income on transport services through the use of public transport, train services, bus transit, minibus taxi commuting, amongst other forms of public transport.

According to Statistics South Africa Household Survey in 2013, more than 40% of people living in informal settlements spent 34.9% of their income on transport costs. Venter (2011) contended that the low-income households in most cases are the ones paying more for public transport trips relative to the rich due to the location of many low-income households. Furthermore, employment opportunities and other economic activities are centred in cities which requires households to use public transport to access these opportunities (Prim, 2016).

The majority of low-income households have become reliant on social grants as their only source of income (Lekezwa, 2011), making it difficult to afford public transport. Therefore, this high expenditure is a concern because it usually results in compromising a low-income household's ability in improving their living conditions. Moreover, the high transport expenditure often results in high job search costs, thus limiting the poor to labour market opportunities. High transport expenditure has become a huge concern in South Africa, this compromises the low-income earners to access basic services and enhance their livelihood opportunities. The developing of an affordable transport system is a potent tool to alleviate poverty in South Africa (Prim, 2016).

Therefore, in this case, a clear understanding of how and to what extent household income affects public transport is vital, in order to come up with potent policies to manage low-income earners' high expenditure on public transport in order to ensure sustainable development in South Africa.

1.3 Objectives

The principle objective of this study was to investigate the effect of household income on public transport demand in South Africa. The following were the specific objectives of the study:

- To examine the nature of public transport demand in South Africa.
- To empirically investigate the effect of household income on public transport demand.
- To make policy recommendations based on the findings.

1.4 Hypothesis

The following is the hypothesis that this study sought to test:

H_0 : Public transport demand is not responsive to income.

H_1 : Public transport demand is responsive to income

1.5 Justification of the Study

Literature on the determinants of public transport demand in South Africa is very limited and thus, this study will add to the existing literature. This study is a valuable source of information for policy makers in the transportation industry, as they need such information to formulate potent policies. It is imperative to analyse the developments that have taken place since the publication of the 1996 White Paper in order to improve the public transport policy. Furthermore, the study will aid in a broader understanding of the nature of available academic research work about the transport modes in South Africa from a researcher perspective. Holmgren (2013) concluded that changes in household income affect the demand for public transport both directly and indirectly – directly through increased car ownership by high-income households, and indirectly by low-income households demanding more public transport. This study will aid in the preventive modalities based on the final outcome of the results.

According to Statistics South Africa (2015), more than two-thirds of households who fall in the lowest income quintile spent more than 20% of their monthly household income per capita on public transport. That is quite confounding, and the biggest impediment to upward mobility and improved quality of life of these households. Therefore, this study is relevant to transport policy makers in the transport department, as the government's policy of subsidies and regulation directly affects the cost of public transport. Furthermore, this study can aid the government to identify sectors that are in need of government subsidies and infrastructural development to elevate sustainable economic development.

1.6 Ethical Considerations

Ethics are the norms and standards that explain proper conduct. They assist in distinguishing between acceptable and unacceptable behaviours. With this research study, secondary data was employed from the 2017 General Household Survey, which focused on household data only. Ethical clearance was applied for and the data was used with utmost integrity.

1.7 Organisation of the Study

This research study is divided into six chapters as follows. Following this Introduction (Chapter 1) is chapter 2 which gives an overview of public transport in South Africa. Chapter 3 presents a review conducted on both the theoretical and the empirical literature pertaining to the

determinants of public transport demand. Chapter 4 discusses the research design and the methodologies. Chapter 5 presents the regression model estimated for the study and provides interpretations of the results. Summary conclusions, policy recommendations and limitations to the study are discussed in Chapter 6

1.8 Summary of the Chapter

This chapter serves as an introduction to the research study. The chapter pointed out that transport expenditure has become a substantial cost in the household especially for low income households in South Africa. Furthermore, the studies that were undertaken in both the developing and developed countries suggested that household income has a significant effect on public transport use. In addition to income, other economic variables influence the mode of transport used. In South Africa, apartheid disparities left a gap in transport infrastructure which continue to have an effect on accessibility of transport means through race, geographical location and affordability of vehicles. To explore how these determinants, primarily income affect public transport use, cross-sectional data from the 2017 General Household Survey was identified to be used in the study. In the subsequent chapter, an examination of the South African public transport system.

CHAPTER 2

PUBLIC TRANSPORT SYSTEMS IN SOUTH AFRICA

2.1 Introduction

The purpose of this chapter is to present an overview of public transport systems in South Africa. The knowledge of public transport policies assists in shedding light on the understanding of public transport demand by households from different backgrounds regarding income. This chapter is divided into three main sections. The first section explains what public transport is and the government expenditures on public transport in South Africa. The second section focuses on transport policies, such as those that are aimed at improving the conditions of public transport in South Africa. The third section looks at the trends of public transport – focusing on road and rail passenger transport for the period 2008-2017.

2.2 Modes of Public Transport

Public transport refers to the modes of transport which are available for public use. Public transport can be perceived as a merit good, which is a service that is considered for public investment (Prim, 2016). In any given country, access and opportunities available to the public vary from location to location. Individuals need to be provided with access to mobility to enable access to employment opportunities and basic services. The provision of public transport systems should provide each citizen with a basic level of mobility (Preston & Rage 2007) to afford everyone access to job opportunities within city regions. There are a number of public transport modes available in South Africa which are explained below.

2.2.1 Air transport

South Africa's aviation is one of the best globally (Dindar, 2016). According to the Travel and Tourism Report that was published in 2011, that compared 139 countries, South Africa was ranked 54th and is the highest within the sub-Saharan countries (Dindar, 2016). In the past, air transport was a system that was considered suitable for wealthy businessmen, it was regarded as not suitable to carry goods and services like the railways do (Mhlanga & Steyn, 2016).

Today, aviation systems play an important role in the tourism industry of South Africa and also play a vital role in the socio-economic development of the country (Mhlanga & Steyn, 2016).

In South Africa, aviation affects the lives of many by providing jobs for both skilled and unskilled labour.

2.2.2 Maritime transport

The maritime transport sector includes the commercial and the non-commercial shipment of good and services that sail through inland waters (Department of Transport, 2017). Furthermore, the maritime industry compromises of marine systems, including the carriage of individuals as well as goods from one destination to another. The maritime industry connects suppliers from across the globe which enables the growth of international trade (Department of Transport, 2017). The majority of products that are consumed by consumers are traded through sea systems and operations and are distributed to retailers by the rail and road network. The South African maritime industry is quite well developed; it is an essential component of international trade. Furthermore, maritime transport makes an increasing contribution to the gross domestic product and creates job opportunities relating to marine manufacturing, research, sea engineering, and sea law, to name a few (Department of Transport, 2017).

2.2.3 Rail transport

Rail transport systems refer to the transportation of goods and services as well as the freight services around South Africa, the South African Development Community region and all other continents across the world (Mathabatha, 2015). Furthermore, the rail industry is divided, comprising the freight rail industry that carries goods and the passenger rail services which caters for individuals (Department of Transport, 2017). Over the years, there has been significant growth in car ownership whilst the passenger rail services have not improved much, hence the decrease in the demand (Department of Transport, 2017). The South African railway network is extensive and it assists the road network in moving cargo across the country. However, in recent years, the maintenance has deteriorated as a result of the lack of funding. This has resulted in individuals not demanding rail service as it does not meet their expectations. Rail transport contributes significantly to the country's economic development through exporting goods and services, thus boosting the economic competitiveness of South Africa (Mathabatha, 2015).

Rail transportation is not governed by any policy; the Department of Transport is in the process of formulating the policy (Department of Transport, 2015). Therefore, the rail transportation

has adopted the public transport policy which does not specifically look into the issues under the rail transport mode.

2.2.4 Road transport

In the sub-Saharan region, road transportation has become the most used form of public transport for transporting goods and individuals. Furthermore, in many of the African countries like South Africa, the importing and exporting of goods and services are done across land by road transport (Kgamanyane, 2015). Moreover, this is mainly because rail services and maritime transport are not well developed and maintained, leading to the over use of road transport. This has led to the road network being highly congested. Furthermore, this has become a huge concern to the public as the South African road network is deteriorating (Van de Mescht, 2006). Further, there has been an increase in freight vehicles being overloaded with heavy goods, thus damaging the provincial roads extensively (Van de Mescht, 2006).

2.2.5 Pipelines

This mode of transport is the most unique, the pipe aids in the movement of freight services. It is the way and a vehicle at the same time (Pienaar, 2009). Furthermore, the pipe is connected to all terminals for freight storage. The pipelines transport oil and petroleum products and they have been receiving major investments in South Africa.

2.3 Accessibility and Usage of Public Transport in South Africa

2.3.1 Usage Patterns based on Income and Geographical Location

The primary aim of public transport systems is to enhance the accessibility of mobility throughout the city for the promotion of social, economic and environmental goals (Banister, 2000). It should be the primary aim of the public transport systems to meet the demands of all users from different income groups and locations at an affordable cost and to be accessible to the urban poor. In an urban context, where the private motor vehicles have taken over, the development of public transport systems is crucial to those who cannot afford private motor vehicles (Prim, 2016). The users from the different income groups and locations have differing experiences of the public transport systems of the economy. Furthermore, Marchese (2006) argued that urban residents who have low time demands are the ones that make use of public transport, whereas those that have high time demands cannot make use of public transport system due to its perceived unreliability.

These differences in time demand can usually be seen in sectors of the economy where the skilled and semi-skilled workers in the manufacturing and service sectors are differentiated. Some of the semi-skilled workers work odd hours through shift work and time is a very crucial factor in their industries, for example in the retail work industry. In light of the time demand, great emphasis needs to be placed on the development of transport systems that are affordable, and reliable (Marchese, 2006). Moreover, the bus rapid systems that are currently in place need to be maintained and it is crucial that these bus rapid systems be introduced in other cities across South Africa not only the major cities (Johannesburg, Durban and Cape Town)

Criden (2008) emphasised how costs of and accessibility to means of transport by low-income earners has been limited as the majority of people at the low-income quintile reside in the peri-urban areas. Economic opportunities are further away from rural locations because of inadequate transport systems – due to very low accessibility of public transport, low-income workers often have difficulty in accessing jobs. Minimum wage jobs in urban areas are mostly shift work which require individuals to work in the evenings or during the weekend, but public transportation systems are not accessible to the informal settlements and peri-urban routes at those times.

Developing and uplifting the poor is a very crucial matter in South Africa and one of the fundamental reasons of poverty in South Africa is the lack of access to basic services. However, there is an inadequate road network across the informal settlements, resulting in public transportation not being accessible to the poor and therefore limiting these individuals from accessing job opportunities in order to break out of poverty (Chaitoo & Venkatesh, 2010).

It is quite evident that road infrastructure in many peri-urban areas in South Africa is still poor. The roads are mostly not tarred and the tarred roads are not in a good condition, resulting in limitations to access to public transport, again limiting individuals to economic opportunities (Mamabolo, 2013).

2.3.2 Expenditure on Public Transport in South Africa

A report by Statistics South Africa (2015) on Measuring Household Expenditures on Public Transport indicates that the average per capita monthly household travel cost is higher for households from the highest income quintile (R404) compared to households from the lowest income quintile (R136). However, the reason pertaining to such a difference in travelling cost is that the high-income households use their own private cars for travelling, whilst the low-

income households use public transport. Furthermore, taxis were reported to be the most expensive mode of travel with an average per capita monthly cost of R254, followed by trains (R248) and buses (R231). The low-income households use the mode of transport that is accessible where they reside. Moreover, these individuals are mostly unskilled and semi-skilled individuals who do not travel to work every day. Furthermore, it was found that households from the lowest income quintile spent a higher proportion of their income on public transport compared to households from the highest income quintile. More than two-thirds of households who fall in the lowest income quintile spent more than 20% of their monthly household income per capita on public transport (66,6%). Less than 3% of households from the highest income quintile spent more than 20% of their monthly household income per capita (2,9%) on transport. Individuals from the high-income households do not all rely on public transport for travelling hence a small percentage of these individuals were using public transport. The vast majority of the low-income households rely on public transport as their only means of transport for travelling.

The passenger public transport system in South Africa consists of the road passenger network and the rail passenger network, which are subsidised by the South African government. According to Ryneveld (2014), government expenditures on transport are allocated through grants. There is the Public Transport Operating Grant (PTOG) which is an operating subsidy for buses that have been operating for years, which includes services such as Putco bus services operating in the Gauteng province. The system is operated through tender contracts between bus operators and the government and operates in the metro municipalities. The main objective of the grant was to ensure that the bus services offered to the public are affordable and accessible to the commuters. The subsidies have resulted in the bus services being affordable to commuters, including students and workers, etc. The provincial government together with the metropolitan municipalities has to make agreements ensuring that these grants to operators tally with the contractual contracts (Department of Transport, 2018). These contracts are closely monitored and supervised by contracting authorities through monitoring the operators' claims. Those appointed to monitor on a daily basis are expected to submit monitoring reports to the authorities on a monthly basis.

Furthermore, there are the Public Transport Infrastructure Systems Grant (PTISG) and Public Transport Network Operating Grant (PTNOG) which focus only on the government's new initiatives to create Rapid Integrated Public Transport Systems (RIPT's) such as Reya Vaya in

Gauteng and My Citi in the Western Cape. For the rail network, there is the Passenger Rail Agency of South Africa (PRASA) that is the subsidy for passenger rail (Ryneveld, 2014). These grants cater mostly for the low-income households residing in the informal settlements situated in the peri-urban areas. Bus and rail services have become an affordable mode of transport as a result of these subsidies. However, accessibility to these transport systems is a factor for the low-income households which resort to using mini-bus taxis as expensive as they are.

The allocation of national spending by the government on public transport is shown in Table 2.1 and it is denoted in percentages of total expenditures.

Table 2.1 Allocation of national spending by public transport

Key National Subsidies	2010/11	2011/12	2012/2013	2013/2014	2014/15	2015/16	2016/17
Public Transport Opera.	16.53	4.15	4.32	4.55	4.83	5.05	5.32
Public Transport Infras.	10.91	4.61	4.88	4.67	4.97	5.10	5.10
Public Transport OP	0.00	0.00	0.00	0.88	0.90	1.04	1.36
Taxi recapitalization	2.10	0.45	0.41	0.47	0.42	0.45	0.78
Total PRASA subsidy	30.06	9.47	10.23	10.51	14.95	18.27	19.29
Current subsidy	14.40	3.34	3.53	3.68	3.89	4.07	4.28
Capital subsidy	16.66	6.13	6.70	6.83	11.06	14.20	15.01
Gautrain capital	25.90	0.01	0.00	0.00	0.00	0.00	0.00
Gautrain ridership	0.00	0.60	0.83	1.04	0.99	0.98	0.97
TOTALS	85.50	19.29	20.67	22.12	27.06	30.89	32.83

Source: Authors' illustration based on Ryneveld (2014)

There was a rapid increase in spending of 39.7% between 2013/14 and 2015/16 mainly caused by the increase in spending made by the Passenger Rail Agency of South Africa. Within the five-year period from 2006/7 to 2010/11 the expenditure on passenger rail services was 65.5% which is quite shocking as the demand for rail transport has decreased over the years (Lombard,

Cameroon & Makonyama, 2007). In 2010, South Africa hosted the World Cup and hence the PTOG and PTISG were relatively high.

The National Household Survey (2013) was of the view that the demand for rail is high mainly because of affordability to low-income households that are located in areas where rail public transport is easily accessible.

Table.2.2 breaks down the subsidy allocated as per passenger trip on municipal buses, mini-bus taxis as well as the Gautrain services.

Table 2.2: Operating subsidies for public transport in South African cities

Mode	Operating subsidy per passenger trip	Fare box recovery rates as % of operating costs
Municipal bus services	R16. 75 – R24. 36	13%to 31%
Conventional bus services	R11. 40 – R16. 89	31% to 44%
Bus rapid transport	R11. 76 – R16. 12	28% to 44%
Mini-bus taxis	R0.00	0%
Gautrain	R60. 03	57%
PRASA Metrorail	R3. 73	39%

Source: Authors'illustration based on Ryneveld (2014)

According to Ryneveld (2014), South African passenger fares cover between 13% and 57% of the operating costs of public transport services. For mini-bus services, it is very high as the government does not cover any subsidy, resulting in passengers covering 100% of the fares (Van Ryneveld, 2014). These mini-bus taxi services are easily accessible and hence the demand for them is quite high compared to other modes of transport. According to Browning (2001), the problem of mini-bus taxis not being subsidised by the government is that the actual operation and capital structure of the vehicles is in the hands of the individual owner rather than being a collective company that is handled by professionals. There are a number of burning issues regarding mini-bus services, namely reckless drivers and the high rate of accidents but these issues do not decrease the demand (National Household Survey, 2013). Mini-bus taxis are an expensive mode of transport but low and middle-income households are sometimes left

with no other alternative but to use these services as a result of accessibility, resulting in higher expenditures by low-income households on public transport use (Statistics South Africa, 2015).

2.4 Policies aimed at improving Public Transport in South Africa

In South Africa, the public transport expenditures and subsidies are governed through policies. This section summarises public transport policies and legislations that were established since 1994. The White Paper is the crucial policy document that guides the overall planning and establishment of public transport and is explained below.

2.4.1 White Paper on National Transport Policy (1996)

The White Paper on National Transport Policy (Department of Transport, 1996) is the fundamental policy document in South Africa and it is the guide to all public transport planning and legislation. The ultimate goal of transport is to provide "smooth and efficient interaction that allows society and the economy to assume their preferred form" (Department of Transport, 1996). The transport policy is divided into two sections, Infrastructure together with Operations and Control. Public transport policy falls under Operations and Control and is nested under Land and Passenger Transport. The public transport policy covers all passenger movements whether from the rural areas or urban together with cross-border transport (Department of Transport, 1996).

The ultimate goal of the Department of Transport with respect to Land and Passenger transport is "the promotion of a safe, reliable, effective, efficient, coordinated transport system in South Africa, urban and rural areas, and the Southern African region, managed in an accountable manner to ensure that people experience improving levels of mobility and accessibility" (Department of Transport, 1996). In the past, the government introduced the bus rapid systems in the major cities of South Africa. These bus systems are indeed safe, affordable and effective; however, inaccessibility of these bus systems remains a challenge. The middle and low-income households that are unable to access these affordable bus services resort to using mini-bus taxis, resulting in overall higher expenditure on transport.

At the time the White Paper was established, it was already evident that middle and low-income earners from distressed locations lacked access to public transport, which was and still is the majority customer base of public transport Statistics South Africa Expenditure Survey (2015). Furthermore, the key objective of the White Paper was to shift the focus to customer needs, resulting into information being identified through comprehensive interactions with customers

(Ryneveld, 2008). Therefore, to support the key objective of the policy, other fundamental objectives of the White Paper are to ensure that spatial developments are in line with the passenger policy. Passenger transport must be consumer friendly, and should accommodate individuals from different locations and all individuals from different income quintiles, and must be provided efficiently (Department of Transport, 1996).

Furthermore, based on the fundamental objectives of the White Paper, the policy considers the provision of public transport highly and that it should be sustainable and carried out in such a manner that it will be distributed efficiently – easily accessible to low-income earners living in distraught areas. In terms of infrastructure for public transport, the policy is set out for different modes of transport. In order to ensure the provision and maintenance of the road infrastructure network is used efficiently, the road network is facilitated by a Road Agency, which has to ensure the smooth running of all operations (Department of Transport, 1996). Following this section, Moving South Africa, National Land Transport Strategic Framework and the National Development Plan of 2012 are discussed below.

2.4.2 Moving South Africa (1998)

The National Department of Transport (1998) conducted a project known as Moving South Africa (MSA). This project was completed in September 1998. The MSA was designed to enable the Transport Department to produce a programme for strategic action that extends the short-to-medium policy formulation that is documented in the Transport White Paper Policy into a long-term strategic formulation (Department of Transport, 1996).

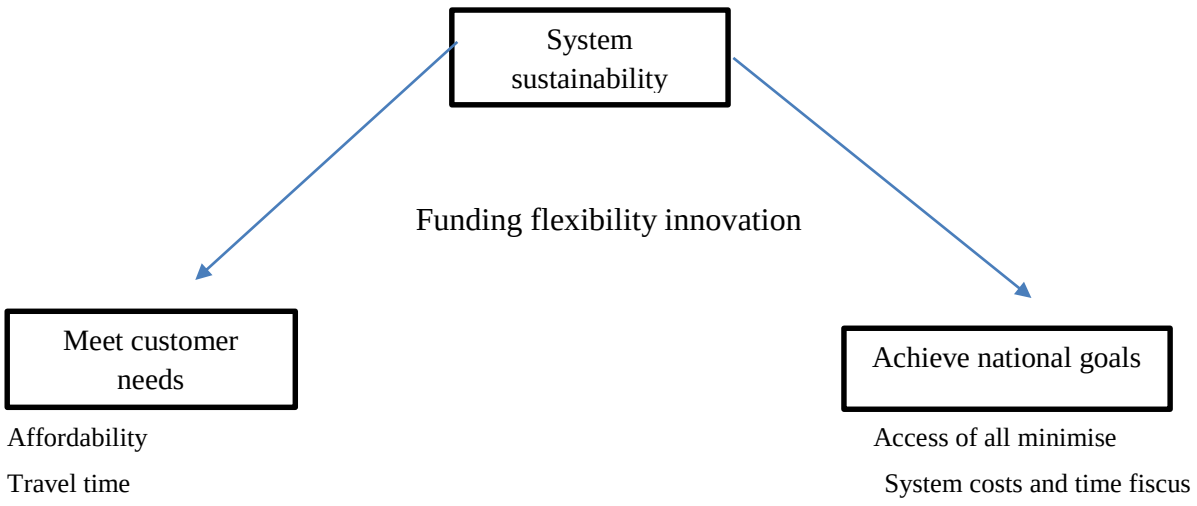

Figure 2.1: Public Transport Objectives

Source: Author's illustration based on Moving South Africa (1998)

The MSA is a project aimed to create a shared vision and consistent decision rules for all members of the transport industry. The strategic project creates a goal for urban transport to support the overall goal of the National Transport Policy (National Planning Commission, 2012) as explained next.

It provides an effective and sustainable urban transport system, planned and regulated through the lowest possible level of government, based on competition and largely private sector operation, which reduces systems and improves customer services in order to meet customer and national objectives for user cost, travel times, choice and safety (Moving South Africa, 1998).

The MSA does not mention rural transport, it mainly focuses on urban transport systems. However it does suggest that due to the unavailability, the general strategic principles developed are to be applied to the rural situations as well (Luke & Heyns, 2013).

Following this section, the National Land Transport Strategic Framework (NLTSF) is discussed below.

2.4.3 National Land Transport Strategic Framework (NLTSF)

The National Land Transport Strategic Framework (NLTSF) is a legal document in terms of the National Transport Act, 2009, NLTA, (Act no.5 of 2009), section 34. (Department of Transport, 2015). The NLTSF is set out for South Africans over the years 2015-2020 and is aimed as a guide for land transport planning. The strategic planning for land transport planning will aid in achieving the economic and environmental objectives. These identified priorities all link the framework to the National Development Plan (NDP), National Transport Master Plan (NATMAP), and the provincial and local government strategies (Department of Transport, 2015). One of the fundamental roles of the NATMAP is to act as a guideline for transport planning on land use patterns using the NDP (2030) as a guideline to the goals than need to be reached by 2030.

In the White Paper on National Transport Policy 1996, one of the strategies for land passenger transport , is to, "ensure that passenger transport services address user needs, including those

of commuters from different income quintiles , pensioners, learners, the disabled, tourists and long distance passengers". Despite the transport policy, access to transport services is utterly poor across the range of locations where low to middle-income earners reside and this needs to be addressed by 2030 according to the fundamental goals of the National Development Plan.

2.4.4 The National Development Plan (2012)

In August 2012, the National Planning Commission (NPC) presented the National Development Plan, which aimed at readdressing poverty and reducing inequality within SA by 2030. The NDP presented a long-term strategy, which included numerous different factors to aid in the developing of the SA economy and society.

The NDP investments in transport infrastructure and the improvement of public transport are seen as the key development areas to focus on in achieving the 2030 objectives (Luke & Heyns, 2013). There are specific strategies in the NDP relating to public transport that are intended for poverty reduction.

According to the NDP, investments in public transport are highly recommended, which will benefit the low-income households, who demand public transport but lack easy access to it. The establishment of safe, reliable and affordable public transport for the people should "bridge" the geographical distances affordably for all South Africans in different income bands so as to have access to previously inaccessible opportunities.

Furthermore, South Africa needs to invest in economic infrastructure to be able to provide basic services such as public transport to meet the household needs of the different income holders (National Planning Commission, 2012). This can be achieved by focusing on providing safe and reliable public transport to the distraught locations where low-income earners are residing. This will enhance poverty reduction because by having access to public transport these households will have access to economic opportunities.

Additionally, public transport investments should be increased by attracting both public and private economies of scale to bridge the gap. Subsidies should also be made available because there will be individuals from a very low-income band who demand public transport but cannot afford the services. This tool will increase the affordability of transport for low-income commuters. Public transport responsibilities should not be handled by the Department of

Transport but should be handed over to the local municipalities who are the ones who deal directly with the consumer demand and consumer needs of that particular aspect.

2.5 Facilitation and Shortcomings of Public Transport Policy in South Africa

The National Transport Policy (1996) argued that efficiency has to be established in the Department of Transport and this is achievable "by ensuring competition in the provision of infrastructure and operations".

The 1996 White Paper further stipulates that, "Government proposes a form of regulated competition which requires that operators function in a competitive environment in a manner which compiles with the government objectives".

The 1996 White Paper further addressed the need to provide accessible and affordable public transport services in rural areas. According to the Department of Transport (2017), some improvements have been made but the progress is very slow, especially in the peri-urban and rural areas. The National Public Transport Regulator (NPTR) was established under the terms of Section 20 of the National Land Transport Act, 05 of 2009. Aspects that are South Africans' main issues are mobility and accessibility, which have been prioritised since 1996, with documents such as the National Development Plan as well as Moving South Africa emphasizing such issues, and yet the concerns remain unchanged (Luke & Heyns, 2013). In a study conducted by Walters (2014), it was concluded that the reason for the lack of policy implementation in South Africa is a result of lack of capacity and expertise. Walters (2014) also argued that the reason for the lack of policy implementation is lack of funding to sustain these objectives.

In the context of developing countries, developing a sustainable public transport system is a challenge. Identifying and finding solutions to the public transport system is one of the major tasks faced by the government in the majority of developing countries, such as Pakistan (Naqvi, 2011).

Despite high expenditure on the improvement of public transport systems, the challenge worsens because of bad planning. In some African countries and Asian countries, individuals are divided according to their race and income status, (whether they are from low, middle or

high-income households), making it very difficult to develop the most efficient and effective public transport systems to cater for all citizens (Prim, 2016).

Lastly, public transport is an essential for the day-to-day lives of the urban poor, providing them with access to employment opportunities and services from different locations. Internationally, accessibility remains a challenge. This challenge is more difficult and complicated in developing countries where people are still situated in locations according to their income class (Prim, 2016). A comparison of road and rail transportation is important to analyse in order to determine which modes are in greater demand by households. The graph in Figure 2.2 show a comparison of the two.

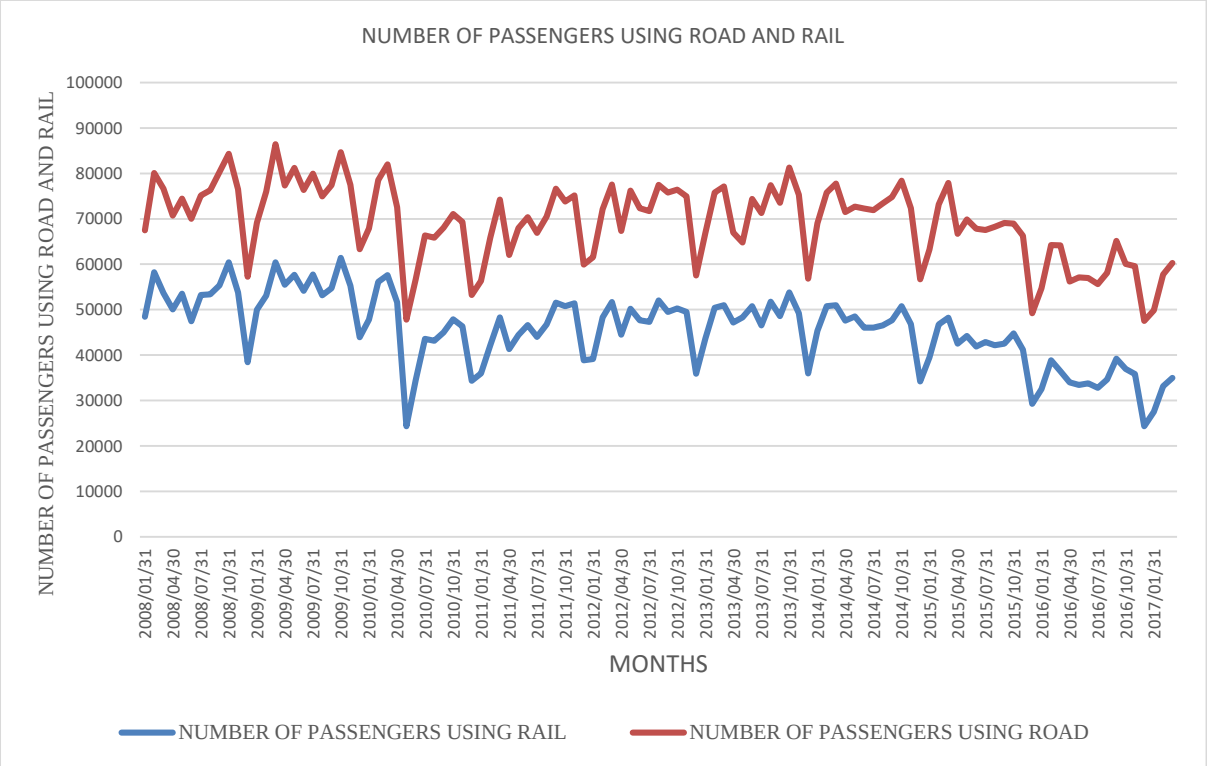

Figure 2.2: Number of Passengers using road and rail transport

Source: Author's illustration based on Easy Data (2017)

Figure 2.2 illustrates the trends of the number of passengers using road and rail passenger transport from 2008 to 2016. According to the National Household Survey conducted in 2013, more than half of public transport users utilise road transportation because of easy

accessibility of mini-bus taxis. Furthermore, with rail usage, it is a completely different case; accessibility is a huge barrier to commuters. Lombard, et al. (2007) discovered that there is an absolute growth of individuals using public transport in South Africa, particularly in the mini-bus (taxi) industry. This was also confirmed by the 1998 Moving South Africa Vision 2020 finding that there is "disruptive competition" on all the subsidised modes of public transport.

In 2008, the country was facing a financial crisis, resulting in many individuals being unemployed and not travelling frequently, and transportation industries such as rail transport shrunk, causing the country to slip into depression mode (Baxter, 2009). During 2009, the economy recovered from the financial crisis and the number of passengers using public transport increased (Rothengatter, Yoshitsu&Woltgang, 2011). According to Lombard, et al. (2007), the increases in rail passenger use is consistent with population growth and employment growth. During the first six months of 2008, the number of passengers using rail was increasing because of the financial crisis. Thus, individuals moved from road to rail as it was the most affordable public transport mode at the time as the bus rapid systems were not yet fully introduced in South Africa.

In mid 2008, the number fell as the employment rate decreased resulting in fewer individuals using public transport to the cities. In 2009, the economy slowly recovered from the recession and rail transport was increasing at a normal rate. Over the years, rail passenger transport increased, although in some months it decreased at a normal expected rate.

According to Rothengatter et al. (2011), passenger transport is mostly driven by the disposable income of individuals, whether individuals use public transport or private cars. However, accessibility has a role in determining which mode of transport individuals are using.

It is quite evident from Figure 2.2 that in phases of an economic downturn the number of passengers using road passenger transport deteriorated and at times of an economic upturn, the figures went up. According to the National Household Survey (2013), the huge decrease in 2013 was a result of an increase in fare price. In 2014 up to the year 2017, the number of passengers using road passenger transport has been increasing and decreasing at a normal rate with the latter probably because of more people using rail passenger transport.

Rail transportation depends on the accessibility to individuals at their designated locations. In areas where rail services are available, which is mostly in metropolitan areas, individuals make

use of the rail services available to them (Ryneveld, 2008). Lombard et al. (2007) further commented that the reason for a decrease in rail transport was a result of an increase in the number of job promotions leading to individuals owning private cars or moving to a faster mode of transport – mini-bus taxis and the Gautrain services.

Table 2.3 illustrates the amount of household income spent by individuals on public transport relative to their income bracket.

Table 2.3: Percentage of household income spent on public transport in relation to monthly household income

Monthly household income (2001)	PERCENTAGE OF HOUSEHOLD INCOME SPENT ON PUBLIC TRANSPORT				
	0%	**1-5%**	**6-10%**	**11-20%**	**20%+**
Up to R500	20.8	0.05	24.5	5.8	49.8
R501-R1000	14.1	33.5	20.9	13.2	18.3
R1001-R3000	15.1	28.8	24.0	22.0	10.1
R3001-R6000	32.5	35.4	18.6	10.7	2.8
More than R6000	68.8	23.8	5.4	1.9	0.0

Source: Authors' illustration based on Department of Transport (2003)

Statistics South Africa conducts an Income and Expenditure Survey (IES) every five years. The IES seeks to establish what South Africans spend their money on. Essentially, one out of every two Rand spent by South African households goes towards housing and food expenditure items. Transport is the second largest expenditure group and is estimated at 17.1% of total household consumption expenditure. The average South African household spent R16 319 on transport between September 2010 and August 2011 (Department of Transport 2003), which amounts to roughly one out of every six Rand spent on transport.

Table 2.3 illustrates a comparison of transport expenditure relative to household income. It shows that commuters from the low-income households spend more of their income on public transport, the highest being mini-bus taxis because of the easy accessibility, which is an average of a third of their earnings (Department of Transport, 2003).

Table 2.4 breaks down the use of public transport modes by location.


IN LUMINE TUO
VIDE BIMUS LUMEN
University of Fort Hare
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Table 2.4: Percentage of mode of transport used by province

Modes of travel	**WC**	**EC**	**NC**	**FS**	**KZN**	**NW**	**GP**	**MP**	**LP**	**RSA**
Train	10.4	1.4	0.6	1.2	2.5	1.0	8.2	0.7	26.9	4.4
Bus	7.3	6.5	2.7	5.8	13.3	13.5	6.3	14.9	22.6	0.2
Taxi	25.7	47.7	29.4	44.8	49.7	44.3	38.2	45.2	45.8	41.6
Car/bakkie/truck	15.4	7.4	14.1	8.6	9.0	9.9	9,9	7.4	7.1	9.7
Walk all the way	7.1	27.7	37.9	24.4	14.6	18.4	15.7	19.9	16.2	18.5
Other	2.0	1.2	2.7	2.4	0.7	2.9	2.9	1.0	0.7	1.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Author's illustration based on Department of Transport (2013)

The Department of Statistics South Africa (2015) report on Measuring Household Expenditure on Public Transport found that taxis are the commonly used mode of public transport in South Africa with just more than half (51.0%) of the households that use public transport (76.7%) relying on them, followed by buses (18.1%) and trains (7.6%). This was highlighted in the Measuring Household Expenditure on Public Transport technical report released by Statistics South Africa.

According to Table 2.4 above, the four modes of public transport used by households to travel by average are taxis (41.6%), train (4.4%), walking all the way (18.5%) and travelling by car bakkie or truck (9.7%). Analysing the above statistics, it is evident that the rural provinces (Eastern Cape and KZN) tend to have a higher usage of taxis than any other mode, leading to higher expenditure on transport (Department of Transport, 2013). This could be caused by the lack of accessibility of other modes of transport, resulting in individuals from low-income households demanding the most expensive mode of transport. This is not assisting in elevating the livelihood of the low-income earners.

Mini-bus taxis are a mode of public transport, however, they are not being subsidised by the government making the fare prices higher than other modes. This is not fair on low and middle-income households who have to use taxis by default as a result of the inaccessibility of other public transport modes. Furthermore, the low and middle-income households in South Africa encompass 77.3% of the population, yet inaccessibility to such a huge number remains a challenge.

Accessibility in peri-urban areas is also a challenge as 40% of the individuals residing there spend over 30% of their income on public transport, resulting in a huge impediment in the alleviation of poverty in this country. Table 2.5 denotes public transport use by mode.

Table 2.5: Usage of public transport in South Africa

Location	**Taxis**		**Buses**		**Trains**	
Province	**2003**	**2013**	**2003**	**2013**	**2003**	**2013**
Western Cape	45.5	51.4	9.3	14,8	14.9	21.9
Eastern Cape	53.6	62.1	18.1	12.5	1.6	2.3
Northern Cape	38.5	51.0	6.7	7.5	3.0	1.2
Free State	60.7	68.6	9.9	14.4	1.0	1.8
Kwazulu-Natal	63.4	78.8	27.9	23.0	2.2	6.0
North -West	60.2	71.6	15.9	21.8	2.1	2.5
Gauteng	62.9	68.0	7.6	15.9	14.1	20.3
Mpumalanga	64.6	78.4	21.3	28.7	0.6	0.9
Limpopo	62.7	78.8	23.8	41.6	0.3	1.2
RSA	59.0	69.0	16.6	20.02	5.7	9.9
Metropolitan	59.9	66.69	13.4	18.87	13.3	19.6
Urban	60.3	66.01	9.2	12.03	2.9	4.1
Rural	57.4	75.11	24.6	29.60	0.7	1.8

Sources: Author's illustration based on National Household Survey 2013

Public transport use has changed significantly over the past ten years, between 2003 and 2013. There has been an increase in the number of households that use taxis (from 59% to 69,0%) buses (from 16,6% to 20,2%) and passenger trains (from 5,7% to 9,9%) (National Household Travel Survey, 2013).

The increases in taxi use occurred in all nine provinces where in some instances it increased much higher relative to other province such as Kwazulu-Natal and Limpopo with a 15% increase. Rural areas have shown a greater increase in the use of public transport as a whole relative to the metropolitan and urban areas. This alone proves that the demand for public

transport by low-income households from rural locations. South Africa's road network is illustrated in Table 2.6.

Table 2.6: South Africa's road Network

Provincial Authority	Paved	Gravel	Total
Eastern Cape	5, 578	26,340	32,218
Free State	6,313	21,325	27,638
Gauteng	3,449	1,895	5,344
Kwazulu- Natal	6,749	14,437	21,186
Limpopo	6,639	15,396	22,035
Mpumalanga	4,592	8,887	13,839
North-West	5,551	14,961	20,512
Northern Cape	2,539	23,205	25,744
Western Cape	6,106	10,194	16,300
Total Provincial	48,176	136,640	184,186

Source:-Author's illustration based on the review of the South African Road Network 2010

Table 2.6 shows that up to 74% of South African roads is gravel and only 26% is tarred. The provincial authorities are responsible for road provision and maintenance of these gravel road, which require frequent maintenance relative to paved roads. This poses difficult for provinces like the Eastern Cape with 82% of gravel roads in most places and where low-income earners reside (Mamabolo, 2013). Criden (2008) and Chaitoo and Venkatesh (2013) emphasised that rural areas demand public transport to have access to economic opportunities in the urban areas. As a result of the road infrastructure being of substandard quality, public transport does not use those routes (Mamabolo, 2013).

Table 2.7 illustrates the distribution of income.

Table 2.7: Percentage distribution of households' per capita income quintiles and population group of household head

Quintile levels	Black/African	Coloured	Indian/Asian	White
Upper Quintile	10.1	20.5	43.4	75.8
4 th Quintile	19.0	28.1	37.8	17.0
3 rd Quintile	22.1	25.9	12.6	4.2
2nd Quintile	24.0	16.1	3.4	1.1
Lower Quintile	24.7	9.4	2.8	1.8

Source: Author's illustration based on the Income and Expenditure Survey 2011

Table 2.7 outlines the distribution of South Africa's income by quintiles within each population group. The income quintiles have the following values:

- Upper quintile: R57100 and above
- 4th quintile: R21 003- R57 099
- 3rd quintile: R9 887- R21 002
- 2nd quintile: R4 544- R9 886
- Lower quintile: Up to R4 543.

As illustrated in Table 2.7, the income inequality biasness amongst the racial groups is visible, where 24.7% of Black African households are in the lower income quintile.

Furthermore, the White households' vast majority are the highest income quintile (75.8%) with only 1.8% of the households falling in the lower income quintile. Relative to Blacks, the Coloured households were the opposite, 9.4% of households fell in the lower quintile and 20.5% fell in the upper quintile. In comparison, the Indian/Asian were found to be mostly in the upper quintile 43.4% while 2.8% were in the lower quintile. The South African government has created policies to alleviate poverty through social grants. Nevertheless, these policies have not succeeded in reducing the inequalities of the country and in providing equal opportunities for all South Africans (Leibbrandt, Wegner & Finn, 2011).

2.6 Summary of the Chapter

This chapter forms a background to this study by having analysed the public transport system in South Africa. An overview of public transport is important to understand the determinants of public transport and the impact household income has on public transport demand. Accessibility of the different modes of transportation is an area of concern in most geographical areas, moreso in the peri-urban areas. Furthermore, In South Africa, rail is suggested to be the

more affordable transport mode. As a result of disparities in policy formulation rail transport is not easily accessible to all areas. Accessibility to means of transport and income differences are suggested to have an effect on public transport mode choice. The next chapter shall provide a theoretical explanation on the effects of these on transport mode choice.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

The rationale of this section was to study both the theoretical and the empirical literature concerning public transport demand. This is particularly vital in gaining insight into the theoretical framework. The focus of the study was on the effect of household income on public transport demand. Therefore, the theories pertain to focus on the determinants of public transport demand which are income, price, utility and behaviour. Public transport was treated as a commodity as more focus was placed on the elasticities of demand. The chapter first deals with the theoretical literature which comprises the consumer demand theory, utility maximization theory, urban transport economic theory and the theory of planned behaviour. The second part of this chapter presents the empirical literature that explains the overall determinants of public transport demand.

3.2 Theoretical literature

This section discusses the theoretical determinants of public transport. These theories are focused on the consumer behaviour and demand elasticities. The consumer demand theory focuses on both changes in household income and price, the utility maximisation theory focuses on consumer choice, the urban transport economic theory focuses on social and marginal benefits of public transport and lastly, there is the theory of planned behaviour. There is no theoretical consensus on the relationship between public transport demand and household income.

3.2.1 Consumer demand theory

3.2.1.1 Tenets of the Theory

Economists would rather measure real economic variables than monetary terms. They assume that “money is a veil” which gives the analyst a clear view of what people do and what they care about – which is real commodities. Relative prices and relative income are two of these real measures (Jehle & Reny, 2011).

In the consumer demand theory, the price level was assumed to be the number of units of the good that must be forgone to acquire an additional unit of the other good, which can be written out as:

$$\frac{P_i}{P_j} = \frac{\$/Unit_i}{\$/Unit_j} = \frac{\$}{Unit_i}.\frac{Unit_j}{\$} = \frac{Unitsof_j}{Unitsof_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(3.1)}$$

However, in the equation above, P_i is assumed to be the money price for a particular mode of transport and is measured in units of dollars per unit acquired of good i (Jehle & Reny, 2011). The money price for good i is the amount of units, which in this regard is public transport that an individual will have to forgo when acquiring a different unit of good i.

Furthermore, real income is measured through the maximum number of units a consumer could acquire if he spent his entire income on purchasing a commodity, only if y is the consumer's money income. The ratio of money which is y/p_j, is then assumed to be his real income in terms of commodity j and will be measured in units of good j, and will be written out as:

$$\frac{y}{p_i} = \frac{\$}{\$/unitof_j} = unitsof_j \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(3.2)}$$

A change in the variable y could have a negative or a positive impact on public transport demand. An increase in income could result in an individual affording a private car, which in turn will decrease the demand for public transport. A change in price of the commodity i could result in an individual consuming a different mode of transport, thus decreasing the units of commodity j.

The following section explains in detail the consumer demand theory through the following subheadings: demand elasticities, Engel curves, income elasticities of demand and the demand elasticity relations.

3.2.1.2 Demand elasticities

According to Jehle and Reny (2011), the demand elasticities and income shares can be represented by the Marshallian demand function, and can be written as follows:

$x(p, y)$ and let;

$$\eta_i = \frac{\partial x_i(p,y)}{\partial_y} \frac{y}{X_i(p,y)} \quad \text{(3.2.1)}$$

$$\in_{ij} = \frac{\partial x_i(p,y)}{\partial p_j} \frac{p_j}{x_i(p,y)} \quad \text{(3.2.2)}$$

And let

$$S_i = \frac{p_i x_i(p,y)}{y} \text{ so that } s_i \geq 0 \text{ and } \sum_{i=1}^{n} s_i = 1. \quad \text{(3.2.3)}$$

The symbol η_i is the income elasticity for good i and what it does is to measure the percentage change in the quantity demanded should there be a 1% change in the income of the consumer. The changes in income will cause shifts in the demand for public transport. Furthermore, an increase in income will sometimes lead to consumers demanding less of public transport, which would mean public transport is an inferior good (Jehle & Reny, 2011). However, for the low-income households public transport is a necessity. Moreover, these individuals may not afford owning a private car which they probably regard as a luxury good. Therefore, public transport can be classified as a normal good and can sometimes be price inelastic.

Jehle and Reny (2011) further explained that the symbol $\in_{ij}$ goes on to explain the price elasticity of demand for good i and measures the percentage change in the quantity demanded should there be a 1% increase or decrease in the price of the good.

With price elasticity, the demand for public transport, should there be an increase in price, will be determined by the income group. In a low-income household, an increase in the price of public transport will yield a positive outcome for transport suppliers.

Individuals from low-income households do not have alternative transport, they are solely dependent on public transport. However, the individuals might switch modes depending on the availability in that particular area but will remain within the public transport sphere.

S_i denotes the income share, which is the fraction of the consumer's income spent on expenditures of good i. The income share focuses on how much a household spends on public transport expenditure and these values may not be negative and should sum up to 1 (Jehle & Reny, 2011)

3.2.1.3 Engel curves

Engel curves explain how a consumer's consumption of goods and services vary according to the consumer's resources, such as their income (Lewbel, 2006). Furthermore, Chai and Moneta (2010) defined these Engel curves by explaining in depth that it is how household expenditures depend solely on income. Moreover, they stated that the Engel law states that "the poorer a family is, the larger the budget share if it spends on nourishment". These curves determine the income elasticity and whether or not that particular commodity is a normal, luxury or an inferior good. It is a function explaining how a consumer's total expenditure on goods and services is aligned to the total resources, holding prices fixed, so $q_i = g_i(y, z)$ where q_i is the total quantity of public transport consumed by a household (Chai & Moneta, 2010). Furthermore, y is income or total expenditure on goods and services spent on public transport at that point in time and z is the vector of other variables such as age (Chai & Moneta, 2010).

3.1.1.4 Income elasticity of demand

The demand side model is one of the fundamental propositions of public transport and income changes (Fedderke, 2014). Furthermore, the model comprises non-linear Engel-curves with utility preferences that generate high-income elasticities for new goods that consumers will treat as luxuries. As the demand for public transport matures in the long run, it tends to become a necessity and individuals get to a point where they cannot function without public transport use (Fedderke, 2014).

Consider an agent economy with an infinite number of public transport and ranked by the index i, and the utility derived from consuming good i in the quantity demanded c be denoted by

$$v(c(i)) = \left(\frac{1}{2}\right)\left[s^2 - (s - c(i))^2\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.2.4$$

Where s denotes the level of consumption of public transport under the hierarchic preferences, where individuals, because of affordability, cannot consume some modes of transport.

If all the goods produced are available on the market =, the objective function will be:

$$\mu(c(i)) = \int_{\circ}^{\infty} \left(i^{-\nu}\right)\left(\frac{1}{2}\right)\left[s^2 - s - c(i)^2\right] di \; st \int_{\circ}^{\infty} P(i)c(i)di = E \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.2.5$$

$c(i) \geq 0 \forall\, i$ ……………………………………………………………………………………………3.2.6

The optimal consumption of good i when supplied at the marginal cost price is $c(i) = s - i^{\lambda}\lambda$

Which gives the equilibrium composition of demand for public transport as:

$$c(i) = s\left[1 - \left(\frac{1}{N}\right)^{\lambda}\right], i \in [0, N] \ldots\ldots\ldots\ldots 3.2.7$$

It is now evident that the quantity demanded of any good i will depend on the relative position it holds on the "hierarchy of needs", how badly an individual depends on public transport (i, N), with the goods in the lower position of the hierarchy receiving higher priority, since $c(i)$ decreases in i. According to Fedderke (2014), with economic development the number of public transport produced rises which then increases N leading to the demand of already existing goods increasing but at a diminishing rate.

The demand for public transport across the economy can change at any point in time, while the income elasticity of transport demand under any given constant saving rate is given by:

$$\in i, Y = \lambda \frac{\left(\frac{i}{N(\tau)}\right)^{\lambda}}{1 - \left(\frac{i}{N(\tau)}\right)^{\lambda}} \ldots\ldots\ldots\ldots 3..2.8$$

With the introduction of the new good, $i = N(\tau), \in_{i,Y} \rightarrow \infty$ which means that the new good is rendered as a luxury good, while $\frac{1}{N(\tau)}$ declines, consumption remains in unity (Fedderke, 2014).

$\in_{i,Y} \rightarrow 0$ When the income elasticity of the individual is close to zero, the changes in income whether it is increasing or decreasing will not have an effect on the demand for public transport because the commodity will have now been a normal good and be regarded as a necessity to the society.

3.1.1.5 Demand elasticity relations

An individual's budget constraint enables discipline in the response a consumer has to the changes in circumstances relating to the price of transport and the consumer's income.

According to Jehle and Reny (2011), if $x(p, y)$ is said to be the consumer's Marshallian demand function, then the budget constraints must hold equality on the set of prices for public transport and the level of income by an individual. Where:

$$y = \sum_{i=1}^{n} p_i x_i (p, y) \quad \text{(3.2.9)}$$

If any single fare price of public transport or the consumer's income changes, it must balance before and after the change takes place (Jehle & Reny, 2011). Furthermore, the consumer's demand responses to the price of public transport or any increase or decrease in their income should add up in a way that equality in the budget constraints is preserved. Moreover, the effect that changes in income and/or price have on transport demand are not perfectly reversible. Therefore, the logarithm of income is decomposed into series; the accumulating series of increases in income as well as the decreases in income (Hauksdottir, 2010).

3.2.2 Utility Maximization Theory

Minal and Sekhar (2014) defined utility as "an indicator of value to an individual". In a discrete experiment, the decision maker out of a set of alternatives will choose a single alternative. Furthermore, an individual is seen and understood to choose a mode of transport that maximizes his utility (Minal & Sekhar, 2014). Therefore, the utility that can be derived from a choice of transportation mode by an individual is determined by a given attraction by the individual on that specific trip. This is known as the utility maximization. This can further be defined as alternative "I" being the chosen one amongst a set of alternative modes of transport and only if the utility that is derived from alternative "I" is greater or equal to the utility of all other alternative modes. According Minal and Sekhar (2014), based on the utility maximization rule, an individual will choose the mode of transport that gives them the highest utility. However, there is always uncertainty about an individual's decision-making process.

Furthermore, it was discovered that there are utility models that do not take into account the individual's taste and preferences; these utility models are of the assumption that individuals

make rational decisions and offer information. This type of model is known as the deterministic utility model (Minal & Sekhar, 2014).

In a South African context, this differs amongst income groups – for low-income earners the utility increases as they use public transport, which is quite different for high-income earners because the utility diminishes. There are instances where an individual chooses alternative 'I' over alternative 'j' when 'J' is actually the better alternative relative to 'I'. A number of reasons cause this. The individual might not have enough information about the transport modes available or the individual might receive incorrect information about the modes of transport alternatives available to them.

Another reason is that the individual personal attributes regarding the individual's status in the community and not necessarily the individual's income could influence their travel making decisions, which are unknown to the analyst and thus lead to misperceptions

These errors mentioned are considered under the Random Utility Model which further assumes that when an individual is making a choice out of a group of alternatives, he will choose the alternative that best meets his utility, the alternative that is most beneficial for himself. Golob, Beckmann and Zahavi (1981) pointed out that consumers allocate expenditure to their commodity groups to maximize their utilities which are subjected to their budget constraints. Furthermore, the small changes in prices of these commodities do not affect the first group of decisions. He further explained the definition of commodity groups, which are aligned to modelling travel decisions as:

$$\mu = \mu(x, c, t) \quad \text{(3.3.1)}$$

Where μ denotes the household utility level of a commodity, in this case travelling, x is the amount it costs to travel and c denotes the consumption of non-travel goods while t denotes leisure time (Golob et al., 1981). This further explains that different factors affect an individual choice of travel and those factors could strongly determine the choice of mode made by an individual.

When specifying the prices that an individual has to pay to travel, following a budget constraint when allocating all household expenditures denoted by:

$$P_x x + P_c c \leq Y \quad \text{(3.3.2)}$$

Where the general consumption of public transport is denoted by p and p_c and Y is the individual's disposable income.

Baltatescu, Maha and Cuza (2013) argued that the neoclassical consumer's theory explained that an individual involved in any economic action is a rational individual and has all available information needed to make a decision on various consumption bundles. Furthermore, an individual makes his choice in an order that best fits his preferences, giving huge consideration to the price of public transport and the income available to him – the budget constrained. This is very true for South Africa, for both low and high-income earners. Low-income earners would opt for the mode with a low money cost. It is slightly different for high-income earners because the price of public transport is not their main determinant – it is the time it will take to reach their destination.

3.2.3 Urban Transport Economic Theory

In order for the society to economically and socially function effectively, an adequate transport system is a necessity. Enhanced mobility for the low-income earners is the most crucial condition for achieving the Millennium Development Goals in the developing world. Although on the one hand the transport sector imposes a number of side effects on the society, including environmental problems, noise pollution, traffic accidents and congestion, on the other hand the public transport sector offers economic and social advantages to society (Immers & Stada, 2007). Moreover, Kanemoto (2006) contended that the transportation industry is associated with external costs, putting a strong emphasis on traffic congestion. Furthermore, traffic jams in the mornings and evenings are very common in urban cities across the world, and these vary depending on the location and time (Kanemoto, 2006). The cost structure of urban transportation is very tricky, it causes a variety of externalities such as traffic congestion, noise and air pollution as well as congestion accidents (Immers & Stada, 2007; Kanemoto, 2006; and the Centre of International Economics, 2001).

Consumers who utilise private cars incur different types of user costs referred to as private costs. For example, private car users incur motor-car running costs (the cost of fuel, maintenance of the car, tyres) as well as the opportunity cost of travel time (Kanemoto, 2006). Furthermore, congestion costs have specific characteristics relative to the other external costs, because these are externalities imposed on users by users (Kanemoto, 2006). The Centre of International Economics (2001) is of the same view that congestion is very costly to users.

Road users account for traffic congestion by acknowledging the private costs whereby each user is creating and suffering simultaneously. Kanemoto (2006) is of the view that other externalities such as noise and air pollution are externalities imposed by the transport sector.

However, the Centre of International Economics (2001) disagrees; instead it is of the view that greater use of public transport would have a positive impact on lowering the level of traffic congestion by providing an external benefit to all car users through the reduction of travel time and hence recovering the time lost. The urban economic theory entails traffic congestion by elaborating on it through a canonical model (Arnott, 2001).

The basic model 3.3.3 studies the point-input and point-output road, under the assumption that the drivers on the road are identical and the only economic decision each driver decides on is trip frequency (Arnott, 2001). In the model, the congestion cost model is captured by a congestion cost function, which aligns the trip cost to the traffic volume and the capacity. The model is described utilising social welfare analysis algebraically. P is the price per trip and W is the capacity available, the demand function is denoted by $D(P)$, the short run average cost function by $B(Q)$ and capacity construction cost $K(W)$. The model is written as follows:

$$\max_{Q,W} B(Q) - Q_C(Q,w) - k(w) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3.3)$$

Which the gives the optimality conditions:

$$Q: B'(Q) - (c(Q,w)) + Q\frac{\partial c(Q,w)}{\partial Q} \equiv 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.3.3a)$$

$$w: -Q - \frac{\partial c}{\partial w} - K' = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3.3b)$$

Equation (3a) shows that the traffic volume on the road is such that the marginal social benefit equals the marginal social cost, which in the short run is equal to the average cost plus the externality cost. Equation (3b) denotes the road width, which is the marginal social benefit from road expansion, the reduction in the travelling costs by passengers, holding traffic volume fixed, which equals the marginal construction cost. Furthermore, individuals decide on which mode of transport to use denoted by frequency based on the price of the trip known as the social surplus maximization problem, whilst the government decides on the congestion toll:

$$\max \max_{Q,P,W.T} \quad (B(Q) - Qp) + Q_\tau - k(w)$$

$$s.t \qquad i) Q = D(p)$$

$$ii) p = \tau + C(Q, w) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Which reduces to:

$$\max_{P,W} B(D(p)) - D(p) c(D(P) w) + K(w) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

The solution to $Q = D(p)$ and $p = c(Q, w))$ may be the no-toll equilibrium.

The equations above were created to account for other margins of cost (Arnott, 2001). Individuals extended all the equations to thoroughly explain the route and modal choice. Furthermore, regarding route choice, an individual chooses his route on a network to minimise travelling costs, known as the Wardrop Principle (Arnott, 2001). Individuals are not concerned about the social cost externalities such as congestion imposed, instead they are interested in the travelling costs a route choice will impose on them (Centre of International Economics, 2001). Additionally, modal choice depends on whether the modes available to passengers are perfect substitutes or not (Arnott, 2001). If the modes available are perfect substitutes for the demand, the very same route principle applies it relies on price except that there is congestion between buses and cars but there will not be any congestion in different links.

According to Arnott (2001), when transport modes are not perfect substitutes, the maximization problem becomes an extended issue with D, P, w being the dimensional vectors where individuals from different income groups gain different benefits.

The Centre of International Economics (2001) further explained that regarding the route and modal decisions made by passengers deciding on whether to travel by private car or public transport, the individual will firstly consider the costs and benefits of choosing which to use as they will bear the consequence of whichever option they decide on. According to the Centre of International Economics (2001), the private costs (individual) of using rail transport will, for example, include the fare paid to purchase the train ticket as well as the opportunity costs of the individual's travel time. Eventually, an individual will make a decision based on the private

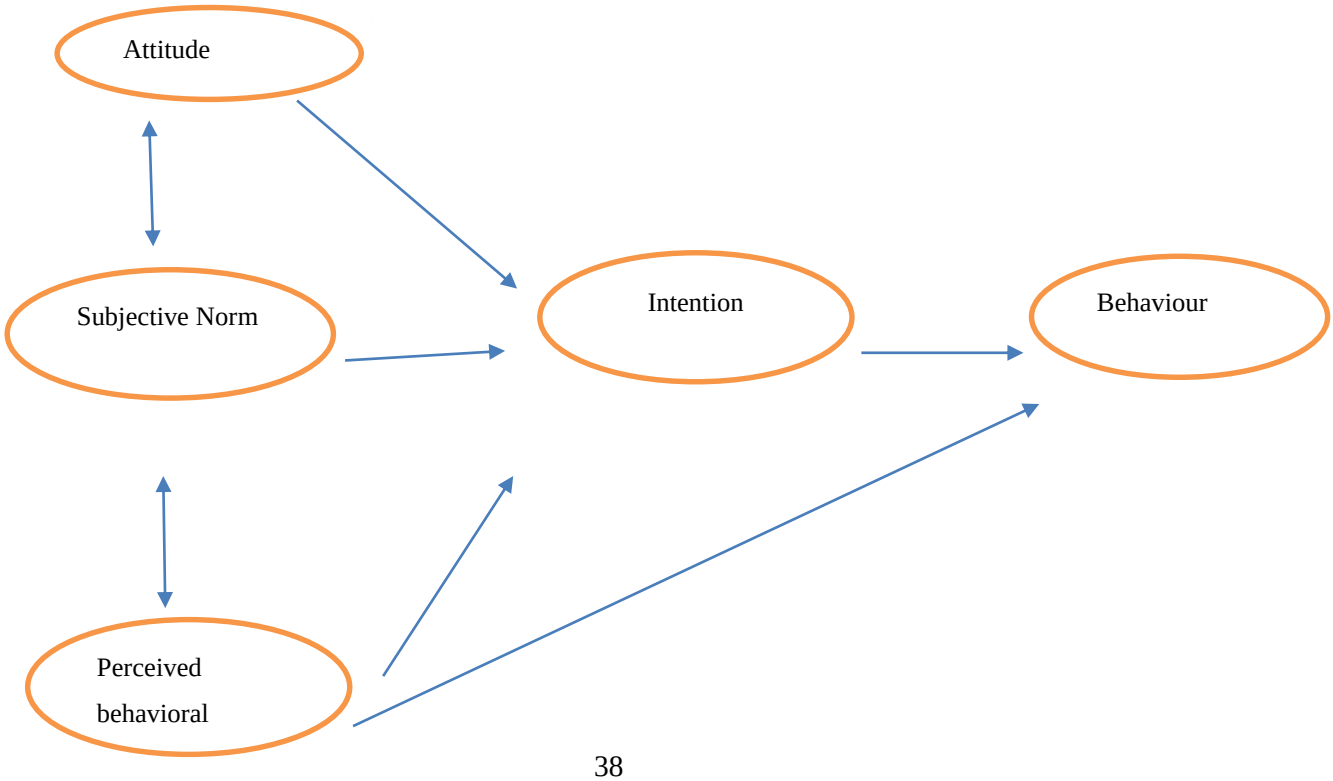
costs and benefits involved that are presented to him. In reality, the cost of transport goes beyond the individual, it extends to the community at large. An increase in the use of private car use does impose a lot of social costs. An increase in the use of public transport may lead to a decrease in air pollution.

The Centre of International Economics (2001) further contends that the benefits of a cleaner society are not exclusive to the individual who makes the conscious decision to switch to public transport use. With regard to individuals who use public transport, in most large urban cities the social costs exceed the social benefits (Centre of International Economics, 2001).

3.2.4 Theory of planned behaviour

The theory of planned behaviour (Ajzen, 1991) is an extension of the theory of reasoned action and it was created to answer some of the limitations of the theory of reasoned action (Ajzen , Fishbein, 1980) and (Ajzen & Fishbein, 1975) in dealing with the behaviour which individuals have no control over. The theory of planned behaviour focuses on three independent factors of intention – attitude towards behaviour, subjective norms and perceived behavioural control (Ajzen, 1991) as explained in figure below 3.1.

Figure 3.1:Theory of Planned Behaviour



Source: Author's illustration based on the theory of planned behaviour

3.2.4.1 Intent

An essential factor in the theory of planned behaviour is the individual's intention behind performing a certain behaviour (Ajzen, 1991). Intentions capture the driving factors behind the behaviour of an individual, the determinants of an individual's behaviour; they are the indicators of how much individuals are willing to push to get a certain behaviour (Ajzen, 1991). Ajzen (1991) was of the view that the stronger the intent to perform a particular behaviour, the more likely it is to breed positive outcomes on that particular act.

Furthermore, it is essential to understand that a behavioural intent can have good performance of the behaviour only if the behaviour is under control and there are no inevitable circumstances that may disrupt the individual from performing the behaviour (Ajzen, 1991). Furthermore, the performance of most behaviours tends to depend to some extent on certain factors such as money, education and time – these factors represent an individual's control over the behaviour (Ajzen, 1991). An individual may want to travel by private car; the individual's income may not afford the individual to buy a car and they should use public transport services for travel. The three factors explained below have an influence on an individual's decision regarding which mode of transport they want to use

3.2.4.2 Perceived behavioural control

The perceived behavioural control belief was included in to the theory of planned behaviour to answer the questions and limitations that exist in the theory of reasoned action (Fishbein &Ajzen, 1975) and(Fishbein &Ajzen, 1980).

This belief was included in the theory to be able to overcome situations whereby an individual will not have control over the behaviour (Ajzen, 1991). According to Ajzen (1991), the perceived behavioural control belief is defined as "given the presence or absence of requisite resources and opportunities, the individual's perception of the ease or difficulty in performing the behaviour of interest". Furthermore, the perceived behavioural control belief can be partly based on past experiences. Moreover, for an individual to make present decisions –the mode of transport the individual has been using in the past or through exchange of information with

other individuals on which transport mode should be used presently and also on factors such as income – may control the behaviour of interest (Ajzen, 1991).

Therefore, the more accessibility given to the modes of public transport and opportunities, the greater is the perceived control of a particular behaviour (Ajzen, 1991) and thus the more likely is the use of public transport in South Africa (Gopi & Ramayah, 2007). According to the theory of planned behaviour, perceived behavioural control together with intent can adopt behavioural achievements (Ajzen, 1991). However, perceived behavioural control can be unattainable when an individual lacks information about the behaviour or when new unfamiliar information has come to light, as it then becomes clear that this belief can be realistically used to predict the possibility of a positive successful behavioural intent (Ajzen, 1985).

3.2.4.3 Subjective norms

These norms refer to societal pressures individuals get on whether to perform or not to perform a particular behaviour, whether an individual should use public transport or rather a private car (Ajzen, 1991). It is the influences individuals get from the social environment on the individual's behaviour. If the majority of people at the place where an individual resides are using their own private cars for transportation, irrespective of bus services being available, the individual might end up succumbing to societal pressure and using his own private car. The rationale under subjective norms is that under societal pressures an individual would be willing to perform a behaviour even though the individual does not agree or is not in favour of that particular behaviour at that given time. These are behaviours we consider or perceive important because they are from people who matter in our lives.

3.2.4.4 Attitude

In the theory of reasoned action, attitude was explained as the effect that evaluates positive feelings from negative feelings of individuals on certain behaviours (Fishbein & Ajzen, 1975). In the theory of planned behaviour, attitude is explained as the level of favourableness and unfavourableness of what an individual feels towards an object (Ajzen, 1991). There are two main components of an individual's attitude towards a behaviour, for example there is attitude towards an object (bus, train) and there is an attitude towards the use of that object (using bus services or train services) (Ajzen, 1991).

3.2.4.5 Behaviour

According to the theory of planned behaviour presented, an act of a behaviour occurs when intentions and perceived behavioural control are interlinked (Ajzen, 1991). Moreover, in order for predictions to be accurate, several components need to be taken into account. Firstly, the determinants of measures taken to measure perceived behavioural intention and intent have to interlink with the behaviour that is to be predicted (Ajzen, 1991). Then, the determinants of using a particular mode of transport have to be taken into account before predicting which mode of transport is suitable for travel services. Therefore, the motivation that individuals have to perform a certain behaviour lies in how hard they are willing to try and the effort they are willing to put into executing the intention which influences the behaviour (Ajzen, 1991). The accuracy in the predictions of behaviour declines with the increase in time interval between intent and actually performing the behaviour (Ajzen, 1991).

3.2.4.6 Behavioural intention

In the theory of planned behaviour as mentioned above, intention is defined as an individual's perception towards performing a particular behaviour (Fishbein & Ajzen, 1975). When the behaviour of an individual is solely under the individual's control, it is possible to predict the intention of a particular behaviour. Furthermore, it makes it possible to predict with significant accuracy which mode of transport an individual should use when it involves factors that are under the individual's control. However, this does not mean that the measures of behaviour and intention are perfectly correlated (Ajzen & Fishbein, 1975).

Overall, there is lack of compatibility between the measures of behaviour and the measures of behavioural intent even though one cannot be predicted without the other (Ajzen, 1991). When individuals do not immediately act on their said intention, this leads to low intention and behaviour relation making it difficult to predict actual behaviour (Ajzen, 1991).

3.2.5 General Evaluation of the Theoretical Literature

The mainstream theory for the study is the Consumer Demand Theory which assumes that public transport choice is determined by income and price. Moreover, the theory assumed that changes in income cause shifts in the demand for transport. The theory further explained that an increase in income could lead to car ownership leading to a fall in the use of public transport, therefore, becoming an inferior good. Arguably public transport is considered a normal good

for low income household. An increase in income could lead to an increase in public transport use and the mode of transport preferred by the household.

3.3 Empirical Literature

This section reviews the empirical evidence on the determinants of public transport demand. There are diverse views among researchers regarding the determinants of public transport demand. There are several ways to categorise empirical literature; this study is categorised by the countries studied. This section is therefore divided into empirical literature for South Africa, empirical literature for developing countries and lastly empirical literature for developed countries.

3.3.1 Empirical Literature in South Africa

Clark and Crous (2002) explored the Strategic Review of Public Transport user needs in Cape Town Metropolitan. Revealed preference (RP) and stated preference (SP) methods were used in this study. The main objective was to review the current state of user needs in the public transport operations in the Cape Metropolitan area. Furthermore, the findings revealed that the public transport services were not maintained in terms of increasing subsidies that were required by users as well as satisfying the user needs effectively and efficiently. Furthermore, Lombard, et al. (2007) conducted research on the Trends in Passenger Transport in South Africa. The main purpose of this paper was to provide information about the travel behaviour of South African citizens. The study concluded in this study were that the population densities in South African cities are very low in comparison to the world, leading to a negative influence on the viability of public transport in South Africa. Moreover, metropolitan areas have experienced the most changes in terms of population growth, increases in car ownership and lengthening of travel time.

A study on transport expenditures and affordability was undertaken in South Africa. The main aim of this paper was to review expenditures and affordability of transport among low-income households. The results indicated that where a person is located along the urban-rural areas has a significant impact on transport expenditures and perceived affordability level (Venter, 2011). The public transport users from the deep rural locations and medium income earners in the urban townships are the ones that face the highest affordability and expenditure problems in South Africa.

Luke and Heyns (2013) conducted a research study on the public transport policy and performance focusing more on the public's opinion results in South Africa. The purpose of the study was to compare the current transport policies and the public's opinion of these policies. The main findings were that the current public transport policies are meeting the majority of needs of the South African population. However, issues relating to the affordability, safety and accessibility for the low-income households are still a major problem and need to be addressed. Furthermore, an investigation of the relationship between the population density and transport in the City of Johannesburg Municipality was explored by (Weakley and Bickford 2015). The study found that there is a correlation between urban population density and public transport use (different modes) in the City of Johannesburg.

Private cars are used mostly in low-density areas and public transport more in high-density areas. Those living in low-density areas are not likely to use public transport relative to those living in high-density areas because of cost and walking time factors.

Prim (2016) did a study on the responsiveness of public transport systems to the development of urban and economic nodes in Johannesburg. The study sought to explore how recent transport policies and developments are responding to changing settlement types and changing commuter patterns around Johannesburg and how these developments affect the interests and needs of the city's low-income commuters. The study followed a qualitative approach. The main findings were that individuals residing in the West of Johannesburg have very low accessibility to opportunities and services. The development of public transport systems does not meet the interests and needs of the urban poor.

3.3.2 Empirical Literature in Developing Countries

Ayub and Khan (1995) in their study on the impact of household income on demand for means of transportation and communication argued that income elasticities of demand needed to be calculated separately to get clearer results. The results indicated that the income elasticities of demand for public transport were unitary. However, the income elasticities for public transport expenditures comprised much less than unity which indicated that in Pakistan public transport remains a necessity.

Furthermore, an investigation into public transport service modal choice, affordability and perception in Zimbabwe was explored by Nyarirangwe & Mbara (2007). Data for the study was collected through household surveys and questionnaires. The variables used were

household income and monthly expenditure on transport. The main findings were that public transport in Zimbabwe is unaffordable, resulting in households' expenditure for public transport being very high. Urban transportation in China is going through a huge change in their transportation industry because of the fast moving and growing urbanisation and greater understanding of urban transportation. Huapu (2009) conducted researched on the urban transportation in China regarding its state of reform and future trends. The main purpose of this study was to provide needed literature for future urban transportation development in China. The main conclusions were that this development in China is going to be a long process, which promotes a coordinated development of the transportation industry in China and the economy as a whole.

Crotte, Danile, Graham and Noland (2011) in their study on the role metro fares and income had on sustainable transportation services concluded that income elasticities are negative and are very close to unity in the long run. Furthermore, their zero response to fares indicate that the increase in fares levels might be too low relative to the incomes. The rapid growth rate of vehicles in Bhopal (India) was putting a lot of strain in their urban roads; which inspired Jaiswal and Sharma (2012) to conduct a study exploring the optimisation of public transport. The results showed that the public transport services in Bhopal lack comfort, lack accessibility for users and those that are available lack frequency; hence users would rather use their own private cars.

A research study on the types of factors affecting choice of mode of work trips in a developing city of Gaza was explored Almasri and Alrae (2013). The main purpose of the study was to enable policy makers to develop a model for work trips within Gaza. The results concluded that travel time, car ownership, age and monthly household income were the main determinants of public transport in Gaza.

The determinants of demand for transport services in Kumasi in Ghana were investigated by Boansi and Adarkwa (2013). The main aim of this study is to establish the main attributes affecting the demand for transport services in Ghana during 1997. Step-wise multiple regression was used in estimating OLS in this study. The data from this study was obtained from 400 commuters using the simple random sampling technique, carefully taking into consideration their level of income. The determinants found to be affecting the demand for transport were level of service, fares, income of commuters and population and trip duration in

Kumasi. Surprisingly, upon analysing the data, population variations were estimated at 66.45%. Therefore, the main influence on transport demand was population.

Chee and Fernandez (2013) conducted a study in the most populated city in Malaysia. The authors' focus was on factors linked to the choice of mode of transport to use. The results determined that more than 60% of a sample is formed by private cars. Possessing a driver's licence and having frequent access to private car use are the strong factors affecting public transport demand in Penang.

In Brazil a study was done on the effects of income and fare variation. The study showed that there is a gap between the increase in urban bus fares and household income of the Brazil population, thus leading to a decrease in the demand for bus services between 1995 and 2003 (De Carvalho&Pereira, 2011).

A review by Oh and Gwilliam (2013) on the urban transport systems, focused more on the transition to long-term sustainability in the Russian Federation, with the aim of assessing the current condition and performance of urban transport systems in the medium-to-large size Russian cities. Survey data was conducted in this study with over 25 cities completing the questionnaires. There were numerous findings in this paper but the main one was that transport congestion is a huge challenge in the vast majority of these cities.

Most of these Russian cities have not adopted any concept on how to handle the demand for transportation, which leads to numerous problems that could have been handled through transport modelling as adopted by most European countries. Cheng, Xiaoying, Xeuwu and Lei (2013) conducted a study in China on the travel behaviour of the urban low-income group in an area of Hazou City. The main aim of the research study was to investigate the patterns of travel made by China's urban low income groups. The clustering analysis was done to identify the low income group from the rest of the income groups. The main findings were that the urban low-income people have very much lower mobility than those from other income groups.

Aljoufie (2014) looked at the current public transport demand in Jeddah. As a result of the rapid urban growth rate, the amount of daily trips has decreased. The author used the GIS model and the results revealed that more than 50% of the Jeddah population have very low or even no access to public transportation services. Sam, Adu-Boahen&Korsah (2014) assessed the factors that influence public transport mode of preference in Ghana. The study revealed that income is

not the only main factor determining the demand for public transport; safety, comfortability and reliability were the main determinants for students of Ghana. A study on the determinants of mode choice in the middle-east cities was done by Soltanzaden and Masoumi(2014). The main realization of the study was how socio-economic factors are significant in public transport demand. An increase in the accessibility and availability of public transport services in these cities may encourage individuals to shift from private car use to commuting with public transport.

A study was conducted on the effects of income and fare variation on the demand for bus transit services in Brazil by (De Carvalho&Pereira, 2011). The purpose of the research study was to look into urban bus fares and households' income and to analyse their demand for bus transit over the last 15 years. The results indicated the issue was affordability, a rise in bus fares with a decrease in population income especially in the poorest cities of Brazil.

Li, Song, Cheng&Yu (2015) investigated modal choice in Beijing. The sole purpose of this study was to look into the determinants of public transport demand for short distance travel to reduce private car use. The results showed that household income, car ownership and age have an enormous effect on the use of public transport in Beijing. In India, a study was conducted on understanding the determinants of demand for public transport and it focused on five divisions of Indian railways (Rahman & Belijapali, 2016). The objective behind this was merely to understand the passengers' responsiveness to changes in fare price in suburban railway systems. This study focused on three cities, namely Chennai, Kolkata and Mumbai. Econometric methods were used involving statistic and dynamic modelling methodologies. It was found that suburban rail demand is inelastic to changes in fare price, which indicates that the revenue will continue to increase irrespective of the changes in fare price. Madhuwanthi, Marasinghe, Rajapakse, Dharmwansa&Nomura (2015) explored the factors influencing travel demand in Sri Lanka. The country suffers from severe congestion on the roads, resulting in huge economic losses annually. The outcome of the study shows that income, safety and comfort and vehicle ownership are the main determinants of transport demand.

Madha, Dhafir and Dawood (2016) in a study they conducted on the factors affecting transport demand came out with different results. The study collected the data from 400 employees which increased the level of accuracy. The results indicate that behavioural traits – attitudes and perception – are strong determinants of public transport demand. Furthermore, the

relationship between urban characteristics, income and the population's commuting pattern was examined by Zhu, Li, Chen and Zeng (2017) in China. The study concluded that the average commuting time by high-income groups took longer than that of the low-income groups. However, the rapid urbanisation taking place in China has resulted in high-income groups using private cars, thus leading to the shortening of commuting time for the low-income groups.

Another study was conducted in China, Beijing, by Wang, Xuedong, Zhou and Xue (2017) focusing on the factors affecting long distance travelling. The results of the analysis indicated that passengers possessing higher education qualifications and high incomes were more likely to use high-speed railway as a result of affordability. On the other hand, individuals from the low-income level and with low education levels were likely to use the ordinary train services.

3.3.3 Empirical Literature in Developed Countries

Asensio (2000) researched the determinants of demand and its implications in the Spanish suburban railways. The aim of this study was to estimate the demand function for suburban railway in Spain. Panel data was used in this study between the years 1991-1995 and it was observed monthly in 11 different urban areas. Furthermore, the findings proved that all other variables have an inelastic effect on transport demand. The main results pointed out that rail demand was inelastic and that the quality of rail service was good.

A study on the demand functions of public rail in Slovenia was done by Beko (2003). The results indicated that the demand elasticities of income and price are inelastic. Furthermore, coefficients of rail transportation indicated that rail services can be classified as normal goods. Therefore, an increase in the average fare prices would generally cause a decrease in the number of passengers, but the decrease will be smaller than the actual fare increase. An econometric modelling of the determinants of transport demand was analysed by Bresson, Dargay, Madre and Pirott (2003) by means of a comparative study between England and France. The results indicated that the fare prices were more expensive in England, which was caused by the bus services available in England. Moreover, the travelling time on the bus services was longer, resulting in the fares being higher. However, subsidisation methods of these two countries were different. The French research project objective focused on the effects of the population change in the demand for transportation, which included all public modes used for travelling. Unlike the French, the British research objective focused only on bus travels

and the data was for both areas. The main findings were that fares are about double the price in England compared to those in France. This is caused mainly by the bus services being included in England, with the travelling time being much longer and thus leading to the fares being higher. This also reflects the different subsidisation methods used in each country.

Balcombe et al. (2004) pointed out that if it is assumed that public transport is a normal good then household income will be expected to increase the number of trips. Furthermore, this would be split into increased public transport trips and car ownership depending on the level of household income increase. Therefore, household income is a determinant of car ownership, which could pose a negative effect on the demand for public transport.

In another study by Bresson, Dargay, Madre and Pirott (2004) which extended from 1975 to 1995 and instead of focusing only on economic variables, structural factors (population, ageing, and growing car ownership) were also included. Combining the economic variables and structural variables showed that the income effect (income elasticity is negative) that was discovered in the previous study is actually a "motorization effect". However, estimates tend to vary because of the extended period. Furthermore, it became evident that the elasticities are not stable in the long run. Moreover, by using the longer period, it was then established that the estimated income elasticities were more negative than those estimated in the short run period.

A research study focusing on factors that could alter modal choice was presented by Racca and Ratledge 2004) in Wilmington. The study provided evidence that the availability of cars (car ownership) is a factor that determined public transport demand. For households who do own a car, income then becomes the predictor of modal choice.

Kalaee, Rezaein, Anadi and Shafabakhah (2006) studied the demand of public transport and the results indicated that factors such as age, gender, family income as well as the neighbourhood characteristics are the main influencers of transport demand. Furthermore, the effect of income on public transport demand would depend on the level of income, which could lead to an increase in car ownership and a reduction in public transport demand (Paulley et al. 2006).

However, a study done by Limtanakool, Dijst and Schwanen (2006) exploring the socio-economic determinants of public transport in the Netherlands revealed that land use traits and

travel time are important aspects to take into account in explaining public transport demand. Furthermore, Nuurden, Rahmat and Ishmail (2007) in their study on the effects of modal shift from private car to public transport pointed out that travel cost and household income were the most important factors affecting an individual's choice of transport.

Brons, Givoni and Rietveld (2009) did a study on access to railway transportation in Amsterdam. The aim of conducting this research was to investigate how crucial accessibility to a railway station is and to investigate the balance between access and the population served. The main findings proved that accessibility is an important determinant of railway use. However, in a study done by Roberto (2008) it was reported that the low-income earners demand public transport and spend a higher proportion of their income on public transport relative to the high-income earners. Research on the objective and subjective determinants of modal choice in Germany was investigated by Scheiner and Holz-Rau (2010) who revealed that the lifestyles and the location individuals reside in were the main determinants of public transport. Therefore, the individuals with a very high status in society, particularly the "younger" generation, were most likely to use their own private cars, whereas individuals with a low income were most likely to demand the mode that is available closer to retail shops.

Wang and Company (2011) on their study of public transport patronage found that a higher proportion of commuters from the high-income households were attracted to rail services and this income group was more sensitive to the quality of service of public transport. The low-income households were more focused on fare prices as a result of affordability. Polat (2012) pointed out that economic factors have a huge impact on public transport demand, therefore, indicating that transport demand depends on the level of household income and transport price. As household income increased the use of motorisation led to a decrease in the demand for public transport. However, a study by Tyrinopolous and Antoniou (2012) which focused on Greece reported that crowding is the main determinant that discourages individuals to use public transport and they resort to using their own private cars. Fouquet (2012) in his study indicated that income and fare price elasticities are high in the UK, but as the economies develop, the elasticities will gradually decline. Buehler and Putcher (2012) were also of the same view that public transport use declines as car ownership increases, income increases and population densities increase.

Furthermore, Holmgren (2013) made similar comments when he studied the determinants of local transport demand focusing on the effects of income changes in Sweden. There were indirect and direct effects of income changes. Generally, higher income was associated with an increase in mobility and that overall trips made by public transit may increase as a result of such a change. However, an increase in income was associated with an increase in motorisation, leading to a decrease in public transport demand.

A research study explored the relationship between public transit commuting and household income in Washington DC. The main purpose of James (2014) conducting the study was to estimate the link between public transport commuting time and household income. Furthermore, the results indicated that transit-commuting time has a negative relationship to household income, illustrating that longer commuting time places a burden on suburban residents from the high-income earners. Miller (2017) in his study revealed that in Chicago there was a greater decline in public transport demand by low-income earners because of the strict budget constraint than for high-income earners who are not affected by high fare prices. Moreover, in a study examined by Liu (2017) on public transport demand in Taiwan, it was revealed that the distance to get to a public transport stop is the main determinant influencing individuals to use public transport.

Through the longitudinal multilevel mixed-effects approach, Boisjoly et al. (2018) explored public transport ridership in the cities of North America. After analysing the results, it was evident that car ownership was the main determinant of public transport in Canada.

3.4 Summary of the Chapter

This chapter reviewed literature relating to the determinants of public transport demand in South Africa. Consideration was given to the Consumer Demand Theory, this theory explained the relationship between a commodity and the price of the commodity, it further explained the relationship between a commodity and income. Evidence of notable links between income and public transport use have been observed in a number of developing and developed countries. It was also observed that these studies applied different approaches to achieve their objectives. An analysis of the methodologies applied in these studies was examined and it was seen that quantitative methods were adopted through Logistical and Probit tools used in examining the effects of income of public transport use. Furthermore, studies undertaken in both developing and developed identified that income, fare prices, location, the level of services (safety,

reliability, comfort), population and congestion, a number of socio-economic factors as the potential determinants of public transport. In South Africa, there is no conclusive evidence on the determinants of public transport demand, therefore the variables chosen for the model of the study were adopted from the various empirical literature in the study to develop a model. The variables adopted in the model were income, location, accessibility, race, social grants, age, gender, household size and disability that will examine the effect these have on public transport demand.

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter provided the methodology that was employed to identify the overall determinants of public transport demand in South Africa. The structure of this chapter is as follows: section 4.2 is the Data; Section 4.3 outlines the descriptive data analysis, which defines the different approaches; Section 4.4 is the model specification together with the variables that were employed and the expected priori and data sources. Following this, Section 4.5 outlines the testing of econometric assumptions ; Section 4.6 deals with the inferential statistics together with the estimation techniques. Section 4.7 outlines diagnostic tests conducted; and lastly, Section 4.8 concludes the chapter.

4.2 Data

Data for this study was obtained from secondary data sources from the General Household Survey 2017. The data includes personal and household data which the study employed for the household surveys. The study employed the cross-sectional data covering the year 2017. Primarily sampling unit was utilised and the sample size was 21225.

4.3 Descriptive Data Analysis

This research is also known as the statistical research. This research is used for identifying and obtaining information about a particular issue, usually a current one (Akhtar, 2016). Statistical research answers these questions: when, where, how and why. It is widely used and most common in the social sciences fields. It is aimed at providing information on current issues pertaining to an individual or a household or even the community at large. Moreover, it may be concerned with an individual's attitude and views on a particular topic that is being done by the researcher.

4.3.1 Causal research/Explanatory research

This research study applied the descriptive research analysis; the objectives of the study, as stated in Chapter 1 were to investigate the determinants of public transport demand in South Africa. The study focused on conducting the research at a household level and statistical

techniques in the form of descriptive statistics through frequency tables and charts were employed in order to gain an insight into households' mode choice and reasons for choosing a particular mode.

4.3 Research approach

Research approaches include the qualitative, quantitative and mixed methods. A researcher can decide to choose any of the approaches. The study followed the quantitative approach which is explained in the following section.

4.3.1 Quantitative approach

The quantitative method analysis is derived from data that is organised in numerical form. Harkiolakis (2018) stated that the quantitative method is under the assumption that the phenomenon being researched is real and is represented through estimating parameters. These parameters better known as the explanatory variables are used to establish the relationship they have with the dependent variable, which will ultimately suggest the cause and effect (Harkiolakis, 2018). This research method requires a large number of participants to partake in the study, the analysis is done through statistical methods and since the data is in numerical format, mathematical methods are usually adopted for processing the data (Harkiolakis, 2018). There are two other approaches that can be utilised, namely the qualitative research approach and mixed methods approach. This qualitativevapproach is of the view that there is no single reality but rather multiple realities to a research phenomenon (Kielmaan, Cataldo & Seelay, 2011). When these two approaches are combined they are referred to as a mixed method approach. This research study utilised the quantitative approach to provide clear conclusions about the research objectives provided in Chapter 1. This was done by utilising secondary data from the General Household Survey data conducted in 2017.

4.4 Model Specification

This study estimated one regression model by employing cross-sectional data, by estimating the determinants of public transport demand in South Africa. The model was analysed employing cross-sectional data for the year 2017 data from the General National Household surveys, focusing on household data.

The model for this study was written as follows:

$$TM_i = (\beta_0 + \beta_1 GEO_{E\,i} + \beta_2 MSAL_i + \beta_3 DTTA_i + \beta_4 HHSZ_i + \beta_5 DIS_i + \beta_6 POPGRP_i + \beta_7 SEX + \beta_8 AGE_i + \beta_9 CHLD5YR_i + \beta_{10} CHLD7YR_i + \beta_{11} SOC_i + \beta_{12} ECONN_i + \beta_{13} NRCELL_i + \varepsilon_i \quad \ldots\ldots\ldots (4.1)$$

TM= Transport mode

GEOTYP= Geographical area

MSAL= Monthly salary

DTTA= Distance to means of transport

HHSZ= Household sizeUN

DIS= Disability

POPGRP= Population group

SEX= Gender of household head

AGE= Age of household head

CHYO5= Children 5 years and younger

CHYO17 = Children 17 years and younger

SOCGRA= Social grant

ECONN= Economically active members between the ages 16–64 years

NRCELL= Total number of cellular phones in house

The model that was estimated is as follows:

$$TM_i = (\beta_0 + \beta_1 GEOTYPE_i + \beta_2 MSAL_i + \beta_3 DTTA_i + \beta_4 HHSZ_i + \beta_5 DIS_i + \beta_6 POPGRP_i + \beta_7 SEX + \beta_8 AGE_i + \beta_9 CHLD5YR_i + \beta_{10} CHLD7YR_i + \beta_{11} SOC_i + \beta_{12} ECONN_i + \beta_{13} NRCELL_i + \varepsilon_i \quad \ldots (4.2)$$

Where β_1 β_2 β_3 β_4 ,β_5 , β_6,β_7 β_8,β_9,β_{10},β_{11} ,β_{12} and β_{13} are the coefficients to be estimated and ε_i is the error term. The error term represents the influence of the omitted variables in the construction of the model.

4.4.1 Definition of variables and prior expectations

Transport Mode Means (TM) = Transport mode choice was used as a proxy for transport demand. The original variable consisted of all public transport modes including mini-bus taxis, bicycles, buses and trains; the variables also included walking and private car use. Furthermore, the variable was regrouped to public modes versus private mode to create a binary model. The variable was measured by whether a household demands public transport or private car use. Exploring the income data from Statistics South Africa on the (2011) Census data showed that low-income households use a larger portion of their income on public transport services relative to high-income households. In South Africa, public transport is demanded by households with lower incomes and households with higher income use private cars.

Geographical type = this variable focused on the geographical area in which households reside. The variable looked at three different geographical areas, namely rural, urban and farms and had to determine which area demands public transport. Geographical areas are very relevant because they determine the areas which need to be focused on regarding the accessibility of transport. The White Paper policy emphasises the importance of accessibility of transport services in the most distraught areas in South Africa (Department of Transport, 1996). For β_1 Location, the demand in urban provinces is expected to be low and in the rural and farm areas it is expected to be high. All geographical areas are expected to yield positive estimates.

Household monthly salary (MSAL) = this variable looked at the monthly salary of households which is the total monthly salary for households and includes allowances, overtime and bonuses (General Household Survey, 2017). This is a crucial element of the study and the impact it has in South Africa. One of the many objectives of the 1996 White Paper is to provide affordable transportation to the different income quintiles in South Africa, to accommodate households from different income backgrounds with safe and reliable transport services (Department of Transport, 1996). An increase in income β_3 in low-income groups will lead to an increase in the demand for public transport and in the high-income range will lead to a

decrease in the demand for public transport, as individuals will be using their own private cars. Overall, the sign is expected to be negative, as an increase in household monthly income will lead to individuals purchasing their own private cars.

Distance travelled to means of transport (DTTA) = Accessibility and connectivity play a huge role in determining which mode of transport to use (Papaioannou & Martinez, 2015). The sign is expected to be positive. Accessibility of public transport will yield a demand in the use of transport.

Household size = The variable is the number of individuals residing in a household. This sign is expected to be positive. The more people living in the household, the more the household will use public transport.

Social grants (SOCGRA) = Social grants refer to the number of individuals receiving grants in the household. The sign is expected to be positive, the more individuals receiving social grants in a household the more the likelihood of the individuals to use public transport.

Economically active (ECONN) = Refers to the individuals in a household who are economically active. The more individuals economically active the greater the likelihood of these individuals to use public transport as a mode of travelling.

Demographic factors (DEMO) = Includes factors such as age and sex of the household head, population race and disability. These are very influential factors for public transport demand.

Boansi and Adakwa (2013) pointed out that demographical factors are part of the determinants of public transport. Bajracharya and Shrestha (2017) in their study illustrated the significant role demographic factors in selecting the choice of travel mode.

Age is expected to have a positive sign. As individuals get older, they start relying on public transport because it is safer for them. Females are expected to demand more public transport than males. Blacks/Africans is the ethnic group that will demand public transport more than any other racial group. Disability is expected to have a negative sign.

Children five years and younger (CHYO5) = The variable refers to children in the household who are five years or younger. McCarthy, Delbosc, Currie and Molloy (2017) were of the view that this is the most overlooked component of travel mode choices across the world. The

authors explained that families with children tend to use private cars rather than public transport. The sign is expected to be negative.

Children 17 years and younger (CHYO17) = The variable refers to the number of children in the household who are 17 years or younger. Aizpuru (2015) in his study on travel modal choice by teenagers concluded that travel mode choice would depend on the overall family income of a household and accessibility to a private car. The sign is expected to be negative.

Disability (UNDIS) = Number of individuals in the household that are disabled. Schmocker, Quddus, Noland and Bell (2008) did a study in London and revealed that disabled individuals prefer using their private cars or be driven by others rather than commuting in public transport modes. The sign is expected to be negative.

Total number of cellular telephones in house (NRCELL) = Refers to the number of individuals who own cellular telephones in the household. The distribution of wealth is used to make decisions about the allocation of resources in a country. Cellular telephones have been found to be a good source of measuring wealth and they can be used to estimate socio-economic status of individuals (Blumenstock, Cadamuro & On, 2015). The sign is expected to be negative, the more members of the household owning cellular telephones, the less demand there will be for public transport use.

4.5 Testing Econometric Assumptions

4.5.1 Descriptive statistics

Descriptive statistics give both numerical and graphical descriptions to summarise a collection of data, whether quantitative or qualitative, to gain a clear understanding (Jaggi, 2010). Descriptive statistics aid in simplifying large amounts of data in a clear sensible manner (Jaggi, 2010). Furthermore, these descriptive statistics include graphs, tables and charts together with the different calculations of descriptive measures. According to (Kern 2014), descriptive statistics summarise the observation made; it is mostly used to explore new and existing areas of research. Conclusions in the statistics are observed.

Charts – illustrate the data in graphical form. Charts are useful in comparing different variables when determining their relationships. Charts are also useful in depicting relationships and trends amongst two or more variables (Bavdekar ,2015). The researcher has to know when to use which graph which generally depends on the type of data that is available. Charts that are

most used in research include histograms, pie charts, bar graphs and line graph (Bavdekar, 2015). In this study, charts were used in comparing how frequently passengers use a mode of public transport as well as to demonstrate the frequency in which household use public transport in comparison to private car use.

4.6. Inferential statistics

Inferential statistics are tests that should be performed at the beginning of the study, for the research objectives of the research study (Omair, 2014). The process includes testing the hypothesis and reaching a conclusion that is based on the initial main objective of the research study (Omair, 2014). The hypothesis is stated as the null denoted by H_0 and the alternative hypothesis denoted by H_1. Additionally, H_0 is related to stating there is no difference which is generally the opposite of H_1 which is the objective of the study. After making inferences about the population based on the results, it is then decided whether the hypothesis is accepted or rejected. In order to determine the likelihood of individuals choosing a certain alternative over another, models are used. The categorical variables can be analysed either by employing logistic regression analysis, probit regression analysis, and multinomial logistic regression analysis. The probit model was utilised and it is discussed below.

4.6.1 Probit model

The probit model is an alternate of the logistic model (Kliestik,Katarina &Misankova, 2015). Probit modelling is based on the cumulative normal distribution. The dependent variable y is a binary variable and takes on the values of 0 and 1. In explaining the behaviour of a dichotomous dependent variable, a cumulative distribution function (CDF) is used (Vasisht, 2012).

Using the example above, assuming that in the car ownership example, the decision of the ith household to own a car or not depends on unobservable utility indexed I_i which will be determined by the independent variables in the model. Therefore, the larger the value of index I_i, the greater is the probability of a household owning a car (Vasisht 2012).

The index denoted by I_i can be expressed as $\mathrm{I}_i = \beta_1 + \beta_2 \mathrm{X}_i$ …… (7)

Where X_i is the household income of the ith household

Assumption of the probit model

It is assumed that for each household there is a critical level of the index $\left(\mathrm{I}_i^*\right)$, if the index I_i exceeds I_i^* the family will own a car otherwise it will not (Vasisht, 2012). The index $\left(\mathrm{I}_i^*\right)$ is not observable, and if it assumed to be normally distributed with equal mean and variance it then makes it possible to estimate (7) parameters and get some concrete information about the unobservable index $\left(\mathrm{I}_i^*\right)$.

To estimate β_1 and β_2 (7) written as follows:

$$\mathrm{I}_i = \beta_1 + \beta_2 \mathrm{X}_i + U_i \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Steps involved in estimating the probit model

Estimate P_i from the grouped data, similar to the logit model

$$\hat{P}_i = \frac{n_i}{N_i}$$

Using $\hat{P}_i$, obtain n.e.d $\left(I_i\right)$ from the standard normal CDF, for example, $I_i = \beta_1 + \beta_2 \mathrm{X}_i$ (Vasisht, 2012)

Add 5 to estimate $\left(I_i\right)$ for them to be converted to probits obtained as the dependent variable in (8)

Similar to the Logistic model, the is heteroscedasticity in the disturbance term in the probit model. One has to transform the model to yield sufficient estimates of the regression model (Vasisht, 2012)

Advantages of the probit models

By allowing a dichotomous variable to be transformed into a continuous variable, the probit and logit models produce statistically sound results. There are no real significant differences between the probit and logit models, although the estimates obtained by the two models cannot be compared (Kliestik, et al.,2015). In order to get the same results from these different models,

the logit model estimates will have to be multiplied by $3^{1/2}/\pi$ as in that way the results will be the same (Kliestik, et al., 2015).

4.6.2 Estimation Techniques Used

4.6.2.1 Marginal effects

With regards to the binary independent variables, marginal effects measure the discrete change of predicted variables (Williams, 2018). They measure how the predicted variables differ when the independent binary variables change from 0 to 1 (Williams, 2018). Marginal effects are mostly used by researchers from the economics discipline, as these effects provide a valid estimation of the exact amount of the change in the dependent variable (Y) that will be caused by an additional unit change in the independent variable X_k (Williams, 2018).

Furthermore, there are categorical variables that can only take on two values, 0 and 1, such as gender whereby you either choose male or female. With a variable like gender, it is impossible to compute how $\mathrm{P}(\mathrm{Y}=1)$ would change if gender would be changed from 0 to 5 (Williams, 2018). Williams (2018) further explained that the marginal effects of means (MEM) for categorical variables, like gender, could only explain how $\mathrm{P}(\mathrm{Y}=1)$ changes from the said 0 to 1. Whilst holding other variables constant, this can be denoted as:

$$MEX_k = \mathrm{P}_i\left(\mathrm{Y}=1/\mathrm{X}, \mathrm{X}_k=1\right) - \mathrm{P}_r\left(\mathrm{Y}=1/\mathrm{X}, \mathrm{X}_k=0\right)$$

There are three different quantities that are extracted from marginal effects (Leeper, 2018) and these are explained below.

There is the marginal effect at representative values (MERs) which mainly focuses on the calculations of the marginal effects of variables separately, on a combination of independent variables (Lepper, 2018). He further explained that there is the marginal effect of means, which was explained above; this marginal effect calculates the effects of each variable at a mean covariate (Leeper, 2018). Lastly, there are the average marginal effects (AMEs) which calculate the marginal effect of every independent variable value X (Leeper, 2018).

4.7 Diagnostic tests

This stage is crucial in the analysis of the determinants of public transport demand, for the validation of the estimated parameters. Gujurati (2004, 516) argued that diagnostics tests are

essential and should be conducted and performed to ensure that the model is a good fit in such a way that all the parameters have the correct signs. Additionally, these variables are statistically significant, R- squared and T –statistic value is reasonably high.

4.8 Summary of the Chapter

The chapter laid down the model which determines the effect of income on public transport demand. Included in the model are variables which are likely to affect public transport modal choice. Potentially, the determinants for public transport were, amongst others, household monthly income, household size, disability and age. The succeeding chapter presents will run the discussed examination of the data and the final Probit technique that the study estimated using the statistical package, Statistics and data software (STATA). Finally, the diagnostic tests shall be conducted on the residuals.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Introduction

The previous chapter presented the analytical framework of the study by reviewing the model and the estimation techniques used in the study. This chapter presents the main results and discussions on descriptive and inferential statistics on the National General Household Survey data for the year 2017. The main objective of this study was to investigate public transport demand in South Africa. This chapter explains how the main objective of the study was achieved. The study utilised the probit regression model in order to determine the factors influencing public transport demand in South Africa. The chapter is divided into subsections. The first section presents the results of the descriptive statistics. Results and diagnostic tests are presented in the second and third sections.

5.2 Descriptive Statistics

5.2.1 Factors explaining the demand for public transport

A frequency distribution table and pie charts were used for the determinants of public transport demand in South Africa. The variables utilised included sex of household head, population group of household, geographical area, mode of transport use, head of household age, household monthly salary, children five years and younger, children 17 years and younger, economically active, household size, social grants, distance to means of transport, disability and cellular cell phones in the house. Each of these explanatory variables were explained in Chapter 4.

Table 5.1: Summary statistics

Variables	Observations	Mean	Std deviation	Min	Max
Head age	21,225	48.1315	15.74397	12	107
Household monthly salary	21,225	6241.198	14818.09	0	484700
Children 5 years or younger	21,225	.4049941	.7105192	0	6
Children 17 years or younger	21,225	1.220966	1.535816	0	14
Economically active	21,218	.976765	.8537143	0	7

Household size	21,225	3.405936	2.322947	1	22
Social grant	21,225	1.178657	1.604251	0	14
Distance to transport means	7,102	.286539	1.20996	0	15
Disability	21,209	.1459286	.4358808	0	11
Cellular phones in the household	20,277	2.463678	1.608883	1	35

Source: Authors' computation

Table 5.1 depicts the summary statistics of the study. This included the summary of head of household age, household monthly salary, children five years and younger, children 17 years and younger, economically active households, household size, social grants, distance to means of transport, disability and number of cellular phones in the household. With reference to table 5.1, the head of household had a total of 21.225 observations with an average of 48.1315.

The standard deviation of the mean difference is 15.743 of the difference in the distance between the observations and the mean. A minimum data value of 12 of head of household age and a maximum value of 107 years are evident. The household monthly salary shows observations totalling 21.225 and an average salary of 6241.198. The standard deviation of the average difference is 14818.09 and the minimum household salary is valued at 0 with a maximum of 484700.

Children five years and younger together with children 17 years and younger had an equal number of observations of 21.225; their average differed with the former at .4049941 and the latter had an average of 1.220966. Both had a minimum of 0 and the maximum of children five years and younger was six and children 17 years and younger was 14.

The number of economically active individuals in a household reflected a minimum of 0 and a maximum of seven members in a household. Furthermore, the number of individuals in a household reflected a minimum of 1 and a maximum of 22 individuals. The average number of individuals' dependent on social grants were valued at 1.1788657 at a minimum of 0 and a maximum value of 14.

The distance to transport means averaged .976765 kilometres at a minimum of 0 and maximum of 7. Kilometres. Regarding the number of disabled individuals, the number of observations was 21.209 with an average value measured at .4358808; the standard deviation of the mean distance was valued at .4358808 with a minimum data value of 0 and maximum of 11. The

number of individuals owning cellular phones in the household was averaged at a data value of 2.463678 with a minimum data value of 1 and a maximum of 35 individuals.

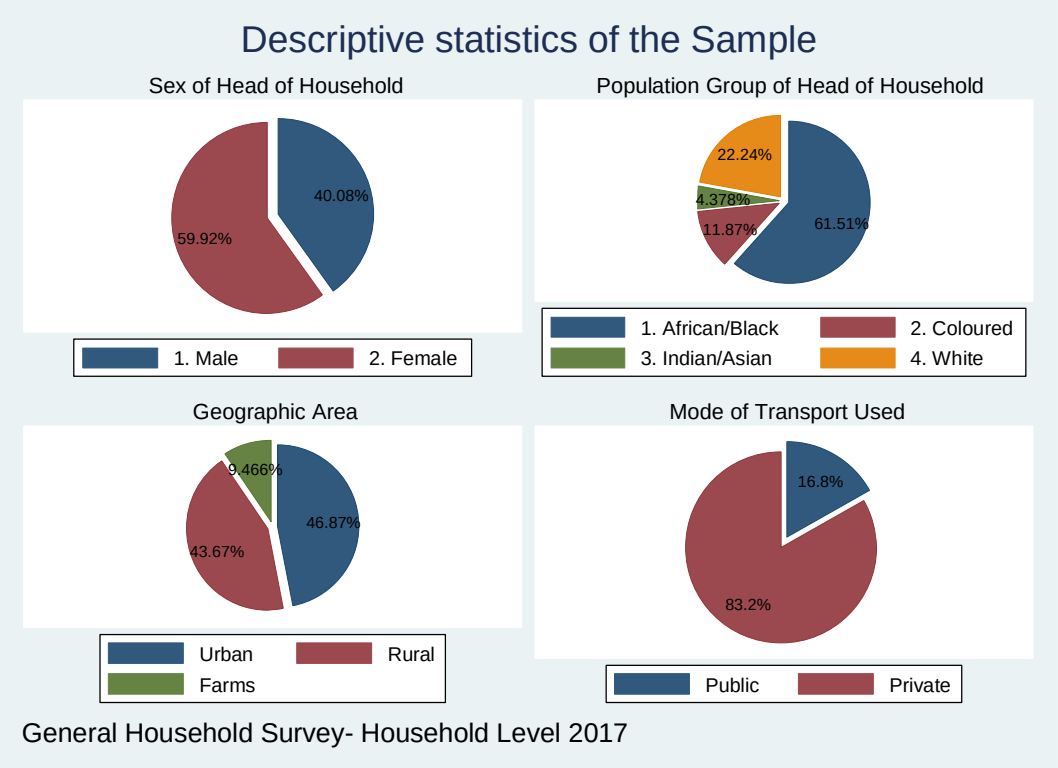


Figure 5.1: Descriptive statistics of the sample

Source: Authors' own illustration

5.2.2 Sex of household

According to the results of the pie chart (Figure 5.1), the percentage of males who took part in the sample was 40.06% and the percentage of females who took part was 59.92%. The most common reason that females are the gender that participates more than males is personal disinterest (Markanday, Brennan, Gould&Pasco, 2013). Some other reasons were the inability to cope with the questions asked in the survey, invasion of privacy as well as time constraints (Markanday et al., 2013).

Moreover, the decisions individuals take on whether to cooperate depends on numerous factors (Menold & Zuelli, 2010) including the social environment of those selected individuals in the survey, the structure of the households included in the survey and the traits of the survey

factors. Age is also an important aspect in participating in the surveys, which depends on the research being conducted by the survey holders.

5.2.3 Population group of head of household

According to the results of the frequency distribution, the survey revealed that 61.51% of household heads are African/Black, 22.24% are White, 11.87% are Coloured and 4.378% are Indian/Asian that took part in the survey. This is not always the case in other countries. Sheldon, Graham, Phothecary and Rasul (2007) conducted a research study on coming up with strategies that would increase the black ethnicity participation in general surveys in Europe as it was relatively low compared to other ethnic groups across the country.

5.2.4 Geographical area

Regarding the geographical area of the respondents, 46.87% of them were from urban areas, 46.67% were from the rural areas and the 9.46% were from farms. The latter group could possibly lack education and thus have difficulty in understanding the survey questions. These percentages are quite staggering because in many studies (Griffin, Khan&Ickowits, 2002) it is highly unlikely that rural respondents would be fewer than respondents from the cities (urban area). This could have been caused by numerous reasons (Ozay, Ayhan, Onsuz, Isikili&Metintas, 2015). For example, the respondents from rural areas may have participated to assist the interviewer and somehow believed that the research would be beneficial to their current living conditions.

5.2.5 Mode of transport used

The comparison of usage preferred by households revealed that 83.2% of the respondents used private cars as a mode of transport and 17. 8% of the respondents used public transport. This revealed that the respondents are less likely to use public transport relative to private car use. These percentages also reveal that an individual residing in a household that has a private car available for use is 83.2% less likely to use public transport in South Africa. The comfort of a vehicle is one of the reasons that households prefer private car use rather than public transport, with another factor for preference in car use being how flexible it is, moving from one destination to another (Chee & Fernandez, 2013).

A number of households choose to travel to work by private car because in most cases public transport use is inaccessible (Corpuz, 2007). In China, more than 80% of households use public

transport and less than 20% use private cars; this is because China has taken various transport policies to reduce car dependency (Li, Lo&Guo 2018).

5.3 Probit Regression Analysis

Table 5.2: Probit regression

Log Likelihood = -11 359, 72

Number of Observations = 11 359, 72
LR Chi2 (16) = 2174-00
Pro ≥ Chi2= 0, 0000
Pseudo R2= 0, 0873

Transport mode	Coefficient	Std. Err	z	$P \geq z$	95% Confidence Interval	
					Lower Bound	Upper Bound
Geographical type						
Rural	.414096	.0223303	18.54	0.000	.3703295	.4578625
Farms	.7666255	.0489265	15.67	0.000	.6707313	.8625197
Monthly household salary	-8.88e-06	1.17e-06	-7.60	0.000	-.0000112	-6.59e-06
Distance to transport means	-.0004165	.0000229	-18.19	0.000	-.0004613	-.0003716
Household size	-.0261226	98921	-2.64	0.008	-.0455107	-.0067345
Disability	-.002945	.0037598	-0.78	0.433	-.0103141	.0044241
Population head						
Coloured	- .470106	.0424545	-11.07	0.000	-.5533154	-.3868966
Indian/Asian	-.187766	.0789731	-2.38	0.017	-.3425505	-.0329815
White	-1.148934	.0697896	-16.46	0.000	-1.28572	-1.012149
Sex of household: Female	.1366109	.0203484	6.71	0.000	.0967288	.1764929
Age	.0015609	.0007392	2.11	0.035	.0001121	.0030097
Cellular phones in household	-.0011882	.0005507	-2.16	0.031	-.0022676	-.0001088
Children 5 years or younger	.0834049	.018898	4.41	0.000	.0463655	.1204443
Children 17 years or younger	-.0492136	.0167851	-2.93	0.003	-.0821118	-.0163155
Social grants	.0291576	.0123473	2.36	0.018	.0049574	.0533578
Economical active	.0312928	.0149367	2.10	0.036	.0020174	.0605682
_cons	-.4474525	.0389923	-11.48	0.000	-.5238761	-.3710289

Source: Author's illustration based on General Household Survey (2017)

The dependent variable is binary with 1 being for public transport use and 2 being private car use. The coefficients therefore provided statistics on the likelihood of an individual responding to public transport relative to private transport. The smaller the p-value the stronger the significance of the coefficient to the dependant variable; the larger the p-value the weaker the significance is. The regression analysis is explained below.

5.3.1 Meaning of Coefficients and the discussion of the Results

Geographical area: The coefficient signs for the variable rural is positive, which indicates that an increase in the number of people residing in rural areas increases the probability that these individuals will demand public transport.

There is a significant relationship between rural areas and public transport. Mobility is one of the greatest needs of any population across the world. One of the main indicators of public transport in rural areas is accessibility. It is evident that rural areas lack accessibility to public transport – as stated by Sipus and Abramovic (2017) who concluded that it is the lack of spatial coverage that has led to many rural areas having inadequate access to public transport. Moreover, railway transportation can only be available in areas where there are proper railway tracks which is usually only available in the urban areas (Sipus & Abramovic, 2017).

The main reason for rural poverty in South Africa is the lack of access to basic services; the burning issue is the lack of road networks leading to inadequate access to public transport services. An improvement in the accessibility of public transport in South African rural areas is vital for the improvement of the livelihoods of individuals as this will help in combating poverty and to increase economic growth (Chaitoo & Venkatesh, 2010).

One of South Africa's rural strategies is to develop levelled and sustainable rural transportation systems through improving access to transport through improved infrastructures centred in rural areas (Chakwizira & Mashiri 2015). The National Department of Transport (DoT) in South Africa together with Statistics South Africa conducted the National Household Travel Survey (NHTS) in 2003 with the aim of gaining insight into household travel patterns across the country. Initially, the NHTS only conducted their surveys in urban areas, but over the years surveys have included the rural areas and farms. The positive relationship between public transport and rural geographical areas has proven that rural areas demand public transport more than other geographical areas in South Africa and that is something that the transport authorities need to focus on.

As expected, the sign of the variable farms is positive, there is a positive relationship between farms and public transport with the p value 0.000 indicating a statistical significance. An increase in the number of households situated in the farming areas increases the probability of them using public transport.

Monthly household salary: According to the regression Table 5.2, the coefficient shows a negative relationship between monthly household salary and public transport. A unit increase in the monthly household salary is likely to cause a decrease in the demand for public transport. Furthermore, a change in income is likely to affect our travel demand behaviours. Holmgren (2013) argued that an increase in income could affect public transport demand in two ways – either positively or negatively. An increase in income may pose a negative impact on public transport demand because of individuals affording to purchase their own private cars.

With individuals owning cars will result in fewer trips or close to none by public transportation. Boansi and Adarkwa (2013) found that in developing countries, the impact household monthly income has on public transport demand depends on whether the individual is from a low/middle-income or high-income household. Individuals from a low-income household would increase the number of trips if the household income increases, whilst in higher income households an increase in income would lead to private car use. In this case, the monthly household salary denotes both low and high-income households.

In Bigerna and Polinori's (2011) study they argued that in developing countries, like South Africa, car ownership is income elastic to the extent that public transport services are considered an inferior good. A study in Netherlands by Klok (2010) was also of the view that public transport is indeed an inferior good as an increase in income often leads to a decrease in the demand for public transport. Income does not have any significant relationship with public transport demand.

Distance to transport means: As expected, the sign of the distance to the nearest transport is negative; a one-unit increase in the distance to means of transport (DTTA) will decrease public transport use by -.0004165.

These results indicated that there is a negative relationship between the distance to the nearest transport and public use. Distance to transport means is strongly related to accessibility of the "long distance between the stations" or having no access to public transport (Soltanzadeh & Masumi, 2014). Accessibility is one of the keys objectives of the National Department of Transport (DoT). Criden (2008) emphasise how accessibility and availability of public transport means is a burning issue, particularly in the low/middle-income households residing in peri-urban areas. Accessibility plays a vital role in individual choice to use public transport.

Further, it seems as though that accessibility has a huge impact on an individual's decision of whether to use public transport or not.

Papaioannou and Martinez (2015) supported the above assertion that generally households will demand public transport if there is reasonable accessibility, whereas no transport accessibility would pose a negative impact on transport use by preventing individuals from using public transport.

Longer distance was found to have a negative relationship with public transport (Heinen, Van Wee & Maat, 2010). In a study done by Han, Li, Wei and Tiantian (2018) in the developing country of in China, it was found that individuals prefer public transport use over private car. However, they are dissatisfied with the level of inconvenience of the public transits available. The inconvenience was reflected by the distance between households and the bus station, the distance between the destination and the bus station, as well as the departure frequency of the bus, which was also found to be a problem (Han et al., 2018).

Household size – A one-percentage point increase in the number of household members decreases public transport use by that particular household by -.0261226 percentage points. The coefficient HHSZ is negative and is statistically significant, indicating that an increase in the household size deteriorates the demand for public transport use. The sign was expected to be positive, and surprisingly proved to be negative. Household size generally has a significant impact on public transport use. The low price cost of using a private car is one of the reasons small size families would rather use a car than public transport (Soltanzadeh & Masumi, 2014).

Middle size and large families use a private car because it is considerably more safe and faster to reach a destination, and in some instances, there is little or no access to public transport (Soltanzadeh & Masumi, 2014). Seemingly, as the number of members in a household increase, this decreases the utility to walk but increases the use of cycling (Pucher & Buehler, 2008). Furthermore, more individuals in a household means more children which then explains the positive relationship it would have with private car use (Pucher & Buehler, 2008).

Disability – The sign of the DIS variable turned out to be negative by -.002945. A one-percentage point increase in the number of disabled individuals in a household decreases public transport use. The sign was expected to be negative. There is a negative relationship between

disability and public transport use. The p-value of 0.433 indicated a statistically non-significant relationship.

A study was conducted in Australia by the Rural Access Project (2009) investigating transport usage and travelling demands of people with a disability. The findings were in line with the availability and accessibility of public transport as well as the affordability. It was estimated that 20% of the Australian population is living with a disability. A dominant mode of transport used by the individuals living with a disability is private transport regardless of the purpose of the trip (Rural Access Project, 2009).

Individuals living with disabilities are dependent on private car use in order to access services. Parents of younger children living with disabilities fear the day they can no longer provide for the children. Moreover, having no support structure from families providing public transport, these individuals have no other alternative than depending on scarce public transport services (Rural Access Project, 2009). People living with disabilities face a challenge of social exclusion because of the inaccessibility of public transport services, making it difficult for these individuals to participate in education and employment opportunities. Bezyak, Sabella and Gattis (2017) found that individuals with disabilities face significant barriers when it comes to public transport use.

Regarding accessibility and physical barriers, public transport is not user friendly and attitudinal barriers of some individuals also mean that those living with disabilities do not use public transport (Bezyak et al., 2017). Public transport is vital for the economic as well as the social well-being of all individuals; however, in many developing countries public transport services do not serve the needs of individuals living with disabilities and hence the negative relationship (Mashiri, Marian, Bogopane-Zulu, Muande &Venter, 2008).

In South Africa, many disabled people from low and middle-income households do not have access to reliable public transport services in order to access opportunities (Rivasplata, 2006). Ricket (2011) in his study concluded that South Africa, together with other countries, should address the accessibility issue of people living with disabilities as it hinders access to opportunities.

Rivasplata and Le Roux (2018) conducted a study which focused on transport provision amongst the youth having disabilities. Some participants in this study did not face any

challenges regarding public transport accessibility. This was because the schools these students attended provided private car transport to accommodate the students with disabilities. However, the access to private car use posed an issue to students residing in disadvantaged geographical areas, in particular Blacks and Coloureds (Rivasplata & Le Roux, 2018).

Population race head – The results on the regression analysis were as follows: an increase in the percentage point of Coloureds by -.470106 will lead to a decrease in the demand for public transport in the household. The coefficient Asian/Indian in the regression analysis is negative by -.187766. A one-point increase in the number of Asian/Indians would lead to a decrease in public transport use. There is a negative relationship between Asians and public transport use. The expected prior was positive but surprisingly the results were negative.

The sign of the White variable turned out be negative by -1.148934. An increase in the White population race would decrease the demand for public transport use. The expected prior was negative. Ton, Duives, Cats, and Hoogendoom (2018) in their study on the determinants of mode choice in the Netherlands found similar results. There was no relationship between ethnic group and public transport use amongst the population of the country.

Population sex head – The variable female turned out to be positive by .1366109. A one-point increase in the number of females in a household would lead to an increase in public transport use. There is a positive relationship between females and public transport usage in South Africa. The p-value 0.000 indicates a statistical significance.

Matthies, Kuhn and Klockner (2002) looked into a model of travel mode in Germany. The results obtained confirmed that women have a greater willingness to decrease private car use and that women use public transport more frequently as a result of having weaker car habits- are not interested in driving a car. The theory of planned behaviour as well as the utility maximisation theory was utilised in this study. The authors measured willingness to reduce car use on three levels, namely intention, preference and actual behaviour (Matthies, Kuhn & Klockner, 2002).

Gender remains an important determinant of public transport use across different cities in France (Ng & Acker, 2018). The results suggested that females prefer using public transit services such as a train and bus to private car use in all the cities that were included in the study (Ng & Acker, 2018). It was also discovered that females are the gender that has complicated

travel patterns which leads to many hours spent on the road as a result of traffic congestion more than males and they tend to use taxis because of the convenience through flexibility. If given a chance, through better alternating public transport choices, women would be willing to give up private car use for good.

Age – As expected, the variable age turned out to be positive by .0015609; a one-percentage point increase in age increases public transport use. Results indicated that there is a positive relationship between age and public transport use in South Africa. In Penanang, Chee and Fernandez (2013) found age to be statistically significant and positively related to public transport use. Nuurden et al. (2007) reported that individuals who are more elderly are the ones likely to shift from private car use to public transport services only if the quality is high and the minimum age for driving has been raised. Yamamoto et al. (2003) also reported that the older population of 65 years and above prefer travelling by bus services in Japan.

In Penang, individuals who are 29 years of age and less prefer public transport because of its safety and security, mostly because it is considerably lower in price (Chee & Fernandez, 2013). There are more reasons why they would prefer to use public transport such as not owning a car, positive promotion of public transport culture, and personal interests.

Cellular phones in households – A one-percentage point increase in the number of individuals who own cellular phones in a household would lead to a decrease in public transport use by -.0011882. As expected, there is a negative relationship between cellular phones in households and public transport use.

Children five years or younger – As expected, the relationship is positive by .0834049. A one-point percentage increase in the number of children five years or younger will increase public transport use. There is a positive relationship between the variable and public transport use. Ton et al. (2018) found similar results. The study looked at children 12 and younger and there was a positive relationship, which could be caused by accessibility and affordability of public transport use (Ton et al., 2018). Previous research by (Heinenet al., 2010) found a negative relationship with reason being that children in the Netherlands start cycling at a very young age.

Children 17 years and younger – This variable turned out to be negative by -.0492136. A one-point percentage increase in the number of teenagers in a household will lead to a decrease in

public transport use. The expected prior sign was to be positive, but the results proved to be negative. Yamamoto et al. (2003) found that individuals aged 18 had a strong preference for private car use in Nagoya, Japan. This result was unexpected because children 17 years and younger rely on public transport for travel because of convenience. Nevertheless, an increase in the number of children in the household in some cases encourages private car use. Parents will be driving the children to school and picking them up afterwards. If the household size were minimal with one child, only then would public transport use be sufficient (Pucher & Buehler, 2008).

Social grants – As expected, the sign of social grants turned out to be positive by .0291576. A one-percentage increase in the number of individuals in household receiving social grants will increase public transport use. There is a positive relationship between social grants and public transport usage in South Africa. In South Africa, there are five social security grants: the State Old Pension, the Foster grant, disability grant, the child support grant and the care dependency grant (Samson Mcquene& Van Niekerk , 2006). For an individual to be eligible for a grant, depends on income. All these grants are financed through tax revenues collected yearly.

In South Africa, it has become evident that the lack of skills in individuals limits employment opportunities for the poor and in the labour force market and the poor are relying solely on social grants as their source of income (Lekezwa, 2011). Social grants yielded a positive result with transport use mainly because individuals from low-income quintiles reliant on social grants are mainly based in the peri-urban and rural areas and they need public transport to get to economic opportunities in the urban areas.

Economically active – The sign of economically active individuals turned out to be positive by .0312928. A one-point percentage increase in the number of economically active individuals in a household will increase public transport usage. As the independent variable increases so will the dependent variable.

5.4 Predictive Margins

Table 5.3: Predictive margins

Predictive margins Number of obs = 20,743
Model VCE : OIM
Expression : Pr (Transport mode), predict ()

	Margin	Delta method	z	$P \geq z$	95% Confidence Interval

		Std. E			Lower Bound	Upper Bound
GEO TYPE						
Urban	.2331257	.0037305	62.49	0.000	.225814	.2404375
Rural	.3668009	.0060409	60.72	0.000	.3549609	.3786409
Farms	.4947803	.0173813	28.47	0.000	.4607136	.5288471
HEAD OF POPULATION						
Black/African	.3115332	.0034332	90.74	0.000	.3048042	.3182621
Coloured	.1743679	.0100262	17.39	0.000	.154717	.1940189
Asian/Indian	.2516026	.0236173	10.65	0.000	.2053136	.2978196
White	.0569959	.0075068	7.59	0.000	.0422828	.071079
HEAD SEX						
Male	.268224	.004068	65.93	0.000	.2602508	.2761972
Female	.3109112	.31091102	66.02	0.000	.3016811	.3201412

Author's illustration based on the General Household Survey (2017)

Table 5.3 lists the predictable margins of the categorical variables that are in the model which include the geographical area, gender and the head sex. These are discussed below.

Geographical type – If all respondents of the sample would have answered that they all live on farms, then the average response to public transport use would have been 0.49%. If the respondents had answered that they reside in the rural areas, the average response would have been 0.36%. Lastly, if the respondents would have responded and said they reside in the urban areas, the average response to public transport use for households in urban areas would have been 0.23%.

This means that, with everything held constant, public transport demand on farms is higher than in urban areas and rural areas. Furthermore, it is evident that public transport demand in urban areas is low, compared to all other geographical areas stated above.

In a study by Pucher and Renne (2004) on urban-rural differences in mode choice in the United States, they concluded that private car use is a dominant mode of travel for both types of areas. Regardless of factors such as age, race and income of the households residing in urban and rural areas, every household tends to rely on private car use (Pucher & Renne, 2004). Almost 90% of all the rural households in the United States owns at least one car (Pucher & Renne, 2004).

Transport patterns in the developed and developing countries both in the rural and urban areas tend to differ. According to the South African Living Conditions Survey (2015), households in the rural formal areas have spent the highest proportion of income on transport services. The

distance between where they reside and where the shopping centres are, is further than it is for the urban areas (Living Conditions Survey,2015). Therefore, households situated in the rural areas have no alternative but to travel to the next town for accessibility to shopping centres to purchase goods and services. This results in the predictive margins on average for rural areas to be higher than for the urban areas.

Head sex – If all respondents had answered that they were females, the average response to public transport usage would have been 31%. If the respondents had answered that they were males, the average response to public transport use would have been 26%. In a study that was conducted by Yang, Li, Wang, Zhao and Chen (2013) on modelling gender-based differences in mode choice, the results indicated that males that have private cars in their households are highly likely not to use public transport services. However, in this study it was found that females do not adhere to this regardless of there being a car in the household. Females' choice of mode of transport to use is dependent on socio-demographical factors (Yang et al., 2013).

Females who are employed travel more by public transport; however, the males' travel choice is not related to whether they are employed or not employed (Yang et al., 2013). Household income has an indirect effect on the females' choice of travel rate, which indicates that females in the high-income bracket in China are less likely to use public transport, although the males' decision to not use public transit is not related to the household income (Yang et al., 2013). Moreover, with both genders, as they get older they tend to use more public transport relative to private car use.

Race – If all respondents were to answer that the household head is Black/African while other ethnic groups are kept at their means then the average response would have been .3115332. If all the respondents responded by the household head being a Coloured, then the average response from all households would have been .1743679 while holding the other variables as they are. The Asian probability of using public transport mode is .2516026 which is lower than the Black/African. Lastly, the probability of Whites using public transport is .0569959. It is quite evident by the results above that Black/African probability of using public transport is the highest, compared to all other ethnic groups, which could be the result of geographical areas and accessibility which have already been discussed above. However, surprisingly, Asians/Indians were more likely to use public transport as a mode of travel relative to the probability of coloureds.

All the p values on the marginal effects denoted significance

Table 5.4: Predictive margins on household income

Predictive margins Number of obs = 20,743
Model VCE: OIM
Expression: Pr (Transport mode), predict ()
at Q42Msal_hh = 6259.371 (mean)

	Margin	Delta method Std. E	*z*	$P \geq z$	95% Confidence Interval	
					Lower Bound	Upper Bound
_cons	.2829883	.003064	92.36	0.000	.276983	.2889937

Author's illustration based on the General Household Survey (2017)

Table 5.4 is the predictive margin on the dependent variable, household income. The results indicate that the predicted value of transport mode would be .2829. The probability of household monthly salary having an impact on public transport mode is predicted at an average 28%. According to the Statistics South Africa (2015) report on measuring household expenditures on public transport, the average per capita monthly household travel cost is higher in the households that are in the high-income quintile (R404) than it is in the low-income households (R136).

Although the figures may show a large difference, the lowest income quintile households were the ones that spent a large proportion of the monthly income on public transport use compared to the households from the high-income quintile (Statistics South Africa, 2015).

Over two thirds of households from the low-income quintile spent over 20% of their monthly salary on public transport and less than 3% of households in the high-income households spent 20% of their income on transport (Statistics South Africa, 2015). For households in the high-income quintile, public transport usage is a choice, hence the low percentage of households spending their monthly income on public transport. With low-income quintile households, public transit use is a necessity to enable individuals from different geographical areas to travel in order to access opportunities in the urban areas.

5.5 Diagnostic Tests/Measures of Fit

The Wald test is a test that looks at the significance of the independent variables in the probit model. There is a binary outcome variable in a probit regression together with a group of independent variables (Kyngas & Rissanen, 2001).

Table 5.4. show the results of the test statistic test. The first test included all explanatory variables that were tested (null hypothesis) in the model. All the coefficients were simultaneously equal to 0 which denotes the null hypotheses. The results showed the chi-squared value which is generated by the Wald test as well as the p-value that is associated with the chi-squared. Following this, were the results only showing a chi-squared value of 1703.33 with 16 degrees of freedom.

The general criterion that is used for the p- value is 0.05, and with the results obtained by the Wald test, it is possible to reject the null hypothesis. Furthermore, rejecting the null hypothesis means that all the parameters included in the model are not equal to zero. Including all variables in the model results in a statistically significant fit for the model; all these variables do have an effect on transport mode choice.

Following this, only one predictor variable was included which was Msal_hh (monthly household salary). The coefficient is simultaneously equal to zero. The results show the chi-squared value as well the p-value. The chi-squared value of monthly household salary is 57.78 with 1 degree of freedom. With the results generated by the Wald test, the null hypotheses are rejected; household monthly salary is effective in explaining transport mode choice.

Table 5.5: Measures of fit

Measures of fit for Probit of transport mode

Log likelihood Intercept Only : 12446.758		Log-Like Full Model	-11359.720
D (20723):	:22719.440	LR (16)	2174.075
McFadden's R2:	:0.087	Prob ≥ LR	0.000
Maximum Likelihood R2	: 0.100	McFadden's Adjusted R2	0.086
McKelvey and Zayoina;s R2 : 0.224		Cragg & Uhler's R2	0.142
Variance of y^*	:1.289	Efron's R2	0.092
Count R2	:0.714	Variance of Error	1.000
AIC	:1.097	Adj Count R2	0.006
BIC	:-183266.436	AIC * n	22759.440
		BIC *	-2015.036

Source: Author's illustration based on the General Household Survey (2017)

The goodness of fit may be judged by McFaddens R-squared or Pseudo R squared, both of which are important indicators of the goodness of fit for regression analysis. The Pseudo R

squared is applicable to both the binary and multinomial logistic models (Hemmert, Schons, Wieseke &Schimmlpfenning, 2018). Furthermore, the parameters in a probit model are estimated through maximum likelihood.

The Pseudo R squared compares the log likelihood of the model being estimated as well as the log likelihood of the null model (Hemmert et al., 2018). The null model includes only the intercept and no parameters; the log likelihood includes all explanatory variables in its model. Table 5.5 represents the measures of fit for the probit of transport mode. Results from the measures of fit indicate that the adjusted R squared value is 0.086 of the model that included all the variables as a good model fit, thus, rejecting the null model.

5.5 Summary of the Chapter

The focus of this chapter was to present the results of the overall research study. The analysis performed focused on public transport as mode choice preference in comparison to private car use in South Africa. The main objective was to gain insight in the effect of household income by estimating the overall determinants of public transport demand through mode choice preference between public transport and private car use. The factors that were included in the study were monthly household salary, household size, distance to transport means, age, disability, geographical area, economically active, gender, race, children five years and younger, children 17 years and younger and social grants. These factors aided in determining the likelihood of being a frequent user of these two transport modes.

In achieving this, the chapter started by examining the descriptive analysis through frequency tables and pie charts which amongst other variables included transport mode. Furthermore, the results indicated that households in South Africa use private car (83.2%) more than public transport (16.8%).

The Probit model was chosen for estimation purposes. The model was used to measure the effect the independent variables had on the dependent variable – transport mode. Furthermore, almost all the variables indicated a statistical significance. However, the results indicated that household monthly salary, distance to transport means, disability, and household size had an impact on choosing public transport as a mode. Additionally, the analysis revealed that public transport was more attractive to the Black/African ethnic group. Predictive margins were estimated amongst the categorical variables as well as the household monthly salary. Diagnostic tests were performed and they all showed that the model was a good fit.

The conclusions drawn from the results of the estimation have resulted in the recommendations and possible areas of research that were presented in the preceding chapter

CHAPTER 6

SUMMARY OF FINDINGS, POLICY IMPLICATIONS, RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

This chapter concludes the research study. This includes the findings and results relating to the objectives in Chapter 1. The chapter attempts to draw all the necessary conclusions from the results and to recommend future policy formulation.

6.2 Summary of Findings

The overall objective driving the research study was to examine the effect of household income on public transport demand in South Africa; the specific objective was to examine the overall nature of public transport through the analysis of the factors that affect public transport use in South Africa. To achieve this objective, a number of assessments were performed. Firstly, an overview of public transport in South Africa was done, which provided the basis for understanding of public transport policy in South Africa. Secondly, the study considered the theoretical literature from the perspective of the consumer demand theory, which focuses on consumer income and prices of commodities, the theory made two mixed assumptions. A change in the variable income could have either a positive or a negative effect on the purchasing of a commodity. In the study context, an increase in income might increase car ownership, decreasing public transport use depending on the level of income in that particular household. Moreover, for low income households, an increase in income might yield a positive outcome by an increase in the frequency of public transport use. Thirdly, in addition to the theories, a number of empirical studies were reviewed from South Africa, other developing economies and developed economies. A number of these studies used econometric models to test the determinants of public transport demand, particularly in developed countries were data was easily accessible. However, quite a number of studies used survey data to test for the results. Additionally, the majority of these studies identified income, geographical area, accessibility, fare prices, level of service and car vehicle ownership as the potential determinants of public transport demand. The determinants of public transport varied in the empirical literature, depending on the methodology, data availability and the country being analysed.

Based on the review of literature on the determinants of public transport demand and on the data availability, an empirical model linking public transport use with the determinants of public transport was specified. Transport mode choice was used as a proxy to examine public transport demand. The independent variables that were employed in the study were geographical area, monthly household salary, distance to transport means, household size, disability, population race head, sex of household head, age, cellular phones in household, children five years and younger, children 17 years and younger, social grants and lastly, economically active individuals in the household. Descriptive statistics were employed to analyse the statistical properties of the variables. To conduct the analysis, data from the 2017 Household survey was employed. The study employed the PROBIT model in estimating the determinants of public transport demand in South Africa.

Socio-demographical variables such as income, age, and gender play a significant role in determining mode choice. The findings of this study revealed that household monthly salary has a negative impact on public transport use. This means that an increase in household income will decrease the demand for public transit. Furthermore, if households would be able to afford private car ownership; public transport would be considered an option rather than a necessity. Females are less dependent on private car use relative to males. The elderly are more dependent on buses and trains for travelling. Individuals residing in rural and farm areas are more likely to use public transport; the issue is accessibility of public transport in those areas. Distance to transport means has a negative impact on public transport use; the further away the bus stop or train station from a household is, the less likely that individuals will use public transport. Disability has a negative impact on public transport use; individuals living with disabilities prefer using their own transport because of comfort and accessibility. Individuals receiving social grants have a positive relationship with public transport use. These individuals are mostly from the rural areas, are unemployed and because they are dependent on the monthly grant allowances, they cannot afford private car use and are spending a large sum of their social grants on public transport as a result of spatial issues in South Africa. Household size has a negative relationship with public transport use. As the number of individuals in the household increases, public transport is no longer an interest and the household would rather use private cars.

6.3 Implications and Recommendations

Despite the improvements and innovations of the transport sector in South Africa, the challenges regarding the development of accessible and sustainable public transport faced by the urban and rural sector remains an issue (Chakwizira & Mashiri, 2015).

- Inaccessibility of transport systems remains an issue in South Africa. Policy makers together with transport authorities should highlight the need to restructure public transport service routes – locate transport means closer to where households are situated in the peri-urban areas.
- It is essential to improve the quality of public transport through providing adequate facilities, timely services, and comfortable travelling. Policy makers need to relook their current policies. The individuals living with disabilities should be one of their priorities as public transport should accommodate individuals living with disabilities. This will encourage more individuals living with disabilities to use public transport.
- Rail transportation is an affordable mode of transport in South Africa. Government and the authorities that are involved in the infrastructure development should highlight the need to revamp existing rail tracks that are no longer in use, or rebuild them if need be, to accommodate low-income households in rural areas across South Africa. The Department of Transport is in the process of formulating a policy for rail transportation, this should be highlighted.
- City development strategies should prioritise public transport, more specifically introducing the mass rapid transport system across South Africa.
- Policy makers should make spatially focused initiatives a priority; this could be a great initiative for improving affordability of transport systems for low and middle-income households.

6.4 Possible Areas for Further Research

Most of the studies reviewed had examined the determinants of public transport at a country level, including this one, which concentrated at examining the determinants of public transport in South Africa. However, it must be noted that peri-urban and rural areas are where most low-income households are situated and these locations are indirectly overlooked. It is therefore suggested that the significance of this research study could be improved through future research

focusing specifically on households in the peri-urban and rural areas. These determinants of public transport need to be understood for economic development of South Africa.

6.5 Delimitations of the Study

The unavailability of data, more particularly in developing countries like South Africa is one of the limitations which has affected the research. In many instances, some of the variables had to be omitted because of data unavailability. The study focus was South Africa, it would have been more informative if the focus was in a particular area within South Africa consisting of pre- and post-observation of public transport use. However, the issues that were faced in this research study did not in any way significantly affect the findings that have been presented.

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APPENDICES

Appendix 1 Regression Analysis

```
                                                LR chi2(16)       =    2174.08
                                                Prob > chi2       =     0.0000
Log likelihood =  -11359.72                     Pseudo R2         =     0.0873

------------------------------------------------------------------------------
  Transport_mode |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
        Geo_type |
           Rural |    .414096   .0223303    18.54   0.000     .3703295    .4578625
           Farms |   .7666255   .0489265    15.67   0.000     .6707313    .8625197
                 |
      Q42Msal_hh |  -8.88e-06   1.17e-06    -7.60   0.000    -.0000112   -6.59e-06
         Q68Dtta |  -.0004165   .0000229   -18.19   0.000    -.0004613   -.0003716
         hholdsz |  -.0261226   .0098921    -2.64   0.008    -.0455107   -.0067345
       undisab_hh |   -.002945   .0037598    -0.78   0.433    -.0103141    .0044241
                 |
     head_popgrp |
    2. Coloured  |   -.470106   .0424545   -11.07   0.000    -.5533154   -.3868966
3. Indian/Asian  |   -.187766   .0789731    -2.38   0.017    -.3425505   -.0329815
       4. White  |  -1.148934   .0697896   -16.46   0.000    -1.28572   -1.012149
                 |
        head_sex |
      2. Female  |   .1366109   .0203484     6.71   0.000     .0967288    .1764929
        head_age |   .0015609   .0007392     2.11   0.035     .0001121    .0030097
        Q63NrCell |  -.0011882   .0005507    -2.16   0.031    -.0022676   -.0001088
      chld5yr_hh |   .0834049    .018898     4.41   0.000     .0463655    .1204443
     chld17yr_hh |  -.0492136   .0167851    -2.93   0.003    -.0821118   -.0163155
    soc_grant_hh |   .0291576   .0123473     2.36   0.018     .0049574    .0533578
    econact_hh_r |   .0312928   .0149367     2.10   0.036     .0020174    .0605682
           _cons |  -.4474525   .0389923   -11.48   0.000    -.5238761   -.3710289
------------------------------------------------------------------------------
```

Appendix 2 Predictive Margins

```
Predictive margins                              Number of obs     =     20,743
Model VCE    : OIM

Expression   : Pr(Transport_mode), predict()
```

	Margin	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
Geo_type						
Urban	.2331257	.0037305	62.49	0.000	.225814	.2404375
Rural	.3668009	.0060409	60.72	0.000	.3549609	.3786409
Farms	.4947803	.0173813	28.47	0.000	.4607136	.5288471
head_popgrp						
1. African/Black	.3115332	.0034332	90.74	0.000	.3048042	.3182621
2. Coloured	.1743679	.0100262	17.39	0.000	.154717	.1940189
3. Indian/Asian	.2516026	.0236173	10.65	0.000	.2053136	.2978916
4. White	.0569959	.0075068	7.59	0.000	.0422828	.071709
head_sex						
1. Male	.268224	.004068	65.93	0.000	.2602508	.2761972
2. Female	.3109112	.0047093	66.02	0.000	.3016811	.3201412

```
Predictive margins                              Number of obs     =     20,743
Model VCE    : OIM

Expression   : Pr(Transport_mode), predict()
at           : Q42Msal_hh      =    6259.371  (mean)
```

	Margin	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
_cons	.2829883	.003064	92.36	0.000	.276983	.2889937

Appendix 3 Ethical Clearance Certificate

University of Fort Hare
Together in Excellence
Govan Mbeki Research & Development Centre
P/Bag X9083, East London, 5201. E-mail: mslmalele@ufh.ac.za Tel & Fax: 043 704 7022

06 June 2019
Moss Vuyokazi
Department of Economics
University of Fort Hare
East London campus
South Africa

Dear Moss Vuyokazi

This is to acknowledge receipt of your application for Ethical Clearance for your research project titled: ***The Determinants of Public Transport Demand in South Africa***

On behalf of the University Research Ethics Committee (UREC) we have checked your proposal and would like to let you know that there is no need to issue an ethical clearance certificate. Even though in research where secondary data is being reviewed that does not involve collecting data from humans and animals directly, researchers are strongly urged to observe good ethical conduct when using information by others (acknowledge sources and avoid plagiarism).

Yours sincerely

Professor Munacinga Simatele
Deputy Dean of Research & Internationalisation Faculty of Management and Commerce

Appendix 4 Certificate of Language

PROOF OF EDITING CERTIFICATE

TO WHOM IT MAY CONCERN

Language editing

I, Jeanne Enslin, acknowledge that I did the language editing of **Vuyokazi Moss's** dissertation submitted in fulfilment of the requirements for the degree Master of Commerce (Transport Economics) at the University of Fort Hare.

The title of the dissertation is:

THE DETERMINANTS OF PUBLIC TRANSPORT DEMAND IN SOUTH AFRICA

The quality of the final document, in terms of language, formatting and references, remains the student's responsibility.

Detailed feedback of all the editing work has been provided to Vuyokazi in writing and is evident in the version of the dissertation in revision marking (with many comments).

Jeanne Enslin
Language editor
082-6961224.